

# Journal of Mechatronics, Electrical Power, and Vehicular Technology

Volume 06, Issue 2, December 2015

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**Journal of Mechatronics, Electrical Power, and Vehicular Technology (MEV)** is an international 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:

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## FOREWORD FROM EDITOR-IN-CHIEF

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In this issue, eight papers are published with the total number of paper pages of 62 pages. The selected papers have passed high level of reviews and revisions based on the standard operating procedure of the journal. The authors come from Indonesia, Malaysia, Philippines, Australia, and USA. Four topics of the papers are related to mechatronics which address obstacle avoidance method for a group of humanoids inspired by social force model, algorithm of 32-bit data transmission among microcontrollers through an 8-bit port, development of a fixed wing unmanned aerial vehicle (UAV) for disaster area monitoring and mapping, and development of a low-cost electronic wheelchair with obstacle avoidance feature. Two topics are related to electrical power concerning study on performance improvement and economical aspect of gas turbine power plant using evaporative cooling system, and design and implementation of controller for boost dc-dc converter using PI-LPF based on small signal model. In the scope of vehicular technology and related topics there are two papers presented those are comparative study between internal ohmic resistance and capacity for battery state of health estimation, and estimating power needed to fuel electric paratransits in Bandung.

Since the first issue, our journal provides discretion in financial term by waiving the article processing charge. We are planning to improve the quality by registering the journal to other international academic citation index. We wish to offer our thanks to the Indonesian Institute of Sciences (LIPI) for their continuing unwavering support. Also, we would like to acknowledge our immense gratitude to our International Editorial Board members, reviewers and authors.

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

Bandung, December 2015

Editor-in-Chief

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## ABSTRACTS SHEET

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Ali Sadiyoko<sup>a,b</sup>, Bambang Riyanto Trilaksono<sup>b</sup>, Kusprasapta Mutijarsa<sup>b</sup>, Widyawardana Adiprawita<sup>b</sup> (<sup>a</sup>Mechatronics Engineering Department, Universitas Katolik Parahyangan, Bandung, Indonesia; <sup>b</sup>School of Electrical Engineering & Informatics, Institut Teknologi Bandung, Indonesia)

Obstacle Avoidance Method for a Group of Humanoids Inspired by Social Force Model

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 67-74, 11 ill, 0 tab, 11 ref.

This paper presents a new formulation for obstacle and collision behavior on a group of humanoid robots that adopts walking behavior of pedestrian crowd. A pedestrian receives position information from the other pedestrians, calculate his movement and then continuing his objective. This capability is defined as socio-dynamic capability of a pedestrian. Pedestrian's walking behavior in a crowd is an example of a sociodynamics system and known as Social Force Model (SFM). This research is trying to implement the avoidance terms in SFM into robot's behavior. The aim of the integration of SFM into robot's behavior is to increase robot's ability to maintain its safety by avoiding the obstacles and collision with the other robots. The attractive feature of the proposed algorithm is the fact that the behavior of the humanoids will imitate the human's behavior while avoiding the obstacle. The proposed algorithm combines formation control using Consensus Algorithm (CA) with collision and obstacle avoidance technique using SFM. Simulation and experiment results show the effectiveness of the proposed algorithm.

(Author)

Keywords: humanoid robots; formation control; obstacle avoidance; social force model; consensus algorithm.

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Midriem Mirdanies, Hendri Maja Saputra, Estiko Rijanto (Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences, Bandung, Indonesia)

Algorithm of 32-bit Data Transmission Among Microcontrollers Through an 8-bit Port

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 75-82, 19 ill, 4 tab, 13 ref.

This paper proposes an algorithm for 32-bit data transmission among microcontrollers through one 8-bit port. This method was motivated by a need to overcome limitations of microcontroller I/O as well as to fulfill the requirement of data transmission which is more than 10 bits. In this paper, the use of an 8-bit port has been

optimized for 32-bit data transmission using unsigned long integer, long integer, and float types. Thirty-two bit data is extracted into binary number, then sent through a series of 8-bit ports by transmitter microcontroller. At receiver microcontroller, the binary data received through 8-bit port is reconverted into 32 bits with the same data type. The algorithm has been implemented and tested using C language in ATmega32A microcontroller. Experiments have been done using two microcontrollers as well as four microcontrollers in the parallel, tree, and series connections. Based on the experiments, it is known that the data transmitted can be accurately received without data loss. Maximum transmission times among two microcontrollers for unsigned long integer, long integer, and float are 630  $\mu$ s, 1,880  $\mu$ s, and 7,830  $\mu$ s, respectively. Maximum transmission times using four microcontrollers in parallel connection are the same as those using two microcontrollers, while in series connection are 1,930  $\mu$ s for unsigned long integer, 5,640  $\mu$ s for long integer, and 23,540  $\mu$ s for float. The maximum transmission times of tree connection is close to those of the parallel connection. These results prove that the algorithm works well.

