VSB – TECHNICAL UNIVERSITY OF OSTRAVA

FACULTY OF MECHANICAL ENGINEERING

International Conference

From Smart City to Smart Factory for Sustainable Future: conceptual framework, scenarios, and multidiscipline perspectives

CONFERENCE PROCEEDINGS

10-12 May 2023

Ostrava

Czech Republic

ISBN 978-80-248-4682-8 (on-line)

DOI 10.31490/9788024846828

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Team of Authors

Ostrava 2023

VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF MECHANICAL ENGINEERING | DEPARTMENT OF MACHINING, ASSEMBLY AND ENGINEERING METROLOGY

VSB - Technical University of Ostrava
Faculty of Mechanical Engineering
Department of Machining, Assembly and Engineering Metrology
17. listopadu 2172/15, 708 00 Ostrava Poruba
Czech Republic

Editors: Aneta Slaninková, Phu Ma Quoc
Ostrava, 2023, 1st Edition

ISBN 978-80-248-4682-8 (On-line)
DOI 10.31490/9788024846828

Funding

This conference was organized in association with the project Innovative and additive manufacturing technology-new technological solutions for 3D printing of metals and composite materials, reg. No. CZ.02.1.01/0.0/0.0/17_049/0008407 financed by Structural Funds of the European Union and project.

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CONTENT

Introduction

The international conference SCFF23 is organized for researchers, experts, and students to share their vision about the future under the concept of "From Smart City to Smart Factory for Sustainable Future" from multidiscipline perspectives.

The aim of the conference is to provide an opportunity for participants with different expertise to meet up and share their knowledge, disruptive ideas, solutions to existing problems that hinder us from moving forward to more modern and sustainable life using technologies. The conference facilitates mutual exchanges of experiences and establishment of long-lasting international cooperations. The scope of the conference includes discussions about Innovative and Sustainable technologies, solutions, and frameworks for applications of state-of-the-art technologies to Smart City and Smart Factory.

The conference will be held on the occasion of the final conference of the project Innovative and Additive Manufacturing Technologies - New Technological Solutions for 3D Printing of Metals and Composite Materials, reg. no. CZ.02.1.01/0.0/0.0/17_049/0008407.

Scope

The scope of the conference includes but is not limited to the below topics which contribute to the use of technologies in Smart City and Smart Factory for Sustainable Future. The objective is to promote innovative research and works in the field of applied sciences, technologies, engineering, and management. Participants can submit to the following tracks:

Track 1
Smart Factory; Smart Manufacturing; Additive Manufacturing; Smart Materials; Smart Robotics; Autonomous Driving; Digital Twin.

Track 2
Smart Electronics; Internet of Things; Electronics and Telecommunication; Wireless Communication.

Track 3
Artificial Intelligence; Machine Learning; Cloud Computing; Cyber Security; Network Analysis; Big Data; Blockchain; Data Visualization; Metaverse; XR; AR; VR.

Track 4
Sustainability; Smart City; Smart Village; Smart Education; Environmental Technology; Digital Transformation; Healthcare; Biotechnology.

Track 5
Smart Economy; Smart Business; Industrial Management; Business Administration; Ecommerce; Business Intelligence; Economics; Economic Development; Political Economy; Management; Logistics.

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Keynote speakers

Dr. Kang Seung Won

Becamex Business School, Vietnam

Measuring Contributions of Technological Change in GVCs on the Economic Growth of EMEs

Dr. Kang Seung Won is an economist with expertise in International Economics and E-Commerce. He received his PhD in Economics from Texas A&M University, USA in 1994 and worked in the Department of International Commerce at Woosong University, Korea before joining Eastern International University, Vietnam in 2010, where he currently serves as the Dean of Business School. The presentation at this upcoming conference will explore the impact of technological change on economic growth resulting from the participation of emerging countries in the global value chains (GVCs).

Dr. Tan-Nhu Nguyen

Eastern International University, Vietnam

A Digital Twin of Human Head for Smart Healthcare in Clinical Decision-Support System for Facial Mimic Rehabilitation

Tan-Nhu Nguyen is a lecturer at Eastern International University. He got his Ph.D. degree at the University of Technology of Compiegne, France, in Biomechanics and Bioengineering and achieved the best thesis award issued by l'Agglomération de la Région de Compiègne, France. His work was also funded as a start-up project by SATT LUTECH company, France. He will present how a digital twin of human faces/heads could help solve facial palsy complex treatment problems. The model could provide personalized mimics with internal structures: skull and muscle network. Moreover, the model could also be employed to play serious games for remotivating patients in their facial mimic exercises. This work, for the first time, could provide real-time full-head animation, skull prediction from head shape, and motivational serious games for facial mimics.

Dr. Van Dung Nguyen
Ton Duc Thang University, Vietnam

Internet of Things in Agriculture

Van Dung Nguyen received the B.Eng. and M.Eng. degrees in telecommunications engineering from the Ho Chi Minh City University of Technology, Vietnam, in 2008 and 2012, respectively. He had a Ph.D. degree in computer science and engineering from Kyung Hee University in 2018. He was a Post-Doctoral Researcher with the ICNS Laboratory, Kyung Hee University from 2018 to 2021. From 2009 to 2010, he was a Developer with TOSADENSHI, Vietnam. Now, he joins Ton Duc Thang University, Vietnam, where he is a Lecturer of electronics and telecommunications. From 2013 to 2018, he received a scholarship for his graduate study from Kyung Hee University. His research interests include designing the MAC protocols in vehicular ad hoc networks and wireless sensor networks, cloud computing, mobile edge computing, Internet of Things, AI, Mobile Edge Orchestrator.

Dr. Tomasz Kozior
Kielce University of Technology, Poland

10 years of 3D Printing at Kielce University of Technology - Development and Prospects for Further Work

Tomasz Kozior is a scientist and a teacher employed at the Faculty of Mechatronics and Mechanical Engineering of the Kielce University of Technology, Poland. Since 2012, he has been researching the mechanical, dimensional and shape metrological and tribological properties of materials used in 3D/4D printing. He will present the results of his research on innovative applications of 3D printing based on plastics and metal powders.

Prof. Sergej Hloch
VSB-Technical University of Ostrava, Czech Republic

Ultrasonic Pulsating Water Jet: Innovative Technology for Surface Treatment, Medical Applications, and Cultural Heritage Preservation

Sergej Hloch, will present using an innovative technology - ultrasonic pulsating water jet working on the physical background of the periodically repeating impact pressure in the form of water droplets. Clarifies the importance of droplets impingement with different types of materials, including materials produced by 3D printing for various practical applications, including possibly reducing the CO2 footprint. He introduces other possibilities of this technology with an interdisciplinary overlap for various scientific fields, such as surface treatment, research and development of mini-invasive athermic technique for medical purposes, using the technology for the protection of the cultural heritage of sandstone reliefs.

SHORT PAPERS

10 years of 3D Printing at Kielce University of Technology

Kozior T[1,*]

[1] Department of Metrology and Unconventional Manufacturing Methods, Faculty of Mechatronics and Mechanical Engineering, Aleja Tysiąclecia Państwa Polskiego 7, 25-314 Kielce, Poland.

[*] Corresponding author: tkozior@tu.kielce.pl

Abstract: The article presents a review of the literature on modern unconventional manufacturing technologies - 3D printing. The content contains information on the results of currently conducted research in the field of mechanical properties measurements, dimensional and shape accuracy and tribological wear of the manufactured models at Kielce University of Technology. Attention was focused mainly on materials based on plastics, however, a description of materials based on metal powders was also included. The results of research and directions of further scientific work were presented.

Keywords: 3D Printing, FDM, SLS, PJM, L-PBF

Introduction

Modern unconventional manufacturing technologies, which include 3D printing, are increasingly used in new industries such as casting, machining, injection molding, medical, dental, automotive, aviation, etc. Currently, materials based on plastics, metal powders and ceramics are used to build models. The development of materials chemistry means that more and more often 3D printing technologies allow the construction of models from materials such as composites or biocompatible materials. Currently, 3D printing allows for the production of models with a high degree of complexity and geometric features that are impossible to produce using other conventional methods. This situation makes 3D printing widely used for prototype production, in short production series, or when combined with *Reverse Engineering*, it allows for the production or reconstruction of damaged (damaged) models. In addition, thanks to the increasing range of materials, 3D printing is used to build composite models in combination with technologies such as electrospinning, which allows you to increase the potential use of 3D printing, for example in the medical and filtration industries. A big challenge in terms of the precise production of models using 3D printing technology is the production of thin-walled models for applications such as automation and robotics, the medical or defense industries. In this case, it is extremely important to properly select the technological parameters of the manufacturing process and develop an appropriate manufacturing strategy. The dynamic development of 3D/4D printing technology, chemistry of materials and requirements for the quality of manufactured models makes additive technologies the subject of numerous studies and interest of the broadly understood industry. Therefore, a laboratory of unconventional manufacturing technologies has been operating at the Kielce University of Technology, Poland since 2012, which is equipped with four 3D printing systems: selective laser sintering - SLS, photo-forming of liquid polymer resins - PJM, bonding of ceramic powder 3DP (CJP) and fused deposition modeling - FDM/FFF and cooperation with companies that perform 3D printing from metal powders L-PBF.

Materials and Methods

3D printing technologies can be divided due to many criteria, where one of them is the type of model material, which can be a solid, liquid or powder. Technologies based on 3D printing from powders mainly concern laser methods such as: L-PBF (laser powder bed fusion), SLM (selective laser melting), SLS (selective laser sintering). In the case of liquids, we are mainly talking about technologies based on photo-curing of liquid polymer resins [Pagac 2021]: PJ (Polyjet), PJM (Polyjet Matrix), SLA (stereolithography). In the case of solids, the most popular method is the FDM/FFF (Fused Deposition Modeling/Fused Filament Fabrication).

Results and Discussion

The development of 3D printing technology and the materials used creates new challenges in terms of research. Therefore, selected aspects of the key research undertaken by the author at Kielce University of Technology are presented below:

- production of thin-walled models

- manufacturing of composite models using 3D printing and electrospinning technology

- control of the technological proces, taking into account the process parameters and their impact on the quality of the technological surface layer.

It seems that in the case of thin-walled models, the limited thickness of the built layer and the problem of adhesion between the layers are a major challenge, which, taking into account the influence of the printing direction, is a big challenge. The conducted research has shown that thin-walled models with a wall thickness of less than 2 mm show a much greater anisotropy of mechanical properties depending on the direction of model production, and in some cases the models are so weak that it is impossible to carry out the testing process.

In the case of combining the electrospinning technology [Blachowicz 2020] and 3D printing, many new construction possibilities arise for many industrial areas, such as medicine, food industry or filtration. We can notice that here too the technological process of manufacturing plays an important role and the type of material used in 3D printing affects not only the adhesion between the layers of the composite, but also the orientation of the nanofibers (Fig. 1), which effect the possibility of, for example, filtration. In addition, the type of material used also affects the result of the contact angle test and determines the hydrophobic and hydrophilic properties. Such a situation means that research conducted in the field of such composite models produced by combining two technologies must include advanced tests and take into account a large number of technological parameters of production.

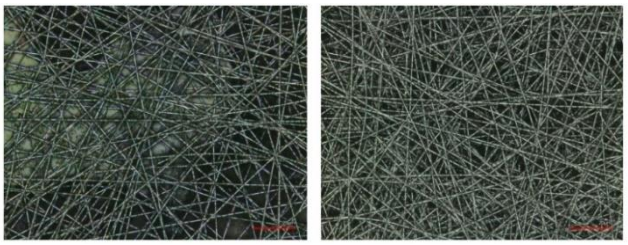

Fig. 1: Electrospinning on 3D printed PJM samples.

Research in the field of the technological surface layer [Brown 2018] conducted at the Kielce University of Technology, in turn, focuses on optical and contact measurements of models produced with 3D printing technologies. Great attention during the research is devoted to measurement problems such as a large number of unmeasured points for optical measurements or the problem of testing soft materials by means of contact tests. In addition, metrological research is based on modern measurement methods, such as the wavelet transform, and the scope of the work carried out applies to both 2D and 3D profiles, including the assessment of roughness, waviness and primary profile parameters, where great attention is paid to materials for medical applications.

Conclusions

Summing up, the scope of work carried out at the Kielce University of Technology in the field of research on models produced by 3D printing covers many innovative scientific areas with high potential use in industrial practice. The results of the conducted research work indicate many new metrological problems and the need to adapt the appropriate measurement procedures or create new, for example, research standards and increase the standardization process. Important research from the point of view of practical use includes, above all, the analysis of technological limitations that have been set for the 3D printing technologies available at the Kielce University of Technology.

Conflict of Interest: The authors declare no conflict of interest.

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Thermo-mechanical properties of ABS matrix composite filament reinforced with multi-layer graphite oxide composite fibers for FDM 3D printing

Thanh-Dung DO[1], Minh-Tung LE[1], Huy-Hieu-Nghia NGUYEN[1], Anh-Quang LE[2], Thai-Hung LE[1,*]

[1] School of Materials Sciene & Engineering, Hanoi University of Science & Technology, Hanoi, Vietnam.

[2] Institute of Technology, Hanoi, Vietnam.

[*] Corresponding author: hung.lethai@hust.edu.vn

Abstract: The properties of plastic filaments have an essential role in the printability and properties of printed products made by 3D printing FDM. Therefore, ABS plastic filament-reinforced graphite oxides were fabricated to investigate the properties change for the purpose of improving the properties of products printed from ABS plastic. ABS plastic filament reinforced multi-layer graphite oxide with 1 %, 3 % and 5 % content, respectively, was fabricated and tested for mechanical properties, printability and printing temperature, which showed some changes in properties compared to original ABS plastic filaments.

Keywords: 3D printing, FDM, ABS, Multi-layer graphite oxide

Introduction

Fused Deposition Modeling (FDM) is a gradual additive manufacturing process that belongs to the material extrusion process. This method mainly applies to printing polymer materials such as ABS, PLA... When the nozzle has reached the print temperature, the molten plastic filament is fed to the nozzle to melt material. The melting materials is extruded into thin filaments and deposited layer by layer at predetermined positions to shape the product. The strength of printed products often depends on the infill density and printing pattern [Do 2022]. However, the strength and properties of the printed product also depend on the properties of the original printed filament, and this is an attractive subject research to improve the properties of the printed product. To enhance the properties of ABS printed plastic filament, [Le 2021] have tried to mix with Multi-Walled Carbon Nanotubes show that melt flow index decrease and the tensile strength of the samples improved along with the addition of MWCNTs as filler (0.5 wt% to 2.0 wt%). Adding Graphene oxides to the polymer matrix enhance thermal, electrical conductivity and even antibacterial properties [Nandhini 2016]. With the goal of improving the printability and properties of 3D printed products from ABS plastic by improving the properties of the printed filament, the research focuses on creating ABS plastic filaments reinforced multi-layer graphite oxide (MLGO) and evaluated the printability, print temperature and strength with the reinforcement ratio of 1 %, 3 % and 5 %, respectively.

Materials and Methods

The ABS plastic used in the study is a common ABS plastic in the form of granules with a density of 1.05g/cm^3, Melt Flow Index (MFI) = 6.5 g/10 minutes. Multi-layer graphite oxide (MLGO) was fabricated by the thermal shock method from the research group of ITIMS Institute - Hanoi University of Science and Technology (Fig. 1).

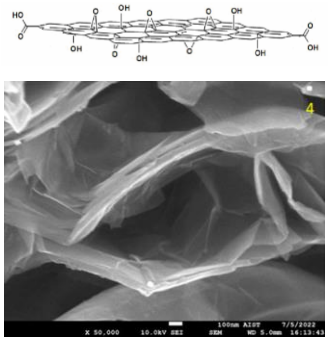

Fig.1: Multi-layer graphite oxide.

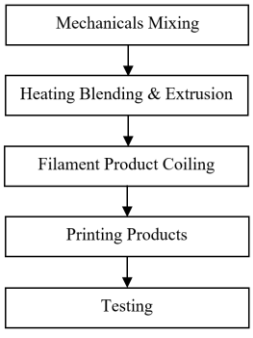

Fig. 2: Filament fabrication and testing process.

Fig. 3: Single filament extruder, Filament coil and Printed samples

The ABS-MLGO filament fabrication process and testing are shown in fig. 2. The extrusion temperature during the process is 200 °C and the extruded filament will be cut into small pieces then put again into extruder to create filament having 1.75 mm diameter. The above procedure was repeated 3 times to uniformly disperse the MLGO in final filament at 1 %, 3 % and 5 %, respectively. The ABS-MLGO product is used for printing on the ANYCUBIC Model S 3D Printer printer. The fabricated filament is printed into a tensile specimen according to ASTM D638 with a length of 115 mm, a width of 6 mm, a thickness of 4 mm (fig 3). The tensile test was performed on the MTS Exceed Model E45 mechanical testing machine with the maximum load of 50 KN.

The Differential scanning calorimetry (DSC) experiment test was conducted on DSC-1150B machine with measuring range from 25 ÷ 300 ℃, heating speed 10 ℃/min.

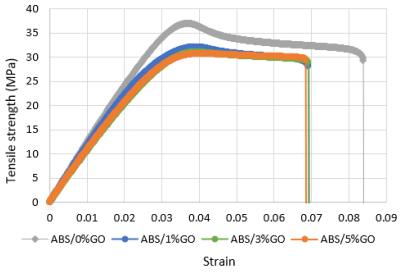

Fig. 4: Stress and strain curve of ABS reinforced multi-layer graphite oxide composite

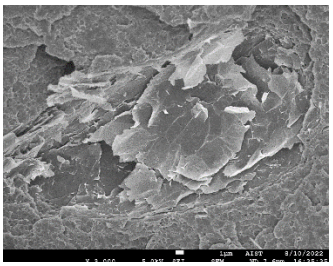

Fig. 5: Fracture face of tensile specimen with the broken of graphite oxide

Results and Discussions

The distribution capacity of MLGO in ABS polymer matrix is less than 7 % because the extrusion of ABS-MLGO composite fiber becomes difficult, the plastic clogging occurs frequently, the extrusion rate is very slow, and it is difficult to control the density and uniformity of filament.

The sample printing process is continuously and fluently when using ABS-MLGO printing filament on the ANYCUBIC printer Model S 3D printer with a nozzle having 0.4 mm diameter.

Tensile test results exhibit that the effect of MLGO content on composite strength is reduced compared to the original ABS plastic, besides that the elastic modulus also tends to decrease slightly when increasing the content of reinforcement as shown in Fig.4. At the fracture surface of the tensile specimen (Fig. 5), it was found that the multi-layer graphite oxide was locally dispersed in the polymer and delaminated, which was the cause of the decrease in the strength of the composite.

DSC test results show that the transition point of vitrification temperature is in the range of 90 - 110 ℃, the melting point is in the range of 220 - 250 ℃. The melting point tends to decrease slightly when the amount of Graphite oxide in ABS plastic increase. The reason of the decrease in the melting temperature is that the MLGO in the matrix increases the heat transfer in the polymer composite filament, which leads to the polymer composite fiber being more easily melted. This is an advantage for FDM 3D printing because it leads to the temperature reduction of the print nozzle and the print bed of the 3D printer.

Conclusions

ABS-MLGO filament has been successfully fabricated up to 5% MLGO content. The filament product can print well on 3D printers with a small print nozzle of 0.4 mm. Printed ABS-MLGO filament has a lower melting point than original ABS filament, so it can reduce print nozzle and print bed temperatures, leading to print easier.

The MLGO reinforcement is not only unimproved the mechanical properties but also reduces the strength of the printed product compared to original ABS.

Conflict of Interest: The authors declare no conflict of interest.

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Generative Design and 3D Printing in everyday life

Amruth M.[1], Vijay S.J.[1,*], Mesicek J.[2], Hajnys J.[2], Ma Q.-P.[2], Pagac M.[2]

[1] Mechanical Department 1, Karunya Institute of Technology and Sciences 1, Coimbatore, India 1.

[2] Department of Machining, Assembly and Engineering Metrology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 70833 Ostrava, Czech Republic.

[*] Corresponding author: amruthsamuel@karunya.edu.in

Abstract: 3D printing technology is a fast-emerging concept in modern industrialization. In such a process, a various type of materials can be added layer-by-layer together to form a solid 3D object directly from a CAD design. 3D printing helps to fabricate details that cannot be obtained with the traditional manufacturing methods. In view of this, generative design is a good companion with 3D printing. The designing method itself is exploratory, in which the designers specify goals and design boundary conditions for the components. The software then traces within the given dimensions to form a geometry that satisfies the given constraints. The results of generative designs are often freeform that can be effectively produced with 3D printing technology. This paper showcases how generative design can be combined with 3D printing to fabricate an everyday life object that is highly feasible for every household.

Keywords: 3D Printing, Additive Manufacturing, Fused Deposition Modelling, Computer Aided Design, Generative Design

Introduction

In recent years, 3D printing technology has made a dramatic impact on the way we create and manufacture complex products with high precision and accuracy. It has become popular in a wide range of everyday applications, including rapid prototyping, custom manufacturing, home printing, custom-made parts for vehicles and machines, and even food [Jandyal 2022]. Generative design is a computer-aided design process that uses algorithms to generate a range of design options based on user-defined parameters. This technology allows designers to explore a vast range of possibilities quickly and efficiently, enabling them to create products that are lighter, and stronger than ever before. The user can then review and evaluate the various designs to determine which option best meets their needs then refine it. To demonstrate how this technology can be used in everyday life, we will design and manufacture an aesthetic monitor stand using the above-mentioned techniques.

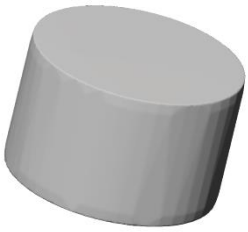
Materials and Methods

The Design Methodology employed in this project is generative design by Autodesk. The design software being used is Autodesk Fusion 360. We first preserve a geometry as a working space for the algorithm. Then, we define the obstacle geometry that cannot be altered and the starting shape for the component. Subsequently, design conditions such as structural load and constraints were established in order to ensure the desired results. Thereafter, design objectives and manufacturing techniques were defined; the objectives chosen were to minimize mass and a safety factor of two, and the manufacturing technique was additive with orientation of Z+. Finally, materials were chosen; as PLA/PTEG or other FDM materials were not featured in the software library, PA-12 was selected due to its similar properties and its ability to meet the structural requirements. For printing the model keeping the dimensions of the model ULTIMAKER S5 was chosen with filament Polymaker Polysmooth, which can be treated with alcohol to get better glossy surface finish.

Results and Discussion

Generative Design is an iterative process and so are the outcomes, which are given below in Fig.1, Fig.2, and Fig.3.

After the final iteration was selected it was imported into the design workspace to make a few cuts for the standoffs and a few fillets. Once the design was ready, the STL file was imported into the slicer Ultimaker Cura. The slicer settings were, Infill 25% Support type – Tree, Build Plate Adhesion – Brim, the time for print was 28 hours and material required was 454 grams, the model orientation and sliced model are shown in Fig. 4. Post printing the model was treated with Isopropyl Alcohol in order to achieve a good glossy finish shown in Fig. 5.



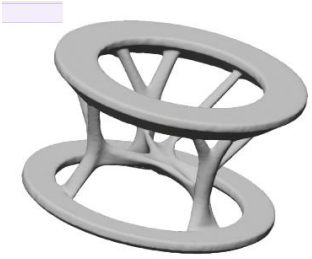


Fig. 1: Iteration 1 (Mass-7.779 Kg) Fig. 2: Iteration 20 (Mass- 2.858 Kg) Fig. 3: Iteration 42(Mass- 0.943 Kg)

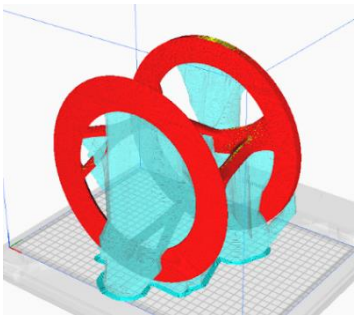
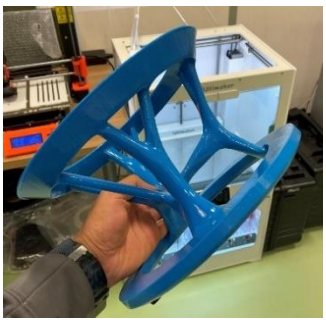



Fig. 4: Sliced Model Fig. 5: Final Printed Part

Conclusions

Thus, this proves that 3D Printing is not only for R&D, prototyping or for industries but can have a vast amount of application in our everyday life, saving time and resources significantly. Particularly for this study, the result is not only functional but also aesthetically pleasing.

Acknowledgements: The research was funded in association with project Innovative and additive manufacturing technology—new technological solutions for 3D printing of metals and composite materials, reg. no. CZ.02.1.01/0.0/0.0/17_049/0008407 financed by Structural Funds of the European Union and project.

Conflict of Interest: The authors declare no conflict of interest.

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Fundamental research of PLA/Fe composite's properties for 3D/4D printing machines

Buu Phat Nguyen[1], Quoc Huy Ho[1,*], Quang Thang Ngo[2], Jakub Mesicek[3]

[1] Faculty of Applied Science, Ton Duc Thang University, Viet Nam.

[2] Faculty of Electrical & Electronics Engineering, Ton Duc Thang University, Viet Nam.

[3] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering,VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic.

[*] Corresponding author: 61900185@student.tdtu.edu.vn

Abstract: While 3D-printed materials and products have not been exploited to their full potential, a new concept has appeared in the dictionary of manufacturing technology - 4D printing. 4D printing is the "evolved version" of 3D printing, with the fourth dimension being time and the ability to "transform and restore". In this study, we create 3D-printed products from polylactic acid (PLA) and 4D-printed products from "smart materials" made from iron magnetic PLA. Mechanical properties of 4D printed products such as tensile and flexural strength will be tested and compared with simulation. The survey results show that the 4D printed products made from PLA/Fe filaments have lower mechanical properties than the prototype PLA but are able to respond well to magnetic fields.

Keywords: 4D Printing, Smart Materials, Polylactice acid, Machine Learning.

Introduction

3D printing is a progressive technology that has been around for a long time since the beginning of the advanced plastics industry. The application of 3D technology is widely regarded as the key to the future of any modeling business, manufacturing industry, or the economy of any developing country. By definition, the purpose of 3D printing is to create an actual three-dimensional object from a sketch on a computer program (e.g. CAD/CAM).

The supply of raw materials will be maximized and processed more economically using 3D printing technology than traditional mechanical processing technologies. After 40 years development of 3D printing technology, the first commercial use of 3D printing technology debuted in 1987 at the Massachusetts Institute of Technology (MIT). In the future, 3D printing technology is still of great interest to scientists and researchers because it can create products with more complex structures and varying sizes than traditional methods such as extrusion or injection molding.

Based on the 3D printing platform, 4D printing technology was developed recently and first introduced by Dr. Skylar Tibbits at MIT. 4D printing technology is more groundbreaking because there is a fourth axis: time. Compared with traditional manufacturing technologies, 4D printing is a new and exciting approach to combining smart materials with product machining. The advantage of 4D printing is that the printed structures show behavior that changes shape over time in response to the stimulus [Baker 2019].

