The 22nd International Conference on Mechatronics Technology
26th – 29th October 2018
http://www.icmt2018.org

ICMT2018
Conference Program

Conference venue:
Seogwipo KAL Hotel, Jeju Island, Korea

Organized by
University of Ulsan, Republic of Korea
Korea Institute of Machinery & Materials

Table of Contents

WELCOME TO ICMT2018

Dear Colleagues,

It is our great pleasure to welcome all local and overseas participants to the **22nd International Conference on Mechatronics Technology (ICMT2018)**. The ICMT 2018 is held at Seogwipo Kal Hotel, Jeju Island of Korea, and we are very happy to meet all of you here in this beautiful Island.

The aim of ICMT is to facilitate close dialogues, networking and collaborations among experts on issues related to research and technological development in mechatronics, as well as in human resource development and education. ICMT 2018 continues to follow the rich tradition of ICMT with interesting topics on automation, robotics, navigation, renewable energy, advanced control techniques, MEMS/NEMS, production systems, smart materials and actuators, machine vision, and advanced mechatronic devices.

With enthusiastic interest and contributions of researchers from Korea, Japan, China, Taiwan, Vietnam, and Italy, we have selected 78 excellent papers to be presented at ICMT2018. Top quality manuscripts will be recommended as extended papers for publications in international journals (SCI, SCIE), e.g, Mechatronics, International Journal of Automation Technology, and Journal of Mechanical Science and Technology.

Autumn is coming on this beautiful Jeju Island, and the conference venue – Seogwipo Kal Hotel is with beautiful scenery and state of the art facility. We hope that you would have meaning time with ICMT2018!

Sincerely yours,

Prof. Soon Yong Yang

Conference Co-Chairman

Prof. Kyoung Kwan Ahn

Conference Co-Chairman

I. ORGANIZATION

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Korea Institute of Machinery & Materials (KIMM)

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Jong-Ku Yoon, Korea Construction Equipment Technology Institute

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Byung Ryong Lee	Korea	Khoa Son Nguyen	Vietnam
Young Jin Yum	Korea	Si Thai Dau	Vietnam
Jung Ho Park	Korea		

CONFERENCE CHAIRMANS:

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Jung Ho Park, Korea Institute of Machinery & Materials

PROGRAM CHAIRMAN:

Hyung Gyu Park

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Members: Byung Ryong Lee, Young Jin Yum, Jong-Up Jeon, Ock Tack Lim, Seung Tae Choi, Gu Hyun Jeong, Doo Man Chun, Yong Soo Seo, Hee Jun Kang, Un Jee Jeong, Il Yeong Lee, Jung Ho Park, Kee Bong Choi, Dong Won Yun, Jun Young Huh, SungDong Kim, Sung Ho Hwang, Jee Sung Jang, Young Bog Ham, Gyu Hong Jeong, Yea Sun Hong, Heon Sul Jeong, Joo Sup Jang, So Nam Yun, Sang Hoon Ji

Conference Secretariat: Nguyen Minh Tri

SPONSORS:

Korea Institute of Machinery & Materials (KIMM)

Korea Construction Equipment Technology Institute (KOCETI)

II. GENERAL INFORMATION

CONFERENCE HISTORY

The ICMT is an annual international conference on mechatronics technology that has been successfully held for 20 years. ICMT offers a forum to discuss state-of-the-art technologies and emerging application trends and provides great opportunities for professional interactions and networking in a friendly and hospitable setting. The first ICMT was convened in Santa Clara, USA, in 1996, and subsequently in Yokohama, Hsinchu, Pusan, Singapore, Kitakyushu, Taiwan, Hanoi, Kuala Lumpur, Mexico City, Ulsan, Sudbury, Cebu City, Osaka Melbourne, Tianjin, Jeju Island, Taipei, Tokyo, Dalian, Hochiminh City, and now at Jeju Island again. The objective of ICMT is to facilitate close dialogues, networking and collaborations among experts on issues related to research and technological development in mechatronics, as well as in human resource development and education.

CONFERENCE SCOPE

The 22nd International Conference on Mechatronics Technology (ICMT2018) covers the following topics:

- Advanced Mechatronics Devices, Sensing and Control.
- Smart Actuators and Materials.
- MEMS/NEMS and Micro/Nano-Manufacturing.
- Precision Measuring Technology.
- Production Systems.
- Sustainable Automotive Technologies.
- Renewable Energy and Smart Grid.
- Bioengineering and Mechatronics Applications in Life Sciences.
- Information and Networking.
- Human Resource Development and Education on Mechatronics Technology.
- Internet of Things, Internet based Manufacturing, AI, Super Smart Society.
- Composite and Polymer Materials.
- Construction machine.

