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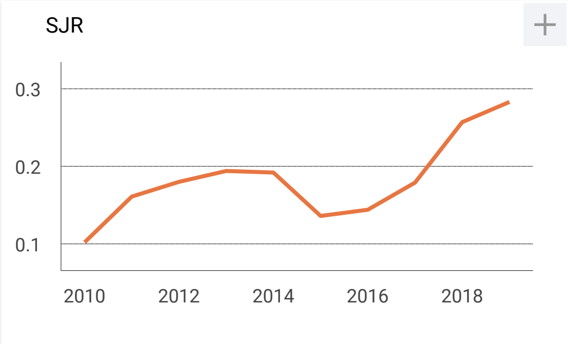

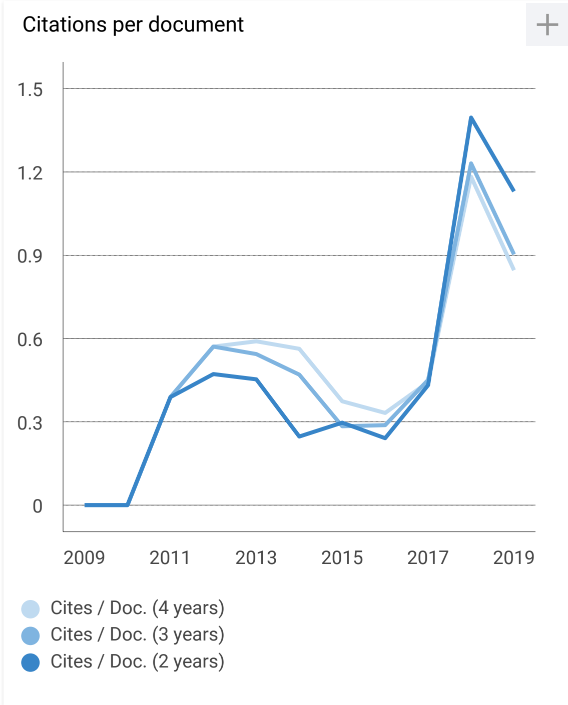

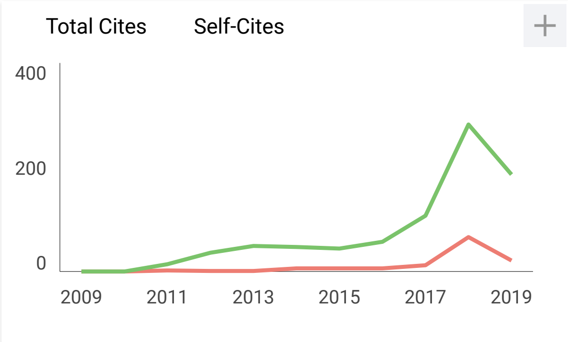

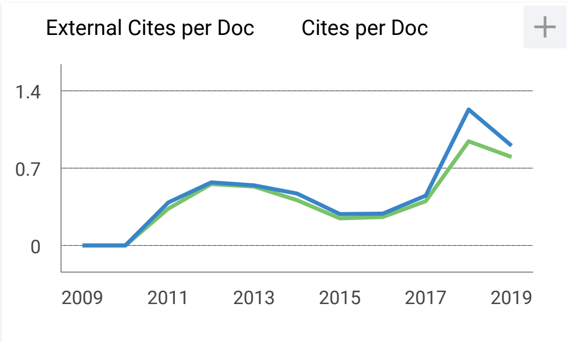

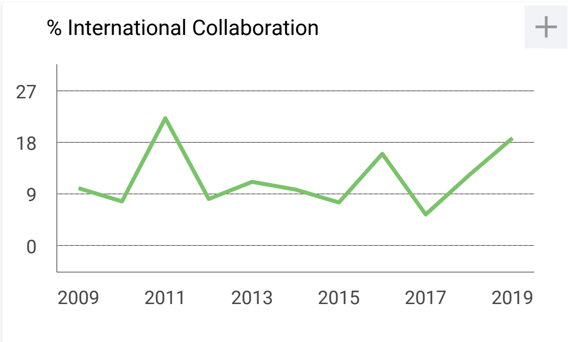

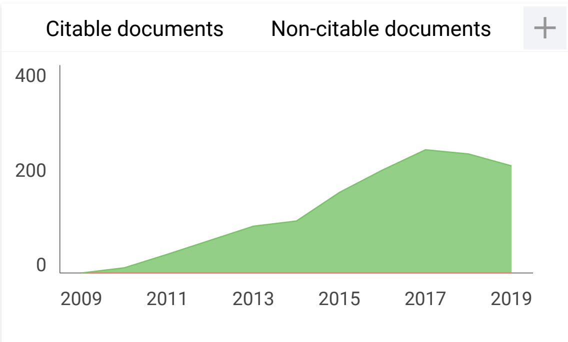

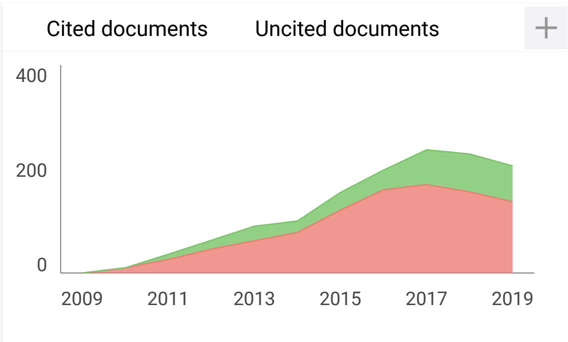

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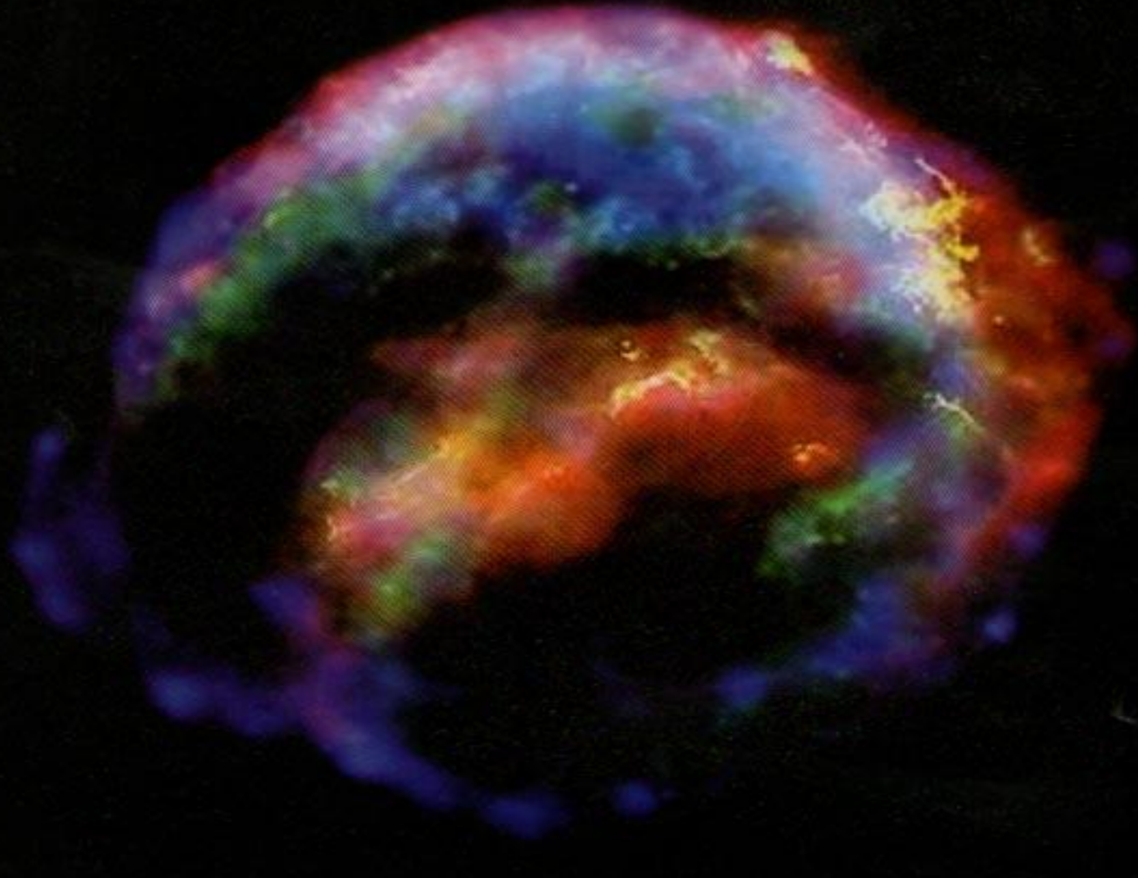

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Title: A Numerical Study of Flame Stabilization in Single Channel and Counter-flow Meso Scale Combustor

Author(s): Muhammad Zahir Hassan, Fudhail Abdul Munir

Pages: 1-8 **Paper ID:** 162004-3737-IJMME-IJENS **Published:** August, 2016

Abstract: The micro power generation system is one of the potential solutions that provides better energy requirement for small devices as compared to conventional batteries. In recent years, numerous works have been conducted to enhance the combustion stability of meso and micro-scale combustors. The utilization of heat recirculation mechanism is one of the approaches to enhance the flame stabilization limits in micro combustors. In this study, flame stabilization in a single channel and counter-flow cylindrical tube combustors with wire mesh was numerically studied. The wire mesh was located between the unburned and burned gas regions of the tubes. A three-dimensional numerical simulation was performed to establish vital parameters such as gas, wire mesh and outer wall temperature. For the validation of the numerical results, the flame blowout and extinction limits were first obtained and compared with experimental results. The utilization of the numerical model enables the improvement on design of the combustor where a counter-flow tube combustor with wire mesh is proposed. Both gaseous and liquid fuels can be used as the primary source for the tube combustor. In a micro power generation system, a combustor with liquid fuel source is preferred as it solves the mobility issue.