The goal of 4D printing in the medical field is to create pharmaceutical products with conductivity mobility in pipelines or drug delivery. Berletta et al. proposed a mixture of shape-memory polymers between thermoplastic urethane (TPU) and polyurethane (PU) as raw materials for 4D printing in order to investigate product properties [Barletta 2021]. In addition, combinations of TPU with other polymers have been applied in this study. Research demonstrates that in the case of combining PLA with TPU/PU, the recovery rate is high, reaching 99.3% at a temperature of 85 °C.

Materials and Methods

The experimental part includes the following major components: creating 3D printed samples from prototype PLA and PLA/Fe filaments in accordance with ASTM D638 and D790 standards to test the tensile and flexural strength of the product.

We used the main materials PLA and PLA/Fe from Proto-Pasta in this study. The 3D design is designed by us on SolidWorks software, and the design file is used for 3D printing using FDM technology. In addition, to test the properties of 3D-printed products, tensile and flexural strength meters are used according to ASTM standards for each test sample.

Results and Discussion

According to this study, the results of the tensile strength and flexural strength tests are shown in Figure 1. For the tensile strength test, the elongation in tension of the 3D-printed sample increases with the tensile stress. The 3D-printed model from PLA has better tensile strength, with a tensile strength that can withstand close to 60

MPa, while the printed model from PLA or Fe has a tensile strength of about 35 MPa. The elongation at break of the PLA sample is about 5.5 mm, corresponding to 0.03% strain. And the elongation at break of the PLA/Fe sample about 4.0 mm, corresponding to 0.024% strain. Therefore, we calculate the tensile modulus of PLA and PLA/Fe samples to be 2000 MPa and 1458 MPa, respectively.

The decrease in mechanical properties of the two printed samples can be explained because the Fe particles present in the dispersion reduce the mechanical resistance of the samples. In addition, Fe particles that are unevenly dispersed in some locations also affect the properties of the printed pattern.

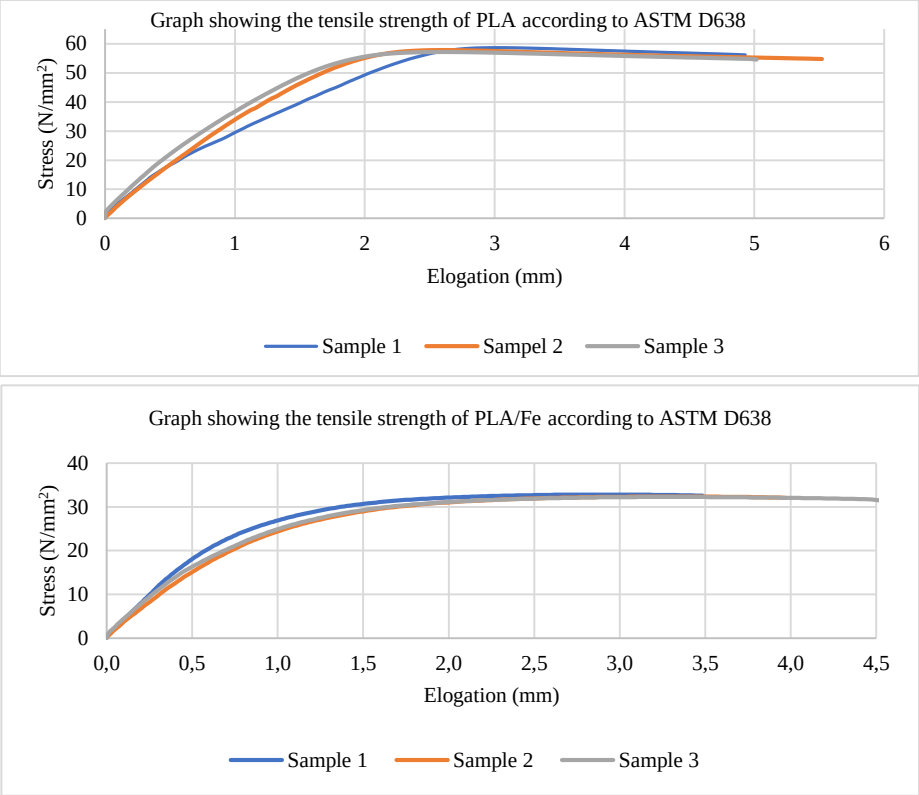

Figure 1. Results of tensile and flexural testing of 3D printed samples.

Conclusions

In this study, we know the mechanical properties of composite materials for 4D printing technology, which will provide basic information for the evaluation and analysis of the properties of the formed products. The results of the study can be evaluated with the mixing ratio of Fe particles in this material, which has not increased the mechanical properties of the product but responds very well to environmental stimuli. In addition, the dispersion of Fe particles in the substrate should be considered to improve the properties of composite materials for 3D and 4D printing.

Conflict of Interest: The authors declare no conflict of interest.

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Experimental study of effect of emulsion rheological characteristics on the pipeline flow

Mechali A[1,*], Mesicek J.[1], Mechali O.[2], Madjid Meriem-Benziane.[3], Petru J.[1]

[1] Department of Machining, Assembly and Engineering Metrology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 70800 Ostrava, Czech Republic.

[2] Ecole Supérieure Ali Chabati, Réghaia, Algeria.

[3] Mechanical Engineering Department, University of Chlef, P.B. 151, Chlef 02000, Algeria

[*] Corresponding author: abdesselam.mechali.st@vsb.cz

Abstract: Rheology is science of deformation and flow, it is a science with theoretical mathematical principles it has a wide range of practical applications in defining the behavior of materials, recently there are many applications of rheology in defferent fields such as biology, material sciences, biomedicine, additive materials, oil industry, food industry and many others**.** Emulsion is one of rheological complex fluids which considers as an important part in our daily life. It can be used in many different fields such as beauty care products, sustenances, pharmaceutics, natural frameworks, oil preparing and so forth. The purpose of this study was to improve the previous results and to investigate the rheological charecteritics of light crude oil before and after preparing the emulsions for better understanding the oil behavior in pipelines.

Keywords: Newtonian, non-Newtonian, emulsion, rheostress, corrosion, inhibitor

Introduction

This paper is divided into four sections: The first section is devoted to the notions of rheology. It talks about the rheological behavior, the effect of the viscosity in fluid, the classification of fluid. It indicates to Newtonian and Non-Newtonian fluid. The second section is presented the emulsions, different types of emulsion, the mechanism of emulsion, the formation of emulsion and Emulsion rheology and viscosity measurement. The third section, influence of emulsion-solid interaction it talks about the corrosion and the inhibitor. It talks about the corrosion of the pipeline, inhibitor of corrosion (its proprieties, nature and classes) and the mechanism of inhibitor. The last section is based on a excremental study of effect of emulsions (oils and inhibitors), we have done an experiments by using rheometer (Rheostress) we used crude oil, emulsion (crude oil+ water) and the final emulsion (crude oil + water + inhibitor). Finally, this paper is ended by general conclusion.

Materials and Methods

In this study, five different crude oils were used to investigate the rheological emulsion by experimental analysis. They were brought from various oil fields in Algeria and prepared in the laboratory. The samples of fluids were named with letters A, B, C, D, and E under temperature of 20 °C. Emulsion fluids (crude oils + water) were prepared in three different concentrations for each one as following steps: (i) 25 % crude oil + 75% water, (ii) 50% crude oil +50% crude water, and (iii) 75% oil +25% water. Furthermore, the inhibitor was added to emulsion fluids in three different concentrations (2%,4% and 6%). of the inhibitor was added to emulsions for studying the effects of inhibitor on the emulsions behavior. Moreover, the rheological behavior for different types of complex fluids (crude oils+ water + inhibitors) was examined by the rheometer

Results and Discussion

Fig.1 describes analytically (Bingham model) and experimentally, the rheological behavior of viscosity variation versus share rate for each crude oil. Complex fluids of emulsion (five crude oils + water) in three different concentrations (75%, 50% and 25%) have a non-Newtonian description according to the viscosity behavior shown in Fig.1.

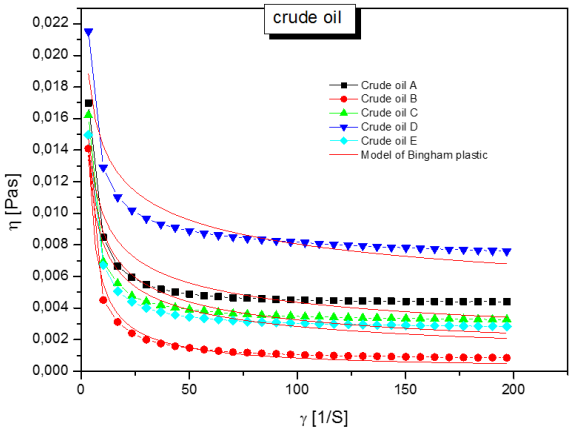

Fig. 1: viscosity behavior for five types of the crude oil after modeling.

Tab. 1: Values of measurements and simulation for emulsion

Samples	R^2	Model
Emulsion A	0.986	Herchel-Bulkey
Emulsion B	0.9832	Herchel-Bulkey
Emulsion C	0.9998	Bingham plastic

Meriem-Benziane et al. have studies the rheological emulsion behavior of Bingham elasto-plastic and Herchel-Bulkey models [Meriem-Benziane 2012]. The Bingham elasto-plastic model based on two principal parameters; k and n, however, Herchel-Bulkey model is depended on three parameters; τ_0, k and n, where τ_0 is the initial shear stress k is the consistency and n is the follow index respectively. Bingham model can be written as follow :

$$\tau = k.\,\dot{\gamma}^{n-1} \qquad (1)$$

The Herchel-Bulkey model can be written as the next equation:

$$\tau = \frac{\tau_c}{\dot{\gamma}} + k.\dot{\gamma}^{n-1} \qquad (2)$$

Conclusions

The function of $\tau = f(\dot{\gamma})$ clearly confirmed that both of crude oil and emulsion exhibited a non -Newtonian fluid the results were as follow:

(1) Herschel–Bulkley model for
the emulsions A and B and for emulsion (crude oil + inhibitor (2%)).
the emulsions B and C for emulsion (crude oil + inhibitor (4%)).
the emulsions A, B and C for emulsion (75% crude oil-25% water).

(2) Bingham plastic model for

The light crude oil
the emulsion A, D and E for emulsion (crude oil + inhibitor (4%)).he emulsions B and C for emulsion (crude oil + inhibitor (4%)).
the emulsions D and E for the emulsion (75% crude oil-25% water).
the emulsions A and E for the emulsion (50% crude oil-50% water).

Conflict of Interest: The authors declare no conflict of interest.

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Bottle Inspection System for Classification with Machine Vision

Tran-Phi-Long Vu[1,*], Duy-Phuong-Thanh Nguyen[1], Thanh-Hai Diep[1]

[1] Eastern International University, School of Engineering, Binh Duong province, Vietnam.

[*] Corresponding author: long.vu.set16@eiu.edu.vn

Abstract: Automated visual inspection systems (AVIS) are increasingly prevalent across a wide range of industries worldwide. In this paper, we describe the utilization of two algorithms to assess our visual inspection system for bottle inspection. The first algorithm is specifically designed to inspect bottles using liquid level and cap position to classify 8 cases of unacceptable bottles and 1 case of acceptable bottles. The second algorithm is based on YOLOv7 and YOLOv7-tiny, which are real-time object recognition algorithms based on a highly accurate, fast, and efficient convolutional neural network model. We collected 3000 images for 9 cases of bottles, and divided them into 70% training images, 20% validation images, and 10% test images. Both algorithms significantly improved the ability to classify bottles in our test environment and reduced the time required to check completed bottles. Based on our experimental results, both algorithms achieved an accuracy above 96.5% with quick response time, validating the significant improvements in bottle inspection achieved using these proposed methods.

Keywords: Automated Visual Inspection System (AVIS), Bottle Inspection, Machine Learning Vision

Introduction

Visual inspection is a crucial aspect of ensuring the quality of finished products in all manufacturing industries. In industry, error checking of a bottle on production line is a difficult job for human inspector due to the high concentration. However, over the past few years, several university students and lecturers have been researching Bottle Visual Inspection systems. For instance, a study by [Sridevi 2016] proposed a method using computer for detecting and classifying plastic bottle caps, while [Felipe 2019] focused on detecting liquid levels in glass bottles. Although these two studies satisfactorily meet the requirements, hardware and accuracy limitations remain. As such, this paper presents a design proposal for an embedded system capable of monitoring the status of bottles and classifying them as either good or bad. The system is designed to be compact, easy to install and affordable with an accuracy of 96.5%-100%**.**

Materials and Methods

In this paper, we proposed two methods to detect and classify liquid level and the cap position of bottle. The first one is our proposed algorithm which is shown in Fig. 1. The primary focus of this algorithm is to achieve a fast processing speed while maintaining an acceptable level of accuracy. Furthermore, it is capable of running on lightweight and relatively simple hardware. In the second method, we have applied YOLOv7 and YOLOv7-tiny algorithm by [Wang 2022] and a simplified flowchart of this algorithm is depicted in Fig.2. This algorithm emphasizes accuracy and is well-suited for challenging lighting conditions.

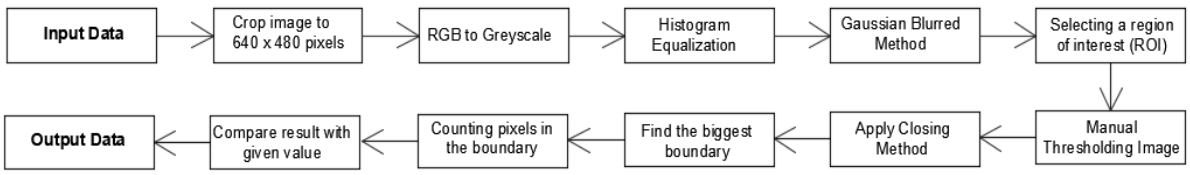


Fig. 1: The flowchart of first algorithm

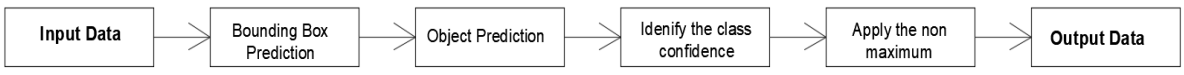


Fig. 2: The flowchart of second algorithm

We collected our own dataset including roughly 3000 images taken at various possible cases of bottle and divided them into 2100 images for training, 600 images for validation and 300 images for testing. We constructed a prototype model as illustrated in Fig. 3 to assess the aforementioned two methods in reality.

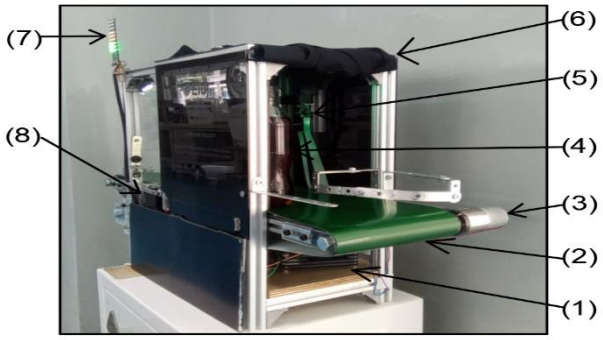


Fig. 3: A full prototype of bottle inspection system. (1) Raspberry Pi 4 controller. (2) Belt conveyor. (3) Conveyor motor. (4) Testing bottle. (5) Camera module and illumination board. (6) Inspection zone. (7) Indicator of the classification result (8) Sorting mechanism.

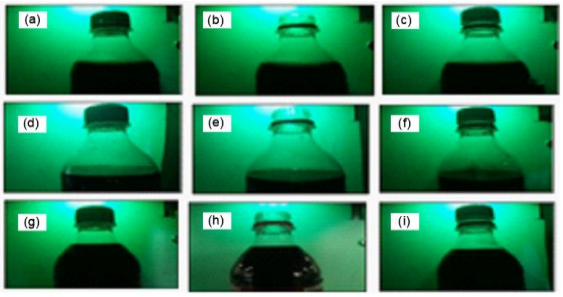
Results and Discussion

The evaluation and determination of these results were conducted on 300 images for each method. The average accuracy of two methods is shown in Tab. 1. The first classification model exhibits the quickest processing time compared to the other method. In the second method, YOLOv7-tiny model yields excellent accuracy at 99.7%, although it has a slower processing speed than the first method. The YOLOv7 model achieves 100% accuracy, but at the cost of the slowest processing time. The 9 possible cases of bottle are mentioned in Fig. 4, including 1 good case and 8 bad cases: (a) Normal cap and normal level, (b) No cap, normal level. (c) Unfixed cap, normal level. (d) Normal cap, low level. (e) No cap, low level. (f) Unfixed cap, low level. (g) Normal cap, high Level. (h) No cap, high Level. (i) Unfixed cap, high level.

Tab. 1: The accuracy and processing time

Methods		**Average Accuracy**	**Processing Time**
1	Our proposed algorithm	96.5 %	16 (ms)
2	YOLOv7-tiny	99.7 %	960 (ms)
	YOLOv7	100 %	4200 (ms)

Fig. 4: The possible cases of bottle



Conclusions

This study proposed two approaches for categorizing bottles based on liquid level and cap position. For the first method, it has faster speed, acceptable accuracy, and reasonable cost, but necessitates computer vision expertise from the user. The second method, on the other hand, yields greater accuracy, but demands more robust hardware, while not requiring extensive specialized knowledge from users. These suggested methods perform well in terms of testing time and the reliability rate of bottle inspection on the production line.

Conflict of Interest: The authors declare no conflict of interest.

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A Brief Review on Current Materials Being Used in 4D Printing

Que Tran T.Nguyen[1], Buu Phat Nguyen[1,*], Jakub Mesicek[2]

[1] Faculty of Applied Science, Ton Duc Thang University, Viet Nam.

[2] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic.

[*] Corresponding author: buuphat2001@gmail.com

Abstract: This review discusses the advantages of 3D and 4D printing in manufacturing, medical, and innovative material technology. 4D printing adds an extra dimension of time to the 3D printing process, allowing objects to change shape or properties over time. Various 4D printing techniques, such as FDM, FFF, SLA, and SLS, use different materials and methods of mixing to create objects that respond to environmental stimuli. When selecting the optimal printing technique and material, factors such as the object's geometry and mechanical properties must be considered. 3D and 4D printing technology has revolutionized the production process, enabling greater customization and precision, and opening up new possibilities for personalized medical care and the creation of innovative materials.

Keywords: Smart Materials, 3D/4D Printing, Composites, Magnetic field, Electric field, Temperature.

Introduction

The rise of high-tech industries has brought about a paradigm shift in production processes, with 3D printing emerging as a cutting-edge technique for companies, industries, and nations to embrace. Unlike conventional processing methods, 3D printing technology enables the creation of physical three-dimensional objects from computer-generated sketches, using materials and a 3D printing technique (Cad/Cam). The adoption of this technology promises to increase the supply of raw materials while using them more efficiently.

This review focuses on the development of composites blends such as PLA, PCL, and TPU, as well as the various techniques in 3D and 4D printing. The research team recommends some common materials used in 4D printing, including thermoplastic polyurethane and composite in typical applications. By providing an overview of 3D and 4D printing technologies and materials, this review aims to enhance readers' understanding of the technical characteristics and optimal printing techniques in each particular object, and provide insights into the future of this exciting new technology.

Discussion

The sources of printing materials in 3D technology are various and plentiful and may include thermoplastics such as polylactic acid (PLA), Acrylonitrile butadiene styrene (ABS), polycarbonates (PC), or polyethylene terephthalate (PETG). Furthermore, polymer matrix composites, green ceramics, and metal are employed, as well as components such as sugars and chocolates that may be used to create 3D printing materials also. In comparison to 3D printing which requires flexible materials, 4D printing allows for wider material selection and this context discusses about SMPs. Shape-memory polymers, or SMPs, are polymers possessing shape memory capabilities. The “shape memory” polymers are determined by two factors: the material’s ability to alter shape and its ability to recover through interaction with the environment. Smart polymers have physical or chemical characteristics that change when they are exposed to external stimuli. Humidity, ambient temperature, pH, light, electric and magnetic fields are examples of these stimuli.

Baker et al. have created a three-layer structure that can memorize original shapes from TPU [Baker 2019]. In research, they have a mixture of shape-memory polymers between TPU and PU as raw materials for 4D printing to investigate product properties. In addition, the combinations of TPU with other polymers have been applied in this study. Research demonstrates that in the case of combining PLA with TPU/PU, the recovery rate is high, reaching 99.3% under the temperature of 85°C. Dogan et al. have implemented a composite consisting of PLA and TPU in two different ratios: 80/20 PLA/TPU and 50/50 PLA/TPU with 1,4-phenylene diisocyanate (PDI) in this mixture [Dogan 2017]. The experimental results showed that the ratio of 80% PLA with 3% PDI had a better recovery than the other proportion. Dong et al. have detected a feature of shape memory structure between PLA/TPU/CNT nanocomposite and a PLA/TPU ratio of 9/1 [Dong 2021]. Also, they showed conductive stimulation of this structure, the ratio recovery higher than in the case of temperature excitation that is possible to achieve a Poisson ratio when these polymers are combined.

When observing the storage modulus between PLA and TPU at the glass transition temperature range, those who detect the storage modulus of PLA decreased rapidly while TPU polymer decreased slightly. The difference in thermodynamic properties of these two polymers causes the composite's structure to expand when getting heat

and shape recovery when cooling [Wang 2021]. In addition, the combination between Fe_3O_4 nanoparticles and TPU by Menon et al. applied with technique PEG as a hole-forming factor [Menon 2018]. The shape memory of the TPU is not changing due to the EMI being a protective coating. The polymer feature has got from the Fe_3O_4 nanoparticles. In addition, Shi et al. have created a product with good resilience and the potential treatment for oil spill cleanup. The products made between TPU and Fe_3O_4 nanoparticles are mixed with silane (FAS) for excellent magnetic induction and superior mechanical properties compared to pure TPU [Shi 2021] . The study concluded that the presence of Fe_3O_4 brought about the magnetic induction of the product, but when added to FAS will reduce the recovery feature. In another respect it has excellent waterproofing ability. Some other studies by Zheng et al. have demonstrated PLA/Fe_3O_4 with a weight ratio of 20% and PU/Fe_3O_4 that both have magnetic properties, but the shape memory ability decreased with other mixtures. However, the mechanical properties of the 1:1 PU/Fe_3O_4 ratio still provide better mechanical properties than pure PLA [Zheng 2009] . But when using this composite material from PLA/TPU of Carlson and Li, a recommendable feature exhibits shape-memory effects, fast recovery has potential in industrial plastic.

Conclusions

In general, 4D printing technology has advanced significantly and overcomes the stalemate of 3D printing technology. Besides, the FDM printing method is the most widely utilized of these technologies. In our plan, it shows that thermal excitation is the most common, and that it is straightforward to produce even with single-polymer materials. Other materials, such as Fe_3O_4, must be coupled with electric and magnetic fields during excitation. The composites will have a high rate of form recovery and rapid shape recovery when electrical stimulation is applied. After evaluating the research, it can be seen that thermoplastic polyurethanes (TPU) are ideally suited for the future investigation of magnetic and electric field-sensitive materials.

Conflict of Interest: The authors declare no conflict of interest.

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Study on Selective laser melting of STS316L-Cu mixtured powder and its properties

Thuyet-Nguyen Minh[1,*], Hung-Le Thai[1]

[1] School of Materials Science and Engineering, Hanoi University of Sience and Technology, Vietnam.

[*] Corresponding author: thuyet.nguyenminh@hust.edu.vn

Abstract: Selective laser melting (SLM) is known as a promising process to manufacture complex geometry parts and low lot sizes which has potential for applying in synthesis alloys and composites. Owing to the typical physical properties of copper it is challenging to achieve good surface quality and low porosity by the widely used laser-based additive manufacturing processes. This paper deals with the role of alloy composition, powder size and process parameters in a SLM machine to evaluate the ability of SLM in manufacturing of TS316L steel-Cu alloys. The STS316l-Cu alloy samples were printed from a mixture of STS316L and Cu powders. The two types of laser patterns (offset-filling and meander) with the laser powers of 100W, 120W, 130W, and the laser speeds at 700mm/s, 800mm/s, 1000mm/s and 1400mm/s were used to produce the 1cmx1cmx1cm cubic shape samples. After then, the microstructure and mechanical properties of the as-built samples then was investigated**.**

Keywords: Stainless steel 316L; Cu powder, 3D-printing, Selective laser melting, Laser patterns, microstructure.

Introduction

Selective laser melting (SLM) is one kind of additive manufacturing (AM) processes using a CO_2 laser source as the energy supply source to produce 3D objects from metallic, polymer and ceramic powder materials. SLM is a promising manufacturing process compared to traditional methods due to its remarkable advantages in case of production complex components even from high melting point materials and reduce the production time as wel as provide good mechanical properties products. Therefore, the SLM has been applied in various applications such as aerospace, medical as well as many others industrial fields. Normally, the charging materials for SLM process are pure metallic and alloy powders including Ti, Ni, Cr and stainless steel powders. According to the AM principle the SLM we can use for fabrication alloy or composite objects from a mixture of two or more than two individual powder materials. That ability is useful for the development of synthesis of alloys and composites. However, there are lack of studies about that matter. Herein, we report a study on application of SLM process to produce STS316L-Cu alloy samples from the mixture of the STS316L and Cu powders. The purpose of this paper is to investigate and present the results about the potential in production of alloy objects and their properties by using SLM system with various parameter conditions.

Materials and Methods

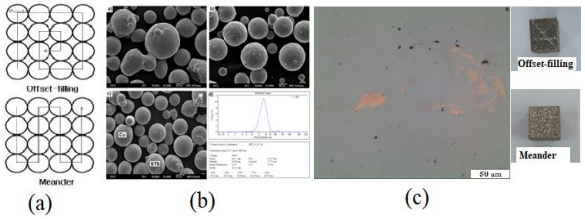


Fig.1: (a) The schematic of laser pattern in SLM; (b) Materials; (c) Printed samples

Elemental powders of STS316L and Cu (average size: 45µm) with the spherical shapes were used in this study. They were mixed together with the ratio of 95:5 in weight percent by using a mechanical mixing equipment. The mixed powder was charged into the SLM system (METALSYS 150). Then, the specimens were built in the cubic shape with 2 scanning strategies Offset-filing and Meander (Fig.1a). The phases and morphology characteristics of the as-built samples were observed by using analysis methods include optical microscope (OM) and field emission-scanning electron microscope (FE-SEM). Mechanical properties of the samples were also evaluated.

Results and Discussion

Before using for SLM process, Cu and STS316L powders were mixed well in a mixing machine for 1 hour. The morphology of powders, mixture and the particle size distribution of the mixture is presented in Fig.1b. After processing in SLM system, the as-built samples were removed from the substrate for investigating. Fig.1c shows the OM image of the specimen after mechanical polishing with SiC papers. There were two main phases that could be observed. One is matrix phase (gray color) which is attribute to the rich of STS316L phase and the additive phase which is attribute to Cu phase. It is noted that, iron and copper are immiscible alloys, however, the OM image shows that the as-built sample exposed a well mixed structure. This result confirmed the ability of the SLM

process in manufacturing of alloy components which is very useful for industrial applications. There was also phase (dark color) which is responding to the pores.