III. CONFERENCE VENUE

Seogwipo KAL HOTEL

Address: 242 Chilsipri-ro, Seogwipo City, Jeju Special Self-Governing Province, Korea (486-3, Topyeong-dong, Seogwipo-si, Jeju-do, Korea)

Tel: +82-64-733-2001

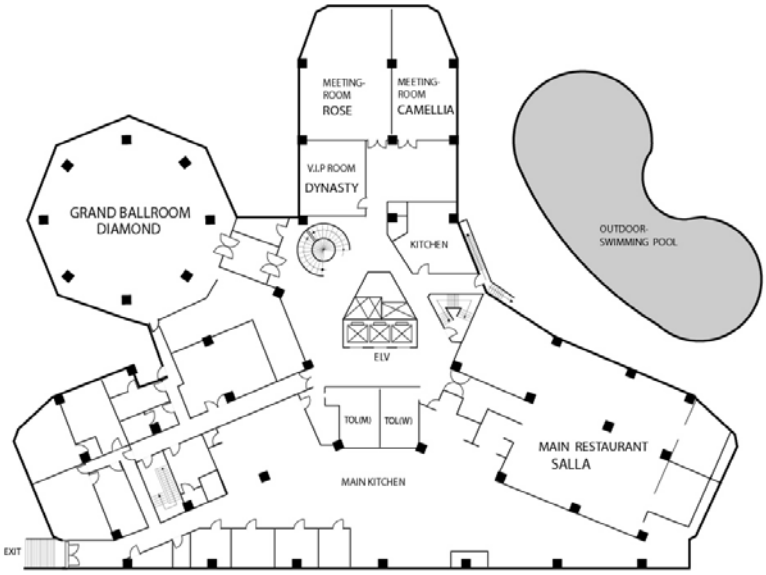
Website: https://www.kalhotel.co.kr

Access: 50 mins by taxi from Jeju International Airport

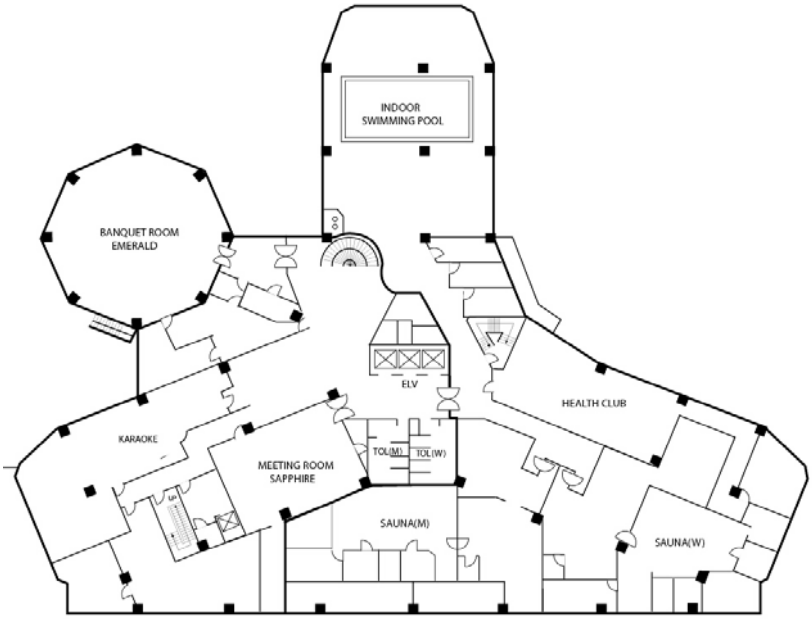
The following picture displays local map of Seogwipo KAL HOTEL

The conference is held on the basement 1st and 2nd floor of Seogwipo KAL HOTEL. Layout of the conference floor is as follows

- **Basement 1st Floor**



- **Basement 2nd Floor**



Accommodation: Seogwipo KAL HOTEL

Discounted Rate	Double (one or two bed): (Sun.~Thu.)	Mountain view	KRW 110,000 / per day
		Ocean view	KRW 140,000 / per day
	Double (one or two bed): (Fri.~Sat.)	Mountain view	KRW 140,000 / per day
		Ocean view	KRW 170,000 / per day
	Breakfast (optional)	KRW 18,000 / person / day	

III. REGISTRATION

CONFERENCE REGISTRATION

The attendee conference fee includes registration, proceedings, welcome reception, lunches, banquet, and technical tour. Fees are shown in US Dollars.

Category	Early	Late
Regular attendee (Including Speaker)	600 USD	650 USD
Student attendee (Including speaker)	300USD	350 USD
Banquet fee for an additional guest	50 USD	

EARLY REGISTRATION

- Online registration at: http://www.icmt2018.org/default/04/01.php
- Payment method: Bank transfer or payment directly at the conference.

LATE REGISTRATION

Late registration can be done at conference site. Payment by credit card or cash.