Keywords: Micro power generation, micro-scale combustors, heat recirculation.

Full Text (.pdf) | 874 KB

Title: A Suggested Analytical Solution for Vibration of Honeycombs Sandwich Combined Plate Structure

Author(s): Muhsin J. Jweeg

Pages: 9-17 **Paper ID:** 161503-1604-8484-IJMME-IJENS **Published:** August, 2016

Abstract: In this work, a suggested analytical solution for vibration analysis of honeycombs sandwich combined plate is presented. The differential equation of motion for the vibration analysis of honeycombs sandwich combined Plate is solved to evaluate the natural frequency of the plate with different design parameters . The analytical results are first calculated using the mechanical properties of honeycomb structure such as modulus of elasticity, modulus of rigidity, Poisson's ratio, and density of honeycomb structure, then finding the effect of honeycomb structural properties on the natural frequency of combine sandwich plate. The results are the natural frequencies of combine sandwich plate with different honeycomb structural dimensions effect as, length, height, thickness, and angle of regular hexagonal honeycomb structural effect. In addition to, the effects of thickness of combined plate , thickness of honeycomb structural , aspect ratio of plate, and other parameters, on the natural frequency of the plate. A comparison between analytical results obtained theoretically by solving the general equation of motion for sandwich combine plate with honeycomb structure and those evaluated with other researchers gave a good agreement, where the largest discrepancy percentage was about (2 %).

Keywords: Honeycombs Sandwich,Vibration, plate.

