ABSTRACTS

Behrouz Najjari, Mohammad J. Fotuhi, Mousa Vaezipour
Theoretical and Empirical Improvement of a Fast-Switching Electro-Pneumatic Valve by using Different Methods

In this paper, a non-linear model of a 2–2 way, on–off fast-switching valve is used. The model includes subsystems of electrical, magnetic, mechanical and fluid. Pulse width modulation (PWM) technique is adopted to energise the on–off solenoid valve and allow the air to flow towards the actuator. Since the non-linear behaviour of valve is of great importance, to reduce the delay in performance of switching valves, different approaches are proposed. Furthermore, hysteresis, proportional integrator (PI), optimal model predictive and fuzzy logic controller (FLC) are used and compared. Also, to improve the valve behaviour, an empirical setup based on AVR microcontroller with FLC is implemented. Empirical and simulation results indicate that all proposed control methods have superior performance. However, the fuzzy method is easy to implement in practice.

Shahida Rehman, Akhtar Hussain, Jamshaid Ul Rahman, Naveed Anjum, Taj Munir
Modified Laplace-Based Variational Iteration Method for the Mechanical Vibrations and its Applications

In this paper, we are putting forward the periodic solution of non-linear oscillators by means of variational iterative method (VIM) using Laplace transform. Here, we present a comparative study of the new technique based on Laplace transform and the previous techniques of maximum minimum approach (MMA) and amplitude frequency formulation (AFF) for the analytical results. For the non-linear oscillators, MMA, AFF and VIM by Laplace transform give the same analytical results. Comparison of analytical results of VIM by Laplace transform with numerical results by fourth-order Runge–Kutta (RK) method conforms the soundness of the method for solving non-linear oscillators as well as for the time and boundary conditions of the non-linear oscillators.

Andrzej Werner
Method for Enhanced Accuracy in Machining Free-Form Surfaces on CNC Milling Machines

The present article describes a method for enhanced accuracy in machining free-form surfaces produced on CNC milling machines. In this method, surface patch machining programs are generated based on their nominal CAD model. After the pretreatment, coordinate control measurements are carried out. The obtained results of the measurements contain information on the values and distribution of observed machining deviations. These data, after appropriate processing, are used to build a corrected CAD model of the surface produced. This model, made using reverse engineering techniques, compensates for the observed machining deviations. After regeneration of machining programs, the object processing and control measurements are repeated. As a result of the conducted procedure, the accuracy of the manufacture of the surface object is increased. This article also proposes the introduction of a simple procedure for the filtration of measurement data. Its purpose is to minimise the effect of random phenomena on the final machining error correction. The final part of the article presents the effects of the proposed method of increasing the accuracy of manufacturing on 'raw' and filtered measurement data. In both cases, a significant improvement in the accuracy of the machining process was achieved, with better final results obtained from the filtered measurement data. The method proposed in the article has been verified for three-axis machining with a ball-end cutter.

Mohamed Ramla, Houssem Laidoudi, Mohamed Bouzit
Behaviour of a Non-Newtonian Fluid in a Helical Tube under the Influence of Thermal

This work is an evaluative study of heat transfer in the helical-type heat exchanger. The fluid used is non-Newtonian in nature and is defined by Oswald's model. The work was performed numerically by solving each of the Navier–Stokes equations and the energy equation using the package ANSYS-CFX. Following are the aspects that have been dealt with in this paper: the effects of thermal buoyancy, fluid nature and the tube shape on the heat transfer, and the fluid comportment. The interpretation of the obtained results was done by analyzing the isotherms and the streamlines. The mean values of the Nusselt number were also obtained in terms of the studied parameters. The results of this research enabled us to arrive at the following conclusion: the intensity of thermal buoyancy and the nature of the fluid affect the heat transfer distribution but keep the overall rate of heat transfer the same.

Ahmad Hanan, Tariq Feroze, Awais Arif, Hasan Iftikhar, Afzaal Ahmed Khan, Sarmad Javaid
Performance Evaluation of a Single Cylinder Compressed Air Engine: An Experimental Study

The quest to reduce dangerous environmental emissions has led to the research and use of alternate and renewable energy sources. One of the major contributors to the dangerous environmental emissions is the automotive industry. The world is, therefore, quickly moving towards hybrid and electric vehicles. An alternate pollution-free automotive engine is a compressed-air engine, which is powered by compressed air and is more efficient than the electric engine since it requires less charging time than a traditional battery-operated engine. Furthermore, the tanks used in compressed-air engines have a longer lifespan in comparison to the batteries used in electric vehicles. However, extensive research is required to make this engine viable for commercial use. The current study is a step forward in this direction and shows the performance analysis of a single-cylinder compressed-air engine, developed from a four-stroke, single-cylinder, 70 cc gasoline engine. The results show that compressed-air engines are economic, environmental friendly and efficient.