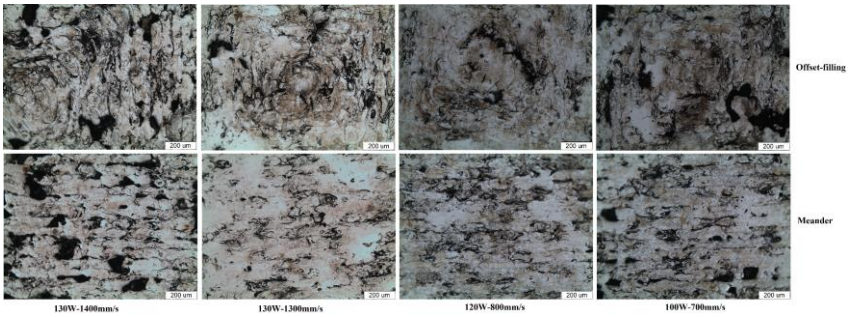


Fig.2: Microstructure of as-built samples after etched with a suitable solution.

Fig. 2 shows two phases mixed together homogeneously in the as-built samples which were for Cu and STS316L phases. It could be recognized that the microstructure of samples reflects the pattern parameter conditions, thus, it shows the typical characteristics of SLM samples such as the lack of fusion, melt pools on the surface. At a higher scanning speed 1400 mm/s many vacancies were observed even with the high power at 130W. The borders of the melt pools are observed clearly illustrating that the powders was melted and solificated rapidly but not efficiency. When the parameter was changed to 130W/1000mm/s and 120W-800mm/s the etched surfaces show less vacancies than that. However, at 100W-700mm/s condition the sample exhibited the same microstructure with the sample prepared at 130W-1400mm/s. This demonstrates that it is better to conduct the SLM process for STS316L-Cu mixture powders at the power range 120-130W and laser speed range 800-1000mm/s. In addition, the as-built samples printed by meander pattern exposed a better dense microstructure in comparison to the offset-filling specimens (Fig. 2). The meander specimens show a good overlap between melt pools without cracks in the matrix while offset-filling samples exhibited the concentration of cracks at the center of each sample. The density and microhardness of the as-built samples were measured and presented in the Table. I. These values of density and hardness confirmed the advantage of meander to offset-filling strategy during SLM of Cu-STS316L powders.

Tab.1: Density values and Microhardness of the as-built samples at different paramete conditions

Process parameter (W, mm/s)	Pattern	Vickers hardness (HV)	Density (g/cm^3)
130W-1400mm/s	Offset-filling	170.5	7.168
	Meander	178.0	7.432
130W-1000mm/s	Offset-filling	175.6	7.609
	Meander	171.2	7.822
120W-800mm/s	Offset-filling	179.1	7.729
	Meander	178.5	7.905
100W-700mm/s	Offset-filling	173.8	7.422
	Meander	182.6	7.778

Conclusions

The STS316L-Cu alloy components could be fabricated from the mixture powders by using SLM process. The as-built samples showed solidification tracks, melt pools on the macro-scale which is related to scanning stratery. Microstructure of the samples show the homogeneous phase of TST316L and Cu materials in each metl pool and the processing with meander strategy at 120-130W of power and 800-1000mm/s of laser scanning speed showed the better rerults in reducing the vacancies and increasing the density and hardness for the as-built samples.

Acknowledgements: This research was funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under Grant Number 107.99-2018.336.

Conflict of Interest: The authors declare no conflict of interest.

Activated carbons derived Acacia Crassicarpa bark by carbothermal functionalization for dye adsorption characteristics

Nam V.N.[1], Dat X.N.[1], Mai X.T.N.[1], Anh T.D.[1], Ninh V.T.[1], Tung C.D.[1], Trung D.N.[2], Tue N.N[2], Hung T.L[1], Khanh Q.D.[1,*]

[1] School of Materials Science and Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam.

[2] School of Chemical and Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam.

[*] Corresponding author: khanh.dangquoc@hust.edu.vn

Abstract: Nowadays, dyes are widely used in industries, in spite of that organic dyestuffs are gravely harmful to human beings and microorganisms. This study explores the potential use of activated carbon prepared from *Acacia Crassicarpa bark* for removal of methylene blue and methyl orange from wastewater. The effects of various temperature ranges and heating rates on carbonization process were investigated. The experimental results demonstrated that the pore volume and the amount of carbon content were increased cause the percentage of dye removal increased accordingly. In addition, the optimum conditions for high surface area carbon with NaOH as a chemical activating agent are identified.

Keywords: acacia crassicarpa bark, activated carbon, carbonization, wastewater

Introduction

Activated carbon is a commonly used in water treatment based on the adsorption mechanism. The present study is currently being done to assess the different carbonization modes in order to improve the adsorption capacity of *Acacia Crassicarpa bark*. Following that, figuring out the ideal circumstances to achieve activated with better quality (high porosity, high surface area, high carbon content), which helps to increase the removal of adsorbates, specifically methylene blue (MB) and methyl orange (MO).

Materials and Methods

Experimental materials

Acacia Crassicarpa bark used as a raw material was obtained from Thai Nguyen Province, Viet Nam. The chemicals used were all commercial products. MO and MB were selected as the adsorbates in this study.

Preparation of activated carbon

Firtsly, *Acacia Crassicarpa bark* was washed several time with tape water to remove dirty and dried in dry oven for 24h. At a temperature between 350 and 400 ^{o}C, the anaerobic calcination procedure aims to oxidize the treated cellulose and then, grinding the powder for 6h. In the carbonization process, the samples were first heated with the constant heating rate of 3 ^{o}C/min at the temperature ranging from 25 to 550 ^{o}C and followed by 1050 ^{o}C for 90 minutes with the change in the heating rate between 5 and 10 ^{o}C /min. Samples are marked according to the heating rate. For carbonization mode with a heating rate of 8 ^{o}C /min and third time carbonized, the sample was denoted as AC9. Afterwards, taking samples impregnated with 0.5M NaOH with a ratio of 1:10 in 1h, then washed with distilled water to until it reached pH = 7 - 8 and dried at 105 ^{o}C for 24h.

Characterization of the activated carbon

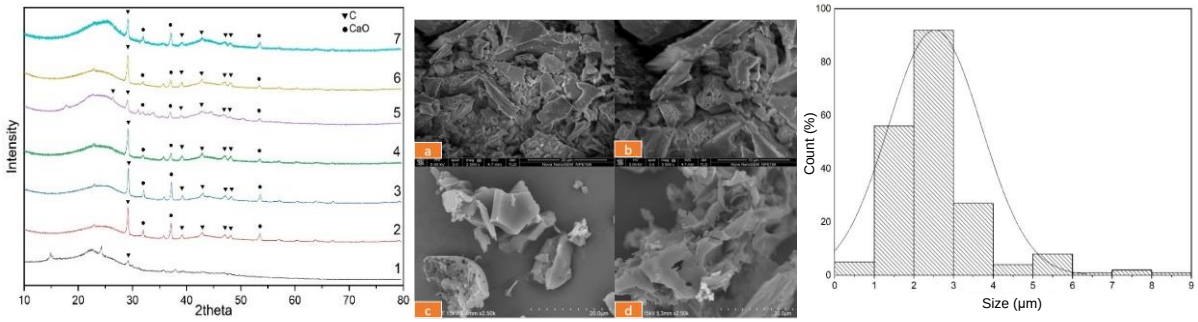
Multiple analytical methods, including elemental analysis, X-ray diffraction (XRD), UV-Vis spectroscopy, BET, and SEM, were used to thoroughly characterize the synthesized adsorbent.

Adsorption experiments

A temperature of 25°C and pH of 7.0 were fixed throughout all experiments. Firstly, preparing 50 ml volumetric flasks containing MB solutions with different concentrations from 0.5, 1, 2, 4, 6, 8, 10, 12, 14, 16 (mg/L) with 0.005g AC9 and do the same with MO but with different concentrations levels are 10, 15, 20, 25, 30, 35, 40 (mg/L) with 0.01g AC9. These samples were ultrasonicated for 1 h and shaked with the speed of 200 rpm in 1h, and then centrifuged for 30 min. When the adsorption equilibrium was reached, the amount of residual dye concentration was determined at their specific wavelength (664 nm for MB and 464 nm for MO) using a UV-Vis spectrophotometer. The adsorption capacity qe (mg/g) were calculated as follow: $q_e = \frac{(C_0 - C_e)V}{W}$, where Co (mg/L) and Ce (mg/L) are the initial and equilibrium concentrations of MB or MO, respectively, V is the volume of the solution (L), and M is the weight of the adsorbent (g).

Results and Discussion

Different heating rates result in changes in size and in carbon content after carbonization above 550 °C.



(1) (2) (3)

Fig. 1: (1) XRD pattern of AC samples, (2) SEM images of AC before and after carbonization, (3) Particle size distribution graph.

Due to carbonization, amorphous activated carbon were transformed to crystallize carbon, it is proved that the carbon peak at 2θ is 26.26 °; 29.20 °; 43.27 °; 47.26 ° and 48.52° (which coincide with the JCPDS standard peaks 04-019-9068, 01-089-8495, 04-007-2136, 04-013-5952), and clearly exhibited a high intensity of carbon crystallization. In addition, there are some impurity peaks of CaO 2θ of 32.2°; 37.3 °; 54.3 °. SEM results showed that the fabricated coal surface had many rough areas and broken debris, observed that the particles appeared many pores, the average pore size was 0.15 μm, demonstrating the surface area. specific surface increases. Furthermore, the average particle size reached 2.58 μm, which was nearly 1 μm smaller than the original. This AC samples accepted on the Langmuir isotherm adsorption model describes a monolayer retention of adsorbent atoms (molecules, ions) on a uniform surface.

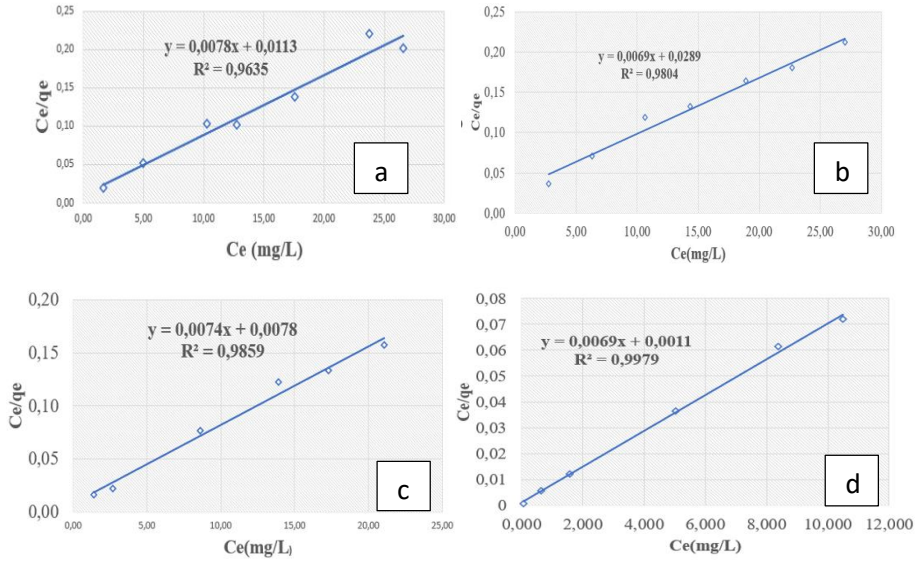


Fig. 2: Adsorption isotherm of Methyl orange (a) and Methylene blue (b) on AC9 before activating. Adsorption isotherm of Methyl orange (c) and Methylene blue (d) on AC9 after activating.

Conclusions

Fabrication of activated carbon materials from Acacia bark using the carbonization method combine with NaOH as activating agent shows that AC has relatively good quality from size, structure to specific surface. Methyl orange and methylene blue had a maximum adsorption of 144.93 mg/g each on activated carbon, respectively. Thus, this technical to develop the use of activated carbon in reducing pollutant in aqueous solution.

Conflict of Interest: The authors declare no conflict of interest.

Metrological analysis of the measurement uncertainty of the geometry of models manufactured by 3D printing

Malara D.[1], Bochenek A.[1], Nawotka M.[1], Kozior T.[1,2,*]

[1] Central Measures Office, Digital Technology Department, Metrological IT Laboratory, Elektoralna street 2, 00-139 Warsaw, Poland.

[2] Department of Metrology and Unconventional Manufacturing Methods, Faculty of Mechatronics and Mechanical Engineering, Aleja Tysiąclecia Państwa Polskiego 7, 25-314 Kielce, Poland.

[*] Corresponding author: dominik.malara@gum.gov.pl; aleksandra.bochenek@gum.gov.pl

Abstract: The paper presents the results of metrological tests of the dimensional accuracy of sample models manufactured using 3D printing technology – Fused Deposition Modeling - FDM/FFF. The samples were produced with recommended technological parameters from PLA material manufacturer. In addition, a comparative analysis was carried out regarding the measurement uncertainty depending on the calculation method used and the number of samples. Based on the results of the research, discrepancies were found regarding the presentation of the measurement results of dimensional accuracy along with their credibility.

Keywords: 3D printing, metrology, FDM/FFF, PLA

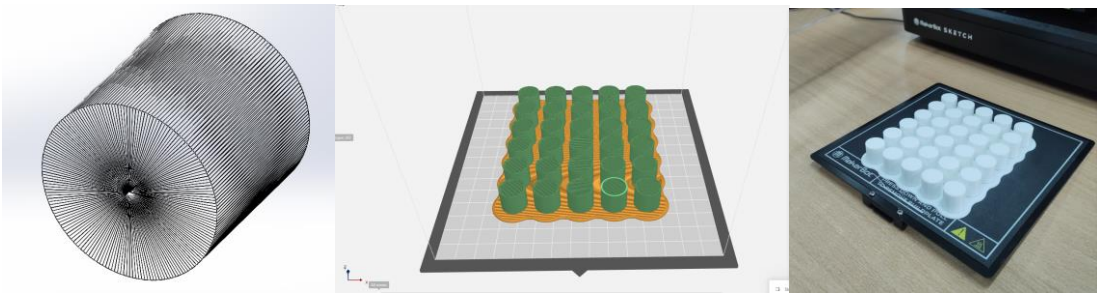
Introduction

The development of 3D printing technology brings with it more and more requirements regarding the dimensional and shape accuracy of the manufactured models, as well as their repeatability. This is especially important in connection with the ongoing industrial revolution 4.0 and the requirements related to it. Currently, 3D printing technologies use materials based on plastics, ceramics, and metal powders, which means that their use is increasing year by year and already applies to such fields as: foundry, automotive, aviation, medical, food industry, prototype production, etc. [Pagac 2021].

In the case of conducted research published in many scientific journals, the published results are often based on a small number of both analyzed samples and performed measurements, where they often lack reliable statistical analysis. Such a situation may entail far-reaching consequences related to, for example, the need to calibrate the 3D printer, its service and even replacement. Therefore, the presented publication presents a comparative metrological analysis regarding the dimensional accuracy of samples produced by 3D printing technology - FDM/FFF in order to illustrate the differences resulting from the method used to present the measurement result and to determine the quality of the manufactured models.

Materials and Methods

The samples were manufactured from PLA materials using the Makerbot Sketch – FDM 3D printer. Test samples were produced with a layer thickness of 0.2 mm, the temperature of the printing nozzle was 220 °C, build plate temperature - 50 °C, and infill density - 20%. The CAD model in a form of cylinder (diameter 15 mm, high 15 mm) was approximated to STL file with 1440 triangles. In order to compare the measurement uncertainty and its reliability, the mean value, standard deviation, type A and type B standard uncertainty and expanded uncertainty were calculated [Adamczak 2016]. In addition, the above-mentioned measurement uncertainty assessment coefficients were determined for 3, 5, 10, 20, and 30 samples.



a) b) c)

Fig. 1: Samples manufacturing: a) STL file, b) 3D printing simulation, c) printed samples

Results and Discussion

The results of the dimensional accuracy measurements are presented in Table 1. The measurements were carried out using a dial caliper with a measurement accuracy of 0.01 mm.

Tab. 1: Samples measurement results.

No.	Dimension [mm]	No.	Dimension [mm]	No.	Dimension [mm]
1	15.05	11	15.06	21	15.01
2	15.09	12	15.03	22	15.03
3	15.08	13	15.02	23	15.10
4	15.05	14	15.02	24	15.05
5	15.09	15	15.01	25	15.06
6	15.03	16	15.06	26	15.05
7	15.03	17	15.09	27	15.01
8	15.02	18	15.07	28	15.03
9	15.06	19	15.05	29	15.01
10	15.07	20	15.01	30	15.04

Conclusions

Based on the analysis of the test results, it can be concluded that there are clear differences in the interpretation of the diameter measurement results of the sample models manufactured using 3D printing - FDM/FFF technology. Incorrect interpretation of statistical data carried out for an insufficiently large population of test samples entails costly decisions regarding the manufacturing process and makes it impossible to properly assess the quality of both the technological process and the condition of the printer. Satisfactory results were obtained for a population of more than 20 samples.

Conflict of Interest: The authors declare no conflict of interest.

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Preparation and properties of porous Cr doped Al_2O_3 by powder metallurgy method

Hong M.D.[1], Ha H.T.N.[1], Van T.N.[1], Thanh V.T.[1], Linh B.V.[1], Nam H.N.D[1], Hung T.L.[1], Yen N.N. [2], Khanh Q.D.[1,*]

[1] School of Materials Science and Engineering, Hanoi University of Science and Technology, Hanoi 100000, Viet Nam.

[2] School of Materials Science and Engineering, Kyungpook National University, Daegu 41566, South Korea.

[*] Corresponding author: khanh.dangquoc@hust.edu.vn

Abstract: Porous alumina ceramics were prepared by powder metallurgy method using Cr_2O_3 as sintering additive. The powder mixtures were prepared by mixing NH_4HCO_3 as a pore forming agents. In order to investigate the influence of particle shapes on characters of sintered porous Al_2O_3, both disk micro-sized and spherical nanosized Al_2O_3 powders were used as the starting powders. The sintered porous Al_2O_3 had a mixed porous structure in which open pores occupy the majority. At an optimal pore-forming agent concentration, the sintered porous Al_2O_3 using nano-sized powder had a smaller pore size in comparison with the micro-sized powder, and the lower porosity. The compressive strength of porous Al_2O_3 prepared from nano-sized powders has a much higher value compared to the one prepared from micro-sized counterpart especially, with Cr dopant.

Keywords: alumina, titanium dioxide, porous, powder metallurgy

Introduction

Porous Al_2O_3 is a type of technical ceramic widely used as a high temperature resistant material because of their high strength, high melting temperature, and low thermal conductivity. Among processing techniques, powder metallurgy is one of the widely used methods within sacrificial fugitive techniques that allows the porosity and pore size to be controlled through the particle size of the initial porosity. On the other hand, powder metallurgy has many advantages: simple process, low material loss, lower temperature than other methods and environmentally friendly. Porous Al_2O_3 could be processed either by a partial sintering method without pore former or by using different pore formers such as wax spheres, naphthalene particles, PMMA, NaCl, and starch. To increase the sintering ability of Al_2O_3 at lower temperature (1500ºC), can use some additives can form inter-oxide phases or solid solution in Al_2O_3 sintering as CuO_2, TiO_2, MgO and Cr_2O_3. Some publications show that a small content of additives (<0.5%) not only the increases in the sinterability of Al_2O_3 at lower temperature but also significantly increase the strength of the sintered ceramics.

Materials and Methods

The experiment was used Cr_2O_3 and $Cr(NO_3)_3$ with purity of 99.9% (Macklin, China) as the sintering additive due to it lowered the sintering temperature and increased the strength of porous Al_2O_3 and ammonium bicarbonate (NH_4HCO_3) as the pore former because of its low melting point (41.9ºC). Al_2O_3 (purity of 99.5% and average particle size of 8µm, Macklin, China) was mixed with vảious volume content of NH_4HCO_3 and 5 mass% poly vinyl alcohol (PVA), 0.5 wt.% Cr_2O_3 using a ball milling with a ball:powder ratio of 4:1 in 3 hours. The green pellets were formed by uniaxial pressing in a 20 mm diameter cylindrical steel die with a pressure of 300 MPa. The green pellets were annealed at 200ºC for 2 hours to totally eliminate the pore former and subsequently at 500ºC for 2 hours to remove the binder. And then, the pellets were sintered in an electrical resistance furnace (HT1600, Linn, Germany) at 1550ºC for 2 hours in argon atmosphere.

The density and porosity of the sample after sintering were determined by liquid displacement method. Phase identification was done by X-ray diffraction (XRD, D5000 Siemens, Germany). Porous structure, shape and pore size was observed by Scanning Electron Microscope (JEOL, Japan). Compressive strength and flexural strength were determined using Universal testing machine (MTS 809, USA) according to JIS-R 1608-2003 and JIS-R 1664-2004 standards.

Results and Discussion

SEM image (Figure 1a) presented that when using Cr_2O_3 as sintering additive led to a remarkable enhancement of the bonding between Al_2O_3 particles due to the formation of particles surface with better adhesion at the grain boundary. Figure 1b shown the effect of pore former content NH_4HCO_3 on the total porosity, closed porosity and open porosity of the porous Al_2O_3 sample using Cr_2O_3 as a sintering additive. The results shown that the porous ceramic samples all have a mixed porous structure (including both closed and open pores), and the open pores account for the majority. As can be seen, the pore volume was proportional to the pore former concentration, hence it was revealed that the added pore formers were mostly burned out leaving pores after sintering. The pore former content is proportional to the porosity of the sample. When increasing the pore former content from 0 to

80 vol.%, the total porosity of the sample increased from 29.8% to 79.3%. The open porosity slightly increased when the pore former concentration increased up to the values, at which the closed porosity reached to maxima (30% of NH_4HCO_3). Subsequently, the open porosity sharply increased, and approximately equaled total porosity at maximum pore former concentration. The strength of the porous ceramic is inversely proportional to the porosity of the sample. When the porosity of the sample increased by 29.8% to 79.3% corresponding to the pore former content used from 0 to 80 vol.%, the compressive strength of the sample decreased from 368.5 to 1.4 MPa and the flexural strength of the sample decreased from 128.8 to 29.0 MPa (Figure 1c). The porosity and the mechanical properties are inversely related, thus higher content of the porosity of the sintered samples lead to the lower compressive and flexural strength. The higher mechanical strength of the porous ceramics fabricated from Cr doped Al_2O_3 powder was attributed to a high amount of the grain boundary due to finepowder and a high densification of pore walls due to Cr dopant.

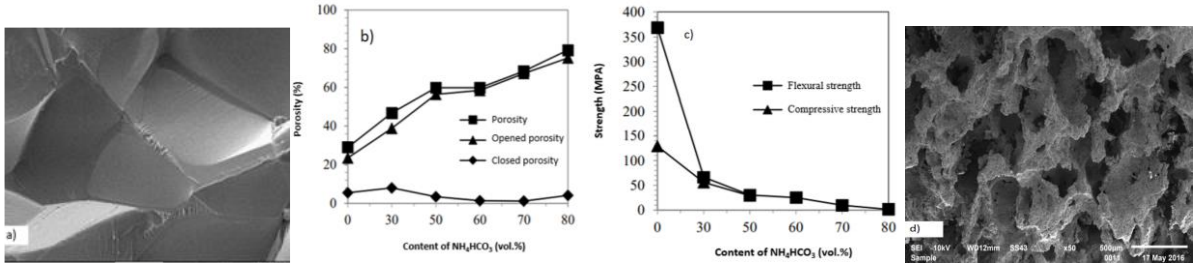

Fig. 1. a) SEM images of Al_2O_3 sample sintered at 1500°C for 4h using Cr_2O_3, b) and c) Effect of NH_4HCO_3 contents on porosity and strength of porous Al_2O_3 samples with 0.5 wt.% Cr_2O_3, d) SEM images of porous Al_2O_3 sample sintered with 0.5 wt.% Cr_2O_3 and 80 vol.% NH_4HCO_3.

Figure 1d displayed the microstructure of porous Cr-doped Al_2O_3. The result showed that the pores have complex shape, uniform distribution, and average size 190 µm. The pore shape and size are completely different from the shape and size of the pore forming agents. The pores had irregular shape regardless of the initial Al_2O_3 powders used. This unusual phenomenon could be resulted from the agglomeration of pore former particles during the powder mixing processes, the pressure increasing during pore former removal or less shrinkage during sintering processes of the starting powders. When increasing the pore former content from 50 to 80 vol.%, the density of pores increases and the pores are interconnected. The additional porosity of samples could be attributed to the volume fraction of fine pores from partially sintering.

Conclusions

Porous Cr doped Al_2O_3 was successfully fabricated by powder metallurgy method with NH4HCO3 as pore forming agents. Cr_2O_3 used as a sintering additive significantly increased the sintering ability of alumina, thereby significantly increased the mechanical properties of porous Al_2O_3. The porosity of the sintered samples increases with the concentration of the pore former and reaches the highest value of 79.3% corresponding to 80 vol.% ammonia bicarbonates used. The flexural strength and the compressive strength are inversely proportional to the porosity of the sample. The particle size of the initial pore former agent increases, which increases the pore size, but the content of the pore former is limited. At the same porosity, the samples prepared from Cr doped Al_2O_3 had the higher mechanical strength than that of pure Al_2O_3. The obtained results suggested that the proposed process could be efficiently used to tailor the porosity, pore size and pore connectivity in porous Al_2O_3 by controlling the initial alumina powder as well as of the pore former.

Conflict of Interest: The authors declare no conflict of interest.

Flatness deviation of casting patterns produced by PolyJet Matrix technology

Zmarzły P.[1,*], Gogolewski D.[1], Kozior T.[1]

[1] Department of Metrology and Non-conventional Manufacturing Methods, Faculty of Mechatronics and Mechanical Engineering, Kielce University of Technology, al. Tysiąclecia Państwa Polskiego, 25-314 Kielce, Poland.

[*] Corresponding author: pzmarzly@tu.kielce.pl

Abstract: The paper concerns the assessment of the impact of the printing direction (Pd) and the thickness of a single layer (Lt) of the printing material on the flatness of casting patterns manufactured using PolyJet Matrix additive technology. 3D printers Connex 350 and FullCure 720 polymer resin have been used to produce of samples. The flatness of casting patterns has been examined using coordinate measuring machines Prismo Navigator offered by Zeiss company. Research results indicated that the printing direction (Pd) and the thickness of a single layer (Lt) affect the value of the flatness deviation FLTt of the printed models. In addition, depending on the size of the analyzed surface, a variable character of flatness was noticed.