Registration date:

- October 26th, 2018 (Friday) 15:00~20h00
- October 27th, 2018 (Saturday) 09:00~17h00
- October 28th, 2018 (Sunday) 09:00~17h00

IV. ASSOCIATED EVENTS

Welcome Reception:

- **Date/Time:** October 26th, 2018 (Friday), 18:30~20:30
- **Place:** Diamond Hall, Basement 1st Floor

Opening Ceremony:

- **Date/Time:** October 27th, 2018 (Saturday), 09:00~09:20
- **Place:** Diamond Hall, Basement 1st Floor

Banquet and Closing Ceremony:

- **Date/Time:** October 28th, 2018 (Sunday), 18:00~20:30
- **Place:** Diamond Hall, Basement 1st Floor

Best paper Award:

- **Date/Time:** October 28th, 2018 (Sunday), 18:00~20:30
- **Place:** Diamond Hall, Basement 1st Floor

Technical tour:

- **Date/Time:** October 29th, 2018 (Monday), 10:30~15:00
- **Place:** Jeju Peace Museum and Lee Joong-Seop Street

V. CONFERENCE PROGRAM

CONFERENCE SCHEDULE

26th Oct. 2018 (Friday)	
Time	**Events**
15:00 ~ 18:00	**Registration** at B1F, Seogwipo KAL Hotel
16:30 ~ 17:20	**Tutorial** at B1F(Rose) Mr. Dongwon Yun, Daegu Gyeongbuk Institute of Science & Technology *Topic*: Locomotion inspired by animals for robot development
17:30 ~ 19:00	Welcome Reception at B1F (Diamond Hall)

27th Oct. 2018(Saturday)		
Time	**Events**	
09:00 ~ 17:00	Registration at B1F, Seogwipo KAL Hotel	
09:00 ~ 09:20	**Opening Ceremony** at B1F (Diamond Hall)	
09:20 ~ 10:00	**1st Keynote Speech** at B1F (Diamond Hall) Prof. Akio YAMAMOTO, University of Tokyo Topic: Electrostatic Actuator Technologies for Interactive Systems [Chair: Prof. Joon Wan Kim]	
10:00 ~ 10:40	**2nd Keynote Speech** at B1F (Diamond Hall) Prof. Jae Jong LEE, Korea Institute of Machinery and Materials Topic: Multi-Functional Nanoimprint Lithography Systems Technology for fabrication of 3D Nanostructure and its applications [Chair: Dr. Jung Ho Park]	
10:40 ~ 11:00	**Group Photo**, Break	
Technical Sessions	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 1	**Composite and Polymer materials**
11:00 ~ 11:20	*Paper ID* 02	*Paper ID* 22
11:20 ~ 11:40	*Paper ID* 34	*Paper ID* 32
11:40 ~ 12:00	*Paper ID* 10	*Paper ID* 45
12:00 ~ 13:00	Lunch	
Technical Sessions	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 2	**Sustainable Automotive 1**
13:00 ~ 13:20	*Paper ID* 41	*Paper ID* 43
13:20 ~ 13:40	*Paper ID* 49	*Paper ID* 46
13:40 ~ 14:00	*Paper ID* 50	*Paper ID* 64
14:00 ~ 14:20	*Paper ID* 52	*Paper ID* 65
14:20 ~ 14:40	Break	

Technical Sessions	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 3	**Smart Actuators 1**
14:40 ~ 15:00	*Paper ID* 12	*Paper ID* 07
15:00 ~15:20	*Paper ID* 18	*Paper ID* 08
15:20 ~ 15:40	*Paper ID* 20	*Paper ID* 16
15:40 ~ 16:00	*Paper ID* 53	*Paper ID* 54
16:00 ~ 16:20	Break	
Technical Sessions	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 4	**Precision Measuring 1**
16:20 ~ 16:40	*Paper ID* 21	*Paper ID* 04
16:40 ~ 17:00	*Paper ID* 25	*Paper ID* 13
17:00 ~ 17:20	*Paper ID* 26	*Paper ID* 19
17:20 ~ 17:40	*Paper ID* 33	*Paper ID* 29
17:40 ~ 18:00	*Paper ID* 85	*Paper ID* 87
18:00 ~ 20:00	**International Steering Committee Meeting**	