Agustinus Winarno, Benidiktus T. Prayoga, Ignatius A. Hendaryanto
Linear Motion Error Evaluation of Open-Loop CNC Milling Using a Laser Interferometer

The usage of computerised numerical control (CNC) machines requires accuracy verification to ensure the high accuracy of the processed products. This paper introduces an accuracy verification method of an open-loop CNC milling machine using a fringe counting of He–Ne laser interferometry to evaluate the best possible accuracy and functionality. The linear motion accuracy of open-loop CNC milling was evaluated based on the number of pulses from the controller against the actual displacement measured by the He–Ne fringe-counting method. Interval distances between two pulses are also precisely measured using the He–Ne interferometry. The linear motion error and controller error can be simultaneously evaluated in sub-micro accuracy. The linear positioning error due to the micro-stepping driver accuracy of the mini-CNC milling machine was measured with the expanded uncertainty of measurement and was estimated at 240 nm. The experimental results show that linear motion error of the open-loop CNC milling can reach up to 50 μm for 200 mm translation length.

Julius Niyongabo, Yingjie Zhang, Jérémie Ndikumagenge
Bearing Fault Detection and Diagnosis Based on Densely Connected Convolutional Networks

Rotating machines are widely used in today's world. As these machines perform the biggest tasks in industries, faults are naturally observed on their components. For most rotating machines such as wind turbine, bearing is one of critical components. To reduce failure rate and increase working life of rotating machinery it is important to detect and diagnose early faults in this most vulnerable part. In the recent past, technologies based on computational intelligence, including machine learning (ML) and deep learning (DL), have been efficiently used for detection and diagnosis of bearing faults. However, DL algorithms are being increasingly favoured day by day because of their advantages of automatically extracting features from training data. Despite this, in DL, adding neural layers reduces the training accuracy and the vanishing gradient problem arises. DL algorithms based on convolutional neural networks (CNN) such as DenseNet have proved to be quite efficient in solving this kind of problem. In this paper, a transfer learning consisting of fine-tuning DenseNet-121 top layers is proposed to make this classifier more robust and efficient. Then, a new intelligent model inspired by DenseNet-121 is designed and used for detecting and diagnosing bearing faults. Continuous wavelet transform is applied to enhance the dataset. Experimental results obtained from analyses employing the Case Western Reserve University (CWRU) bearing dataset show that the proposed model has higher diagnostic performance, with 98% average accuracy and less complexity.

Michał Kolankowski, Robert Piotrowski
Design of Three Control Algorithms for an Averaging Tank with Variable Filling

An averaging tank with variable filling is a nonlinear multidimensional system and can thus be considered a complex control sys-tem. General control objectives of such object include ensuring stability, zero steady-state error, and achieving simultaneously shortest possible settling time and minimal overshoot. The main purpose of this research work was the modeling and synthesis of three control systems for an averaging tank. In order to achieve the intended purpose, in the first step, a mathematical model of the control system was derived. The model was adapted to the form required to design two out of three planned control systems by linearization and reduction of its dimensions, resulting in two system variants. A multivariable proportional-integral-derivative (PID) control system for the averaging tank was developed using optimization for tuning PID controllers. State feedback and output feedback with an integral action control system for the considered control system was designed using a linear-quadratic regulator (LQR) and optimization of weights. A fuzzy control system was designed using the Mamdani inference system. The developed control systems were tested using theMATLAB environment. Finally, the simulation results for each control algorithm (and their variants) were compared and their performance was assessed, as well as the effects of optimization in the case of PID and integral control (IC) systems.

Piotr Jankowski
On the Nonlocal Interaction Range for Stability Of Nanobeams with Nonlinear Distribution of Material Properties

The present study analyses the range of nonlocal parameters' interaction on the buckling behaviour of nanobeam. The intelligent nonhomogeneous nanobeam is modelled as a symmetric functionally graded (FG) core with porosity cause nonlinear distribution of material parameters. The orthotropic face-sheets are made of piezoelectric materials. These kinds of structures are widely used in nanoelectromechanical systems (NEMS). The nanostructure model satisfies the assumptions of Reddy third-order beam theory and higher-order nonlocal elasticity and strain gradient theory. This approach allows to predict appropriate mechanical response of the nanobeam regardless of thin or thick structure, in addition to including nano-sized effects as hardening and softening. The analysis provided in the present study focuses on differences in results for nanobeam stability obtained based on classical and nonlocal theories. The study includes the effect of diverse size-dependent parameters, nanobeams' length-to-thickness ratio and distributions of porosity and material properties through the core thickness as well as external electro-mechanical loading. The results show a dependence of nonlocal interaction range on geometrical and material parameters of nanobeam. The investigation undertaken in the present study provides an interpretation for this phenomenon, and thus aids in increasing awareness of nanoscale structures' mechanical behaviour.

Mohamed F. Abd Alsamieh
Numerical Study of Transient Elastohydrodynamic Lubrication Subjected to Sinusoidal Dynamic Loads for Rough Contact Surfaces

The purpose of this paper is to study the behaviour of transient elastohydrodynamic contacts subjected to forced harmonic vibrations, including the effect of surface waviness for concentrated counterformal point contact under isothermal conditions. Profiles of pressure and film thickness are studied to reveal the combined effects of sinusoidal external load and surface roughness on the lubrication problem. The time-dependent Reynolds' equation is solved using Newton–Raphson technique. The film thickness and pressure distribution are obtained at different snap shots of time by simultaneous solution of the Reynolds' equation and film thickness equation including elastic deformation and surface waviness. It is concluded that the coupling effects of the transient sinusoidal external load and wavy surface would result in increase in modulations of the pressure and film thickness profile in comparison to the case where the smooth contact surfaces are subjected to sinusoidal external load.