Keywords: PolyJet Matrix, FullCure 720, flatness deviation, CMM

Introduction

The intensive development of modern industry requires the search for more efficient production methods. Additive manufacturing technologies especially 3D printing technologies are becoming increasingly popular. In the beginning, there were mainly used to build single prototypes and models. Now, due to the fall of prices of building materials and 3D printers, they are used in almost every industry i.e. in automotive, aerospace and medicine [Budzik 2022]. Additive technologies can also be used in foundry, e.g., to produce casting patterns or foundry molds [Tolochko 2019]. It should be noted that traditional methods of making foundry patterns are time-consuming and require highly qualified personnel. In addition, the use of traditional production methods in some cases has a negative impact on the environment. Moreover, the application of 3D printers allows for "immediate" printing of the final part, which significantly improves the procedure of production o casting patterns. In addition, the use of more environmentally friendly materials in production is highly desirable.

It should be added that one of the important factors affecting the accuracy of the printing of casting patterns is the technological parameters of 3D printing. In particular, in the case of PJM printing technology, where the building material is liquid polymer resin, the key factors are the thickness of a single layer of the building material and the printing direction. Therefore, the influence of these parameters on the accuracy of the casting patterns should be studied in detail.

One of the most important parameters describing the geometrical accuracy of the manufactured elements is the flatness deviation described as the FLTt parameter. Its measurement is especially important in the case of the production of precise prototypes or casting patterns. It should be noted that there is a lack of research work related to the assessment of the flatness of the surface of printed parts, in particular with the PJM technology in the context of the foundry industry. Therefore, the authors of the article presented such studies in this paper.

Materials and Methods

A special research model has been designed to carry out the research. The shape of this model takes into account the most important features of casting models, i.e. appropriate slopes, rounding and flat surfaces. A Connex 350 3D printer and a liquid polymer resin under the trade name FullCure 720 were used to make the casting patterns. Two variable technological parameters of the PJM technology were tested, i.e. printing direction (Pd=0˚, Pd=90˚) and the thickness of a single layer (Lt=0.016mm, Lt=0.032mm).

Flatness deviation was measured using the Prismo Navigator coordinate measuring machine equipped with the Vast Gold scanning measuring probe. Three key surfaces of the casting model were evaluated (see. Fig. 1).

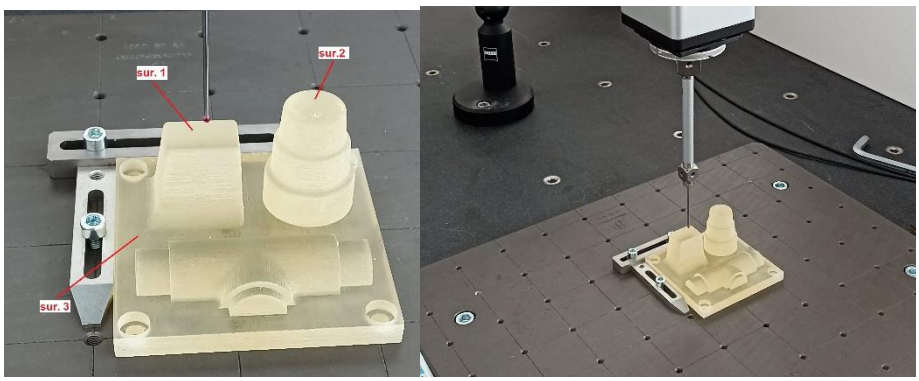

Fig. 1: Flatness measurement of casting patterns produced by PJM technology.

Results and Discussion

To assess the flatness of the surface of the analyzed model, the FLTt parameters interpreted in accordance with the ISO12781 standard as peak-valley flatness deviation of the surface were used. The research results have been presented in Table 1.

Tab. 1: Research results.

Layer Thickness, mm	Printing Direction, º	FLTt (sur. 1), mm	FLTt (sur. 2), mm	FLTt (sur. 3), mm
0.016	0	0.015	0.023	0.069
0.016	90	0.024	0.024	0.095
0.032	0	0.026	0.031	0.099
0.032	90	0.035	0.059	0.108

Analyzing the test results presented in Table 1, it can be concluded that the smallest values of flatness deviation FLTt for all examined surfaces were obtained for casting patterns made taking into account the thickness of a single building layer of Lt=0.016mm and the printing angle of Pd=0˚. Hence, the highest values of the flatness deviation FLTt were obtained for Lt=0.032mm and Pd=90˚. In addition, it can be stated that the dominant values of flatness deviations were recorded for the base of the model (sur. 3). It should be noted that this is the largest analyzed surface, which, as a result of the printing process, may be more exposed to the influence of printing errors and deformation.

Conclusions

Research results have shown that the printing direction and the thickness of a single layer of building material in the PJM technology have a significant impact on the value of the flatness deviation of the key surfaces of the casting patterns. In this case, it is recommended to use the printing angle 0˚ and the smallest thickness of the layers of the building material, i.e. Lt=0.016mm. As part of further research, the authors will assess flatness deviations of casting models made with other incremental technologies and take into account variable technological parameters.

Acknowledgments: The research was financed by the National Centre for Research and Developments part of the Lider XI project, number LIDER/44/0146/L-11/19/NCBR/2020, under the title "An analysis of application possibilities of the additive technologies to rapid fabrication of casting patterns".

Conflict of Interest: The authors declare no conflict of interest.

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Multiscale assessment of casting patterns surfaces produced by PolyJet Matrix additive technology

Gogolewski D.[1,*], Zmarzły P.[1], Kozior T.[1]

[1] Faculty of Mechatronics and Mechanical Engineering, Kielce University of Technology, al. Tysiąclecia Państwa Polskiego 7, 25-314 Kielce, Poland

[*] Corresponding author: dgogolewski@tu.kielce.pl

Abstract: The article presents the results of an experimental study evaluating the effect of the forming process on the variation of the surface topography of samples made by PJM technology under various technological parameters. The material used to manufacture the samples was FullCure 720. The evaluation of the surface topography was carried out using one of the multiscale methods - wavelet transformation. The decomposition was carried out using selected mother wavelets on 2D surface profiles. The analysis showed differences in the variation of the distributions of surface topography irregularities before and after carrying out a certain number of moldings. The study provides information on the distributions of irregularities and morphological features on the surface of additively produced samples, as well as the influence of real molding conditions on the variation of surface irregularities of casting patterns.

Keywords: wavelet transformation, multiscale analysis, surface topography, additive technology, casting

Introduction

The dynamic development of science and technology determines the possibility of using additive technologies in more and more new application fields [Pagac 2021]. One of the key fields where a potentially large use of them is possible is the foundry industry [Tang 2021]. The rapid fabrication of the first sample and the ability to evaluate the ready-made model can often lead to greater company competitiveness and potential financial benefit. However, it is crucial to evaluate the quality of the made patterns as well as to control the technological process. The development of additive technologies has resulted in the use of more and more complex algorithms for evaluation. One of the dynamically developed algorithms used in the evaluation of surface roughness distributions is wavelet transformation. The method allows the evaluation of surface features while taking into account scale size and detecting information that is often filtered out when other metrology operations are used [Gogolewski 2023a]. The wide spectrum of mother wavelets determines the possibility of optimizing the filtering process in terms of identifying additional morphological features on the surface. Based on the current state of the art, it should be concluded that wavelet analysis is a suitable tool that can be successfully developed to assess changes in surface topography. Potentially high diagnostic capabilities and sensitivities to relatively small changes in the analyzed signals highlight the need for in-depth analysis [Gogolewski 2023b]. Currently, there is a lack of research relating to multiscale analysis of the impact of the forming process on surface roughness. The research fills out a research gap and increases the potential practical applicability of additive technologies and modern multiscale methods in aspects of their use in the foundry industry, which is part of the fourth industrial revolution.

Materials and Methods

The test specimens were produced by PJM (PolyJet Matrix) technology from FullCure 720 material using a Connex 350 printer. The analyzed technological parameters were the layer thickness, which was selected as Lt = 0.016 mm and Lt = 0.032 mm, and the printing direction 0° and 90°. Measurements of 2D surface topography before and after molding were carried out using a Talysurf PGI1200 stylus profilometer. Measurement parameters were selected in accordance with current standards.

The wavelet transform analysis was carried out using a number of mother wavelet forms with different properties. This allowed us to evaluate the influence of different wavelet types on the analysis results, The wavelets selected for the study were: db2, db12, db20, coif5, sym2, sym8, bior1.5, bior2.4, bior3.9, bior5.5.

Results and Discussion

The study was carried out to determine the nature, size and amount of additional morphological features formed on the surface of parts produced by PJM technology, as well as to assess the influence of the forming process (one-hounded forming cycles) on the variation of surface topography. In addition, statistical analysis using one-way ANOVA was applied for individual mother wavelets. It was assumed that the critical value sufficient to determine similarity is $p > 0.05$. Fig. 1 shows the surface profile before and after the forming process..

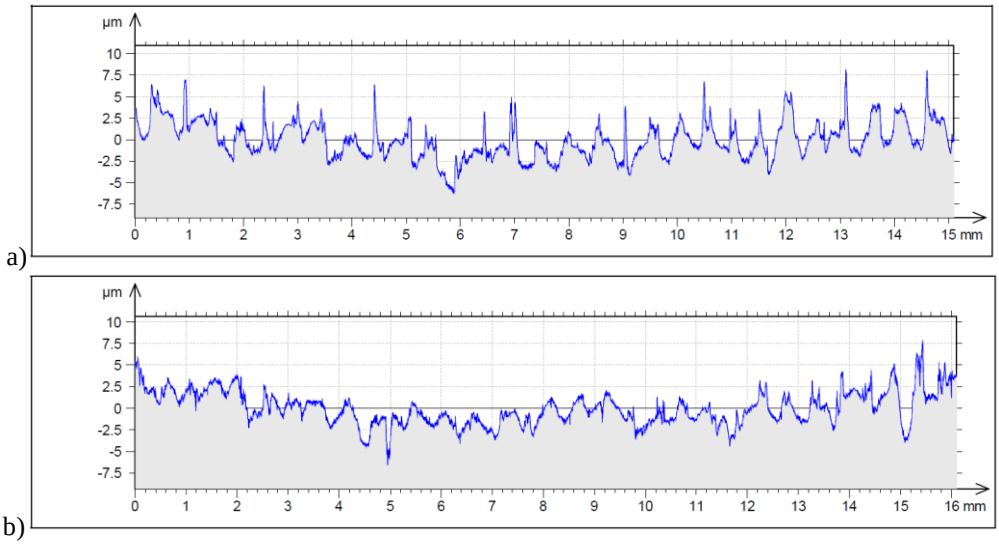

Fig. 1: Example of surface profiles a) before the forming process b) after the forming process.

The statistical tests performed and the analysis using selected mother wavelets showed a variation in the nature of the roughness distributions with respect to scale. The ability to discriminate the surface profiles obtained before and after the forming process gives information on the influence of the forming process on the variation of the surface topography, and allows to better understand the possibility of potential mold wear.

Conclusions

This paper presents an evaluation of the variability of the distributions of surface irregularities of parts manufactured with the PolyJet Matrix additive technology. Tests conducted using wavelet transform and statistical analysis showed the occurrence of characteristic features on the analyzed surfaces. The forming process caused the surface topography to change but with different intensities at particular scales. The study of the values of wavelet transform coefficients at successive levels of analysis showed that for lower scale values the individual features formed during the forming process smoothed out. For larger scale values the tendency is the opposite. This indicates the fact of deformation of the surface by the forming process in terms of its long-term features.

Future research will be focused on evaluating the influence of the forming process on the variation of roughness distributions for other selected additive technologies, as well as for samples made by conventional methods. The analysis is planned to include 2D profiles as well as 3D surfaces.

Acknowledgements: The research was financed by the National Centre for Research and Developments part of the Lider XI project, number LIDER/44/0146/L-11/19/NCBR/2020, under the title "An analysis of application possibilities of the additive technologies to rapid fabrication of casting patterns".

Conflict of Interest: The authors declare no conflict of interest.

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Formation flight control of a team of quadrotors drones via robust fixed-time homogeneous sliding mode

Mechali A.[1,*], Mechali O.[1], Mesicek J.[1], Petru J.[1]

[1] Department of Machining, Assembly and Engineering Metrology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 70800 Ostrava, Czech Republic.

[*] Corresponding author: mechtel166@gmail.com

Abstract: The robust leader-follower formation stabilization is investigated in this paper for a group of quadrotors. Motivated by the weighted homogeneity and Sliding Mode Control (SMC) theories, a fixed-time-SMC-based controller is designed to achieve aerial shape stabilization and trajectory tracking. The control design and the stability analysis show that the formation tracking errors are guaranteed to be fixed-time stable. ROS/Gazebo simulations in the form of comparative studies are drawn to corroborate the findings of this note. Compared to the existing literature, the depicted outcomes confirm the effectiveness of the proposed controller in terms of chattering alleviation, disturbance rejection, and uniform fixed-time convergence.

Keywords: Multi-agent system, fixed-time stability, sliding mode control, weighted homogeneity theory

Introduction

Convergence-time and robustness are primary performance criteria for the formation control algorithms [Mechali 2022]. Regrettably, the existing control methods are incapable of achieving fixed-time convergence and robustness simultaneously. This study aims to investigate the combination of the weighted homogeneity theory and SMC theory. To the best of the authors' knowledge, few reported works in the literature, e.g. [Ai 2019, Li 2019, Ma 2021], address the fixed-time control for multi-quadrotor systems.

The key contributions of this work can be summarized as follows:

(i) Motivated by the homogeneity and SMC theories, a fixed-time-SMC-based controller is skillfully designed to achieve aerial shape stabilization and trajectory tracking.

(ii) Realistic ROS/Gazebo simulations in the form of comparative studies are drawn to corroborate the findings of this note which is motivational for further real-time validation.

Problem Formulation

Consider a leader-follower configuration. The quadrotors' dynamics is modeled by differential equations as

$$\begin{cases} \ddot{x}_i = -m_i^{-1}\left[(c\Phi_i s\theta_i c\psi_i + s\Phi_i s\psi_i)u_{i,z} - k_{i,x}\dot{x}_i + d_{i,x}^{\text{ext}}\right], \\ \ddot{y}_i = -m_i^{-1}\left[(c\Phi_i s\theta_i s\psi_i - s\Phi_i c\psi_i)u_{i,z} - k_{i,y}\dot{y}_i + d_{i,y}^{\text{ext}}\right], \\ \ddot{z}_i = -m_i^{-1}\left[(c\Phi_i c\theta_i)u_{i,z} - k_{i,z}\dot{z}_i + d_{i,z}^{\text{ext}}\right] + \text{g}. \end{cases} \tag{1}$$

Definition 1. Let the formation tracking errors be defined as $e_{i0}^{\xi}(t) \triangleq \xi_i(t) - \xi_0(t) - \delta_{i0}^{\xi},\ i = \overline{1,N}$. This study aims to design $u_{i,z}$, where, for $\forall e_{i0}^{\xi}(t)$, $\exists T_{\text{f}} > 0$, such that $\lim_{t \to T_{\text{f}}} \xi_i(t) - \xi_0(t) = \delta_{i0}^{\xi}$, for $0 < T_{\text{f}} \leq T_{\text{f}}^{\max}$.

Control Design

The control law is proposed as

$$F_{i,x}^{d} \triangleq u_{i,x}^{\text{r}} + u_{i,x}^{\text{eq}}. \tag{2}$$

where $u_{i,x}^{\text{r}} \triangleq -k_{s_i^x}\left(\text{sign}^{1+\frac{1}{\mu}}(s_i^x) - \text{sign}^{1-\frac{1}{\mu}}(s_i^x)\right),\ \mu > 1, k_{s_i^x} > 0,\quad u_{i,x}^{\text{eq}} \triangleq -\hat{d}_{i,x}^{\text{lum}} + \ddot{x}_0 - \upsilon(t) - \omega(t)$,

$s_i^x(t) \triangleq \dot{e}_{i0}^x(t) + \int_0^t \left[\upsilon\left(e_{i0}^x(\tau)\right) + \omega\left(\dot{e}_{i0}^x(\tau)\right)\right]d\tau$, $\upsilon(t) \triangleq k_1^x \text{sign}^{\gamma_1}(e_{i0}^x) + k_2^x \text{sign}^{\gamma_2}(\dot{e}_{i0}^x)$, $\omega(t) \triangleq \bar{k}_1^x \text{sign}^{\bar{\gamma}_1}(e_{i0}^x) + \bar{k}_2^x \text{sign}^{\bar{\gamma}_2}(\dot{e}_{i0}^x)$.

Stability Analysis of the Closed-Loop-System

Theorem 1. Consider the perturbated nonlinear system (1) and the distributed control law synthesized in (2). It results that the formation tracking error $\boldsymbol{e_{i0}^{x}(t)}$ can be stabilized at the origin in a bounded fixed-time.

Proof. The proof is relatively long to be depicted here, hence omitted.

Results and Discussions

The simulation outcomes are presented in Fig. 1. This figure shows the ability of the proposed controller in stabilizing the formation shape. To quantify the obtained results, the ISE index is calculated and depicted in Tab. 1. It can be noted that the suggested controller enjoys better results compared to the other controllers.

Tab. 1: ISE index for the formation tracking errors.

Follower quadrotor	Controller	e_{i0}^{x}	e_{i0}^{y}	e_{i0}^{z}
Follower 1	FC 1	3.578	3.633	2.273
	FC 2 (Li, Yang, and Zhang 2019)	2.437	2.239	0.477
	FC 3 (Proposed)	**0.348**	**0.177**	**0.088**
Follower 2	FC 1	3.771	4.268	1.931
	FC 2 (Li et al. 2019)	2.501	3.702	0.447
	FC 3 (Proposed)	**0.344**	**0.328**	**0.087**

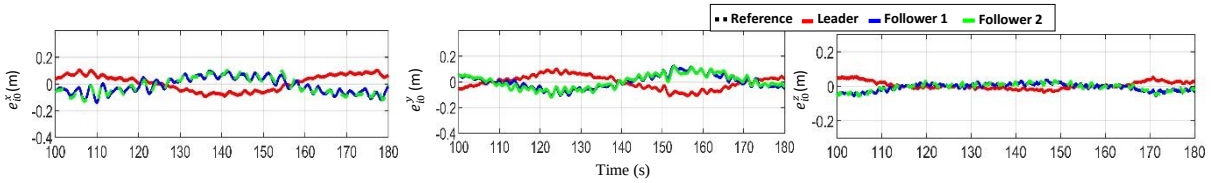

Fig. 1: Formation tracking errors (proposed FC 3).

Conclusions

This note presents formation controller for a team of quadrotors. A homogeneous-SMC-based controller is designed to stabilize the aerial formation shape. Real outdoor flight experiments demonstrate the superiority of the designed controller in terms of performance improvements compared to other related controllers. Further works, could extend the present study for a collaborative task such as payload transportation.

Conflict of Interest: The authors declare no conflict of interest.

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Improving the Accuracy of the Smoking Behavior Warning System Using YOLOV7-Tiny Combined with LSTM on the Jetson Nano Kit

Vo Thien Linh[1,*], Nguyen Kim Vu Bao[2]

[1] Department of Electrical and Electronics Engineering, University of Transport and Communications, No.3 Cau Giay Street, Lang Thuong Ward, Dong Da District, Ha Noi, Vietnam.

[2] Department of English, University of Transport and Communications, No.3 Cau Giay Street, Lang Thuong Ward, Dong Da District, Ha Noi, Vietnam.

[*] Corresponding author: linhvt_ph@utc.edu.vn

Abstract: The aim of this study was to improve the accuracy of the public smoking detection and warning system by using YOLOv7-tiny in combination with a long short term memory network (LSTM). Compared to the old version, YOLOv4-tiny, YOLOv7-tiny has fewer parameters but significantly higher AP validation. This study used YOLOv7-tiny to extract features from each frame of the video, then this sequence of consecutive feature frames was fed into the LSTM network for prediction. The experiment was performed on a separately collected data set with 6000 photos and 120 short clips containing smoking behavior. The results show that this model has successfully detected smoking behavior with higher accuracy than previous methods.

Keywords: smoking behavior, convolutional neural network, deep learning, YOLOv7-tiny, long short term memory (LSTM)

Introduction

Smoking in public places negatively affects public health. However, dealing with this behavior faces many difficulties because of the lack of human resources to monitor and detect violators. There seems to be few technological solutions that can detect this behavior in an accurate and effective manner [Almeida 2018, Jiang 2022, Vo 2021, Vo 2022]. This study is aimed to provide a solution to this problem. This paper includes the following main contents: (1) overview of YOLOv7-tiny network and LSTM time series data forecasting model; (2) building a convolutional neural network (CNN) and predictive behavior model suitable for the problem; (3) network training and software deployment; (4) testing, calibrating, perfecting the equipment and evaluating the system.

Materials and Methods

To detect smoking behavior, we need to analyze people's actions through their gestures. Smoking behavior contains not only spatial information but also temporal information. With the YOLOv7-tiny method, the time information between frames of a video is not effectively processed, which makes the prediction results less accurate. Therefore, in this study, an LSTM network is added to process temporal informations. YOLOv7-tiny was used to extract features from individual frames of a video [Wang 2022]. The sequence of features of these frames was then fed into the LSTM network for prediction. This study used an exclusive data set of 6000 photographs containing smoking behavior in diverse environments (i.e. indoor and outdoor) and 120 short videos containing smoking behavior. These two types of data made up 80% and 20% respectively of the data set to train and test the system. The network model was implemented using Python and darknet libraries on a Jetson Nano embedded computer.

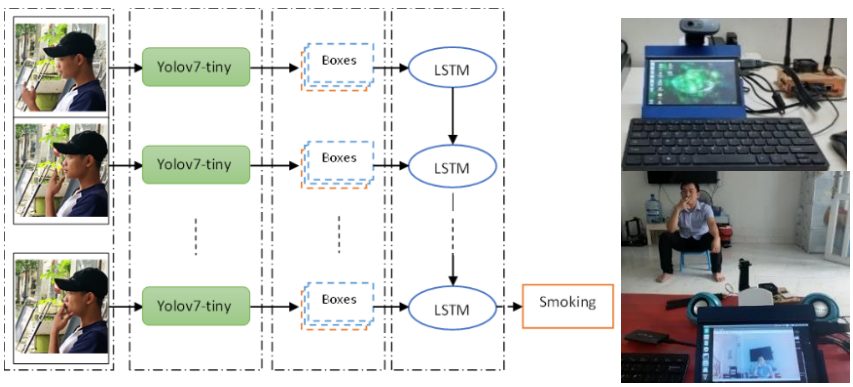

Fig 1. LSTM training diagram and device

Results and Discussion

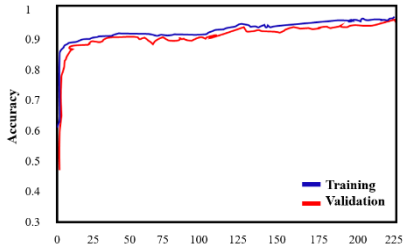

Fig 2. Comparison curve of traning and validation of 225 epochs

The accuracy of the training model on the LSTM network was 96.2% after 225 epochs. The model was then tested on 30 clips containing smoking behavior and 30 clips containing no smoking behavior, under different visual conditions (i.e. light, composition) and with different behavioral patterns (i.e. holding a cigarette, not holding a cigarette).

Tab 1. YOLOv7-tiny combined with LSTM vs. YOLOv4-tiny combined with LSTM

YOLOv7-tiny		Actual values	
		P	N
Predicted values	P	TP=24	FP=7
	N	FN=6	TN=23

YOLOv7-tiny + LSTM		Actual values	
		P	N
Predicted values	P	TP=26	FP=3
	N	FN=4	TN=27

YOLOv4-tiny + LSTM		Actual values	
		P	N
Predicted values	P	TP=25	FP=6
	N	FN=5	TN=24

As presented in the confusion matrix, when tested on a set of videos containing smoking behavior and no smoking behavior, the YOLOv7-tiny method showed an accuracy rate of 78.33%; the YOLOv7-tiny method combined with LSTM showed an accuracy rate of 88.33%, while the similar model with YOLOv4-tiny+LSTM yielded a lower accuracy rate, only 81.67%. With Jetson-Nano-Dev-Kit enabled GPU and SSD M2-SATA 64GB, the processing speed of the YOLOv7 - tiny method reaches 14 FPS (Frame Per Second), the YOLOv7-tiny + LSTM method reaches 7.68 FPS and the YOLOv4-tiny + LSTM method 8.5 FPS.

With confounding cases, i.e., behaviors similar to smoking behavior, the proposed method resulted in more accurate predictions than the YOLOv4-tiny method [Vo 2021, Vo 2022]. The reason is that the YOLOv4-tiny method proved to be less effective when predicting bounding boxes at instantaneous times. Since the bounding box predictions are not sufficiently accurate, the conclusions also have a higher probability of being wrong. In contrast, the YOLOv7-tiny method combined with LSTM has the ability to predict the bounding boxes more effectively, thereby detecting smoking behavior more accurately.

Conclusions

This study showed that the model combining YOLOv7-tiny and LSTM were more effective in detecting smoking behavior than the model combining YOLOv4-tiny and LSTM. This method can be applied in practice with simple equipment requirements: a Jetson Nano embedded computer with camera and speaker connection. For optimal results, it is recommended to install the camera with a direct view of the target subject.

Conflict of Interest: The authors declare no conflict of interest.

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An Efficient Method to Control IoT-based Spider Robot by Speech Detection

Dang Khoa Phan[1], VanDung Nguyen[1,*]

[1] Faculty of Electrical and Electronics Engineering, Ton Duc Thang University; 19 Nguyen Huu Tho, District 7, Ho Chi Minh City, Vietnam; 41900220@student.tdtu.edu.vn, nguyenvandung@tdtu.edu.vn

[*] Corresponding author: nguyenvandung@tdtu.edu.vn

Abstract: To solve monitor the dangerous area that is difficult for humans to reach such as earthquakes, and volcanoes…, one known robot is a spider hexapod robot. The advantage of the spider hexapod robot is to climb or walk into the area to be observed in order to give the information by video capture. Along with the development of IoT applications in the speech detection field, automatic robots can become easy and humanless. Our project develop a spider hexapod robot based on IoT devices and speech detection methods to control robots on the specific demand. Practice results demonstrate that our project works efficiently, stably and has future prospects.

Keywords: spider hexapod robot, speech detection, automatic robots, IoT

Introduction

There are many different types of walking robots with the Internet of Things IoTs. Robotics and IoT work together, called IoRT which collaborates with the fields of the Internet of Things and Robotics to bring the power of computing into the physical world. IoT-based spider robot has six legs for their movement which is more stable and flexible than four- or two-legged quadruped robot [Uddin 2019, Beer 1992, Zhanghe 2014], as shown in Fig.1. IoT creates independent, smart networks, and truly autonomous networks to carry out complex tasks in the physical world [Uddin 2019]. The spider hexapod robot and IoT together have great potential.

Fig. 1: The spider hexapod robot

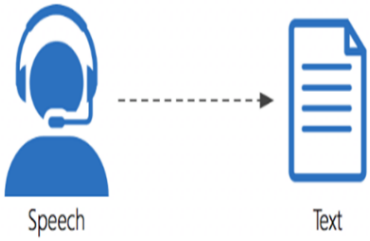

Fig. 2: Speech processing

Materials and Methods

1. IoT: Sensing, connectivity, communication, speech processing (Fig. 2). IoT networks take sensory input, perform speech recognitions, learn from the environment, communicate with spider hexapod robots via simple methods, and perform operations that produce some outcome.
2. Spider hexapod robotics: Sensing, controlling, processing, acting, and interacting.