28th Oct. 2018 (Sunday)			
Time	**Events**		
09:00 ~ 17:00	Registration at B1F, Seogwipo KAL Hotel		
09:00 ~ 09:40	**3rd Keynote Speech** at B1F (Diamond Hall) Prof. Quang Truong DINH, University of Warwick, UK Topic: Electrification and Management Technologies for Transport [Chair: Prof. Kyoung Kwan Ahn]		
09:40 ~ 10:20	**4th Keynote Speech** at B1F (Diamond Hall) Prof. Adolfo SENATORE, University of Salerno, Italy Topic: Mechatronics in automotive transmissions: new powertrain concepts, new challenges [Chair: Dr. Young Bog Ham]		
10:20 ~ 10:40	Break		
Technical Sessions	Sapphire (B2F)	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 5	**Construction Machine 1**	**Renewable Energy 1**
10:40 ~ 11:00	*Paper ID* 05	*Paper ID* 51	*Paper ID* 28
11:00 ~ 11:20	*Paper ID* 36	*Paper ID* 80	*Paper ID* 44
11:20 ~ 11:40	*Paper ID* 38	*Paper ID* 81	*Paper ID* 55
11:40 ~ 12:00	*Paper ID* 39	*Paper ID* 82	*Paper ID* 67
12:00 ~ 13:00	Lunch		
Technical Sessions	Sapphire (B2F)	Rose (B1F)	Camellia (B1F)
	Advanced Mechatronics 6	**Smart Actuators 2**	**Precision Measuring 2 & Renewable Energy 2**
13:00 ~ 13:20	Invited - *Paper ID* 56	Invited - *Paper ID* 35	Invited - *Paper ID* 83
13:20 ~ 13:40	*Paper ID* 75	*Paper ID* 17	*Paper ID* 30
13:40 ~ 14:00	*Paper ID* 61	*Paper ID* 23	*Paper ID* 59
14:00 ~ 14:20	*Paper ID* 69	*Paper ID* 42	*Paper ID* 79
14:20 ~ 14:40	*Paper ID* 70	*Paper ID* 47	*Paper ID* 73
14:40 ~ 15:00	*Paper ID* 71	*Paper ID* 40	*Paper ID* 76

15:00 ~ 15:20	Break		
Technical Sessions	Sapphire (B2F)	Rose (B1F)	Camellia (B1F)
	MEMS/NEMS 1	**Production Systems & Sustainable Automotive 2**	**Advanced Mechatronics 7 & Construction Machine 2**
15:20 ~ 15:40	*Paper ID* 11	Invited - *Paper ID* 24	*Paper ID* 37
15:40 ~ 16:00	*Paper ID* 58	*Paper ID* 03	*Paper ID* 72
16:00 ~ 16:20	*Paper ID* 60	*Paper ID* 27	*Paper ID* 74
16:20 ~ 16:40	*Paper ID* 68	*Paper ID* 66	*Paper ID* 78
16:40 ~ 17:00	*Paper ID* 62	*Paper ID* 77	*Paper ID* 88
17:00 ~ 17:20	*Paper ID* 57		
18:00 ~ 20:30	**Conference Banquet**		

29th Oct. 2018 (Monday)	
10:00 ~ 15:00	**Conference Tour**: Jeju Peace Museum and Lee Joong-Seop Street, lunch

KEYNOTE SPEAKERS

PROFESSOR AKIO YAMAMOTO

The University of Tokyo, Japan

Biography

Professor Akio Yamamoto has received his Ph.D degree from the University of Tokyo, Japan. In 2000, he joined faculty of the University of Tokyo, and has been a full professor in the Department of Precision Engineering since 2017.

His research interests include Sensors & Actuators, Robotics, and Computer-Human Interactions. Especially, he has been focusing on electrostatic actuations and has been pursuing their applications in the fields of robotics and computer-human interactions.

He is a recipient of Mechatronics Journal Best Paper Prize from IFAC, Best Automation Paper Award in IEEE ICRA 2006, Best Paper Award from FA foundation, Achievement Award from JSME Machine Design & Tribology division, and many other awards in mechatronics-related conferences.

Electrostatic Actuation Technologies for Interactive Systems

Summary of the talk: This keynote will introduce several electrostatic linear motors that are realized in centimetric scales. The unique features of the motors, such as being thin, flat, and/or transparent, make them ideal actuators for interactive systems. Several operation principles, including synchronous and induction principles, will be explained and their applications to interactive systems will be discussed. Especially, their integrations with LCD displays will be featured, in which users can interact with computers through visual and tangible interactions.

The talk will also cover other electrostatic actuation technologies, such as electrostatic haptic rendering on flat surfaces. A unique multi-user haptic interaction realized on a large-panel LCD surface will be introduced.

In the past two decades, applications of electrostatic actuations have been mainly found in micro systems. This talk, on the other hand, will unveil the potentials of electrostatic actuation technologies in centimetric scales, through introduction of the above unique systems.

PROFESSOR JAEJONG LEE
Korea Institute of Machinery and Materials, Korea

Biography

- JaeJong Lee received the BS in precision machine engineering from Chonbuk National University in 1985, a MS in production engineering from Korea Advanced Institute of Science & Technology(KAIST) in Seoul in 1987, and Ph.D. in Mechanical Engineering from Korea Advanced Institute of Science & Technology(KAIST) in DaeJeon, Korea in 1998.
- Principal Researcher, Nano-convergence Mechanical Systems Division, Korea Institute of Machinery and Materials (September 1987 to Present.)
- Professor, Department of Nano-Mechatronics, University of Science and Technology. Korea (March 2005 to Present)
- Visiting Researcher, Paul Scherrer Institute, Switzerland (2005)
- Editorial Board member, Microelectronic Engineering (January 2015 to Present)
- International Program Committee member, Micro & Nano Engineering (2015 to Present)
- Vice President of Korean Society of Mechanical Engineers (2018)