(Author)

Keywords: transmission algorithm; 32-bit data; data transmission; 8-bit port; microcontroller; C language.

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Gesang Nugroho<sup>a</sup>, Zahari Taha<sup>b</sup>, Tedy Setya Nugraha<sup>a</sup>, Hatyo Hadsanggeni<sup>a</sup> (<sup>a</sup>Department of Mechanical and Industrial Engineering, Faculty of Engineering, Gadjah Mada University, Yogyakarta, Indonesia; <sup>b</sup>Innovative Manufacturing, Machatronics and Spots Lab (iMAMS), Universiti Malaysia Pahang, Pahang, Malaysia)

Development of a Fixed Wing Unmanned Aerial Vehicle (UAV) for Disaster Area Monitoring and Mapping

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 83-88, 10 ill, 1 tab, 11 ref.

The development of remote sensing technology offers the ability to perform real-time delivery of aerial video and images. A precise disaster map allows a disaster management to be done quickly and accurately. This paper discusses how a fixed wing UAV can perform aerial monitoring and mapping of disaster area to produce a disaster map. This research was conducted using a flying wing, autopilot, digital camera, and data processing software. The research starts with determining the airframe and the avionic system then determine waypoints. The UAV flies according to the given waypoints while taking video and photo. The video is transmitted to the Ground Control Station (GCS) so that an operator in the ground can monitor the area condition in real time. After obtaining data, then it is processed to obtain a disaster map. The results of this research are: a fixed wing UAV that can monitor disaster area and

send real-time video and photos, a GCS equipped with image processing software, and a mosaic map. This UAV used a flying wing that has 3 kg empty weight, 2.2 m wingspan, and can fly for 12-15 minutes. This UAV was also used for a mission at Parangtritis coast in the southern part of Yogyakarta with flight altitude of 150 m, average speed of 15 m/s, and length of way point of around 5 km in around 6 minutes. A mosaic map with area of around 300 m x 1500 m was also obtained. Interpretation of the mosaic led to some conclusions including: lack of evacuation routes, residential area which faces high risk of tsunami, and lack of green zone around the shore line.

(Author)

Keywords: UAV; remote sensing; disaster monitoring; disaster area mapping; photo mosaic.

Edwin Romero Arboleda, Mary Christine Tumaming Alegre, Kathleen Felix Idica (Department of Computer and Electronics Engineering, College of Engineering and Information Technology, Cavite State University Indang, Cavite, Philippines)

Development of a Low-Cost Electronic Wheelchair with Obstacle Avoidance Feature

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 89-96, 6 ill, 2 tab, 18 ref.

A low-cost electronic wheelchair was designed and developed which can perform the similar functions and features as a commercially available wheelchair. It also provides obstacle avoidance capability as added value. The electronic wheelchair was realized by modification of a lightweight manual wheelchair. It uses two electric motors each of 320 W 24 V DC, 5-24 VDC 6 A H-bridge drivers, and a 12 V 17 Ah rechargeable lead acid battery. It equipped with switches, joystick, infrared sensors and ultrasonic sensors. A Gizduino AtMega328 microcontroller is used to read and interpret commands. User's acceptance evaluation results show that the developed low-cost wheelchair is able to receive and interpret commands provided by the joystick, detect if a person is seated on it, navigate to avoid obstacles as well as to detect edge and stairs. Technical evaluation result shows that on a flat surface it could move at the speed of around 39.9 m/min without load and 32 m/min with 80 kg load. At 10 degrees inclined surface, the maximum weight limit is 30 kg with the speed of 12 m/min. At 20 degrees inclined surface, the maximum weight limit is 10 kg with the speed of 3 m/min. Regarding cost, it is just a fraction of a cost compared to the commercially available model. Therefore, the developed wheelchair offers an option for potential users who cannot afford to buy the commercially available one.

(Author)

Keywords: electronic wheelchair; obstacle avoidance; edge detection; Gizduino AtMega328; microcontroller.

Hilman Syaeful Alam<sup>a</sup>, John Sasso<sup>b</sup>, Imam Djunaedi<sup>c</sup> (<sup>a</sup>Technical Implementation Unit for Instrumentation Development, Indonesian Institute of Sciences, Bandung, Indonesia; <sup>b</sup>RRT Sigma Engineering, Melville, New York, USA; <sup>c</sup>Research Center for Physics, Indonesian Institute of Sciences, Bandung, Indonesia)

Study on Performance Improvement and Economical Aspect of Gas Turbine Power Plant Using Evaporative Cooling System

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 97-104, 10 ill, 6 tab, 11 ref.