Full Text (.pdf) | 667 KB

Title: Modelling of Glass Fibre/Epoxy Composite Pipes Under Multi-Axial Loadings Using Finite Element Analysis

Author(s): Z.S. Nazirah, M.S. Abdul Majid, N.A.M. Amin, A.G. Gibson

Pages: 18-33 **Paper ID:** 161504-8989-IJMME-IJENS **Published:** August, 2016

Abstract: The glass fibre reinforced epoxy (GRE) pipes under multi-axial loadings were studied through its performance at various temperatures and different failure criteria. Owing to the orthotropic nature of GRE pipes, it is hard to analyse the stresses generated in them. Therefore, using finite element software, an analysis was conducted to determine the first ply failure of composite pipes, which were subjected to five different stress ratios, ranging from pure hoop to pure axial loadings, at room temperature, 65 °C and 95 °C. The Tsai-Wu, Hashin and Puck failure criteria were used to predict the failure strength of composite pipes. The results were validated with experimental data obtained from previously reported studies. Subsequently, the limits associated with the axial and hoop stress were expressed by failure envelopes graph. There were differences in the results obtained for the various criteria; however, they showed relatively similar trends. During failure analysis, Hashin criterion results in superior predictions for determining the FPF of GRE pipes yielding the smallest % error between the experimental data compared to the other failure criteria. Initial failure stress found decreased at elevated temperatures, except at a 2:1 stress loading, where the initial failure stress increased.

Keywords: Finite element modelling; first ply failure; failure criteria; multiaxial stress ratio; glass/ epoxy composite pipes.

Full Text (.pdf) | 832 KB

Title: **Bearing Fault Prediction using Filter Based Feature Selection Methods and Datamining Techniques**

Author(s): S. Devendiran, N Harsha Teja, D N Praveen, C Hoshima Reddy

Pages: 34-47 **Paper ID:** 164503-1604-7979-IJMME-IJENS **Published:** August, 2016

Abstract: The present work proposes a vibration signal based intelligent bearing fault diagnosis using various prediction models. It includes different feature selection algorithms ReliefF, Information gain, Gini index and random forest algorithm, subsequently classifiers such as JRip,J48,Reduce error pruning, Logistic model tree (LMT) , decision table and RIDOR were used to predict the bearing conditions .The experiment were conducted for four cases such as Normal Bearing, Inner race fault, Outer race fault and Ball fault, at constant speed and load conditions and the vibration data is obtained . The aim of the paper to identify an appropriate model for that maintains high accuracy with adequate computational time. It was observed that RIDOR possess higher accuracy than other classifiers and LMT given optimum computational time with decent accuracy prediction. Other parameters related to classification process were also discussed.

Keywords: Fault Diagnosis, Statistical Features, data mining techniques etc.

Full Text (.pdf) | 931 KB

Title: **Study and Analysis of the Gait and Legs Angle for Hexapod on the Certain Trajectory Using Fuzzy Logic Approach**

Author(s): Mohd Zamzuri Ab Rashid ,Hairol Nizam Mohd Shah , Mohd Shahrieel Mohd Aras, Anuar Mohd Kassim

Pages: 48-56 **Paper ID:** 161203-1604-7474-IJMME-IJENS **Published:** August, 2016

Abstract: One of the features of hexapod is the ability of walking in different types of terrains. This paper is concerned with the pattern on how the hexapod walks on certain trajectory using tripod gait movement. In this project, a hexapod with two degree of freedom on each leg is designed and built for the purpose of legs angle research. The movement of the hexapod is guided by four Infrared Sensors (IR) installed which used to track the black line. Fuzzy Logic Controller (FLC) is applied to create better response of robot behavior than conventional controllers. The controller will be based on the signal input from Infrared Sensors (IR) to control the turning angle of the robot. Leg angle in 10°, 15°, 20° and 25° are tested and analyzed whether it can maneuver the given path successfully or not. In order to get accurate and reliable results, collection of data is programmed in Arduino microcontroller. The experimental data then are collected back to compare the performance of the robot with simulation conducted ealier.

Keywords: Hexapod Robot, Fuzzy Logic Controller, Trajectory.

Full Text (.pdf) | 883 KB

Title: **Flexural Behaviour of Uni-Directional Kenaf Composites Using Experimental and Simulation Methods**

Author(s): B. M. Yassin, R. Zulkifli, W. R. W. Daud, S. Abdullah

Pages: 57-64 **Paper ID:** 167203-1604-7878-IJMME-IJENS **Published:** August, 2016

Abstract: The use of natural fibres as reinforcement materials in composites has increased significantly due to the various advantages they offer. This paper focuses on the flexural characteristics of kenaf/polyester composites that have a uni-directional fibre orientation. The scope of this research is based on the use of kenaf fibres as reinforcement materials. The reason for the selection of kenaf fibres is because they are biodegradable and allow for the ease of availability as kenaf is cultivated locally. The specimens used in the test are in the cylindrical shape with 200 mm length and 10 mm diameter. The composite specimens are prepared using a pultrusion method with uni-directional long kenaf fibres as reinforcement and polyester resin as the matrix. The specimens are tested using ASTM D790-71 standard at four different temperatures of 27□C, 60□C, 100□C and 160□C. 2 different cross-head speed used, 2mm/min and 10mm/min each. Parameters measured in these studies are stress vs. strain, displacement vs. time and displacement vs. temperature. The research findings show that the failure patterns and deformations when compared between numerical analysis and experimental works are practically the same but with minor discrepancies in the values obtained due to different surroundings. The results also reveal that the percentage between the fibres and matrixes plays a vital role in the quality. As the ratio of fibres increases, the ultimate tensile strength of the composites also escalates together with its brittleness. The failure mode and deformation observed from the experimental data have shown that kenaf/polyester composites have good energy absorption capability at room temperature of 27°C, where the strength decreases as the temperature rises.

Keywords: Kenaf fibres, uni-directional orientation, pultrusion process, polymer matrix composites, mechanical properties.