Multi-Functional Nanoimprint Lithography Systems Technology for fabrication of 3D Nanostructures and its applications

Summary of the talk: With the recognition of nanotechnology as one of the future strategic technologies, the R&D efforts have been performed under exclusive supports of governments and private sectors. At present, nanotechnology is at the focus of research and public attention in almost every advanced country including USA, Japan, and many others in EU. Keeping tracks of such technical trends, Center for Nanoscale Mechatronics and Manufacturing (CNMM) and BioNano Health-Guard Research Center (H-Guard) are established in Korea as a part of national nanotechnology promotion policy led by Ministry of Science, ICT. It will hold widespread potential applications in electronics, optical electronics, biotechnology, micro systems, and implantable medical devices with the promises of commercial visibility and competitiveness. In this talk, multi-functional nanofabrication lithography systems technology which is well-known the next generation lithography, i.e. the nanoimprint lithography and the localized spatial lithography technologies for fabrication of nanostructures on the non-flat implantable medical devices in order to monitor the diseases are introduced.

PROFESSOR TRUONG QUANG DINH
The University of Warwick, UK

Biography

Truong Quang Dinh received B.Eng. and D.Eng. degree in Mechatronics from Hochiminh City University of Technology (Vietnam) in 2006 and University of Ulsan (Korea) in 2010, respectively. He is currently an Assistant Professor in Warwick Manufacturing Group (WMG), the University of Warwick. He is leading the research team in Energy Management and System Control and the HiL Control LAB.

He has done extensive research in the areas of control theories, automation, energy saving, management and optimisation, low carbon technologies for transports and construction sectors. He has published more than 55 articles at high quality journals, 80 conference papers, 2 book chapters and 3 patents. He has received a number of awards, including Best Student Paper Award (ICCAS 2007), SICE International Scholarship Award and Finalist Awards (ICCAS-SICE 2009), Best Conference Paper for A Young Researcher Award (ICMT 2009), Best Conference Paper for Outstanding Paper Award (ICCAS 2010), and Best Conference Paper for Outstanding Paper Award (ICCAS 2015).

He is committee member of IEEE IES – Motion and Control. He has been invited as: section chairs for many international conferences; steering committee members of international conference series, including ICMT, PMC (Powertrain Modelling and Control) and ICNEE (International Conference on New Energy and Environment Engineering); lead guest editors for international journals, Advances in Mechanical Engineering, and Applied Computational Intelligence and Soft Computing; editor of the Exchanges: The Interdisciplinary Research Journal. He is a frequent reviewer for over 20 high quality journals.

Electrification and Management Technologies for Transport

Summary of the talk: The energy crises and global environmental pollution have led to urgent demands for low-carbon and energy-saving technologies across all transport sectors, including automotive, off-highway, marine, network rail and aerospace applications. Propulsion electrification is acknowledged as one of the most promising solutions to address these demands. This provides the system more degrees to achieve the optimal energy efficiency and therefore, significant energy saving opportunities. However, complex structures, multi-domain operations

and different transient dynamics of such propulsion systems lead to critical issues and challenges in system modeling, control and management. In addition, due to the system safety and reliability requirements, rigorous performance evaluations need to be performed during the system development process. With the rapid development of digital technologies and computer science, RT (Real-Time) simulation platforms are increasingly deployed as efficient design and validation tools by both researchers and OEMs to bridge the gap between fundamental research using model-in-the-loop simulations and practical implementation/commercialization. In this speech, a review of current electrification evolution and future directions for transport will be presented to understand the importance as well as development challenges of these techniques. Next, advanced modelling, control and management tools for modern transport systems covering from energy sources to system integration will be discussed. Finally, powerful real-time simulation platforms will be introduced to support the system development, rapid prototyping, validation and therefore, to accelerate and de-risk innovations.

PROFESSOR ADOLFO SENATORE
University of Salerno, Italy

Biography

Adolfo Senatore received the M.Sc. degree in Mechanical Engineering from the University of Salerno, Salerno, Italy, in 1998, and the Ph.D. degree in Tribology from the University of Pisa, Pisa, Italy, in 2002.

He has been serving as Associate Professor at the Department of Industrial Engineering, University of Salerno, (2014-current). Researcher of Mechanics for Machine Systems with the Department of Industrial Engineering, University of Salerno, teacher of Mechatronics (2004-) and Mechanical Vibrations (2016-). He is a member of NanoMates, Research Centre for Nanomaterials and Nanotechnology. His scientific work is documented by more than 180 scientific papers in the following areas: frictional modeling and model-based control in automotive transmissions, lubrication in internal combustion engines and journal bearings, effects of nanoparticles as friction reducer additives, vibration measurement methods. During 2012, he visited as Guest Professor the Department of Applied Mechanics of the Technische Universitat Berlin under DAAD program. He served as reviewer for several journals on the topics of Mechanics, Mechatronics, and Tribology.