Speech recognition includes two stages: Voice recognition and Speech recognition.

- Voice recognition involves identifying an individual's exact voice, similar to a method of biometric recognition.
- Speech recognition is the process of identifying words in a sentence and then translating them into computer language.

Results and Discussion

In this project, we have programmed the commands to be "go forward", "go back", "go left", "go right", "stop" so that when the input voice matches the pre-programmed commands, then the robot will move, as shown in Figs. 3,4 and 5.

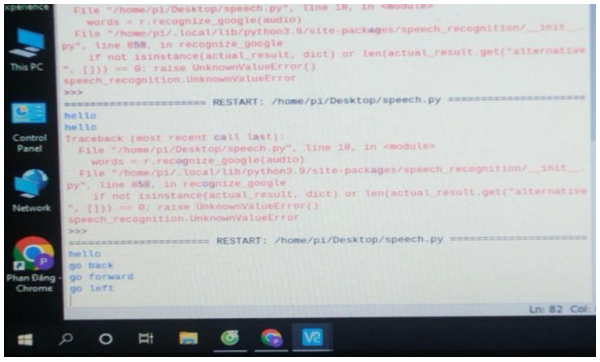

Fig. 3 The operation of the speech detection system.

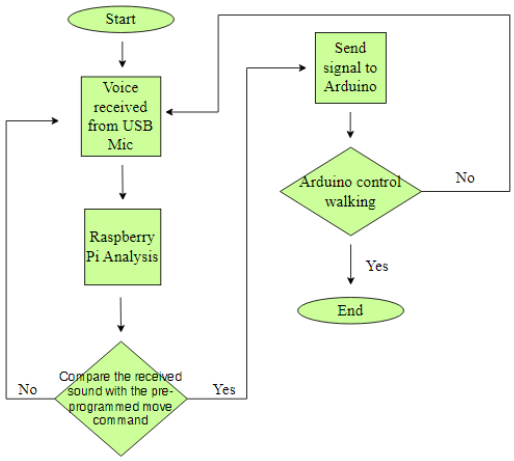

Fig. 4: Flowchart of Spider Robot working process

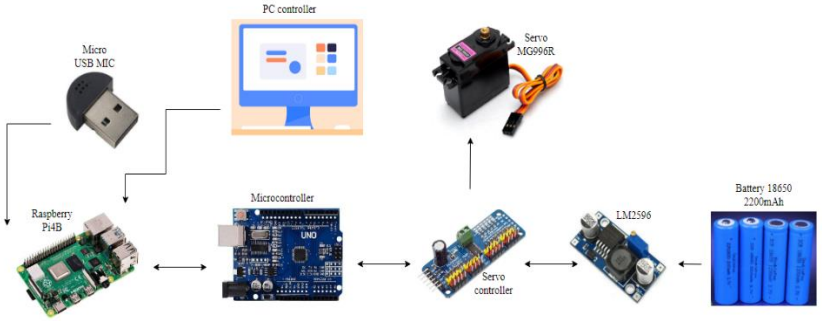

Fig. 5: Electrical throng of total project

Conclusions

Our project developed and evaluated a spider hexapod robot based on IoT devices and speech detection methods to control robots on "go forward", "go back", "go left", "go right", and "stop" voice control. In future work, we will integrate a camera and image detection into a spider hexapod robot to find specific object.

Conflict of Interest: The authors declare no conflict of interest.

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Time to Modernize Rental Management Using IoT Application

Mai Ai Binh Tang[1], Hoang Minh Nguyen[1], Thanh Dat Ngo[1], VanDung Nguyen[1,*]

[1] Faculty of Electrical and Electronics Engineering, Ton Duc Thang University; 19 Nguyen Huu Tho, District 7, Ho Chi Minh City, Vietnam; 41900335@student.tdtu.edu.vn, 42101408@student.tdtu.edu.vn, 41900355@student.tdtu.edu.vn, nguyenvandung@tdtu.edu.vn.

[*] Corresponding author: nguyenvandung@tdtu.edu.vn

Abstract: Along with the advantages of IoTs in Industry, the development of rental management is hugely changing and growing. By using IoT, rental management brings more comfortable and easier for both room renters and owners than traditional management. The main problems of room renters are how to monitor and track information like energy and water wastage monthly or day-to-day life. Therefore, our projects design IoT automation and smart systems to give full deals for their homes, electricity, and other amenities. Using web servers, sensors, database applications, and smart devices, our project together has great potential base on our practical results.

Keywords: rental management, IoT, electricity monitoring system, water monitoring

Introduction

Internet of things (IoT) with the help of IoT sensors, connects various physical objects located on real estate properties, and vast amounts of data can be collected and integrated. According to [Link, available], IoT-driven real estate applications can address challenges such as covid-19 and the limitations it caused, affordable housing, incident management, environmental impact, resource consumption, weather-related risks, etc... Moreover, the use of IoT in real estate varies depending on a specific property's features and purpose, for example, optimizing resource consumption or enhancing sustainability overall. At room for rent, the energy that is mainly being used and consumed on water heating, lighting, air conditioner, refrigerator, and more... Both the energy and water consumptions need to be monitored by both household and room renters.

Materials and Methods

Our project designed IoT-based rental management into three components: IoT-based smart electricity monitoring, IoT-based smart water monitoring, and IoT website application, as shown in Fig. 1.

1. The proposed IoT-based smart electricity monitoring system is designed and developed considering Raspberry Pi 4, a liquid crystal display (LCD), an PZEM 004T current sensor module, relays, and AC sources [Arsene 2022].
2. The IoT-based smart water monitoring GPIO pins of Raspberry Pi 4 (general-purpose input/output) are connected to several YF-S201 flow meters to monitor and collect the water flow through several pipes [Hasan 2021].
3. IoT website application allows the sensor data to be displayed in the user interface. The real-time feed is provided by the sensors using a sampling time of 10 s which can be configured for each IoT devices.

Results and Discussion

Our project designed an efficient technique that can monitor power and water consumption in the room for rent. The website was designed as shown in Fig2. Both household and room renters can monitor them. When the household wants to pay an invoice, he can send an email and sms by using our application via the “Send” Option.

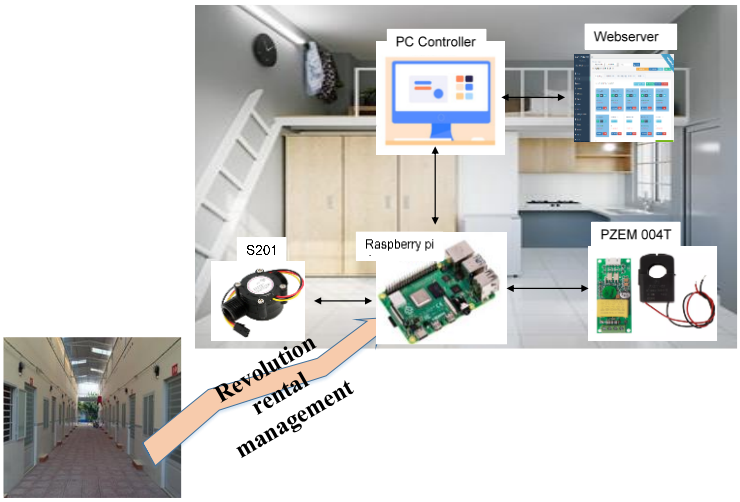

Fig. 1: Design of rental management architecture.

Fig. 2: Website application interface.

Conclusions

Our project proposed the rental management system that can monitor and track information like energy and water wastage monthly or day-to-day life. In future work, we design a security system for both room renters and households to access their information.

Conflict of Interest: The authors declare no conflict of interest.

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Exploring the effectiveness of intelligent computational models for fake news detection

Thanh-Cong Truong[1,*], Trung-Kien Nguyen[1], Quang-Truong Pham[1], Chau-Anh Dang[1], Hoang-My Cao Ly[1], Phuong-Linh Tran Thi[1]

[1] Faculty of Information Technology, University of Finance - Marketing, Ho Chi Minh City, Vietnam

[*] Corresponding author: ttcong@ufm.edu.vn

Abstract: With the increasing popularity of online media, the prevalence of fake news has become a matter of concern, as it is spreading rapidly. It is crucial to verify the accuracy of information before sharing it, as fake news, if left unchecked, can cause substantial harm. While there have been several methods proposed for detecting fake news, including relying on human experts, this approach is not effective for dealing with the current abundance of news. Currently, there is substantial interest in utilizing machine learning and deep learning techniques for distinguishing between real and fake news. In this study, the performance of various computational techniques was evaluated on three different datasets, ISOT, Liar, and COVID-19 Fake News Dataset, through a benchmark analysis. The results indicate that the transformer model is the best of all the models due to its best results and performances in three datasets. This benchmark study serves to assist the research community in further exploring the field of fake news detection by providing guidance on the most effective method for detecting fake news.

Keywords: Fake news detection, machine learning, deep learning, transformer-based model

Introduction

In recent times, information from social media has developed at an unprecedented rate, and the number of people using social media daily to search for information is increasing. However, not all news sources on social media are reliable. As a result, the spread of fake news is becoming more serious. "Fake news" is a term referring to news with the intention of deceiving readers and has been proven to be untrue. Issues of fake news have existed since the emergence of print media. Nevertheless, in today's age of social media, fake news has a very large impact because of the simple access and rapid dissemination of information through media. Typically, to verify the authenticity of news, we rely on the assessment of experts, but this is no longer feasible with the massive amount of news today. Therefore, the automatic detection of fake news on social media is an important issue that has attracted attention from both the scientific community and the public. Methods using Machine learning (ML) and Deep learning (DL) have been proven to be very effective in solving many information security issues, from detecting network intrusion to analyzing malicious software, as well as identifying spam emails. This study aims to compare popular classification methods by conducting experiments on publicly available fake news datasets. Specifically, the authors test the performance of five traditional ML algorithms, three Ensemble methods, and three DL-based techniques on three public fake news datasets: ISOT, Liar and COVID-19 Fake News Dataset.

Materials and Methods

Execution environment

The environment chosen for testing is Google Colab because it is a free service from Google to support research and learning in artificial intelligence, has a GPU to run Python programs, and supports Deep Learning.

Dataset

We used three public datasets to measure the performance of different methods: ISOT, Liar and COVID-19 Fake News Dataset.

Methodology

Initially, the data undergoes a pre-processing stage where redundant elements such as special characters, numerical values, and stop-words are filtered. Subsequently, a feature selection and extraction process is employed to reduce the dimensionality of the feature space through the utilization of following techniques: Term Frequency - Inverse Document Frequency (TF-IDF) with n-grams, and word embeddings. Finally, classifiers are computed on the fake news dataset to produce meaningful results.

Evaluation

Eleven models underwent evaluation through the utilization of a 5-fold cross-validation technique. The evaluation measures employed for this purpose were precision, recall, and the f1-score.

Results and Discussion

Results

Tab.1 illustrates the performance of the methods on three datasets, accordingly. We assess the accuracy, precision, recall, and f1-score for fake and actual class, then compute the average and present an average score of these measures.

Tab. 1: Performance on three datasets

Datasets / Model	LIAR			ISOT			COVID-19		
	Prec.	Rec.	F1	Prec.	Rec.	F1	Prec.	Rec.	F1
LR	0.60	0.60	0.60	0.98	0.98	0.97	0.93	0.93	0.93
Naive Bayes	0.61	0.58	0.48	0.94	0.95	0.95	0.90	0.90	0.90
SVM	**0.65**	**0.65**	**0.65**	0.98	0.98	0.97	0.93	0.93	0.93
KNN	0.56	0.57	0.53	0.85	0.84	0.84	0.82	0.8	0.78
Decision Tree	0.55	0.56	0.55	0.97	0.97	0.98	0.85	0.85	0.85
Random Forest	0.56	0.57	0.55	0.93	0.94	0.94	0.89	0.89	0.89
Extra Trees	0.57	0.58	0.56	0.92	0.93	0.93	0.88	0.87	0.87
AdaBoost	0.57	0.56	0.4	**0.99**	**0.99**	**0.99**	0.94	0.93	0.93
LSTM	0.60	0.61	0.59	0.97	0.97	0.98	0.94	0.94	0.93
BiLSTM	0.60	0.61	0.59	0.98	0.98	0.98	0.93	0.93	0.93
BERT	**0.65**	**0.65**	**0.65**	**0.99**	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**

Discussion

Our investigation reveals that the BERT-based models show exceptional performance compared to other models when applied to all three datasets. Additionally, the SVM (with bi-gram) model either performed equally well or outperformed the Deep Learning models on small datasets. The results also indicated that Deep Learning models with a greater number of attributes performed better, as demonstrated by the superiority of the BiLSTM model over the LSTM model. Of the ensemble models evaluated, the AdaBoost classifier demonstrated superior performance when utilized on a larger dataset. To summarize, the evaluation results indicate that the BERT-based model was the most effective in detecting fake news across all three datasets. However, for smaller datasets, traditional Machine Learning may be a more viable solution due to its lower computational and time complexity.

Conclusions

In this study, the authors present a comprehensive analysis of the performance of various methods for detecting fake news on social media using three datasets. Eleven classification models were evaluated on three real-world data sets and the results were measured using precision, recall, and F1-score metrics. The empirical results indicated that the BERT-based model was the most effective among all the models, achieving the best results across all datasets. As part of future work, the authors plan to investigate the performance of these models on low-resource languages, specifically the Vietnamese language.

Conflict of Interest: The authors declare no conflict of interest.

Comparing Machine and Deep Learning Models for Sentiment and Rating Prediction in E-commerce Reviews

Dang TD[1,*], Mai XA[1], Trinh HK[1]

[1] School of Computing and Information Technology, Eastern International University, Binh Duong, Vietnam

[*] Corresponding author: doan.dang@eiu.edu.vn

Abstract: The growth of e-commerce has led to an abundance of user-generated content (UGC), which can provide valuable information for improving the customer experience. This study investigates the effectiveness of machine learning (ML) and deep learning (DL) models in predicting sentiment and rating from customer reviews. Our models are trained to classify reviews as positive, negative, or neutral and predict customer ratings on a scale of one to five stars. To achieve this, we collected a dataset of 24,228 unique UGC from an e-commerce platform named tiki.vn. Our findings reveal that DL model based on Artificial Neural Networks (ANN) algorithm outperforms five ML algorithms, including Multinomial Naive Bayes (MNB), K-Nearest Neighbors (KNN), Decision Tree (DT), Gradient Boosting Classifier (GBC), Extreme Gradient Boosting (XGBoost) for sentiment classification and rating prediction, demonstrating the potential of DL models in e-commerce. These results have practical implications for the e-commerce industry, highlighting the potential for ML and DL models to extract valuable insights from UGC and improve the overall customer experience.

Keywords: User-generated content, Machine learning, Deep learning, Sentiment analysis, e-commerce platform

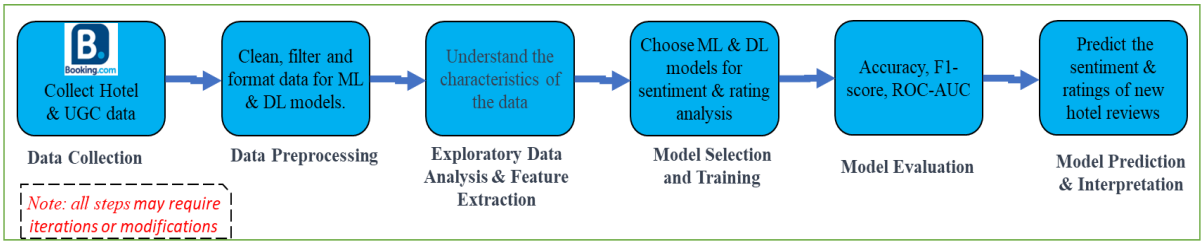
Introduction

In recent years, e-commerce has revolutionized the retail industry, creating an abundance of UGC that can offer valuable insights into customer behavior and preferences [Duan 2022]. UGC comprises a range of customer-generated content, including reviews, feedback, and ratings, that can help businesses understand customer sentiments and improve the overall customer experience [Subramanian 2021]. ML and DL techniques have been widely used to analyze UGC, with studies demonstrating their effectiveness in predicting customer sentiment and rating from reviews [Li 2022]. This study aims to explore using ML and DL models to predict sentiment and ratings from customer reviews in e-commerce platforms. Specifically, we train our models to classify reviews as positive, negative, or neutral and predict customer ratings on a scale of one to five stars. The data used in this study was collected from tiki.vn, a popular e-commerce platform in Vietnam. We compare the performance of DL and ML models in terms of accuracy and efficiency for sentiment classification and rating prediction. Our study contributes to the existing literature on UGC analysis by highlighting the potential of DL models in e-commerce. The results have practical implications for e-commerce platforms, as they demonstrate the potential of ML and DL models in improving the overall customer experience through analyzing UGC.

Materials and Methods

The methodology adopted in this study provides a rigorous approach for predicting sentiment and ratings of tourism user-generated content using ML and DL models [Li 2022] and [Subramanian 2021]. Fig. 1 describes the general procedure to predict sentiment and ratings of tourism UGC using ML and DL models. Data were collected from tiki.vn using the requests library in Python. The dataset includes 20 attributes such as “comment”, “rating”, “product”, ”price”, and others. However, this study uses two attributes: “comment” and “rating” for natural language processing tasks. Data were preprocessed by removing irrelevant information, duplicated reviews, and applying text normalization—finally, 24,228 valid records out of an initial dataset of 28,295. Two models have been developed in the model selection and training: ML and DL models, using five ML algorithms MNB, KNN, DT, GBC, XGBoost and a DL algorithm called ANN [Subramanian 2021].

Fig. 1: General procedure to predict sentiment and ratings of tourism use UGC



Model performance was evaluated using several metrics, such as accuracy, precision, recall, and F1-score, and confusion matrices were used to determine true/false positives and negatives. Python 3.9 and related ML libraries (e.g., pandas, sklearn, keras) were used to complete the processes. However, some steps may require iterations or modifications based on the specific characteristics of the data and the improvement of the performance of algorithms.

Results and Discussion

This study used various ML and DL algorithms to classify sentiment in text data [Kitsios 2022] and [Subramanian 2021]. The ML algorithms used were MNB, KNN, DT, GBC, XGBoost and DL algorithm used was an ANN. We first preprocessed the text data by removing stop words, punctuation, and special characters and stemming the words. We then split the data into training and testing sets (80/20) and trained the models on the training data. In sentiment analysis, ML algorithms achieved an average accuracy of 0.83, with MNB and KNN achieving the lowest accuracy of 0.83 and XGBoost achieving the higher accuracy of 0.88. The XGBoost and ANN achieved an accuracy of 0.88, outperforming other ML algorithms. The precision, recall, and F1 score was also calculated for each algorithm [Subramanian 2021]. XGBoost and ANN both achieved the highest accuracy and F1 score among all algorithms. However, ANN has higher overall accuracy results from the predicted rating scores are described in Tab. 2.

Tab. 2: Performance measures of prediction full models

Modeling Method	**Predict Comment Sentiment**				**Predict Rating Scores**
	Overall Accuracy	**F1-Scores**			**Overall Accuracy**
		negative	*neutral*	*positive*	
Multinomial Naive Bayes	0.83	0.23	0.00	0.91	0.71
K-Nearest Neighbors	0.83	0.06	0.09	0.90	0.71
Decision Tree	0.86	0.61	0.36	0.93	0.75
Gradient Boosting Classifier	0.87	0.61	0.17	0.93	0.71
Extreme Gradient Boosting	**0.88**	**0.68**	**0.08**	**0.94**	**0.76**
Artificial neural networks	**0.88**	**0.66**	**0.39**	**0.94**	**0.77**

These results suggest that DL algorithms can perform better than traditional ML algorithms in sentiment classification tasks. However, it should be noted that DL algorithms require more computational resources and longer training times than ML algorithms. Thus, the choice of an algorithm should be carefully considered based on the specific application and available resources.

Conclusions

This study explores ML and DL models for predicting sentiment and rating using the UGC dataset from tiki.vn that one of the top e-commerce platforms in Vietnam. Five ML and DL models are proposed and implemented. Results showed that DL models outperformed almost ML models in accuracy and efficiency, with ANN achieving the highest accuracy and F1 score. This study adds to the growing research on ML and DL models for predicting sentiment and ratings from e-commerce platforms. In addition, this study has practical implications for e-commerce businesses and sellers, highlighting the potential for ML and DL models to improve the customer experience. These analysis results can help new stores identify opportunities and threats before joining e-commerce platforms [Li 2022]. Future research could explore integrating UGC data and social network data to improve the performance of models [Kitsios 2022].

Conflict of Interest: The authors declare no conflict of interest.

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Web Scraping for Big Data Collection in Tourism: A Case Study of Booking.com

Doan DT[1], Huy DDT[1,*], Thanh NN[1], Vinh ND[1], Dai NT[1]

[1] School of Computing and Information Technology, Eastern International University, Binh Duong, Vietnam

[*] Corresponding author: huy.do@eiu.edu.vn

Abstract: This study addresses the need for more tools for business researchers in the growing tourism and hospitality sector. By utilizing web scraping techniques and the Node.js library Puppeteer, this study presents a novel approach to data collection in this field. The research focuses on obtaining data from Booking.com, the widely used online global travel agency. The collected data encompasses information from hotel service providers and user-generated content (UGC), providing a more comprehensive and diverse perspective on the industry. The results of this study highlight the feasibility and effectiveness of using web scraping techniques for Big data collection in the tourism and hospitality sector, addressing the need for more tools available to business researchers in this field. The findings of this study make a valuable contribution to the existing literature by demonstrating the potential of web scraping as a tool for unstructured data collection for business and economic researchers and practitioners.

Keywords: web scraping, Big data, user-generated content, business and economic studies

Introduction

The tourism and hospitality industry has become a significant area of interest for researchers and practitioners analyzing performance, trends, and challenges [Puh 2022, Zarezadeh 2022]. Traditional data collection methods are often cost-prohibitive and time-consuming, prompting the need for alternative approaches [Chang 2022]. Many studies noted the lack of UGC datasets for empirical business research and emphasized the need for developing new tools and methods for unstructured data collection in the tourism and hospitality sector and related fields [Mariani 2022]. Web Scraping has emerged as an effective and efficient option for large-scale data collection from online sources. Node.js, a popular web application platform, offers a flexible and robust framework for developing web crawlers that can extract data from various online sources. This study presents a novel approach to data collection in the tourism and hospitality sector using a Node.js-based crawling program that focuses on collecting digital content from Booking.com [Chang 2022]. This study will contribute to research communities by demonstrating the feasibility and effectiveness of web scraping techniques for unstructured data collection in the tourism and hospitality sector that can extract data from online sources and provide insights for business and economic researchers and practitioners [Puh 2022]. It has significant implications for developing new tools and methods for Big data collection in the tourism and hospitality sector and other related fields.

Materials and Methods

In this study, to collect data from the Booking.com website focus on hotels in Ho Chi Minh City, Vietnam, this study employed web scraping techniques using a Node.js based crawling program developed with the Puppeteer library [Chang 2022]. Puppeteer provides a high-level API to control headless Chrome or Chromium, allowing for automated web browsing and user interaction. The summary process and code described in the Fig. 1 and Fig. 2.

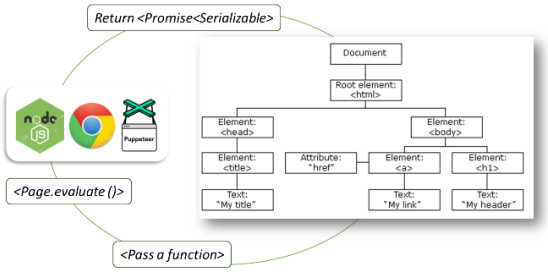

Fig. 1: Flow library Puppeteer works

```
import puppeteer from 'puppeteer';

(async () => {
  const browser = await puppeteer.launch();
  const page = await browser.newPage();

  await page.goto('https://developer.chrome.com/');

  // Set screen size
  await page.setViewport({width: 1080, height: 1024});
```

Fig. 2: Flow library Puppeteer works

The crawling program was designed to visit the Booking.com website and extract visible data from hotel pages for the specified hotel characteristic as hotel name, hotel star, location, address, and all UGC such as reviews, rating categories scores (staff, facilities, cleanliness, comfort, value for money, location, and free WiFi) and customer rating score (*details see Tab. 1*). The crawler was run in Feb 2023, collecting data on all visible hotels listed on Booking.com in Ho Chi Minh City during that time. The extracted data was then saved in CSV format for further analysis. The web scraping methodology in this study allowed for the efficient and comprehensive collection of digital content from the Booking.com website, providing a large and diverse dataset for analysis.

Results and Discussion

Our study collected a large amount of data from the Booking.com website using the Node.js-based crawling program developed with the Puppeteer library. The data collected included information on hotel names, addresses, star ratings, and prices, as well as UGC, such as customer scores, comments, and guest booking information. A total of 1,000 hotels in Ho Chi Minh City, Vietnam, were included in the study; a total of 156,258 records with 33 attributes have been collected. All attributes could be use in future research in the field of tourism and hospitality.

Tab. 1: Summary attributes

Attributes	**Data Type**	**Attributes**	**Data Type**
Hotel information (name, address, star, room type)	Text, various	Hotel average rating scores of 7 categories	Number, from 1 to 10
Hotel overall rating scores	Number, from 1 to 10	Guest comments (like/dislike)	Text, various
Hotel times reviewed	Number	Guest review score	Number, from 1 to 10
Guest nationality	Categorical, various	Guest types of the room used	Categorical, various
Guest Date check-in/out	Date	Guest review with pictures	Binary (0,1)
Guest days	Number, from 1 to 10	Guest Date review	Date

The findings of this study demonstrated the feasibility and effectiveness of web scraping techniques for Big data collection in the tourism and hospitality sector, particularly for Ho Chi Minh City. The collected data provided a comprehensive and diverse perspective on the industry, including insights into hotel features, guest feedback, and other UGC information. The study's findings suggest that web scraping can offer valuable business and economic research data, enabling researchers and practitioners to identify trends, opportunities, and challenges in the tourism and hospitality sector [Puh 2022]. For example, the collected data could inform hotel management, marketing, and product development decision-making. In terms of performance, Puppeteer's headless browser provides more accurate web page interaction than other crawlers using HTTP requests. These methods allow it to bypass anti-bot measures, making it more reliable for web scraping. However, using web scraping techniques also raises concerns about data privacy and ethical considerations.

Conclusions

This study demonstrated the effectiveness of web scraping techniques in the tourism and hospitality sector using the Puppeteer library. The findings indicate that the Puppeteer library offers a viable and effective alternative for web scraping tasks, providing advantages over traditional methods that rely on HTTP requests. These advantages can benefit researchers and practitioners in business and economics by facilitating more comprehensive and diverse perspectives on the industry [Chang 2022]. Future research can explore new tools and methods to collect more diverse and comprehensive data to provide better decision-making and policy development. Future research can use machine learning and natural language processing techniques to perform sentiment analysis and predictive modeling on the collected data [Mariani 2022].