Full Text (.pdf) | 1,575 KB

Title: **Crushing Performances of Winding Square Kenaf Fiber Reinforced Composites**

Author(s): A. E Ismail

Pages: 65-69 **Paper ID:** 166503-1604-9292-IJMME-IJENS **Published:** August, 2016

Abstract: This paper presents the crushing performances of winding kenaf square composite tubes under axial compression. As-received kenaf yarn is firstly wetted with polymeric resin and wound around the square mould. Two

important parameters are used such as number of layers and fiber orientations. The composite tubes are quasi-statically compressed to obtain their force versus displacement responses. Then, the energy absorption performances and other crashworthiness parameters are determined and analyzed. It is found that both parameters have insignificant effect on the force ratios. However, wall thickness has played an important role in increasing the specific energy absorption performances. It is observed that single layered composite tubes collapsed in stable manner. On the other hand, for three layered composites, the tubes failed catastrophically through of global buckling.

Keywords: ---

Full Text (.pdf) | 460 KB

Title: Unique Rotation Tensor Formulation to Predict Three-Dimensional Deformation Behaviour of Aluminum Alloy AA7010

Author(s): M. K. Mohd Nor

Pages: 70-75 **Paper ID:** 166603-1604-4848-IJMME-IJENS **Published:** August, 2016

Abstract: The formulation of unique orthogonal rotation tensor Rˆ for rate dependant constitutive model of orthotropic materials is thoroughly discussed in this work. The implementation of this orthogonal rotation tensor is performed by referring to three theorems; the deformation gradient F is invertible, the plastic stretch U is symmetric and positive definite, and finally the rotation tensor Rˆ is assumed orthogonal hence, R^(-1)=R^T. The accuracy and stability of this tensor to define an isoclinic configuration for three-dimensional deformation behaviour of aluminum alloy AA7010 is then demonstrated using Taylor Cylinder Impact test. As adopted in the previous publication, subroutine chkrot93 is used to check the accuracy of the proposed formulation to calculate a proper rotation tensor Rˆ. The results proved the accuracy of the proposed rotation tensor and its algorithm to calculate a proper rotation tensor and provide a good agreement with respect to the deformation behaviour of material under consideration.

Keywords: Orthogonal rotation tensor, Orthotropic materials, Three dimensional stress state deformation behaviour.

Full Text (.pdf) | 615 KB

Title: Optimization of Natural Hydroxyapatite/SS316L Feedstock for Highest Green Density in Metal Injection Molding by using Taguchi Method

Author(s): M. H. I. Ibrahim, N. Mustafa, A. M. Amin, R. Asmawi, Batu Pahat

Pages: 76-82 **Paper ID:** 166703-1604-1818-IJMME-IJENS **Published:** August, 2016

Abstract: The developments of Metal injection molding (MIM) process are based on combination of powder metallurgy and plastic injection molding approach but applicable to metals and ceramic .The mixture between metal and binder are called as feedstock. The feedstock is shaping by using metal injection molding technique to produce green parts. Thus this paper concentrates on Taguchi method as a tool in determining the optimum density for Metal Injection Molding (MIM) parameters. In this paper combination of stainless steel 316L (SS316L)/ Natural hydroxyapatite (NHAP) with D50 = 6.553 µm was used with 40 wt % Low Density; Polyethylene and 60 %wt Palm Stearin as a binder system. The feedstock of 63 wt % powder loading consist of 90 % wt of SS316 L and 10 wt % NHAP were optimized with 4 significant injection parameter such as Injection temperature (A), Mold temperature (B), Pressure (C) and Speed (D) were selected throughout screening process. An orthogonal array of L9 (3)4 was conducted. Confirmation test will be done base on Signal-to-Noise (S/N) ratio. The optimum injection parameters for highest green density were found at A2, B2, C2 and D2. . The confirmation experiment result is 13.3146 dB and has archived the minimum requirement of optimum performance.

Keywords: Density; Tilapia Fish Bones; Natural Hydroxyapatite; SS316L; Taguchi Method.

Full Text (.pdf) | 557 KB

Title: The Influence of Linear Kinematic Hardening and Non-Linear Combined Isotropic-Kinematic Hardening Plasticity Model on Sliding Contact

Author(s): M. Nagentrau, W. A. Siswanto, A. L. Mohd Tobi

Pages: 83-88 **Paper ID:** 167403-1604-2525-IJMME-IJENS **Published:** August, 2016

Abstract: This paper addresses the plastic strain and stress behaviour of sliding contact using two different plasticity models and sliding amplitudes. A numerical two-dimensional (2D) cylinder-on-flat contact model subjected to normal loading and sliding is investigated. The elasto-plastic Ti-6Al-4V alloy is examined under quasi-static condition in this simulation. The influence of Linear Kinematic hardening and Non-Linear Combined Isotropic-Kinematic hardening plasticity models for sliding amplitude of 0.05 mm and 0.2 mm are studied based on plastic strain and stress distributions. Contact pressure, von Mises stress, tangential stress, shear stress, equivalent plastic strain, tangential plastic strain and also shear plastic strain are analyzed on selected specific element from the surface and subsurface of the substrate (flat surface). The FE model is validated and verified with Hertzian contact theoretical solution. The Linear Kinematic hardening plasticity model predicts higher stress response, meanwhile Non-Linear Combined Isotropic-Kinematic hardening plasticity model gives higher plastic strain. The higher sliding amplitude effect results in higher plasticity accumulation.

Keywords: Cylinder-on-flat, reciprocating sliding, Ti-6Al-4V, Linear Kinematic hardening, Non-Linear Combined Isotropic-Kinematic hardening.