He has been coordinating industry funded projects on high mechanical efficiency systems for electric power harvesting, elastic models of robots and trajectory planning, tribological characterization of innovative lubricants, development of models to estimate the frictional torque in automotive dry-clutch, analysis of physical and tribological properties of linings for synchronizer rings, torque characteristic and control of dry-clutch for automotive mechatronic transmissions.

Mechatronics in automotive transmissions: new powertrain concepts, new challenges

Summary of the talk: Over the next few years, the amount of powertrain concepts for motor vehicles will ceaselessly grow. Regardless of whether they will be driven by internal combustion engines, hybridized powertrains or electrical-only vehicles, the goal of all of these concepts is to

use as low primary energy as possible for driving ground vehicles aiming at reducing CO_2 emissions to the lowest achievable level.

For the transmission, this results in the requirement to generate as few losses as possible when

transmitting the power and converting the speed ratio and torques to supply as much mechanical energy as possible to the wheels, along with improvement of safety, comfort, reliability, shifting quality, and driving performance.

Dedicated hybrid transmissions can be developed from existing transmission concepts, i.e., from planetary automatic transmissions (ATs), continuously variable transmissions (CVTs), automated manual transmissions (AMTs) or double clutch transmissions (DCTs).

With reference to the latter schemes, automotive transmissions based on dry clutch architectures are today widely used, and many architectures have been proposed in these years.

Thermal effects, clutch actuator technologies, torque estimation, and engagement control strategies have been also investigated. Indeed, the performances of dry clutches driven by electronic boards in automated manual transmissions with one or two clutches notably depend on the combination of physical factors as thermal response of pad facings, slip speed, and contact pressure. AMTs and DCTs are interesting mechatronic examples where the control of frictional based devices shows its importance and potentialities. Typically, automated gearboxes feature many advantages with respect to manual transmissions in terms of improvement of safety, comfort, reliability, shifting quality, and driving performance, together with reduction of fuel consumption and pollutant emissions. In order to obtain such goals, several model-based engagement control strategies have been recently proposed in the literature, e.g., classical controller, optimal control, predictive control, decoupling control, and robust control. However, effective controllers are difficult to be designed without having a reliable physical model of the clutch-torque transmissibility characteristic.

This keynote lecture covers the main contribution of the research effort aimed at clarifying how different driveline devices of dry-clutch based transmissions explicitly influence the transmissibility by providing key elements to designers of such mechatronic systems and related control strategies with the purpose of improving knowledge about driveline scheme based on clutch managed by automatic control. Such a target can be especially useful to developers of next generation hybridized powertrains since current forecast about automatic transmissions market is expected to gain traction in all countries where higher fuel economy and ease of driving on congested roads continue to influence buying decisions.

SECTION CONTENTS

***Session 4*: Sustainable Automotive 1**

27th October [Saturday], 13:00-14:20, Room Camellia

Session Chair: Prof. Adolfo Senatore

***Session 5*: Advanced Mechatronic 3**

27th October [Saturday], 14:40-16:00, Room Rose

Session Chair: Prof. Yin Yaobao

***Session 6*: Smart Actuator 1**

27th October [Saturday], 14:40-16:00, Room Camellia

Session Chair: Prof. Kazuhiro Yoshida

***Session 7*: Advanced Mechatronic 4**

27th October [Saturday], 16:20-18:00, Room Rose

Session Chair: Prof. Hee-Jun Kang

***Session 8*: Precision Measuring 1**

27th October [Saturday], 16:20-18:00, Room Camellia

Session Chair: Prof. Sung-Tae Hong

***Session 9*: Advanced Mechatronics 5**

28th October [Sunday], 10:40-12:00, Room Sappire

Session Chair: Prof. Dongwon Yun

***Session 10*: Constriction Machine 1**

28th October [Sunday], 10:40-12:00, Room Rose

Session Chair: Dr. Jong-Il Yoon

***Session 11*: Renewable Energy 1**

28th October [Sunday], 10:40-12:00, Room Camellia

Session Chair: Prof. Ho Pham Huy Anh

***Session 12*: Advanced Mechatronics 6**

28th October [Sunday], 13:00-15:20, Room Sapphire

Session Chair: Dr. Jung-Ho Park

***Session 13*: Smart Actuators 2**

28th October [Sunday], 13:00-15:20, Room Rose

Session Chair: Prof. Tadahiko SHINSHI

***Session 14*: Precision Measuring 2 & Renewable Energy 2**

28th October [Sunday], 13:00-15:20, Room Camellia

Session Chair: Dr. Truong Quoc Thanh

***Session 15*: MEMS/NEMS 1**

28th October [Sunday], 15:20-17:00, Room Sapphire

Session Chair: Prof. Joon-wan Kim

***Session 16*: Production Systems & Sustainable Automotive 2**

28th October [Sunday], 15:20-17:00, Room Rose

Session Chair: Dr. Young-Bog Ham

***Session 17*: Advanced Mechatronics 7 & Construction Machine 2**

28th October [Sunday], 15:20-16:40, Room Camellia

Session Chair: Prof. Doo-Man Chun

VI. PAPER ABSTRACTS

Session 1: Advanced Mechatronics 1

ID 02 Parametric Examination for Non-axisymmetric Aspheric Ultraprecision Machining Using Piezoelectric FTS