Conflict of Interest: The authors declare no conflict of interest.

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A Bibliometrics Study on Internet of Things in Healthcare

Hoang-Sy Nguyen[1,*], Thu-Ngan Phan Thi[2], Quoc-Phu Ma[3]

[1] Becamex Business School, Eastern International University, Binh Duong Province, Vietnam.

[2] Research Construction Technology Institute, Thu Dau Mot City, Binh Duong Province, Vietnam.

[3] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering,VSB-Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: sy.nguyen@eiu.edu.vn

Abstract: Application of Internet of Things (IoT) in healthcare has been a popular topic in the recent years. This paper attempts to provide readers the trend of such applications both from the research and practical perspectives. In particular, we assess the number of scientific articles and patents within the period of 2015-2022. We then use the two-stage process following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and screening techniques. From that, the relations between the affiliations, authorship, research keywords and direction can be drawn. Besides, the paper provides a brief view into the role of IoT in healthcare research and application, which would be useful for both researchers and practitioners.

Keywords: healthcare; IoT; bibliometrics; meta-analysis

Introduction

Internet of Things (IoT) is state-of-the-art information technology (IT) usage in healthcare. In this field, IoT defines the intelligent healthcare devices which are interconnected via the Internet. Owing to the capability to extensively share and act upon the collected data, these devices have the outstanding ability to monitor health remotely, detect disease early, etc. IoT can improve the patients' well-being and significantly reduce the hospitalizing costs.

Materials and Methods

The study was conducted in Dec 2022 on Scopus database with focus only on English documents. In the Scopus database, the searched terms "Internet of Things" and "Health" were used. The query returned 577 articles and 291 patents. The results were then exported to .csv format and analyzed. Regarding the method for the analysis, we used the two-stage process following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [Page 2021] and screening process reported in [Qi 2020]. VOSviewer was then used to visualize the map of research keywords. We also reported the number of publications and patents over years and the top journals that published those papers.

Results and Discussion

The number of articles and patents in the period of 2015-2022 is illustrated in Fig.1.

Articles	3	24	25	49	65	101	140	170
Patents	7	10	24	28	34	54	54	80

Fig. 1: Number of publications and patents throughout the years.

As can be seen in Fig.1, the number of articles and patents regarding the application of IoT in healthcare only started to surge from 2016. Within 7 years, the number grows 7 times for scientific articles and 8 times for patents, indicating the growing interest of both the researchers and practitioners in this topic.

The top 3 journals that the authors chose to publish are listed in Tab.1.

Tab. 1: Journal ranking.

No.	Journal	No. of articles
1	Journal of Healthcare Engineering	60
2	International Journal of Environmental Research and Public Health	35
3	Journal of Medical Systems	33

As can be seen in Tab.1, the journal in the first place published almost double the number of articles in comparison with the journal in the second place.

The extracted articles have the keywords which are connected as shown in Fig.2.

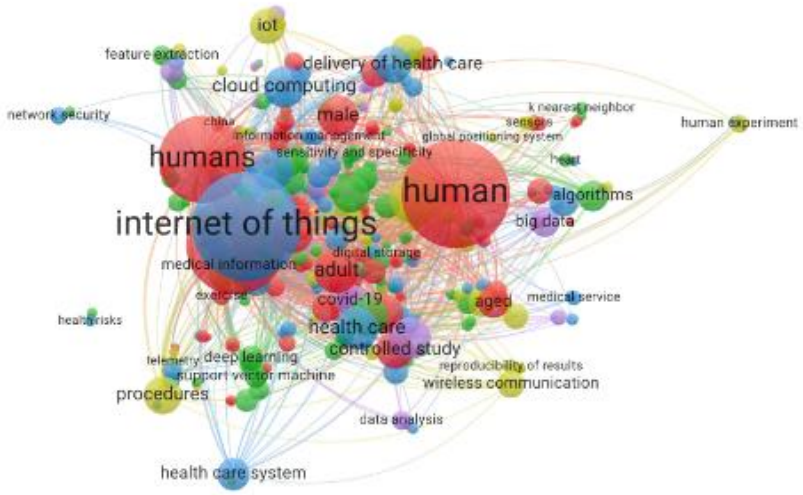

Fig. 2: Relation of the keywords.

The keywords that stand out beside the common keywords such as “human(s)”, “male, “adult” are “medical information”, “cloud computing”, “deep learning”, “support vector machine”, “big data”, “algorithms”, which are companions of the “internet of things”.

Conclusions

To sum up, there is a growing interest in applying IoT to the field of healthcare which can potentially change the whole view of health products. Based on the findings, researchers and practitioners can have some initial view on the topic as they start to investigate the literature. From the increasing number of scientific articles and patents, it is predicted that there will be a new era of a so-called smart healthcare system in the years to come.

Conflict of Interest: The authors declare no conflict of interest.

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Baumol Cost Disease on Healthcare Expenditure in Korea

Seung Won Kang[1,*], Le Tan Phuoc[1], Thi Trang Ninh[1,2]

[1] Becamex Business School, Eastern International University, Binh Duong, Vietnam

[2] Business School, International University, Vietnam National University, Ho Chi Minh City, Vietnam

[*] Corresponding author: kwon.kang@eiu.edu.vn

Abstract: This study aims to examine the impact of Baumol cost disease on healthcare expenditure in Korea, which has been experiencing persistent cost increases. The paper utilizes Bayesian methods to test the impact of the Baumol cost disease on healthcare expenditure, analyzing both government and private expenditures. The primary data source for the study is the Korean Statistical Information Service database. The study provides a more robust and theoretically consistent framework for the analysis and examines the impact of the Baumol cost disease on government and private healthcare expenditures. The results will inform policy implications based on the study's findings.

Keywords: Baumol Cost Disease, Health Expenditure, Labor Productivity, Bayesian Estimation

Introduction

Baumol cost disease explains why costs rise in sectors relying on labor-intensive processes, like healthcare and education [Baumol 1967]. Unlike sectors that adopt new technologies and reduce costs over time such as manufacturing and telecommunication, healthcare and education cannot increase productivity at the same rate, leading to higher costs and prices for their goods and services. In Korea, the cost of healthcare has been rapidly rising due to increasing demand, while improving productivity in the sector remains challenging. Understanding the factors driving the Baumol cost disease in Korean healthcare has significant implications for the economy's competitiveness and efficiency [Oh 2015].

There have been many literatures to investigate the impact of Baumol disease on healthcare costs, with some studies finding support for the theory [Nordhaus 2008, Hartwig 2010, Wang 2021] and others challenging its validity [Nose 2015, Rossen 2016]. As a result, research on the effect of the Baumol cost disease has produced inconsistent results. This study utilizes Bayesian methods to test for the Baumol cost disease's impact on healthcare expenditure, analyzing both government and private expenditures for a more comprehensive understanding of its role in healthcare cost growth.

The paper is organized as follows: Section II outlines the materials and methods used in this study. Section III presents the results and discussion, while the final sections provide a summary of the results and draw conclusions based on the analysis.

Materials and Methods

The primary source of data for this study is the Korean Statistical Information Service (kosis.kr) database, which provides annual data spanning from 1970 to 2020. The Korean Ministry of Health and Welfare's Health and Welfare Statistics Yearbook is the additional source of information on the number of healthcare workforce for calculating the labor share of healthcare sector.

In the Baumol cost disease model, the economy can be divided into two broad categories of sectors: progressive or technologically innovative sector and non-progressive sector. To formally derive Baumol cost disease model, it is essential to assume key elements of the model: 1) there is only one factor of input, labor: 2) two sectors have common wage growths following progressive sector: 3) ratio of output between two sectors are constant over time. Then, Baumol model can be expressed:

$$Y_P = aL_P e^{rt} \text{ and } Y_{PN} = bL_{NP} e^{st} \quad (1)$$

where, Y_P and Y_{PN} indicate the output of progressive and non-progressive sectors, respectively. L_P and L_{NP} are the labor inputs in the progressive and non-progressive sector and a and b are constants. It is assumed that the progressive will grow faster than the non-progressive sector, resulting in a higher value for r compared to s. The equation to test the Baumol cost disease in Korea is derived from this setup, which relies on key assumptions as follows:

$$\frac{\dot{H}}{H} = \lambda\left(\frac{\dot{w}}{w} - \frac{\dot{y}}{y}\right) = (r - s)\frac{1}{L_s} \quad (2)$$

In logarithm expression, equation (2) can be given as:

$$\boldsymbol{ln(H) = \lambda \times \frac{1}{L_s}\left(ln(w) - ln(y)\right) = \lambda \frac{1}{L_s}(r - s)} \quad (3)$$

where, the health expenditure is denoted as *H*, and $\boldsymbol{\lambda}$ represents the coefficient of the adjusted Baumol variable [Colombier 2010, Rossen and Faroque 2016]. The adjusted Baumol variable is defined as $\boldsymbol{ln(w) - ln(y))/L_s = (r - s)/L_s}$ as equation (2), where $\boldsymbol{w}$ denotes a wage rate, and $\boldsymbol{y}$ indicates the labor productivity calculated by dividing real GDP by the number of employees, and $\boldsymbol{L_s}$ represents the share of healthcare workforce in total employment. $\boldsymbol{ln}$ in equation indicates taking natural logarithm of corresponding variables. Equation (3) incorporates additional exogenous factors such as the aging population, GDP, and the value of residential property, which are used to capture the impacts on health expenditure beyond the adjusted Baumol variable.

Results and Discussion

The application of Bayesian estimation to test the Baumol cost disease offers notable contributions to the field. Firstly, the Bayesian approach provides a more robust and theoretically consistent framework for the analysis. Secondly, the study examines the impact of the Baumol cost disease on government and private healthcare expenditure categories. This is crucial because healthcare financing and delivery significantly differ between the public and private sectors. Therefore, analyzing both expenditure types provides a more comprehensive understanding of the Baumol cost disease's role in healthcare cost growth. The results will inform policy implications based on the study's findings.

Conclusions

The Korean healthcare sector has experienced persistent cost increases, which can be attributed to increasing demand for healthcare services and difficulties in improving productivity. While research on the Baumol cost disease has produced inconsistent results, this study uses Bayesian methods to test its impact on healthcare expenditure in Korea. The study utilizes data from the Korean Statistical Information Service and the Health and Welfare Statistics Yearbook to estimate the impact of the adjusted Baumol variable on healthcare expenditure, while also considering the effects of exogenous factors such as the aging population, GDP, and residential property values. The Bayesian approach provides a more robust and theoretically consistent framework for the analysis, and the study examines the impact of the Baumol cost disease on both government and private healthcare expenditure categories, offering a more comprehensive understanding of its role in healthcare cost growth. The results of this study will inform policy implications for the Korean healthcare sector and have broader implications for understanding the Baumol cost disease's impact on the competitiveness and efficiency of the economy.

Conflict of Interest: The authors declare no conflict of interest.

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A systematic literature review of the relationship between Enterprise Risk Management and Information Technology

Nguyen M.[1,*], Le Q.[1]

[1] Becamex Business School, Eastern International University, Nam Ky Khoi Nghia St., Hoa Phu Ward, Thu Dau Mot City, Binh Duong Province.

[*] Corresponding author: mai.nguyenthingoc@eiu.edu.vn

Abstract: In the face of unprecedented global crises like financial downturns, wars, trade conflicts, pandemics, and catastrophes, every business must be able to handle unexpected events and risk management become more important than ever before. Though risk management has evolved into a comprehensive risk management strategy, so-called Enterprise risk management, there still lacks a comprehensive understanding of the impacts of the utilization of these technologies in managing enterprise risk holistically at an organization. This study therefore aims to systematize the studies on the relationship between IT advancement and ERM to clarify what are its main contributions to and challenges for ERM. Results show that IT advancements pose challenges for ERM, but also contribute to various approaches to risk assessment, risk responses, control activities, monitoring risk, and competitive advantages, thus offering several opportunities for ERM. This study discusses these shifts to help researchers and practitioners understand the role of IT in ERM to identify areas for future exploration and help practitioners maintain business operations in the face of uncertainty.

Keywords: Enterprise risk management, enterprise risk, risk assessment, IoT, IT advancement, information IT

Introduction

Contemporary businesses must comply with an increasing number of complicated and ever-changing laws and regulations, as well as adapting to new security threat approaches due to advances in information technology (IT). This has raised human and IT system vulnerability. Although encryption techniques, antivirus software installations, and firewalls can be employed to protect the computing resources of an organization from intrusions and cyberattacks, they may not provide sufficient security [Lee 2021]. IT system assaults on business institutions can cause operational disruptions, privacy and regulatory breaches, penalties, and reputation loss [Kwateng 2022]. Therefore, integrating IT with ERM would improve risk management efficiency, especially prevent the threat of hi-tech attacks. For that reason, IT development and corporate risk management must work together to guarantee the firm long-term survival. This systematic review reviews prior published publications to help researchers quickly identify research gaps in 2023 and dig deeper into this topic. Our goal is to provide researchers with facts and bases to better understand IT and ERM. In this study, we'll address these research questions: (i) What are the key topics and contents of published research on IT development in ERM implementation? (ii) What research possibilities exist on IT use in ERM implementation? Currently, this is the first systematic literature review on the relationship between IT and ERM. This adds to the literature by emphasizing the importance of integrating ERM and IT advances to mitigate both known and unknown risks for industry survival and handle prospective risks in IT firms.

Materials and Methods

This systematic review follows the “Guidance on Conducting a Systematic Literature Review” of Xiao and Watson [Xiao 2019]. Accordingly, a literature review enables researchers to comprehend the scope and extent of the existing research and pinpoint areas that require further exploration [Xiao 2019]. We only included studies that explore the relationship of some types of IT and ERM. Each manuscript was evaluated for its preliminary relevance based on the title, abstract, and if they give an insight about risk management and any types of IT, we obtained its full reference. We conducted the search across 4 commonly used databases by researchers across multiple disciplines, including Google Scholar, DataScience, Emerald, and EBSCOhost. On the other hand, we excluded technical reports (except a few high-quality reports that have well-cited references) and online presentations because they generally lack a peer-review process. In total, we ultimately included 22 studies in our research.

Results and Discussion

Enterprise risk management (ERM)

Enterprise risk management (ERM) has grown from the initial foundations of risk management, founded by insurance professors Robert I. Mehr and Bob Hedges [DB01] and based on acquiring insurance packages, to a more comprehensive approach to risk management, known as ERM. ERM covers all risks, including operational, reputational, and strategic. The Casualty Actuarial Society Committee (CAS) defines ERM as the process through

which a business analyses, manages, leverages, funds, and monitors risks from all sources within an industry to improve its short- and long-term value for stakeholders [Gordon 2019].

Tab 1. Summary of recent research results on the relationship between ERM and IT

Author(s) & Year	**Summary of recent research results**
[Kwateng 2022], [Subhani 2011]	IT is a means of enhancing competitive advantage and preserving shareholders' benefits in today's constantly evolving business environment.
[Mahmood 2018]	Propose Fault Tree Analysis (FTA) to determine the overall risk factor of a Virtual Enterprise;
	Use an Internet of Things (IoT)-based smart concept to mitigate risks.
[Kwateng 2022]	ERM has a significantly positive impact on IT security within financial institutions;
	Redundant technology that can lead to increased risks and concerns in today's corporate financial institutions.
[Sfar 2018]	IT and ERM integration can enhance Internet security, cloud computing security in the IoT environment, and reducing network risks;
	Identified various types of current security risk efforts in IoT for healthcare;
	Use the Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Bayesian Network (BN);
	Propose 5-step model for using IoT security risk management in healthcare

Conclusions

Risk arises in every firm, regardless of industry, and risk management is one of the most essential concerns among enterprises. The progress of information technology has improved the world, but it has also created a slew of challenges connected to cyber-security, privacy, and data security that pose a threat to the security of businesses. The Internet of Things (IoT)-based smart concept is proposed for application in healthcare risk mitigation and risk definition. They have only employed the FTA, DEMATEL, and Bayesian Network as study frameworks, so other frameworks should be used to provide viewpoints from different angles. In this century of IT-based development, managing risk and implementing IT are two of the most important considerations for a company's growth. Unfortunately, no theories for this association have been discovered in those studies, therefore developing a theory to serve as the foundation for future study is critical. Furthermore, there is too little study on ERM and IT linkages in developing nations, and it has only been explored in a few industries such as healthcare, e-commerce, and banking. As a result, there are plenty of opportunities for researchers to do additional research. There are thousands of papers on ERM in many sectors, but only a few of them are about IT and ERM, despite the fact that they are the most vital relationship for businesses to flourish in this 4.0 world. As a result, further study into these challenges should be conducted in order to provide theories, models, implementation guidelines, or notices for firms to manage their IT risk, as well as taking advantage of IT development to tackle the risk issue among enterprises.

Conflict of Interest: The authors declare no conflict of interest.

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Efficiently-Fastly-Smartly Automatic Hotel Managing System in Vietnam

Dang Huy Tran[1], Trung Hieu Nguyen[1], VanDung Nguyen[1,*]
[1] Faculty of Electrical and Electronics Engineering, Ton Duc Thang University; 19 Nguyen Huu Tho, District 7, Ho Chi Minh City, Vietnam;
Email: 41900961@student.tdtu.edu.vn, 41900952@student.tdtu.edu.vn, nguyenvandung@tdtu.edu.vn
[*] Corresponding author: nguyenvandung@tdtu.edu.vn

Abstract: The citizen identification card is used popular and the most important card in the world. Recently, the Vietnam government required all citizens to have new citizen identification cards on which a QR code have printed on the front of the card. Therefore, QR-based applications are applied everywhere, especially Tourism Industry. One of the important conditions for a successful trip tourist is hotel service quality. The pre-booking, registration, user-preferred payment mode, automated check, and check-out need to become self-services. In this project, we design an online hotel reservation using physical devices embedded with sensors, software, cloud computing, and other technologies. The practical results demonstrated the effectiveness of the project in using the citizen identification QR code application to manage the hotel.

Keywords: citizen identification card, QR-based applications, hotel service, online hotel reservation

Introduction

In the Hotel industry, the customers are known as travellers, foreigners, businessmen, tourists, visitors, etc. who try to get room to stay short/full time or pass the night. Therefore, a hotel reservation needs to have the function of providing hospitality services to customers [Boz 2016]. One of the crucial factors for the success of hotel organizations is efficient hotel reservations [Bemile 2014, Azeta 2021]. To be comfortable, the hotel reservation allows customers automatically check in and check out when they arrive at this hotel. On the other hand, the QR code stores information about the item, images, videos, web links, and a lot more. The QR code can be scanned and read by an application known as the QR-Code Reader. In Hotel Industry, QR codes are used to fast-track self-service check-in for passengers [Wara 2014].

Materials and Methods

Our project consists of a camera Pi and Raspberry, as described below.

- The camera Pi is used to take a citizen identification card photo.
- Raspberry Pi 4 is used to image processing, read information of QR-code, store information and make an hotel reservation.

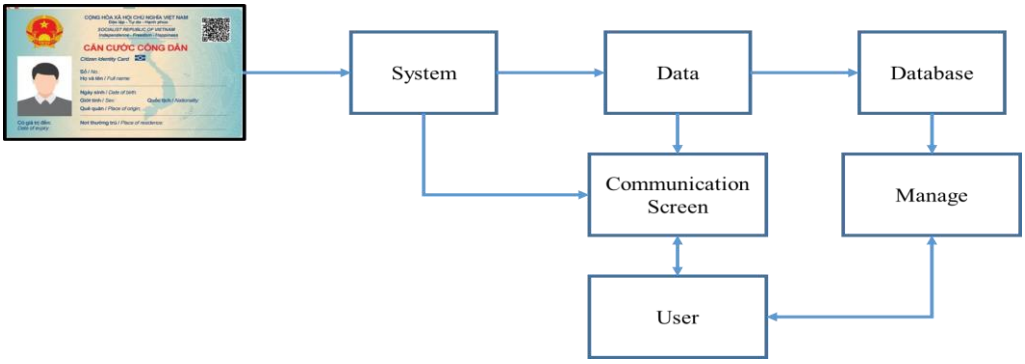

Fig. 1: Flowchart of QR code - based hotel reservation

Fig. 1 shows the operation of the QR code-based hotel reservation. In Vietnam, the citizen identification QR code contains this information: citizen identification, full name, date of birth, gender, and address. That's a lot of information about the person, but we only need the necessary information that is useful in this project such as citizen identification, and full name. After the hotel reservation, all information including citizen identification, full name, check-in, and check-out time will be stored in a database.

Results and Discussion

The decoding procedure consists of image banalization, QR code extraction, perspective transformation and resampling, and error correction. Through these steps, we can recognize different types of QR code images. The citizen identification QR code will be decoded as shown in Fig. 2.

QR code

```
['062201002945', '233306838', 'Trần Đăng Huy', '17/11/2001', 'Nam', '68/31 Hàm Nghi Tổ 8, Duy Tân, Thành phố Kon Tum, Kon Tum', '22/11/2021']
```

Fig. 2: Rough data after decoding QR code

Finally, we will save the final data to the database. By this Excel or another database, we can manage through the internet. The user can check their information, time in and time out, and all of the information they want to know.

	A	B	C	D	E	F	G	H	I
1	Thời gian vào	Thời gian ra	CCCD	CMND	Họ và tên	Ngày sinh	Giới tính	Địa chỉ thường trú	Ngày làm CCCD
2	2023-03-03 12:52:53	2023-01-28 10:56:02	062201002944	233306838	Trần Đăng Huy	17/11/2001	Nam	68/31 Hàm Nghi Tổ 8, Duy Tân, Thành phố Kon Tum, Kon Tum	22/11/2021
3	2023-03-03 12:58:26		091201003975	372004709	Thạch Phi Long	30/01/2001	Nam	165/11 Quang Trung, Vĩnh Quang, Rạch Giá, Kiên Giang	13/08/2021
4	2023-03-03 12:59:34		066201006722	241819498	Nguyễn Trung Hi	04/02/2001	Nam	Tổ Dân Phố 4A, Ea Knốp, Ea Kar, Đắk Lắk	12/08/2021
5									

Fig. 3: Information in database

Conclusions

Our project used a QR-based application for online hotel reservations. By using camera and Raspberry Pi 4, our project allows pre-booking, registration, user-preferred payment mode, automated check, and check-out to become self-services.

Conflict of Interest: The authors declare no conflict of interest.

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Design and Implement IoT-based Robot for Online Appointment Booking at TDT University

HuuDat Tran[1], TanDat Vo[1], NguyenMinhHieu Than[1], VanDung Nguyen[1,*]
[1] Faculty of Electrical and Electronics Engineering, Ton Duc Thang University; 19 Nguyen Huu Tho, District 7, Ho Chi Minh City, Vietnam;
[*] Corresponding author: nguyenvandung@tdtu.edu.vn

Abstract: The COVID-19 pandemic has had a detrimental effect on human life worldwide and has serious drawbacks to public health, food systems, and work. In addition to basic health and hygiene practices, avoiding contact with people is one of the most efficient ways of preventing the virus from spreading. University, for example, is one of the places that have a large number of people like students, teachers, and staff. This project creates an IoT Robot that may help visitors to book appointments through a robot placed in the university's hall by using sensors, cloud computing, and other devices. The robot can directly communicate with office staff or managers to arrange appointments through the Gmail system or via text messages. The results of the study have demonstrated the system's effectiveness, allowing visitors to arrange appointments without direct contact with others.

Keywords: IoT Robot, appointment, COVID-19, Gmail

Introduction

Recently, the IoT service system can support automatic setting, autonomous control, and optimal operation, which are emerging in addition to inter-object connectivity [Shin 2019]. Moreover, it acquires data from the environment, recognizes the situation using the acquired data, and interacts with the user environment according to the service rules and domain knowledge [Bovi 2014]. Much research on intelligent-robot services is applied to services and applications based on specific domains such as education, entertainment, life, and manufacturing [Youngcheol 2005]. We tried to combine intelligent robot service and IoT technology in order to create a new service, as shown in Figs. 1 and 2.

Figure 1: The IoT-robot

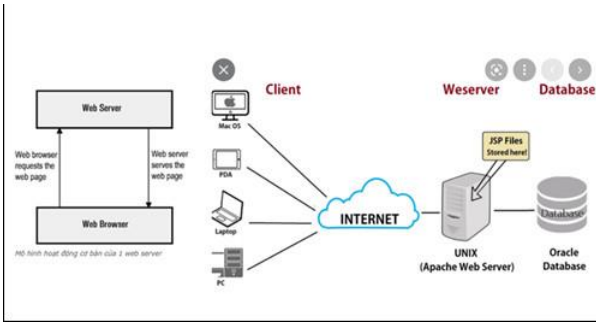


Figure 2: Intelligent-robot services

Materials and Methods

Using an ultrasonic sensor (HC-SR04) to avoid obstacles during movement. The sensor will emit ultrasonic waves, which will propagate in the air. The Web Browser software is where the HTTP address is used to access data from the web server. The Server is where the database is stored, which contains information such as the location of the room or Mr. Nguyen Van A's personal contact such as phone number, email, and room number.

Results and Discussion

Our project was successfully evaluated and the results are shown below in Table.1.

Table 1. Results of the project.

1)

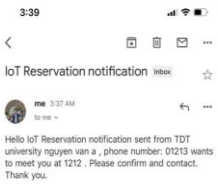
2)

3)

4)

5)

6)



Conclusions

Our project allows visitors to arrange appointments without direct contact with others. In Future work, we develop our project can find the direction to the desired office.

Conflict of Interest: The authors declare no conflict of interest.

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Application of Artificial Intelligence in Higher Education: Benefits and Challenges for Teachers and Students

Vo Xuan The[1], Cao Ly Hoang My[1], Tran Thi Phuong Linh[1,*]

[1] Faculty Information Technology, University of Finance and Marketing, 778 Nguyen Kiem Ward 4 Phu Nhuan District, Ho Chi Minh City, VietNam.

[*] Corresponding author: tranlephuonglinh3004@gmail.com

Abstract: The rapid advancement of sophisticated technologies has had a profound impact on all industries, including the field of education. In recent years, artificial intelligence (AI) technology has gained widespread popularity and significantly influenced educational practices, leading to transformative breakthroughs in teaching and learning methods. In this article, a qualitative approach is employed to provide insights into the potential applications of AI for two key stakeholders in the learning process, namely teachers and learners. Additionally, we analyze the potential positive outcomes that the integration of AI can bring. Finally, the research team presents an evaluation of the challenges and difficulties associated with the application of AI in education, along with predictions for its future prospects.

Keywords: Artificial intelligence, Education, Teachers, Students

Introduction

Artificial Intelligence (AI) has gained widespread usage in the field of education and has exhibited significant advantages in its application, profoundly influencing the teaching process and classroom management. AI has the potential to continually optimize and enhance the learning environment, stimulate students' enthusiasm, initiative, and creativity, and significantly improve teachers' classroom management abilities, ensuring a more reasonable and effective management of the classroom.