Full Text (.pdf) | 594 KB

Title: Process Parameters Evaluation for Direct Investment Casting

Author(s): O. M. F Marwah, S. Sharif, M. S. Shukri, E. J. Mohamad, M. F. Shaari, M. Y. Hashim

Pages: 89-95 **Paper ID:** 168203-1604-7171-IJMME-IJENS **Published:** August, 2016

Abstract: The advancement of the rapid prototyping (RP) technologies evolving toward rapid tooling in producing sacrificial patterns rapidly has profoundly benefits the investment casting (IC) process. Direct expendable pattern fabrication via RP techniques in complex and intricate features significantly reduce the cost when associated with single or low volume production. However inappropriate settings of the RP processes and its variables may cause serious defect in the ceramic shell such as cracking during burning out of the patterns, incomplete collapsibility and poor qualities of end products. By implementing the ANOVA at 95% confidence level to study the relative influence of factors and interactions, result shows that Surface Roughness (SR) and Dimensional Accuracy (DA) drastically affected by input variables within 5 % level of significance. Confirmation runs for all responses were carried out to ensure that the models reliability. The error level for ABS P400 was within reasonable range with less than 19%. It is also found that Visijet SR200 acrylate have better variation below than 14%. This study was conducted in an effort to exploit the application of various RP tand materials in the fabrication of IC patterns by utilizing the RP process parameters in minimizing the errors of responses. Moreover, it is expected that this study will provide valuable information and great assistance to the IC manufacturer in producing precise, low cost and rapid patterns using RP technologies.

Keywords: Direct Investment Casting, Fused Deposition Modeling, Rapid Prototyping, Multijet Modeling, RP Process Parameters.

Full Text (.pdf) | 430 KB

Title: Parameter Optimization of Strategies at CNC end Milling Machine Roland Modela MDX - 40R Cam Against Surface Roughness Made Insoles Shoe Orthotic EVA Rubber Foam

Author(s): P. W. Anggoro, B. Bawono, Andreyas. W, J. Jamari, A. P. Bayuseno

Pages: 96-102 **Paper ID:** 163804-1919-IJMME-IJENS **Published:** August, 2016

Abstract: The Quality Optimizing of surface and processing time insole shoe orthotic (iso) that made from EVA rubber foam (erf) is highly dependent on the determination of machining strategies on a CNC milling process. This paper aims to obtain optimal parameters of surface roughness and machining time iso products made erf. Data processing by Taguchi Design of Experiments used to obtain the most significant effect on the Toolpath parameters of machining strategies on software Powermill 2015. The effect of the four parameters (spindle speed, feeding, depth of cut, and types of milling cutter) set out in this experiment would give effect significant surface roughness and machining time iso products made erf. Orthogonal array is L1224, after the output finish analyzed the experimental results. Experimental results showed four of these parameters have a significant influence on the surface roughness approaching iso product N7 (63 µm scale CLA or Ra = 1.6 to 3.00 µm). The iso product processing time in this experiment are in accordance with the request of the shoe industry for approximately 1-1.5 hours/pair iso. The optimal solution for design Experiment: machining setting is 14,500 rpm, Cutter feed is 2000 mm/min, DoC is 2 mm and type of Cutter is End Mill SECO 93060 With RA =2 µm

Keywords: Insole Shoe Orthotic, EVA rubber foam, Toolpath strategy, Powermill 2015, surface roughness, CNC milling technology.

Full Text (.pdf) | 467 KB

Title: A New 2D Magnetic Induction Tomography System for Phantom Detection and Localization in Medical Applications

Author(s): B. Gowry, Abu B. Shahriman, Z. Zulkarnay

Pages: 103-112 **Paper ID:** 165103-1604-7474-IJMME-IJENS **Published:** August, 2016

Abstract: Here we describe a new cost-effective magnetic induction tomography (MIT) system to identify and localize phantoms in biological tissues. The proposed 2D (two-dimensional) numerical simulation detection system consists of 8 transceiver coils. During the simulation process, one of the eight transceivers acts as a transmitter, and the rest act as receivers, thereby yielding 7 receiver readings. This process was repeated, and 56 (8 transmitters x 7 receivers) induced voltage readings (receiver readings) were obtained by activating different transceivers at a time. The induced voltage readings were then used to reconstruct the images of biological samples using a linear back-projection (LBP) algorithm. To assess the quality of the images, 10 frequency-based features and seven image-based features were extracted from the reconstructed images. Artificial neural network (ANN) and extreme learning machine (ELM) classifiers were used to distinguish the presence and locations of phantoms. The proposed method attained best accuracies of 91.90% (ELM) and 100% (ANN) for frequency features. The obtained results indicate that the proposed MIT design and features provide a promising alternative to detect and localize pathological conditions in the biological tissue.

Parameter Optimization of Strategies at CNC end Milling Machine Roland Modela MDX - 40R Cam Against Surface Roughness Made Insoles Shoe Orthotic EVA Rubber Foam

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Abstract-- **The Quality Optimizing of surface and processing time insole shoe orthotic (*iso*) that made from EVA rubber foam (*erf*) is highly dependent on the determination of machining strategies on a CNC milling process. This paper aims to obtain optimal parameters of surface roughness and machining time iso products made erf. Data processing by Taguchi Design of Experiments used to obtain the most significant effect on the Toolpath parameters of machining strategies on software Powermill 2015. The effect of the four parameters (spindle speed, feeding, depth of cut, and types of milling cutter) set out in this experiment would give effect significant surface roughness and machining time iso products made erf. Orthogonal array is $L_{12}2^4$, after the output finish analyzed the experimental results. Experimental results showed four of these parameters have a significant influence on the surface roughness approaching iso product N7 (63 µm scale CLA or Ra = 1.6 to 3.00 µm). The *iso* product processing time in this experiment are in accordance with the request of the shoe industry for approximately 1-1.5 hours/pair *iso*. The optimal solution for design Experiment: machining setting is 14,500 rpm, Cutter feed is 2000 mm/min, DoC is 2 mm and type of Cutter is End Mill SECO 93060 With RA =2 µm**