The study is intended to improve the performance of gas turbine engines in order to meet both electrical power demand and peak load in the power plant. In this paper, evaporative cooling system had been applied to improve the performance of gas turbine in Pesanggaran power plant in southern Bali Island, Indonesia. Moreover, the economic analysis was conducted to determine the capacity cost, operating cost and payback period due to the investment cost of the system. Based on the evaluation results, the power improvement for the three gas turbine units (GT1, GT2 and GT3) are 2.09%, 1.38%, and 1.28%, respectively. These results

were not very significant when compared to the previous studies as well as on the aspects of SFC (Specific Fuel Consumption), heat rate and thermal efficiency. Based on the evaluation of the economic aspects, the reduction of production costs due to the application of evaporative cooling system was not economical, because it could not compensate the investment cost of the system and it resulted a very long payback period. These unsatisfactory results could be caused by the high relative humidity. Therefore, further studies are needed to investigate the other alternative technologies which are more suitable to the climate conditions in Indonesia.

(Author)

Keywords: performance improvement; economic analysis; evaporative cooling; gas turbine; power plant.

Slamet Kasbi<sup>a,c</sup>, Estiko Rijanto<sup>b</sup>, Rasli Bin Abd Ghani<sup>a</sup> (<sup>a</sup>Malaysia-Japan International Inst. of Tech. (MIIT), Universiti Teknologi Malaysia (UTM) Kuala Lumpur, Malaysia; <sup>b</sup>Research Centre for Electrical Power and Mechatronics, Indonesian Institute of Sciences, Bandung, Indonesia; <sup>c</sup>Ministry of Energy and Mineral Resources (KESDM), Research and Development Agency (P3TKEBTKE), Jakarta, Indonesia)

Design and Implementation of Controller for Boost DC-DC Converter Using PI-LPF Based on Small Signal Model

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 105-112, 9 ill, 2 tab, 10 ref.

Boost DC-DC converters are used in many renewable energy sources including photovoltaic and fuel cell. They are also used in Uninterrupted Power Supply, inverters, electric vehicles and robots. In this paper a boost converter was built and its controller was developed using proportional integral (PI) action for current loop and low pass filter (LPF) for voltage loop. The controller was derived analytically based on small signal model. Experiment results show that the boost controller functions well in regulating the output voltage under a variation of load. During the start up without any load it can elevate input voltage from 119.6 V to output voltage of 241.6 V. The developed controller can regulate the output voltage smoothly under load variation from no load to sudden load of 352 W. When a large sudden load change happens from 0 W to 1,042 W the output voltage experiences small drop before it is recovered to 241.6 V. It can be concluded that the developed control system works well satisfying the design specification.

(Author)

Keywords: controller; boost DC-DC converter; PI; LPF; small signal.

M. Nisvo Ramadan, Bhisma Adji Pramana, Sigit Agung Widayat, Lora Khaula Amifia, Adha Cahyadi, Oyas Wahyunggoro (Department of Electrical Engineering and Information Technology, Gadjah Mada University, Yogyakarta, Indonesia)

Comparative Study Between Internal Ohmic Resistance and Capacity for Battery State of Health Estimation

*Journal of Mechatronics, Electrical Power, and Vehicular Technology*, December 2015, vol. 6, no. 2, p. 113-122, 17 ill, 0 tab, 20 ref.

In order to avoid battery failure, a battery management system (BMS) is necessary. Battery state of charge (SOC) and state of health (SOH) are part of information provided by a BMS. This research analyzes methods to estimate SOH based lithium polymer battery on change of its internal resistance and its capacity. Recursive least square (RLS) algorithm was used to estimate internal ohmic resistance while coulomb counting was used to predict the change in the battery capacity. For the estimation algorithm, the battery terminal voltage and current are set as the input variables. Some tests including static capacity test, pulse test, pulse variation test and before charge-discharge test have been conducted to obtain the required data. After comparing the two methods, the obtained results show that SOH estimation based on coulomb counting provides better accuracy than SOH estimation

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based on internal ohmic resistance. However, the SOH estimation based on internal ohmic resistance is faster and more reliable for real application.

(Author)

Keywords: battery management system; state of health; lithium polymer; recursive least square; coulomb counting.

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travels per day, operate 30 days per month, and use batteries with 50% State of Charge.

(Author)

Keywords: transportation; electric paratransit; in town; electricity demand; feasibility study.

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Estimating Power Needed to Fuel Electric Paratransits in Bandung

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This is the preliminary finding of a study elaborating the total energy consumption when paratransits in Bandung are altered into electric and the scenario to fulfill it. Therefore, there are lots to be done further concerning result of this initial research, of which will be discussed in another publication. In this paper calculation was done to find out the volume of power needed to fuel electric paratransits in Bandung. Steps carried out include computing total energy consumption for all paratransits, clustering stations from classified routes established by local Department of Transport, and estimating the electricity demand in every clustered station. Data used for this study was acquired from Badan Pusat Statistik Kota Bandung and PT PLN DJA APD Jawa Barat and Banten. A total demand of 61.12 MWh per month will surface to charge the total of 5,521 paratransits from 38 available routes in 15 clustered stations under the assumptions that all paratransits only make 6 return

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