To date, numerous studies have been conducted on the application of AI in education; however, few have emphasized its specific application on the primary subjects, namely the teachers and students, throughout the teaching and learning process. This article aims to describe the application of AI to both the main subjects, providing an overview of its implementation throughout the teaching and learning process. Furthermore, it will analyze the positive impact of AI technology in improving the quality of teaching and learning. Finally, the article will outline the potential difficulties and challenges that AI applications may face, and explore how AI technology can be further applied to education in the future.

Materials and Methods

This article employed a qualitative research method, specifically following the three-stage approach proposed by Kitchenham et al. [Kitchenham 2015], which involves planning, conducting research, and completing the report.

Research questions:

1. How does the application of AI affect teachers and students before, during and after the learning process?
2. What challenges associated with AI implementation in education and the future of it?

Data source:

ScienceDirect, IEEE Xplore, ACM Digital Library and Springer Link.

Search results:

The process of conducting electronic database searches involves utilizing specific keywords and Boolean operators. In this study, the keywords used include "Artificial Intelligence," "Higher Education," and "Teaching and Learning Enhancement."

Exclusion criteria:

Papers that were published before 2016; paper not published in peer-review journal, paper not written in English, paper not discuss AI in education.

Following the initial search, a total of 195 documents were collected. After eliminating duplicates, copies, and documents lacking full-text support, the remaining number of documents was reduced to 150. Thereafter, the authoring team undertook an assessment of the titles and summaries according to established criteria. During this process, we excluded purely theoretical research documents and content that were not substantially associated with the application of AI for learners and educators. This process resulted in 60 remaining documents. Subsequently,

the identified documents were evaluated based on predetermined criteria, and a total of 23 articles were selected for inclusion in the report's meta-analysis.

Results and Discussion

Based on the author's research, the application of AI has a significant impact on two main groups in education: teachers and students. The authors conducted research at various stages of the learning process, including before, during, and after. AI can support students in many ways, including the creation of personalized learning paths based on individual learning needs, learning with virtual tutors, and the use of AI to assess learning ability. AI applications for teachers can assist with tasks such as creating lesson plans, monitoring student progress, and assessing competence.

The increasing use of AI technology in education has provided numerous benefits for both teachers and students. For example, AI can optimize time and effort, accurately assess learning capacity and behavior, and assist teachers in developing teaching plans, analyzing student behavior, and adjusting teaching methods accordingly. AI can also help students create personalized learning paths, provide virtual tutors, and assess academic performance. Additionally, AI technology has the ability to analyze large amounts of data in a short amount of time, breaking the limits of time and space for teaching and learning, and providing objective decisions. AI technology can also assist teachers in observing, evaluating, and analyzing students' behaviors, and provide a personalized learning and teaching environment.

The implementation of AI in higher education faces several challenges, including ethical concerns around data privacy, bias, and transparency, a lack of data infrastructure, high costs, resistance to change among faculty and staff, and uncertainty around its effectiveness. Addressing these challenges requires careful planning, stakeholder engagement, and investment in data infrastructure and personnel. It is also essential to ensure that the use of AI aligns with ethical principles and does not perpetuate existing inequities in the education system. Despite these challenges, the potential benefits of AI in higher education are significant, including personalized learning, enhanced student engagement, and improved learning outcomes.

AI can be particularly beneficial for students with intellectual or physical disabilities by collecting and analyzing data to devise appropriate educational approaches. The "patience" and ability of AI to analyze large volumes of data can simplify teaching and learning for people with disabilities.

Conclusions

In this paper, the authors have given an overview of how to apply AI throughout the teaching and learning process, as well as its benefits, difficulties and challenges. Thereby helping teachers and students easily access and use AI technology better to improve the quality of teaching and learning. The above studies can be an important basis for creating the premise for further studies to apply AI technologies better in education. In the near future, the authors will continue researching the issue of AI which will support learning for people with disabilities.

Acknowledgements: The authors would like to thank the teachers of the Faculty Information Technology, University of Finance and Marketing for their support in completing this study.

Conflict of Interest: The authors declare no conflict of interest.

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Cloud Computing Technology in Higher Education Field

Huynh Ngoc Thanh Trung[1], Dang Chau Anh[1], Nguyen Trung Kien[1,*], Pham Quang Truong[1]

[1] Faculty Information Technology, University of Finance and Marketing, 778 Nguyen Kiem Ward 4 Phu Nhuan District, Ho Chi Minh City, Vietnam.

[*] Corresponding author: nguyentrungkien.forwork@gmail.com

Abstract: This study aims to assess the impact of cloud computing technology in higher education, particularly in light of the COVID-19 pandemic. Employing a theoretical review approach, the study conducts a comprehensive analysis of the literature pertaining to this subject, culminating in systematic reviews. The research findings highlight the positive influence of cloud computing technology on the process of teaching and learning in universities. This state-of-the-art technology confers numerous benefits upon educators and students alike, including convenient access to online learning materials and tools, seamless sharing of educational resources, and facilitation of work and learning from remote locations. Furthermore, the study proposes recommendations aimed at enhancing the effective utilization of cloud computing technology in higher education. These recommendations encompass providing comprehensive training and technical support to teachers and students, investing in robust network infrastructure to ensure stable and high-speed connectivity, and fostering research and development in cloud computing technology for higher education. The insights gleaned from this research serve as a valuable guide for effectively leveraging cloud computing technology to cater to the actual needs of both teachers and students.

Keywords: Cloud computing, Education, Teachers, Students

Introduction

In the current era, cloud computing is a widely used technology in various fields, including education. Universities are striving to enhance their capacity in utilizing new technologies to meet the evolving needs of users and the times. Particularly, the use of cloud computing in distance education has gained significant importance during the COVID-19 pandemic, as universities have been compelled to adopt cloud computing technology for remote learning. The adoption of cloud computing service models by universities will continue to be a crucial issue in the post-COVID-19 period due to the numerous advantages that cloud computing offers, especially in facilitating education from remote locations. Drawing on existing academic literature, this paper aims to provide insights into the complex and evolving relationship between cloud computing technology and higher education, shedding light on how technology is reshaping the landscape of higher education, both positively and negatively.

Materials and Methods

This article employed a qualitative research method, specifically following approach proposed by Kitchenham et al. [Kitchenham 2015], which involves planning, conducting research, and completing the report.

Research questions:

1/ How does Cloud Computing impact the educational environment in higher education institutions??

2/ What are the benefits of Cloud Computing for higher education?

3/ What are the challenges and obstacles that Cloud Computing faces?

4/ What are the future directions for the development of Cloud Computing in higher education?

Data source:

ScienceDirect, IEEE Xplore, ACM Digital Library and Springer Link.

Exclusion criteria:

Papers that were published before 2017; paper not published in peer-review journal, paper not written in English, paper not discuss Cloud computing in education.

Search results:

We conducted a literature search using various methods. First, we selected the time frame from 2017 to 2022 and searched for academic articles based on the keywords. The search results yielded a total of 11,495 documents. We then filtered out documents with titles relevant to our study, based on the number of documents found in the selected time frame, resulting in 380 remaining documents. After careful review and reading of the content of each of the 380 filtered documents, we selected the 21 most relevant documents to use in our study.

Results and Discussion

As can be seen in Fig.1, cloud computing has played a significant role in higher education systems by enabling teachers to create and deliver online courses to students at any location, allowing students to access course content anytime, anywhere, and helping reduce costs and improve the quality of education by providing necessary infrastructure, software, and storage services.

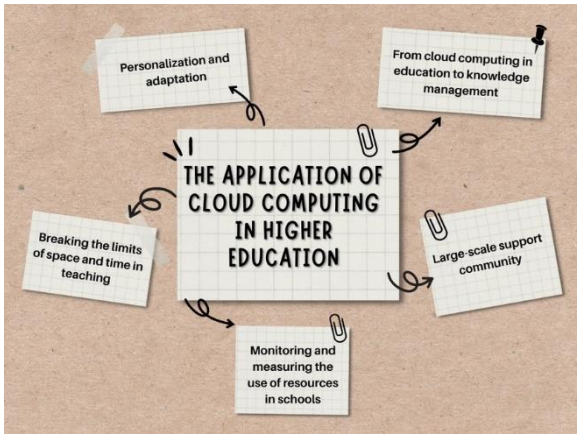

Fig. 1: The application of cloud computing in higher education.

The use of cloud-based platforms, specifically Software as a Service (SaaS) and e-learning, is predicted to drive market growth in higher education.To ensure transparency and efficiency in resource allocation in schools, measuring the use of different resources is necessary. Cloud systems can automatically control and optimize resource usage, providing benefits to both service providers and consumers. The global cloud computing community comprises a vast network of providers, developers, and technology experts who share information, experience, and resources related to cloud solutions, applications, and technologies. This community has made significant contributions to the development and expansion of cloud computing worldwide, providing many opportunities for organizations and businesses to optimize their operations.The use of cloud computing in higher education has created a wide learning space and sparked students' interest in learning. The role of teachers has shifted from being the primary source of knowledge to that of a facilitator and supporter of students in the learning process

Conclusions

In this scientific article, we evaluated the impact of cloud computing technology in higher education, specifically in the context of the COVID-19 pandemic. Through a comprehensive theoretical approach, we systematically assessed the effects of cloud computing technology on teaching and learning processes in universities. Our research findings highlight the positive impact of cloud computing technology on higher education, providing benefits such as access to online learning materials and tools, sharing educational resources, and facilitating remote work and learning for both teachers and students. To optimize the benefits of cloud computing technology in higher education, we recommend providing technical training and support, investing in network infrastructure, and promoting research and development of cloud computing technology. We hope that our recommendations will contribute to the effective use of this technology and enhance the educational experiences of teachers and students in higher education..

Acknowledgements: The authors would like to thank the teachers of the Faculty Information Technology, University of Finance and Marketing for their support in completing this study.

Conflict of Interest: The authors declare no conflict of interest.

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Sustainable financial development: An analysis on commodity market efficiency in Vietnam

Vu Thi Hong Nhung[1,*]

[1] Becamex Business School, Eastern International University, Nam Ky Khoi Nghia Street, Binh Duong, Vietnam

[*] Corresponding author: nhung.vu@eiu.edu.vn

Abstract: This study aims to (1) investigate the weak-form efficiency of the four commodity markets in Vietnam, including agricultural, energy, industrial and metal and (2) rank the efficiency of the markets by using the Multifractal Detrended Fluctuation Analysis (MF-DFA). We also capture the impact of the Russia-Ukraine (RU) conflict. The motivation is from the recent volatility of the global commodity markets due to this conflict. The findings indicate the violation of weak-form efficiency of commodity markets in Vietnam. Regarding the ranking, agricultural is the most efficient market in general while energy markets are hurt the most by the conflict as its ranking falls from the first place before the event to the fourth after that.

Keywords: market efficiency, commodity markets, Russia-Ukraine conflict, MF-DFA

Introduction

High inflation rate worldwide recently causes the Federal Reserve (Fed) to implement the contractionary monetary policies. As a results, many central banks in the world follow Fed's decision which makes the financial markets suffer. VN-Index fell 34% in 2022. This unfavourable result urges the investors to move to the safe havens, such as commodities. Regarding the commodity exchange in Vietnam, Mercantile Exchange of Vietnam (MXV) is the only national centralised commodity trading market organiser in Vietnam, established in 2010. Currently, grains, energies, soft and other raw material, and metals are traded on the MXV, in corresponding to agricultural, energy, industrial, and metal markets, respectively. They comprise of 42 commodities traded as futures contracts. The recent RU conflict contributes to the soaring prices of agricultural products, energy and raw materials. These two countries are the major global suppliers of food items, minerals and energy so the conflict would cause the disruption in the supply. This exacerbates volatility in commodity prices, slowing down the economic growth already hit by the pandemic [Fang 2022].

The increase in the volatility of the commodity markets due to the external shocks could be a sign of the violation of market efficiency. Therefore, this study aims to investigate the weak-form efficiency of the commodity markets in Vietnam and rank their efficiency before and during the Russia-Ukraine conflict. The results provide the implication for investors and portfolio managers in terms of resource distribution. Further, policy reforms are needed in improving the commodity market efficiency and avoiding asset bubbles. Besides physical assets and resources, financial assets and resources have a crucial influence on promoting sustainable future.

Our paper has several contributes. First, the attention towards the commodity market efficiency is limited, especially the efficiency ranking. Secondly, to the authors' knowledge, this paper is the first to study the commodity efficiency in Vietnam. We also cover the RU conflict. Commodity markets in Vietnam are still young but growing fast. By assisting investors and policy makers in productive investment and policy reforms, the examination of the efficiency of the markets will contribute to the sustainable financial development of the country.

Materials and Methods

Our data includes daily futures prices of agricultural, energy, metal, and industrial markets. The data from 30/6/2021 to 24/2/2023 are collected from the MXV. The two sub-sample periods are before and after the Russia invasion of Ukraine on 24/2/2022. The raw data of prices is then transferred into returns to apply in the MF-DFA [Memon 2022, Rizvi 2014].

This paper employed the MF-DFA to examine the multifractal behaviours of the commodity markets in Vietnam. We follow the five steps of the MF-DFA as proposed by Kantelhardt et al. [Kantelhardt 2002]. The multifractality is detected when the generalised Hurst exponents $h(q)$ are dependent of parameter q which is used to determine the order of fluctuation function. Following Rizvi et al. (2014), q ranges from -4 to 4 in this study. Then, the market deficiency D is measured by comparing $h(-q)$ and $h(q)$ to 0.5. If the generalised Hurst exponents equals 0.5, the time series are uncorrelated and its movements cannot be predicted. This is the evidence of the market efficiency.

Results and Discussion

Figure 1 shows the Hurst exponent $h(q)$ for each q. The trend of $h(q)$ is declining throughout the sample periods in all markets, except agricultural. This result confirms the dependence of $h(q)$ on q which is an evidence of the multifractality. Consequenty, the commodity markets in Vietnam violate the weak-form efficiency.

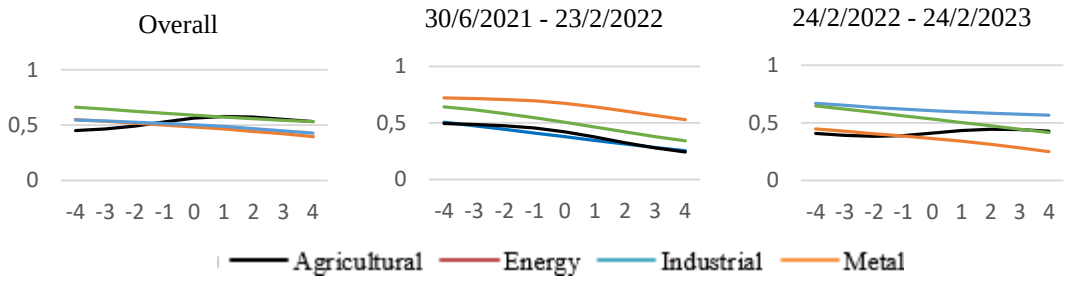

Fig. 1: $h(q)$ for Commodity markets for the entire and sub-periods, and their range over $q \in$ [-4, 4]

Table 1 displays the ranking of market efficiency for the four markets. From the overall data, agricultural markets are the most efficient with D of 0.0404, followed by the industrial and energy markets. The least efficient markets are metals which has D of 0.0973. This level is more than twice the value of the agricultural. However, before the RU conflict, the efficiency gaps between the markets are minor. Metal markets are still the least efficient as D is 0.1493 whereas the energy markets are the most efficient with the value of 0.1256. During the Russia invasion of Ukraine, the most efficient markets are agricultural as they have D of 0.0811 while energy markets turn into the least efficient with the value 0.1507. Comparing the two sub-periods, only energy markets are affected by the RU conflict as the other three show the improvement during that time. This result contradicts Memon et al. (2022) as they show the significant impact of the event on commodity markets in the US.

Tab. 1: Efficiency ranking of Commodity Markets.

	Overall		30/6/2021 - 23/2/2022		24/2/2022 - 24/2/2023	
Market	D	Ranking	D	Ranking	D	Ranking
Agricultural	0.0404	1	0.1267	2	0.0811	1
Energy	0.0761	3	0.1256	1	0.1507	4
Metal	0.0973	4	0.1493	4	0.1143	2
Industrial	0.0588	2	0.1305	3	0.1189	3

Conclusions

This research analyses the multifractal behaviour of four commodity markets in Vietnam by using the MF-DFA and provides the efficiency ranking. The result shows that multifractality exists in the data which violates the weak-form market efficiency. Among the four markets, agricultural is the most efficient, industrial and energy markets rank second and third place, respectively, and metal is the least efficient. However, the energy markets become less efficient during the RU conflict, causing them the least efficient markets during this period. Surprisingly, the other three commodity markets improve after the conflict, implying that these markets in Vietnam behave differently from the markets in the Western countries. The future research might expand the scope to the 42 individual markets to have a deeper understanding of the commodity market efficiency in Vietnam.

Conflict of Interest: The author declares no conflict of interest.

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Evaluating the Challenges of Additive Manufacturing Adoption using the Analytic Hierarchy Process (AHP) Method: Empirical Research in Vietnam

Tran D.[1], Le Q.[2,*], Nguyen L.[3], Ma Q.-P.[4], Hajnys J.[4], Nguyen H.[5]

[1] Office of Community Engagement, Eastern International University, Binh Duong New city, Vietnam.

[2] Becamex Business School, Eastern International University, Binh Duong New city, Vietnam.

[3] Business Administration Faculty, Industrial University Ho Chi Minh City, Ho Chi Minh City, Vietnam.

[4] Department of Machining, Assembly and Engineering Metrology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 70833 Ostrava, Czech Republic

[5] School of Engineering, Eastern International University, Binh Duong New city, Vietnam.

[*] Corresponding author: quang.le@eiu.edu.vn

Abstract: Digital transformation, modern technologies to enable autonomous production capabilities and smart logistical systems are prerequisite strategies that are implemented to gain the competitive advantages in developing countries. Additive manufacturing (AM) or three-dimensional printing offering greater advantages can manufacture complex geometries of product with various materials. AM places a main role in reducing number of a part helping reducing and eliminating assembly time and cost. However, the application is still quite limited, especially in developing countries such as Vietnam. This research paper aims to identify and assess the challenges associated with the application of additive manufacturing in Southeast Vietnam. This study is conducted in three phases. Step one identifies challenges by reviewing previous studies. Step two applies semi-structured interviews with experts to consolidate these challenges to build a multi-level hierarchical structure of challenges. The third stage is to use a multi-hierarchical process (AHP) method to rank these issues in order to organise the necessary resources for a successful response.

Keywords: Additive manufacturing (AM), Critical Challenges, Adoption, Manufacturing Industry, multi-hierarchical process (AHP)

Introduction

Additive manufacturing (AM), known as 3D printing technology, was first introduced in the 1940s [Kantaros 2021]. In recent years, additive manufacturing (AM) has been extensively used in a variety of industries, including the aerospace, automobile, chemical, construction, dental, drone, apparel, footwear, health care, and toy industries [Sheng 2022].

Vietnam is a developing country that is attracting a lot of FDI, but the majority of it is in outsourcing, and the value added is still low. Therefore, to gain the competitiveness, Vietnam must lift up rapidly in technology, digital transformation, and skilled labour. Integrating AM in the production, research, and creation of high-value products is being recognized as a strategic technological movement in the provinces of the southern key economic region, where the industrial proportion is the highest in Vietnam. However, the investors have not fully recognized the benefits and challenges when deciding to invest in AM application in production. This study intends to provide an overview of AM to professionals, investors, and enterprises. It also identifies and evaluates the challenges of adopting AM to manufacturing in economic and technological conditions like Vietnam.

Literature Review

The competitive nature of 21st-century markets requires the continuing enhancement of existing products, and AM is crucial to the fourth industrial revolution [Kantaros 2021]. To assess and identify these challenges, AHP approach is used to figure out the important elements impacting on AM technology adoption among the industries. There are some previously considerable studies used the AHP approach for seeking some beneficial aspects and limitations of this technology. The group of researchers carried out AHP to evaluate implementation factors of AM in India situation, the study includes AM technology, top management commitment, information sharing, supply chain coordination, organizational capability and human resource, process improvement practices, customer and service management, market support, financial capability, technological awareness and education & training [Sonar 2021]. The study revealed that the commitment of the top management ranks first in the hierarchy; thus, the top management is vital for the effective implementation of AM. In case of Taiwan, a study has integrated AHP and TOE framework combining with cost criteria to analyse and offer producers with a useful resource for planning the adoption of AM. The study resulted that different firms have diverse worries with the use of AM due to distinct dimensions and assessment standards and confirmed that there are some factors that might not have been considered [Yeh 2018].

However, a comprehensive assessment of these challenges has not been conducted, and there are particularly few studies on this issue in developing countries such as Vietnam. Therefore, based on the holistic framework of Kabra et al. [Kabra 2023], this research seeks to identify and assess the challenges of the adoption of 3D printing comprise of five perspectives: Strategic challenges (SCs), Organisational challenges (OCs), Financial challenges (FCs), Human challenges (HCs), and Technological challenges (TCs) [Kabra 2023]. This research will employ MCDM (Multi-Criteria Decision Making) approaches, such as AHP, which are well suited to determine and evaluate the challenges.

Methodology

After conducting a comprehensive literature review to identify existing research on the challenges of additive manufacturing adoption, a survey instrument will be established to collect data from experts and decision-makers in the field of additive manufacturing. This study uses the AHP method to rank the implementation problems for additive manufacturing. Based on pairwise comparisons of various criteria to assess their relative relevance, the AHP approach is a multi-criteria decision-making (MCDM) technique.

Expected Results

The expected results of the research paper that uses the Analytic Hierarchy Process (AHP) to identify and evaluate the challenges of adopting additive manufacturing technology could be: Identifying the main challenges, Prioritisation of challenges, Evaluation of solutions, Industry-specific insights. Overall, the research may give useful information on the challenges to additive manufacturing adoption and the best approaches to overcome them. The study, using the AHP approach, may give an organised and rigorous decision-making process that may aid firms in making more informed decisions on the adoption of additive manufacturing.

Conflict of Interest: The authors declare no conflict of interest.

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Sustainable financial sector in Vietnam: An analysis on stock volatility during COVID-19

Vu Thi Hong Nhung[1], Bui Ngoc Kim Kieu[1,*]

[1] Becamex Business School, Eastern International University, Nam Ky Khoi Nghia Street, Binh Duong, Vietnam

[*] Corresponding author: kieu.bui.bbs18@eiu.edu.vn

Abstract: This study aims to investigate the stock volatility of financial sector in Vietnam during COVID-19. Data of 34 financial firms were collected for the period from 23rd January 2020 to 30th September 2021 and analysed using the random-effect model. The results show that as the number of new COVID-19 cases in Vietnam increases, the stocks of financial firms become less volatile. Besides, the relationship between the mortality rate and stock volatility is insignificant. Regarding the firm characteristics, financial firms with larger size, undervalued stock price and better financial performance would have lower stock volatility.

Keywords: Financial sector, COVID-19, stock volatility, panel data analysis

Introduction

Financial sector, including banking, insurance, and securities industries, plays a key role in ensuring the sustainable economic growth. It helps mobilise savings and direct funds into production sectors. Ultimately, it facilitates efficient allocation of resources and increases overall productivity. In Vietnam, financial sector has the largest market capitalisation. During COVID-19 pandemic, Vietnamese banking system accommodated the capital needs in the economy and directed the capital flow to the priority businesses, especially the production sectors and the businesses affected severely by the pandemic.

COVID-19 pandemic was first identified in Wuhan, China, in December 2019. Due to the globalised environment, the virus spread rapidly around the world. More than 550 million people worldwide have been verified to this virus, and as of June 2022, more than 6.2 million people have perished because of it. In Vietnam, the COVID-19 wave in 2021 is the most serious when the economic hub in the Southern area was under the lockdown for three months. To assist the business and citizens, Vietnamese government lowered the interest rates and implemented three stimulus packages. As a result, the risky assets, such as stocks, became more attractive which raised VN-Index up by 40% in 2021. Stock prices of financial firms grew 66% on average, causing a risk of the asset bubble.

This paper aims to study the impact of COVID-19 on the stock volatility of financial sector in Vietnam with the control of firm-specific variables. This study contributes to the knowledge of stock market reactions towards the pandemic. Investors could be benefit in the sense of asset allocation, especially during future unexpected circumstances due to external events. Besides, the policy makers can implement the results to avoid the asset bubble in financial sector and ultimately, encourage the sustainable growth of financial sector in Vietnam. Healthy financial sector is a strong foundation for the sustainable economic development.

Materials and Methods

This paper studies the period from 23rd January 2020 to 30th September 2021. It is from when Vietnam found the first coronavirus case till the lockdown was officially lifted up. The daily stock prices of 34 financial firms were collected. Other firms in the sector were removed from the sample because of the missing data during this period. Other necessary data includes the number of new cases, the number of death cases in Vietnam, firms' market capitalisation, market-to-book value ratio, and ROE.

Adopting [Ashraf 2020] and [Anh 2020], we conduct a panel data regression analysis:

$$VOL_{it} = \beta_0 + \beta_1 \Delta CASE_{t-1} + \beta_2 MKT_{it-1} + \beta_3 MTB_{it-1} + \beta_4 ROE_{it} + \beta_5 RE_{it} + \varepsilon_{it} \dots (1)$$

$$VOL_{it} = \beta_0 + \beta_1 \Delta CASE_{t-1} + \beta_2 \Delta DEATH_{t-1} + \beta_3 MKT_{it-1} + \beta_4 MTB_{it-1} + \beta_5 ROE_{it} + \beta_6 RE_{it} + \varepsilon_{it} \dots (2)$$

where:

VOL is the volatility of stock returns measured by 30-day standard deviation of stock returns, following [Harjoto 2021], where stock return RE is $\ln(P_t/P_{t-1})$ with the stock price P.

$\Delta CASE$ is the increased number of daily new COVID-19 cases in Vietnam
$\Delta DEATH$ is the increased number of daily new COVID-19 death cases in Vietnam
MKT is the natural logarithm of daily market capitalisation of the firm
MTB is the daily market-to-book ratio of the firm

ROE is the return on equity of the firm in the previous year
Model (1) is applied for the overall sample whereas Model (2) is used for the period from 31st July 2020, when the first fatality was recorded in Vietnam, to the sample end. The impact of the death cases is expected to be meaningful only when there are fatality cases. Instead of the fixed-effect model, this paper uses the random-effect regression model because of its ability to deal with time-invariant independent variables.

Results and Discussion

Table 1 summarises the regression results for the two models. Except the insignificant coefficient of *DEATH* in Model (2), other variables show similar results in the two models. The number of new cases is negatively related to the volatility of stock returns of financial firms in Vietnam. The coefficient is significant but closes to zero. This unexpected result contradicts the findings of Harjoto et al. who argue the positive relationship between stock volatility and COVID-19 cases in 57 countries [Harjoto 2021]. Regarding the firm characteristics, *MKT* and *ROE* also have a negative impact on stock volatility but *MTB* has a positive impact. It indicates that stocks of small financial firms with overpriced stocks and poor performance are more volatile during the pandemic in Vietnam.