Index Term-- **Insole Shoe Orthotic, EVA rubber foam, Toolpath strategy, Powermill 2015, surface roughness, CNC milling technology.**

INTRODUCTION

Ethylene vinyl acetate (EVA) is rubber foam material that popularly used in the field of shoes and shoe insole [1] [2] because EVA has good mechanical properties, lightweight material, shockproof and pressure, and has a high elasticity. The Iso making procedures as a complementary product to be accurate if you use a shoe made of EVA foam rubber (*erf*). The Insole Shoe Orthotic (*iso)* product manufacturing procedures with CNC machines is to get a kind of product with high quality and high precision. Orthotics are all tools that are added to the human body to stabilize the body, prevent disability, to protect from cuts, or assist the function of the limb. Insoles Shoe Orthotic is a device designed to restore the function of malformed foot.

Fig. 1. Forms Pattern Human Foot (a) Flat (b) Normal (c) Arc

Fig. 2. Benefits on foot orthotic can change the position of the foot is malformed

Fig. 3. Applications Orthotic Insole Shoes on Feet Flat

Custom functional foot orthotic is a medical device made from a non-weight bearing mold (plaster cast) or a 3D scan of the foot. The tool is designed to control the alignment and function of the foot and lower leg, to overcome or reduce the pressure that causes injury to the bones, joints, tendons, and ligaments. This tool is often used to restrict movement as excessive pronation (rolling in) and excessive supination (rolling out). The tool is also useful to help users perform various activities such as running, walking, and standing more effectively and efficiently. In addition, it also redistributes the pressure foot on the bottom of the foot to relieve pain in the area of the foot that got the brunt of high pressure or weight on the leg suffering from corn/calluses. A custom orthotic function not only works with the principle of only supporting arch of the foot. Orthotic realign the structure of your foot to prevent misalignment and fatigue bones, muscles, tendons, and ligaments. This tool is often used after surgery to help stop or delay the recurrence of the foot deformity. In addition, it is important to focus that device that must function properly in facilitating the function of the foot. This tool works to improve the efficiency of interaction of biomechanical foot to the ground. Custom orthotic designed with accurate standards, using the latest advances in biomechanics and is made with customized with your feet, based on the biomechanics and morphology of your feet.

This device is intended to control the joint motion to the right, to facilitate and improve the movement in certain joints while limiting the other joint, with the overall goal is to prepare the legs for optimal alignment and function during each phase of the cycle. Optimal alignment of the foot which will also help align with the state of the lower extremities and pelvis.

When the foot rests on a custom orthotic that has been designed and manufactured with precision and precision, the load will be supported by a gentle and consistent so that the position of the foot will be redirected to the correct position or the position of the legs become better and convenient for users who are walking, running, and standing. Weight on the leg to be reduced due to more efficient *iso* support, pain due to muscle tension and pressure point was reduced, and the development of the deformity can be prevented, reduced or even stopped.

To produce custom orthotic requires a very thorough process and determine which users get quality *iso* is the best option for treating conditions of the foot. As well as a wide variety of other goods, there is a well-made orthotic some are not in accordance with the characteristics of the user. Orthotic ability to relieve pain in the foot orthotic users depending on the quality. Orthotic quality depends on three main steps, namely

Taguchi experimental design is a powerful method used to achieve high quality at lower no experimentation. This provides a better setting than the traditional experimental design time consuming because a large number of trials and most of the time are not worthy [2],[3],[5],[6],[7],[8]. Taguchi method reduces the sensitivity of the quality characteristics for various noise factor of the unknown. In this study, the relationship between the machining parameter strategy to surface roughness and working time *iso* products made from EVA foam rubber.

MATERIAL & METHODS

Erf with dimensions of 250 x 95 x 23 mm was used in this experiment. This material hardness determined ranged from 35-40 HRC. This material can be used in healthcare solutions such as: orthopedic shoes, insoles, exercise mats, orthotic support [4]. The specification of these materials include: density 55-65 kg/m^3, nominal sheet size (trimmed) 2000 x 1000 mm, nominal thickness (split) 3-36 mm, hardness after 2 second read 25-30 degrees, tensile strength 800kPa , tear strength 4.5kN/m.

The chemical composition of EVA foam rubber can be displayed in the following table:

Table I
The chemical composition of rubber EVA Foam [11]

Material	Properties		Source
Ethylene Vinyl acetate (EVA)	Melt flow index (g/10 min)	2.00	PIL Madras
	Density (g/cm^3)	0.937	
	Vicat Softening Point (^{o}C)	59	
	Vinyl acetate (wt%)	18	
	Viscosity (g/cm^3)	0.170	

The dimensions and shape of this product is targeted close to or similar to the results of scanning the foot of a normal person.

Fig.4. The 3D solid ISO EVA rubber foam

This experiment is done to produce a pair of shoes orthotic insole using reverse engineering technology on CNC machines Rolland Modela MDX 40R. Stages of experimental manufacturing system may be presented in the figure below:

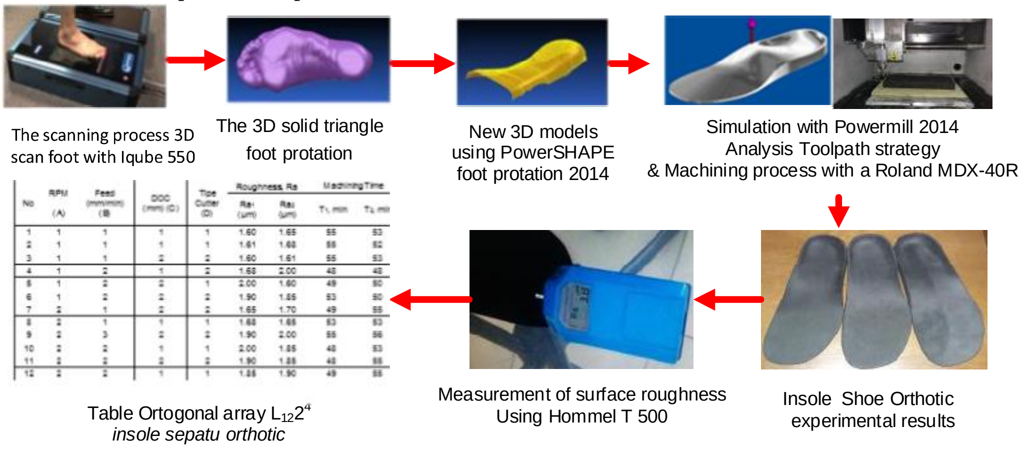

Fig. 5. Stages Taguchi experimental manufacturing system

The initial phase conducted by researchers is the process of brainstorming with some engineer CNC tooling, CNC machining, material rubber, and businessmen shoes (PT. WIMO and CV. DAF) to get the parameters that influence significantly the process of CNC milling with material EVA rubber foam. Based on the results obtained brainstorming four most influential parameters in the manufacturing process of this orthotic shoe insole products, namely: Spindle speed (rpm), Feeding rate (mm /min) Depth of cut (mm), and Type milling cutter used. These four parameters are set according to the results of discussions with engineers from the shoe industry that wants time CNC machining process in the machine ranged from 1.5-2.5 hours for a pair of orthotic shoe insole with surface roughness ranges approaching N7 (63 µm scale CLA or Ra = 1.6 to 3.00 µm) [6]. Each parameter set two levels that can be described in the following table:

Table II
Parameters machining and levels

No	Factor	Level 1	Level 2
1	Speed (rpm)	15,000	14,500
2	Feed (mm/min)	1,750	2,000
3	Depth of Cut (mm)	2.0	3.0
4	Type of Cutter	Endmill MEH 0604	Endmill SECO 93060 F

According to the table II above, the orthogonal array on the Taguchi method is used to determine the optimum process parameters on the machining process of *iso* erf with the response the data set is surface roughness and machining time product.

Orthogonal Array The selection of orthogonal array depends on the calculation of total degrees of freedom. The number of comparisons made between levels to better determine the condition called degrees of freedom. There are four process parameters considered for surgery on the processing and each parameter is on two levels, the level of total degree of freedom is 2. Orthogonal array chosen must have a degree of freedom is greater than or equal to the process parameters. This paper uses orthogonal array $L_{12}2^4$ larger than the total degrees of freedom of process parameters. Taguchi Orthogonal Array provides a better combination of walking and reduce the number of experimental runs, thus making experiments feasible. The combination of process parameters using the $L_{12}2^4$ are given in Table 3 below.

SN Ratio $$S/N = -10 \log \left[\frac{1}{n}(y_1^2 + y_2^2 \ldots y_n^2)\right] \quad (1)$$

$$\mu = \frac{\sum_{i=1}^{N} X_i}{N} \quad (2)$$

$$Mq_A = \frac{SA}{v_A} \quad (3)$$

Sum of Squares for Treatments, $\boldsymbol{SSR} = n_S \sum_{i=1}^{k} \left(\bar{y}_i - \bar{\bar{y}}\right)^2$ is the "Between Group" variation, where the k "groups" or populations are represented by their sample means. If the sample means differ substantially then SST will be large.

Sum of Squares for Error, $\boldsymbol{SSE} = \sum_{i=1}^{k} \sum_{j=1}^{n_S} \left(y_{ij} - \bar{y}_i\right)^2$ is the "Within Group" variation and represents the random or sample-to-sample variation

Total Sum of Squares, $\boldsymbol{SST} = \sum_{i=1}^{k} \sum_{j=1}^{n_S} \left(y_{ij} - \bar{\bar{y}}\right)^2$ is the total variation in the values

Table III
Data Orthogonal array $L_{12}2^4$ of Experiment

No	RPM (A)	Feed (mm/min) (B)	DOC (mm) (C)	Type Cutter (D)	Roughness, Ra		Machining Time	
					Ra_1 (μm)	Ra_2 (μm)	T_1, min	T_2, min
1	1	1	1	1	1.60	1.65	55	53
2	1	1	1	1	1.61	1.68	55	52
3	1	1	2	2	1.60	1.61	55	53
4	1	2	1	2	1.68	2.00	48	48
5	1	2	2	1	2.00	1.60	49	50
6	1	2	2	2	1.90	1.85	53	50
7	2	1	2	2	1.65	1.70	49	55
8	2	1	1	1	1.68	1.65	53	53
9	2	3	2	2	1.90	2.00	55	56
10	2	2	1	1	2.00	1.85	48	53
11	2	2	2	2	1.90	1.85	48	55
12	2	2	1	1	1.85	1.90	49	55

Table IV
Analysis of S/N Ratio for $L_{12}2^4$ of Experiment

No.	Level				Average		S/N Ratio, Ra	S/N Ratio, T
	A	B	C	D	Ra, μm	Machining Time (min)		
1	1	1	1	1	1.63	54.00	-5.979	-36.4098
2	1	1	1	1	1.65	53.50	-6.086	-36.3303
3	1	1	2	2	1.61	54.00	-5.87	-36.4098
4	1	2	1	2	1.84	48.00	-7.079	-35.3857
5	1	2	2	1	1.80	49.50	-6.902	-35.6533
6	1	2	2	2	1.88	51.50	-7.221	-35.9995
7	2	1	2	2	1.68	52.00	-6.242	-36.0906
8	2	1	1	1	1.67	53.00	-6.189	-36.2464
9	2	3	2	2	1.95	55.50	-7.564	-36.647
10	2	2	1	1	1.93	50.50	-7.454	-35.8338
11	2	2	2	2	1.88	51.50	-7.221	-36.0104
12	2	2	1	1	1.88	52.00	-7.221	-36.0906

