

# Journal of Mechatronics, Electrical Power, and Vehicular Technology

Volume 05, Issue 1, July 2014

## AIM AND SCOPE

**Mechatronics, Electrical Power, and Vehicular Technology (MEV)** is an internationally peer-reviewed journal providing authoritative source of scientific information for researchers and engineers in academia, research institutions, government agencies, and industries. The Journal publishes original research papers, review articles and case studies focused on:

**Mechatronics:** including control system, robotic, CNC Machine, sensor, signal processing, electronics, actuator, and mechanical dynamics.

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**Selected Applications:** including all implementations or implications related to mechatronics, electrical power, or vehicular technology.

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# Journal of Mechatronics, Electrical Power, and Vehicular Technology

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## FOREWORD FROM EDITOR-IN-CHIEF

Journal of Mechatronics, Electrical Power, and Vehicular Technology (MEV) has been accredited by the Indonesian Institute of Sciences (LIPI) in April 2012. It started using Open Journal System (OJS) since the online publishing of the third volume released in July 2012. This journal has been indexed by EBSCOhost, Index Copernicus, Directory of Open Access Journal (DOAJ), Google Scholar, Indonesian Scientific Journal Database (ISJD), Indonesian Publication Index (IPI), Crossref, Mendeley, CiteULike, Cite Factor, Academic Journal Database, and ResearchBib. In addition, it has been granted Digital Object Identifier with the DOI Prefix 10.14203.

This issue publishes eight papers, all are written in English, with the total number of paper pages of 66 pages. The selected papers in this issue have passed some levels of reviews and revisions based on the standard operating procedure of the journal. Three topics are related to mechatronics, three topics to electrical power and two topics to vehicular technology. Most of the papers reflect one of the characteristics of this journal i.e. interdisciplinary.

The policy up to this current issue is that both authors and readers are not charged at all. On the other hand, the editorial board is planning to improve the quality by registering the journal to other international academic citation index. Moreover, the editorial board is also considering to gradually increase the number of papers and journal's pages. All of this plan will give consequence on financial burden. Therefore, from the next issue, financial policy will probably change based on that condition.

We wish to offer our thanks to all the editorial members and the Research Centre for Electrical Power and Mechatronics (RC-EPM) – Indonesian Institute of Sciences (LIPI) for their continuing unwavering support. Also, we would like to acknowledge our gratitude to this issue's International Editorial Board members, reviewers and authors.

We hope this publication would contribute to the enhancement of science and technology.

Bandung, July 2014

Editor-in-Chief

# Journal of Mechatronics, Electrical Power, and Vehicular Technology

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## ABSTRACTS SHEET

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Hilman Syaeful Alam<sup>a</sup>, Pudji Irasari<sup>b</sup> (<sup>a</sup>Technical Implementation Unit for Instrumentation Development, Indonesian Institute of Sciences, Bandung, Indonesia; <sup>b</sup>Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences, Bandung, Indonesia)

Rotor-dynamic Characteristic Evaluation of Interior Permanent Magnet Motor using Finite Element Method

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 1-8, 9 ill, 1 tab, 17 ref.

Dynamic characteristics of a critical speed of the rotor components at interior permanent magnet motor were evaluated using one-dimensional (1D) and three-dimensional (3D) finite element methods. Critical speed of the rotor was investigated in the Campbell diagram, which shows the relationship between natural frequency and rotational velocity of the system when the motor is not in operation. The 1D finite element analysis shows that there are two modes which are close to the design frequency of 300 Hz i.e. mode 1 and 2. However the critical rotational velocity in both modes are still far above the maximum velocity design of 6,000 rpm. Validation using 3D finite element analysis demonstrated that all modes were still above the designed frequency and did not find any critical speed below 6,000 rpm. It can be concluded that the critical speed of the rotor of IPM motor is still outside the system resonance region, and can be operated safely.

(Author)

Keywords: natural frequency, Campbell diagram, interior permanent magnet motor, finite element method.

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Yanuandri Putrasari<sup>a</sup>, Haznan Abimanyu<sup>b</sup>, Achmad Praptijanto<sup>a</sup>, Arifin Nur<sup>a</sup>, Yan Irawan<sup>b</sup>, Sabar Pangihutan Simanungkalit<sup>b</sup> (<sup>a</sup>Research Centre for Electrical Power & Mechatronics, Indonesian Institute of Sciences, Bandung, Indonesia; <sup>b</sup>Research Center for Chemistry, Indonesian Institute of Sciences, Serpong, Indonesia)

Experimental Investigation of 2<sup>nd</sup> Generation Bioethanol Derived from Empty-Fruit-Bunch (EFB) of Oil-Palm Performance and Exhaust Emission of SI Engine

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 9-16, 6 ill, 2 tab, 41 ref.