Kuo-Ming Chang, Wen-Tien Cheng, Yung-Tien Liu

Abstract: The non-axisymmetric aspheric ultraprecision machining is increasingly important in current photoelectric industry. In this paper, a piezoelectric (PZT) fast-tool servo (FTS) was employed to conduct non-axisymmetric aspheric machining for a die/mold, the machined result was evaluated by the form error obtained by the Levenberg-Marquardt algorithm (LMA), and parametric examination based on the response surface methodology (RSM) was performed to derive a predictive model of the form error. With the model developed, a high degree of ultraprecision machining can be achieved efficiently, thus increasing productivity.

Keywords: Non-axisymmetric Aspheric Machining, Fast-tool servo (FTS), Response Surface Methodology (RSM), Levenberg-Marquardt algorithm (LMA).

ID 34 Robust networked predictive control for DC motor with delay and dropout

Duc Thien Tran, Chau Duy Le, Cong Phat Vo, Tianshu Li, Huan Liu,
Young Jin Yum, Kyoung Kwan Ahn

Abstract: This paper addresses a robust control of networked control systems under presence of network-induced delay, packet dropout, and external disturbance. These problems occur in both feedback and feedforward channels. A proposed networked predictive control scheme includes an observer, a state predictor, a predictive control, and a delay compensator. The observer is used to estimate all states of the system, the state predictor handles the communication issues in feedback channels, the predictive control based on discrete integral sliding mode control and networked delay compensator are utilized to deal with the communication problems in feedforward channel and external disturbance. Some simulations and experiments are carried out to verify the effectiveness of the proposed control.

Keywords: Discrete integral sliding mode control, State observer, State predictive control, Networked control system.

ID 10 Modeling and Simulation of Civil Aircraft Hydraulic System and its Control Logic Based on MBSE

Li Jing, Xin Donghua, Wu Shuangwei

Abstract: The increasing complexity and interoperability of systems in civil aircraft call for a model-based system engineering (MBSE) approach. This paper describes a whole life-cycle modelling process for the civil aircraft hydraulic system and its control logic under the MBSE architecture, which is decomposed into requirement analysis, function analysis, model synthesis, and validation phases. The requirement and functional analysis completely define the model, and it can be assured the model complies with requirements and fulfills the functionality by verifying and validating. With the help of Simulink platform, the aircraft hydraulic system is modeled by Simscape and its control logic is realized by Stateflow. The accuracy of the model is validated taking the mode control logic of the

Power Transfer Unit as an example. The result also provides references for the application of MBSE architecture in aircraft system design and verification.

Keywords: Civil Aircraft, MBSE, Hydraulic System, Hydraulic Control logic, Simulink

Session 2: Composite and Polymer Materials

ID 22 A Scientific Molding Approach for Precise Injection Molding

Ming-Shyan Huang, Shih-Chih Nian, Yung-Chih Fang

Abstract: Mold testing is a crucial stage of checking the functionality of the developed injection mold and searching for feasible process parameters for assuring a high yield rate in successive mass-production. However, conventional mold testing acts like a black-box in which the flowing behavior of molten plastics within the cavity is unseen, and focuses on the setting of feasible machine parameters which is heavily relied on operators' experience, design of experimental methods, or even trial-and error approach. Such an approach is not only time-consuming but also lack ability of assuring the transferability of machine parameters between varying machine-to-machine operations. This study thereby proposes a scientific molding approach by applying adequate sensors to reveal the physical signals of molten plastics within cavities and interpreting its physical meaning. Based on these scientific information, a systematic and effective mold testing process can be achieved. Instead of machine-parameter list, the proposed method creates process-parameter profiles applicable to the machine-to-machine operation. To reveal the initial concept of scientific molding, an experimental example is also demonstrated in this study.

Keywords: Injection mold, injection molding, polymer processing, process monitoring, scientific molding.

ID 32 A Study on Selection of the Semi-Additive Range and Shape for Piercing Punch Strengthening by Punch Strength Prediction of Ultra-High Strength Part Piercing Process

Shiliang Wang, Yong Seok Kim, Tian Gou, Won Joon Kim, Young Jin Yum, Soon Yong Yang

Abstract: In this paper, a simulation based on the piercing process parameters was performed to predict the punch strength required for piercing process of high-strength sheet material CP1180 (1200MPa). The piercing process parameters were selected from the previous research literature which included shear mechanism and process analysis of sheet material. The simulation processor for punch strength prediction was designed to predict the shape range of partial punch where stress is concentrated by punching action based on piercing process conditions. We predicted the range of width and depth of punch shape that affect shear process. The flat type was found to be the most stable. In this way, the predicted range will be defined as a semi-additive area using a high-strength powder material with the support of metal 3D printing technique. Through this study, semi-additive punch will be fabricated, and durability test will be performed. This semi-additive punch proposed in this paper will contribute to improve the punch strength for high strength sheet material.