The lower stock volatility when the number of new COVID-19 cases increases can be explained by the participation of the large number of new retail investors during this period. This number was 1.5 million in 2021, 1.5 times more than the total of the four previous years. Moreover, the trading volume kept breaking its peak record with the highest of USD2.5 billion on 19th November 2021. The lockdown motivates people to equip themselves with knowledge and experience in new areas, including financial markets. Besides, the stocks that had the highest returns in financial sector at that time are not from the firms with the best financial performance. The increase stock prices were mainly caused by the management strategies through paying dividends and issuing new shares because the top managers have a divestment plan. As a results, investors should invest in financial firms which have sustainable growth and strong corporate governance. Also, they should diverse investment portfolios to non-financial firms to avoid unexpected performance of financial firms' stocks. Additionally, the inverse relationship between stock volatility and COVID-19 cases might be because investors had confidence and trust in Vietnamese government's responses to the pandemic [Anh 2020]. Hence, government's reactions to cope with crisis should take investors' behaviours into account.

Tab. 1: The regression results of models (1) and (2)

Variable	**Model 1**	**Model 2**
CASE	-3.32E-07***	-2.83E-07***
DEATH	-0.003440***	-1.63E-06
MKT	0.004492***	-0.003445***
MTB	-0.012373***	0.004506***
ROE	-0.002214	-0.012282***
RE		-0.002149

Notes: *** represent statistically significant at 5%.

Conclusions

This research analyses the stock volatility of financial sector in Vietnam during COVID-19 by using a random-effect model of panel data analysis. It is showed that the fatality rate has insignificant effect on stock volatility but the number of new cases has a significant negative effect. Besides, the market size and firm's financial performance are also negatively related to the dependent variable while the market-to-book ratio is positively related. Studying financial market and financial sector' stock in particular contributes to the sustainable economic development, especially in terms of efficient resource allocation. Future research can expand to other measures of stock volatility.

Conflict of Interest: The authors declare no conflict of interest.

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The Nexus Between Macroeconomic Determinants and Firm Financial Performance: Evidence from the US Market

Phuoc Le Tan[1,*], Pham Duc Chinh[2], Dao Thi Thanh Tuyen[1]

[1] Becamex Business School – Eastern International University, Binh Duong, Vietnam
[2] University of Economics and Law, Ho Chi Minh City, Vietnam
[*] Corresponding author: phuoc.le@eiu.edu.vn

Abstract: The US macroeconomic environment has changed dramatically in recent years due to the Covid-19 pandemic and the ongoing Russo-Ukrainian War in Ukraine. These changes and events harm inflation, interest rates, exchange rates, and business in the US. This study proposes and employs market-based ratios as a proxy for firm financial performance and examines the relationship between macroeconomic determinants and firm financial performance. Other contributions are applying the Bayesian approach via a non-parametric Bayes estimator, the confidence interval, and the test hurdle t-statistic of 3.0 from the frequentist statistics to analyze and validate the findings. Using the high-frequency data of the S&P 500 firms from 2007-2021, this study finds and confirms that the market risk premium has a statistically significant positive impact on Tobin's Q ratio and excess stock returns. The US prime rate risk premium yields a statistically significant positive impact on Tobin's Q and a negative impact on excess stock returns. The US's government long-term bond risk premium yields a statistically significant negative and positive impact on Tobin's Q ratio and excess stock returns, respectively. Finally, the USD/EUR ratio negatively affects Tobin's Q ratio and excess stock returns. The findings narrow the literature gaps, especially in the US, and assist policymakers, corporate managers, and investors in drafting macroeconomic policy, risk control, and investment decisions.

Keywords: Firm performance, macroeconomic determinants; Bayesian analysis, Gibbs sampling

Introduction

The firm financial performance is crucial to its survival, success, and stakeholders, especially the investors. When investing in stocks, the investors earn from two primary sources: dividends and capital gains. So, the investor makes good earnings if the firm performs well, such as locking in good sales, possessing good corporate governance, strategy, and talented employees, and managing their assets, costs, and information system effectively. This good news will affect the firm stock prices or value since the stock markets are efficient. So, the knowledge of determinants of the firm financial performance is significant to corporate managers and researchers.

The firm financial performance is affected by both micro and macroeconomic determinants. Macroeconomic risks are non-diversified risks and so cannot be eliminated entirely. Thus, macroeconomic determinants can positively or negatively impact the firm financial performance, as demonstrated in the crises in Latin America and East Asia and the 2007 global financial crisis [Cheong 2021]. In the literature, many studies pointed out the effects of macroeconomic determinants on the firm financial performance in developing countries [Doruk 2019]. Even though the macroeconomic volatility in emerging and developing countries is substantially higher than in developed countries [Egbunike 2018], it still significantly impacts affluent countries. Unfortunately, the number of recent studies on the nexus between macroeconomic determinants and the firm financial performance in developed nations is still short [Doruk 2019], except for financial institutions [Isayas 2022]. The possible reason for this phenomenon could be due to the recognition of the efficient market, particularly the US stock markets.

The US macroeconomic environment has changed dramatically in recent years due to the Covid-19 pandemic and the ongoing Russo-Ukrainian War in Ukraine. These changes and events significantly impact inflation, interest rate, exchange rates, and business in the US. So, this study examines the effects of US macroeconomic determinants on the firm financial performance using the market-based ratios due to their high efficiency compared with the accounting ratios and the data of the S&P 500 firms from 2007-2021.

Methodology and Data

The two dependent variables are Tobin's Q ratio and the excess stock returns, the market-based ratios, proxy for the firm financial performance. So, for the stock of firm i, $i = 1, 2, 3, \ldots, N$ at the time t, $t = 1, 2, \ldots, n$, the relationship between the excess market return, US prime rate, long-term US government bond yield, and USD/EUR and Tobin's Q ratio (Model 1 - Eq. 1) and excess stock returns (Model 2 - Eq. 1) are as follows:

$$Tobin's\ Q_{it} = \alpha_i + \beta_i(RM_t - RF_t) + \gamma_i(US_t - RF_t) + k_i(LTB_t - RF_t) + \lambda_i EX_t + \epsilon_{it} \quad (1)$$

and

$$R_{it} - RF_t = \alpha_i + \beta_i(RM_t - RF_t) + \gamma_i(US_t - RF_t) + k_i(LTB_t - RF_t) + \lambda_i EX_t + \epsilon_{it} \quad (2)$$

This study applies the Bayesian statistical method using Gibbs sampling to minimize errors in data mining and avoid data bias [Dyckman 2016]. Other reasons for using the Bayesian method are that it works exceptionally well with time-series data of stock returns because the parameters may not be fixed, not meeting the assumption of the frequentist approach. Also, this study uses high-frequency time series data (quarterly for Tobin's Q ratio and daily for the excess stock returns) from 06/2007 to 09/2021. Among all S&P 500 index components, 434 stocks have complete data from 06/2007-09/2021. So, each stock has 70 and 3600 observations of Tobin's Q ratio and excess stock returns.

Empirical Results and Discussion

Models 1 and 2 yielded beta means of 1.56 and 1.02, respectively. Also, these two models yielded 95% confidence intervals of the beta of (0.89, 2.24) and (0.99, 1.04), respectively. These findings mean that the market risk premium surely has a statistically significant positive effect on Tobin's Q ratio and excess stock returns. These results align with other studies [Barillas 2018, Dai 2020]. Also, Models 1 and 2 yielded gamma means of 74.37 and -7.42, respectively. These two models yielded 95% confidence intervals of gamma of (54.67, 94.07) and (-10.55, -4.28), respectively. These findings mean that the US prime rate risk premium has a statistically significant positive and negative effect on Tobin's Q ratio and excess stock returns, respectively. These results are inconsistent with other studies [Lin 2018, Pham 2020]. Next, Models 1 and 2 yielded kappa means of -72.39 and 1.03, respectively, and 95% confidence intervals of kappa of (-96.07, -48.71) and (-0.03, 2.09), respectively. However, Model 2 also yielded a 90% confidence interval of kappa of (0.14, 1.93). These findings mean that the US government's long-term bond rate risk premium has a statistically significant negative and positive effect on Tobin's Q ratio and excess stock returns, respectively. These results contradict other study [Jareno 2016]. Lastly, Model 1 and 2 yielded lambda means of -29.86 and -0.05, respectively, and the 95% confidence intervals of lambda of (-55, -4.72) and (-0.07, -0.02), respectively. These findings mean that the exchange rate of USD/EUR has a statistically significant negative effect on Tobin's Q ratio and excess stock returns. These results inconsistent with other study [Pham 2020].

Conclusions

The firm financial performance is crucial to its survival, success, and stakeholders, especially investors since they make their earnings from dividends and capital gains – the results of sound financial performance. So, the knowledge of determinants of the firm financial performance is significant to corporate managers and researchers. This study proposes and employs the market-based metrics of Tobin's Q and excess stock returns as two measures of the firm financial performance. This study employs the high-frequency data of the S&P 500 firms from 2007-2021, Bayesian methodology, Gibbs sampling, non-parametric estimator, and frequentist statistics to analyze and validate the relationship between macroeconomic determinants and firm performance. The results show the strong relationship between the macroeconomics determinants and firm performance. So, these findings narrow the literature gaps, especially in the US, and assist policymakers, corporate managers, and investors in drafting macroeconomic policy, risk control, and investment decisions.

Conflict of Interest: The authors declare no conflict of interest.

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The relationship among oil prices, stock prices and exchange rates for sustainable economic growth in ASEAN countries

Vu Thi Hong Nhung[1], Nguyen Thien Phuc[1,*]

[1] Becamex Business School, Eastern International University, Nam Ky Khoi Nghia Street, Binh Duong, Vietnam

[*] Corresponding author: phuc.nguyenthien.bbs19@eiu.edu.vn

Abstract: To contribute to the sustainable economic and financial development, this research examines the trilateral relationship between exchange rates, oil prices, and the stock market across nine ASEAN countries. The study is divided into three periods: pre-COVID-19 announcement, post-COVID-19 announcement, and during the Russia-Ukraine conflict. The study employs a panel VAR analysis based on panel Granger causality testing. The results demonstrate that the three variables do not exhibit interdependence during either the pre-pandemic or the conflict periods. However, during the COVID-19 pandemic, shocks in oil prices and exchange rates have a significant impact on the stock market volatility. Furthermore, the impact of both factors is more profound than the effect of individual factors.

Keywords: Stock prices, oil prices, exchange rates, ASEAN countries, COVID-19, Russia-Ukraine conflict

Introduction

To avoid the spread of the extremely contagious COVID-19 virus, many nations' tourism, airlines, import-export, transportation, and other businesses were severely obstructed, causing crude oil demand to fall dramatically. At the same time, stock markets in many countries are facing the unfavorable time due to the unusual movement of world crude oil prices. The recent Russia-Ukraine conflict also contributes to the soaring prices of crude oil. Since these two countries are the major producers and distributors of the global energy, food, and other natural resources, the conflict has caused an extensive increase in worldwide commodity prices. Ultimately, the conflict remains a potential source of inflation and slower growth in the economies that rely on commodity imports from Ukraine and Russia, making it one of the most important security events in recent years in international politics [Prisecaru 2022].

Consequently, high inflation rate in the US causes a recent USD appreciation. Since oil is priced in USD, oil becomes more expensive in domestic currency terms for countries that do not adopt USD as the domestic currency. Therefore, this paper aims to examine the relationship between oil prices, stock prices, and exchange rates in ASEAN countries during three periods: pre-COVID-19, post-COVID-19 declaration, and post-Russia's invasion of Ukraine. The three-year blockade in China has caused economic disruption and hence, raises concerns about diversifying investment into neighboring regions of China such as Southeast Asia.

Our paper has several contributions. First, the attention towards the linkage between oil prices, stock prices, and exchange rates in ASEAN. Secondly, policymakers and investors can use this knowledge to develop favorable policies and make gainful investments to support sustainability and promote long-term growth.

Materials and Methods

The paper uses data collected from January 2, 2019, to February 28, 2023. The data consists of three series. The first series is the daily closing price of the stock index in nine ASEAN countries including Cambodia (CSX), Indonesia (JKSE), Laos (LSX), Malaysia (KLSE), Myanmar (YSX), Philippine (PSE), Singapore (FTSE), Thailand (SET), and Vietnam (VNI). The second series is the exchange rates of these countries' currency against the US dollar. The final series is the daily Brent oil prices. All data are collected from Bloomberg Terminal. Three sub-periods are before (from January 2, 2019, to March 10, 2020) and after COVID-19 (from March 11, 2020, to February 23, 2022), and Russia-Ukraine conflict (from February 24, 2022, to February 28, 2023).

This paper employed panel VAR to examine the interlinkage between oil prices, stock prices, and exchange rates in nine ASEAN countries as proposed by Kumeka et al. [Kumeka 2022]. This model is used for analyzing the relationships and causality among a set of endogenous variables that change over time and include a cross-sectional dimension. The examination proceeds with the use of the panel Granger causality test, which helps discern whether the previous performance of a variable is useful in forecasting another variable.

Results and Discussion

The results of panel Granger causality test are summarized in Tab.1. In the pre-announcement and the Russia-Ukraine war periods, there is no significant Granger causality relationship among variables. This results contradicts the findings in [Kumeka 2022] who find several Granger causality relationships from oil prices and exchange rates to stock markets and from stock markets and exchange rates to oil prices in the pre-COVID-19 period in oil exporting countries.

However, there is unidirectional Granger causality from oil returns, exchange rate returns, and both of them to stock returns after the declaration of the pandemic. This indicates that during the pandemic, changes in oil prices and exchange rates influence the stock market. Moreover, the combination of the two variables have a more profound effect on the stock market volatility than the impact of the individual variables. Our finding also supports Kumeka et al. in the sense that exchange rate returns Granger causes stock returns [Kumeka 2022].

Tab 1. Result of the panel Granger causality test

	Dependent	Excluded	χ^2	Df	Prob.
Pre-COVID-19	RSMI	REXR	4.613785	4	0.3293
		ROIL	0.063531	4	0.9995
		ALL	4.684394	8	0.7907
	REXR	RSMI	0.055007	4	0.9996
		ROIL	2.541353	4	0.6372
		ALL	2.627486	8	0.9555
	ROIL	RSMI	3.459833	4	0.484
		REXR	0.089003	4	0.999
		ALL	3.550287	8	0.8953
Post-COVID-19	RSMI	REXR	15.92***	2	0.0003
		ROIL	12.08***	2	0.0024
		ALL	28.23***	4	0
	REXR	RSMI	0.223468	2	0.8943
		ROIL	0.869218	2	0.6475
		ALL	1.02874	4	0.9054
	ROIL	RSMI	0.3649	2	0.8332
		REXR	4.029591	2	0.1333
		ALL	4.372493	4	0.3579
Russia-Ukraine conflict	RSMI	REXR	3.662372	2	0.1602
		ROIL	0.874678	2	0.6458
		ALL	4.543731	4	0.3374
	REXR	RSMI	1.165576	2	0.5583
		ROIL	0.323713	2	0.8506
		ALL	1.455884	4	0.8344
	ROIL	RSMI	3.662372	2	0.1602
		REXR	0.874678	2	0.6458
		ALL	4.543731	4	0.3374

*** denote 1% significant level. RSMI, REXR, ROIL are stock, oil, and exchange rate returns, respectively.

Conclusions

This paper investigates the trilateral relationship between oil prices, exchange rates, and stock market in nine ASEAN countries by using a panel VAR analysis based on panel Granger causality test. In general, the three variables fail to show the interdependence on each other before the declaration of the pandemic and during the conflict between Russia and Ukraine. During the pandemic, shocks in oil prices and exchange rates have significant impact on the variations in the stock market. Moreover, the contribution of both factors at the same time to the stock market volatility is more profound than the contribution of the two factors individually. Furthermore, as the IMF and ADB expect ASEAN economy to slow down in 2023 due to inflation and China reopening, future research might cover this period or might investigate deeper into various sectors.

Conflict of Interest: The authors declare no conflict of interest.

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FULL PAPERS

The Conference attracted a number of full paper submissions for publication in MM Science journal.

Copyright protection in additive manufacturing

Minh Thanh Nguyen[1], Jiri Hajnys[2], Marek Pagac[2], Hoang-Sy Nguyen[1,*]

[1] Becamex Business School, Eastern International University, Thu Dau Mot City, Binh Duong Province, Viet Nam

[2] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: sy.nguyen@eiu.edu.vn

Optimization of process parameters for wood laser engraving based on Taguchi method approach

Huyen Nguyen-Thi-Ngoc[1], Thai-Viet Dang[2,*]

[1] Department of Manufacturing Engineering, [2]Department of Mechatronics, School of Mechanical Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam.

[*] Corresponding author: viet.dangthai@hust.edu.vn

Enabling smart factory with deep residual-aided generative adversarial network: Performance analysis end-to-end learning of machine-to-machine

Cong-Danh Huynh[1], Thanh-Khiet Bui[1,*], Jiri Hajnys[2]

[1] Thu Dau Mot University, Thu Dau Mot City, Binh Duong Province, Vietnam

[2] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: khietbt@tdmu.edu.vn

Research trend in the field of additive manufacturing with bibliometrics study

Hoang-Sy Nguyen[1,*], Quoc-Phu Ma[2], Jiri Hajnys[2], Jakub Mesicek[2], Marek Pagac[2]

[1] Becamex Business School, Eastern International University, Binh Duong Province, Vietnam

[2] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering,VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: sy.nguyen@eiu.edu.vn

Research MS access software for application in smart garment factory machine management

La Thi Ngoc Anh[1,*], Vu Thi Duom[1], Le Tieu Thanh[1], Bui Thi Phuong Thao[1]

[1] Hanoi University of Science and Technology, 1st Dai Co Viet, Hanoi, Viet Nam

[*] Corresponding author: anh.lathingoc@hust.edu.vn

Young adults' anti-consumption tendencies toward organic foods in Vietnam

The Anh Phan[1,*], Ngoc Bao Thi Pham[1]

[1] Eastern International University, Becamex Business School, Thu Dau Mot City, Binh Duong.

[*] Corresponding author: anh.phanthe@eiu.edu.vn

Experimental verification of process parameters influencing the mechanical properties of M300 in the SLM process

Krisak D.[1], Hajnys J.[1], Blaha R.[1,*], Mesicek J.[1], Jancar L.[1], Jansa J.[1], Posmykova E.[1], Gazda M.[1], Pagac M.[1]

[1] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: roman.blaha@vsb.cz

The macroeconomic determinants and firm financial performance: Evidence from the US market

Pham Duc Chinh[1, 2], Phuoc Le Tan [3,*], Dao Thi Thanh Tuyen[3]

[1] University of Economics and Law, Ho Chi Minh City, Vietnam

[2] Vietnam National University, Ho Chi Minh City, Vietnam

[3] Becamex Business School – Eastern International University, Binh Duong, Vietnam

[*] Corresponding author: phuoc.le@eiu.edu.vn

Effect of cutting-edge preparation technologies on surface roughness and processing time

Slaninkova A.[1,*], Jansa J.[1], Mrkvica I.[1], Pagac M.[1], Mesicek J.[1], Janeczko R.[1]

[1] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: aneta.slaninkova@vsb.cz

Research the digital transformation model of materials management in Vietnam garment companies

La Thi Ngoc Anh[1,*], Nguyen Thi Hanh[1], Hoang Thanh Thuy[1], Nguyen Kieu Oanh[1]

[1] Hanoi University of Science and Technology, 1st Dai Co Viet, Hanoi, Viet Nam

National University of Arts Education

[*] Corresponding author: anh.lathingoc@hust.edu.vn

Topological optimization of the rocker arm

Posmykova E.[1,*], Mesicek J.[1], Gazda M.[1], Hajnys J.[1], Jancar L.[1], Jansa J.[1], Krisak D.[1], Blaha R.[1], Pagac M.[1]

[1] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: eliska.posmykova.st@vsb.cz

Measuring contributions of technology changes in GVCs on the economic growth of EMEs

Seung Won Kang[1,*]

[1] Becamex Business School, Eastern International University, Thu Dau Mot, Binh Duong Province, Vietnam

[*] Corresponding author: kwon.kang@eiu.edu.vn

Research and design of a path planning using an improved RRT* algorithm for an autonomous mobile robot

Thai-Viet Dang[1,*]

[1] Mechatronics Department, School of Mechnical Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam

[*] Corresponding author: viet.dangthai@hust.edu.vn

Energy consumption, economic growth and development finance: Evidence from the middle-income countries and innovative solutions for effective energy management in smart cities

Thang Cong Nguyen[1], Tra Thi Huong Lam[1,*], Sy Hoang Nguyen[1]

[1] Becamex Business School, Eastern International University, Vietnam

[*] Corresponding author: tra.lam@eiu.edu.vn

Baumol's cost disease and its impact on healthcare expenditures in Korea

Seung Won Kang[1], Tan Phuoc Le[1], Thi Trang Ninh[1,2,*]

[1] Becamex Business School, Eastern International University Binh Duong, Vietnam,

[2] School of Business, International University, Ho Chi Minh City, Vietnam

[*] Corresponding author: trang.ninh@eiu.edu.vn

Investigation of the fabrication process of metal 3D printed powder by molten alloy dispersion method using centrifugation and high-pressure gas

Doan Van Phuc[1], Vu Van Quang[2], Dinh Van Duy[2,*]

[1] Institute of Chemistry - Materials / Military Institute of Science and Technology of Vietnam, Hanoi 10000, Vietnam

[2] Hanoi University of Science and Technology, No1 Dai Co Viet Street, Hai Ba Trung District, Hanoi 10000, Vietnam

[*] Corresponding author: duy.dinhvan@hust.edu.vn

Autonomous mobile robot path planning based on enhanced A* algorithm integrating with time elastic band

Thai-Viet Dang[1,*]

[1] Mechatronics Department, School of Mechanical Engineering, Hanoi University of Science and Technology, Hanoi, Vietnam

[*] Corresponding author: viet.dangthai@hust.edu.vn

Evaluating the challenges of additive manufacturing adoption using the analytic hierarchy process method: Empirical research in Vietnam

Tran D.[1], Le Q.[2,*], Nguyen L.[3], Ma Q.-P.[4], Hajnys J.[4], Nguyen H.[5]

[1] Office of Community Engagement, Eastern International University, BinhDuong New city, Vietnam.

[2] Becamex Business School, Eastern International University, BinhDuong New city, Vietnam.

[3] Business Administration Faculty, Industrial University Ho Chi Minh City, Ho Chi Minh City, Vietnam.

[4] Department of Machining, Assembly and Engineering Metrology, Faculty of Mechanical Engineering, VSB-Technical University of Ostrava, 70833 Ostrava, Czech Republic

[5] School of Engineering, Eastern International University, Binh Duong New city, Vietnam.

[*] Corresponding author: quang.le@eiu.edu.vn

Thermo-mechanical properties of ABS matrix composite filament reinforced with multi-layer graphite oxide composite fibers for FDM 3D printing

Thanh-Dung Do[1], Minh-Tung Le[1], Huy-Hieu-Nghia Nguyen[1], Anh Quang Le[2], Thai-Hung Le[1,*]

[1] Hanoi University of Science & Technology, School of Materials Science & Engineering, Hanoi, Vietnam.

[2] Institute of Technology, Hanoi, Vietnam.

[*] Corresponding author: hung.lethai@hust.edu.vn

Additive manufacturing of M300 steel cutting tools by selective laser melting

Tomas Machac[1,*], Peter Pokorny[1], Jakub Hrbal[1], Marcel Kuruc[1], Tomas Vopat[1]

[1] Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Institute of Production Technologies, Trnava, Slovakia

[*] Corresponding author: tomas.machac@stuba.sk

3D technologies for intangible cultural heritage preservation: Creating 3D models of lacquer art through photogrammetry

Hoang-Sy Nguyen[1], Khanh-Duy Ho Hoang[2], Cong-Danh Huynh[3,*], Quoc-Phu Ma[4], Jakub Mesicek[4]

[1] Becamex Business School, Eastern International University, Binh Duong Province, Vietnam

[2] Research Construction Technology Institute, Thu Dau Mot City, Binh Duong Province, Vietnam

[3] Thu Dau Mot University, Thu Dau Mot City, Binh Duong Province, Vietnam

[4] Department of Machining, Assembly and Engineering Technology, Faculty of Mechanical Engineering, VSB—Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

[*] Corresponding author: danhhc@tdmu.edu.vn

Towards smart building technologies for smart buildings in Binh Duong

Khuyen Tran[1], Anh Tran[1,*]

[1] EIU – BBS, Binh Duong, Viet Nam

[*] Corresponding author: anh.tranphamtuan@eiu.edu.vn

Digitalizing conventional machines: A complete practical implementation solution

Viet-Thang Nguyen[1], Thanh-Hai Diep[1,*], Thanh-Son Nguyen[1,*], Ngoc-Duc Trinh[1], Ngoc-Huan Le[1], Ngoc-Hay Nguyen[1,*]

[1] School of Engineering, Eastern International University, Thu Dau Mot, Binh Duong, Vietnam

[*] Corresponding author: hay.nguyen@eiu.edu.vn, son.nguyen@eiu.edu.vn, hai.diep@eiu.edu.vn

Relationship quality and supplier integration: An empirical study in a manufacturing region

Nguyen Cao To Linh[1,*], Kieu Manh Kha[1,2]

[1] Becamex Business School, Eastern International University

[2] The Business School, RMIT University Vietnam

[*] Corresponding author: s3856643@rmit.edu.vn

Network modelling in international trade of pharmaceutical industry: The interrelations and structural pattern during the global health shock

Tram Nguyen Vu Anh[1], Nha Le Quoc[1], Long Hoang[1,*]

[1] Eastern International University, Becamex Business School, Thu Dau Mot City, Binh Duong, Vietnam

[*] Corresponding author: long.hoang2000@eiu.edu.vn

The relationship among oil prices, stock prices and exchange rates for sustainable economic growth in ASEAN countries: The effect of COVID-19 and Russia-Ukraine conflict

Vu Thi Hong Nhung[1], Nguyen Thien Phuc[1,*]

[1] Becamex Business School, Eastern International University, Nam Ky Khoi Nghia Street, Binh Duong, Vietnam

[*] Corresponding author: phuc.nguyenthien.bbs19@eiu.edu.vn

Development of smart disinfection machine using IoT technology

Truong Duc Phuc[1,*], Tran Van Thanh[1], Nguyen Hoang Vu[1], Dang Tran Bach[1]

[1] School of Mechanical Engineering, Hanoi University of Science and Technology (HUST), No.1 Dai Co Viet Road, Hai Ba Trung, Hanoi, Vietnam.

[*] Corresponding author: phuc.truongduc@hust.edu.vn

Author:	Team of Authors
Department, Institute:	Faculty of Mechanical Engineering, Department of Machining, Assembly and Engineering Metrology
Name:	From Smart City to Smart Factory for Sustainable Future: conceptual framework, scenarios, and multidiscipline perspectives Conference Proceeding
Place, year of publishing:	Ostrava, 2023, 1st Edition
Number of Pages:	82
Published:	VSB - Technical University of Ostrava
Printing:	Editing Centre VSB-Technical University of Ostrava

ISBN 978-80-248-4682-8 (on-line)