Table IV
ANOVA for $L_{12}2^4$ of Experiment

Source	Sq	dof (v)	Mq	F-ratio	Sq'	rho %
A	90.74	2	45.37	76,06	75.74	3.54
B	180.01	2	90.49	151,70	160.01	17.1
C	134.87	2	67.05	123,26	125.27	42.95
D	94.12	2	42.06	05,11	88.12	33.29
E	57.23	10	59,65	1,00	55.23	3.12
St	253.80	10	336.25		225.24	100

From the calculation and analysis of data at four factors, which are considered the most influential factors on the quality of the machining process models based on the pooling up *iso* is the spindle feed, DoC, and Type Cutter.
For the selection of the setting levels each factor, selected value level corresponding to the data common practice in the field. The table 5 and 6 below is setting level of each factor:
Based on the tables 5 and 6 can be seen the value of the data analysis at each level selected. The value chosen based on practical experience that has often done in the field at the time of the machining process.
For the selection of the best setting at each level of the factor is:

a) RPM selected is level 2 or 14,500 for a finer surface quality due
b) Cutter feed used is at level 2 is 2000 mm/min to get the finer quality results
c) This is due to a finer surface quality. Depth of Cut (DoC) is selected at level 1 or 2 mm for the smaller DoC product quality more fined.

Setting Type Cutter also influenced by the type of material and size of the cutter being used. Selected level 2 for the use of cutter type 1 (Endmill MEH) to produce chips that are formed will stick to the cutter, with the quality of the product is less smooth surface. The use of cutter type 2 (Endmill SECO) to produce chips that are formed will be removed directly from the cutter, more refined product surface quality

Tablel V
Setting Level Analysis for Roughness

Faktor	**A**	**B**	**C**	**D**
Level 1	1.82	8.23	10.58	10.85
Level 2	1.72	13.1	10.78	10.52

I J E N S

Tablel VI
Setting Level Analysis Machining Time

Faktor	A	B	C	D
Level 1	54	53.9	44.9	60
Level 2	52	51.2	64.8	44.79

RESULTS AND DISCUSSION

From Table 5 and 6 it can be seen in total scores on each level of the selected factor. The weights are calculated based on the number selected at each factor divided by the total number selected in each factor and factor level. Factors and levels of factors used in this experiment can be seen in table 2

The factor levels that have been determined to do the analysis:

a. Feed rate: Based on the brainstorming process, the feed rate that used in the experiment are three levels in sequence for level 1 and level 2 is 1,750 and 2,000 mm/min. Feed rate have on those values is as designed raw material hardness and type of material used cutter. Raw material that used is erf.
b. Spindle Speed: is the speed of the cutter rotation per minute. CNC machine Roland MDX modela 40R has a minimum limit per minute cutter rotation speed is 5,000 rpm, and the maximum limit is 15,000 rpm. Based brainstorming spindle speed value of the questionnaire used in this study were selected according to the results of brainstorming on questionnaires. Value spindle speed is used is, 14,500 rpm and 15,000 rpm.
c. Step Down: Step down is the movement of the cutter feeds the vertical direction (z-axis). Step down this value is adjusted by the diameter cutter, cutter material, and the raw materials that used in machining. Based on the results of the brainstorming researchers determined level setting step down by 2 and 3 mm.

Selection of Orthogonal Array Design: The selection orthogonal array design to be adapted to a number of factors and total factor level value predetermined based on the results of the brainstorming process. From the results of the brainstorming process obtained a number of factors as much as 4 factors and the number of levels a factor of 2 levels. Based on availability Taguchi orthogonal array design there is the factor number 4 and number 2 level factor level values obtained orthogonal array design $L_{12}2^4$

Taguchi orthogonal array of design variations $L_{12}2^4$ obtained treatment should be performed on each of the experiments. The treatment variations can be seen in Table 4.

According to the table it can be seen the value of the data processing at each level selected. The value chosen based on practical experience that has often done in the field at the time of the machining process.

For the selection of the best setting from table 5, 6 at each level of the factor is:

a. RPM selected is level 2, is 14,500 for a finer surface quality due
b. Cutter feed used is at level 2 is 2000 mm / tooth for finer quality results
c. This is due to a finer surface quality. Depth of Cut (DoC) is selected at level 1 or 2 mm for the smaller DoC product quality is more refined.
d. Setting Type Cutter also influenced by the type of material and size of the cutter being used. Selected level 2 for the use of cutter type 1 (Endmill MEH) to produce chips that are formed will stick to the cutter, with the quality of the product is less smooth surface. The use of cutter type 2 (Endmill SECO) to produce chips that are formed will be removed directly from the cutter, more refined product surface quality

From the results of pooling up done finds that the contribution to the source or a significant factor from highest to lowest is the percent contribution factor C 42.95%, which means these factors significantly affect the machining process by 42.95% out of 100%, factor D with 33.29% percent of the contribution, which means these factors significantly affect the machining process by 33.29% out of 100%, and factor B with the percent contribution of 17.10% which means that these factors significantly affect the machining process by 17, 10% out of 100% with error 3.12%

CONCLUSION

Based on experiments on the behavior of the wear iso Erf

a. There are four parameters that have chosen major engine rotation (rpm), Feeding Speed (mm /min), DoC (Depth of Cut) mm, and Type Cutter
b. ANOVA analysis showed that the Depth of Cut (26.432%) and Type Cutter (15.877%) had a major influence on surface roughness iso. The interaction effect parameter has a significant effect on the surface roughness
c. The optimal solution for design Experiment: machining setting is 14,500 rpm, Cutter feed is 2000 mm/min, DoC is 2 mm and type of Cutter is End Mill SECO 93060 With RA =2 µm

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