The experimental investigation of 2<sup>nd</sup> generation bioethanol derived from EFB of oil-palm blended with gasoline for 10, 20, 25% by volume and pure gasoline were conducted on performance and exhaust emission tests of SI engine. A four stroke, four cylinders, programmed fuel injection (PGMFI), 16 valves variable valve timing and electronic lift control (VTEC), single overhead camshaft (SOHC), and 1,497 cm<sup>3</sup> SI engine (Honda/L15A) was used in this investigation. Engine performance test was carried out for brake torque, power, and fuel consumption. The exhaust emission was

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analyzed for carbon monoxide (CO) and hydrocarbon (HC). The engine was operated on speed range from 1,500 until 4,500 rev/min with 85% throttle opening position. The results showed that the highest brake torque of bioethanol blends achieved by 10% bioethanol content at 3,000 to 4,500 rpm, the brake power was greater than pure gasoline at 3,500 to 4,500 rpm for 10% bioethanol, and bioethanol-gasoline blends of 10 and 20% resulted greater bsfc than pure gasoline at low speed from 1,500 to 3,500 rpm. The trend of CO and HC emissions tended to decrease when the engine speed increased.

(Author)

Keywords: bioethanol, SI engine, performance, emission.

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Rudi Uswarman<sup>a</sup>, Adha Imam Cahyadi<sup>a</sup>, Oyas Wahyunggoro<sup>a</sup> (<sup>a</sup>Department of Electrical Engineering and Information Technology, Universitas Gadjah Mada, Yogyakarta, Indonesia)

Design and Implementation of a Magnetic Levitation System Controller using Global Sliding Mode Control

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 17-26, 19 ill, 0 tab, 14 ref.

This paper presents global sliding mode control and conventional sliding mode control for stabilization position of a levitation object. Sliding mode control will be robusting when in sliding mode condition. However, it is not necessarily robust at attaining phase. In the global sliding mode control, the attaining motion phase was eliminated, so that the robustness of the controller can be improved. However, the value of the parameter uncertainties needs to be limited. Besides that, the common problem in sliding mode control is high chattering phenomenon. If the chattering is too large, it can make the system unstable due the limited ability of electronics component. The strategy to overcome the chattering phenomenon is needed. Based on simulation and experimental results, the global sliding mode control has better performance than conventional sliding mode control.

(Author)

Keywords: Magnetic levitation system, global sliding mode control, conventional sliding mode control, chattering.

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Eka Samsul Ma'arif<sup>a,b</sup>, Endra Pitowarno<sup>a</sup>, Rusminto Tjatur W<sup>a</sup> (<sup>a</sup>Electronic Engineering Polytechnic Institute of Surabaya, Indonesia; <sup>b</sup>Astra Manufacturing Polytechnic, North Jakarta, Indonesia)

A Trajectory Generation Method Based on Edge Detection for Auto-Sealant Cartesian Robot

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 27-36, 19 ill, 5 tab, 17 ref

This paper presents algorithm ingenerating trajectory for sealant process using captured image. Cartesian robot as auto-sealant in manufacturing process has increased productivity, reduces human error and saves time. But, different sealant path in many engine models means not only different trajectory but also different program. Therefore robot with detection ability to generate its own trajectory is needed. This paper describes best lighting technique in capturing image and applies edge detection in trajectory generation as the solution. The algorithm comprises image capturing, Canny edge detection, integral projection in localizing outer most edge, scanning coordinates, and generating vector direction codes. The experiment results show that the best technique is diffuse lighting at 10 Cd. The developed method gives connected point to point trajectory which forms sealant path with a point to next point distance is equal to 90° motor rotation. Directional movement for point to point trajectory is controlled by generated codes which are ready to be sent by serial communication to robot controller as instruction for motors which actuate axes X and Y directions.

(Author)

Keywords: canny edge detection, integral projection, scanning the coordinate, vector direction code.

Roni Permana Saputra<sup>a,b</sup>, Tinton Dwi Atmaja<sup>a</sup>, Budi Prawara<sup>a</sup> (<sup>a</sup>Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences, Bandung, Indonesia; <sup>b</sup>School of Mechanical and Manufacturing Engineering, The University of New South Wales, Australia)

Distributed Control System Design for Portable PC Based CNC Machine

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 37-44, 13 ill, 1 tab, 21 ref.

The demand on automated machining has been increased and emerges improvement research to achieve many goals such as portability, low cost manufacturability, interoperability, and simplicity in machine usage. These improvements are conducted without ignoring the performance analysis and usability evaluation. This research has designed a distributed control system in purpose to control a portable CNC machine. The design consists of main processing unit, secondary processing unit, motor control, and motor driver. A preliminary simulation has been conducted for performance analysis including linear accuracy and circular accuracy. The results achieved in the simulation provide linear accuracy up to 2 µm with total cost for the whole processing unit is up to 5 million IDR.

(Author)

Keywords: Distributed control, portable CNC machine, linear interpolation, circular interpolation.

Dany Perwita Sari<sup>a</sup>, Kang-Pyo Cho<sup>b</sup> (<sup>a</sup>Research Center for Biomaterials, Indonesian Institute of Sciences, Cibinong, Indonesia; <sup>b</sup>CKP Wind Solutions, Gimje Si, South Korea)

CFD and Wind Tunnel Analysis for Mounted-Wind Turbine in A Tall Building for Power Generation

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 45-50, 5 ill, 1 tab, 13 ref.

A mounted wind turbine on the top of a tall building may provide high wind power in regions of high wind speed and low turbulence. The objective of this study is to evaluate wind speed on roof top models to optimize the wind turbine performance for power generation. Comparative analyses from three different roof top models were conducted. Computational Fluid Dynamics (CFD) simulation and wind tunnel testing were performed to evaluate the performance of wind turbine. Wind speed on the building model with a geometric scale of 1:150 was measured in CFD simulation then it was validated in wind tunnel test. Results presented in this paper suggest that an increase of wind speed could be achieved with ¼ circular shapes around the rooftop which can provide additional wind speed of 55.24%, respectively.

(Author)

Keywords: wind speed, roof shape, CFD, wind tunnel, tall building.

Merry Indahsari Devi<sup>a</sup>, Kristian Ismail<sup>a</sup>, Arifin Nur<sup>a</sup> (<sup>a</sup>Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences, Indonesia)

Techno-Economic Analysis of Biogas Utilization as an Alternative Fuel

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 51-58, 2 ill, 12 tab, 16 ref.

This paper will discuss the feasibility and economic analysis of biogas energy as a supply for the diesel engine generator. The techno-economic analysis was performed by using three parameters which are Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) as the feasibility indicators of the biogas power plant project. Calculation of substitution was obtained from the comparison between data of diesel engine using diesel fuel and dual-fuel with biogas. Economic calculations include the substitution percentage of diesel fuel by biogas for dual-fuel. Meanwhile, the calculation of savings was based on the ratio of energy content between diesel fuel and biogas. The eventual outcome is determined using economic comparison between the use of diesel fuel and dual-fuel mode. Feasibility shows that the pilot plant of 1 to 6 kWh using diesel fuel and dual-fuel are not feasible while techno-economic parameter analysis shows that NPV<0, IRR<MARR, while PP is undefined. The biogas power plant project is feasible in some conditions such as there is no labor cost, and 5 and 6 kWh will be feasible under the assumption that expenses for machine maintenance is eliminated. However, even when applying both conditions where biogas is feasible, diesel fuel is still not.

(Author)

Keywords: techno-economic, feasibility, biogas, diesel fuel, dual-fuel.

Rizqon Fajar<sup>a</sup>, Hari Setiaprada<sup>a</sup> (<sup>a</sup>Center for Thermodynamic, Motor and Propulsion The Agency for Assessment and Application of Technology (BTMP-BPPT), Serpong, Indonesia)

The Influence of Injection Timing on Performance Characteristics of Diesel Engine using Jatropa Biodiesel with and without Partial Hydrogenation

*Mechatronics, Electrical Power, and Vehicular Technology*, July 2014, vol. 5, no. 1, p. 59-66, 10 ill, 4 tab, 11 ref.

Experimental research has been conducted to investigate the effects of blend of hydrogenated and unhydrogenated Jatropa biodiesel with diesel fuel in volume ratio of 30:70 (B30) on combustion characteristics (BSFC, thermal efficiency and smoke emission) of single cylinder diesel engine. In this experiment, engine speed was kept constant at 1,500, 2,500, and 3,500 rpm with maximum engine load at BMEP 5 bar and injection timings were varied. Experimental result showed that at engine speed 1,500 rpm, BSFC of B30 hydrogenated and unhydrogenated Jatropa biodiesel were higher than it of diesel fuel at all injection timings (10 to 18°BTDC). At the same condition, partial hydrogenated Jatropa biodiesel showed higher BSFC than unhydrogenated Jatropa biodiesel. However, the difference in BSFC became smaller for all fuels at engine speed 2,500 rpm and 3,500 rpm at all injection timing. Jatropa biodiesel with and without partial hydrogenation tend to have higher thermal efficiency compared with diesel fuel at all engine speed and injection timing. The best injection timings to operate B30 Jatropa biodiesel with and without hydrogenation were 14, 18 and 24°BTDC at engine speed 1,500, 2,500, and 3,500 rpm respectively. This conclusion was deduced based on the minimum value of BSFC and the maximum value of thermal efficiency. Smoke emissions for all fuels were in the same level for all conditions.

(Author)

Keywords: jatropa, hydrogenation, BSFC, thermal efficiency, smoke emission