Keywords: Shear Processes Analysis, Piercing Processes Analysis, Punch Strength Prediction, Semi-Additive Shape, Semi-Additive Punch， Additive Manufacturing.

ID 45 Study of Water Vapor Transfer Behavior using Computational Fluid Dynamics and Molecular Dynamics Simulation in Hollow Fiber Membrane Module for Dehumidification

Eun-A Jeong, Haroon Ahmad khan, So-Nam Yun

Abstract: Hollow fiber membrane modules are widely used in pneumatic equipment for removal of water vapor. The numerical study of multiphase flow through porous membrane has been started a long while ago. This paper presents a model of multiphase flow and molecular dynamics through porous membrane and adsorption of hydrophilic group using ANSYS FLUENT and LAMMPS software. In addition, experiment of dehumidification was conducted to validity of simulations results.

Keywords: Hollow Fiber Membrane Module, Computational Fluid Dynamics, Molecular Dynamics Simulation, Dehumidification, Water Vapor

Session 3: Advanced Mechatronics 2

ID 41 Stability Guaranteed Time-Delay Control for Robot Manipulators

Sang Hyun Park, Maolin Jin

Abstract: A stability guaranteed control scheme, which is robust against model uncertainty, is proposed for robot manipulators. The time-delay estimation technique with an inertia model is adopted to accomplish these advantages. A simulation of 6-DoFs robot shows the efficacy of the proposed method.

Keywords: Robust control, model uncertainty, stability, time-delay estimation (TDE), time delay control (TDC).

ID 49 Design of the Elastic Constraints with Flexures and Linear Springs for the Spatial Rolling Contact Pair

Naoto Kimura, Nobuyuki Iwatsuki, Ikuma Ikeda

Abstract: In order to improve the performance of the spatial rolling contact pair (SRCP) in terms of connection between links, a hybrid elastic constraint with flexure and linear springs are introduced. Flexures are designed to adjust to the rolling contact surface and the linear springs are optimally arranged so as to keep the ideal rolling contact between links. An example of the SRCP with the proposed constraints is designed, fabricated and experimentally examined.

Keywords: Linkage mechanism, Kinematic pair, Mechanical design, Rolling contact, Flexure.

ID 50 The Predictive Control for Networked Control System with Random Delays and Packet Dropouts

Cong-Phat Vo, Duc-Thien Tran, Kyoung Kwan Ahn

Abstract: This paper presents a novel control technique to deal with networked control systems (NCSs) with random delays and packet dropouts in the forward channel (controller-to-actuator) and

the backward channel (sensor-to-controller). A networked predictive control (NPC) strategy is proposed combining an observable control prediction is used to estimate the current state and predict the future states of the plant, while the buffer is employed to compute and compensates for the network transmission. As an application, simulation results show the effectiveness of the proposed method.

Keywords: Networked control systems, Predictive control, Random delay.

ID 52 Design and Simulation of Hydraulic System for Dual Arm Excavator in Disaster Environment

Quang Hoan Le, Sung Woong Choi, Young Jae Kim, Sung Won Choi, Dakarimov Sayat, Soon Yong Yang

Abstract: Nowadays, many hydraulic work machines have been developed for recovery work after disaster such as earthquakes, tornado, tsunami etc. The requirement of adapting to conduct flexible work leads the development of double arm work machine based on hydraulic excavator. However, the limits of 4 DOFs arm of these machines can not satisfy the needs of complex task when rescuing the victims from the disaster site. Thus, this paper will present a design of hydraulic systems for double arm excavator in disaster environment. First, the scopes of the research and development of the machine will be introduced. Then, in the concept design, the hydraulic circuit of the arms will be proposed. The specifications of the valve system are also introduced to define the working ability of the machine. Next, the simulation of the power pack and directional control valves are described to determine the suitable valves to support the large amount of actuators.

Keywords: Excavator, Hydraulic, Double arm, Simulation, Valve.

Session 4: Sustainable Automotive 1

ID 43 Estimation of dry clutch torque in automated manual transmission: vehicle test and real-time algorithm

Adolfo Senatore, Mojtaba Sharifzadeh, Mario Pisaturo, Truong Quang Dinh

Abstract: In this paper, real-time identification of the dry-clutch torque characteristic in automotive environment is investigated. The proposed algorithm provides direct capability for updating the clutch frictional torque map by using engine torque, engine speed and clutch speed as real time measurable signals. The algorithm purpose is the estimation of the clutch incipient sliding position or “kiss-point” in real-time vehicle environment. More launch maneuvers have been considered to test the methodology capabilities and promising results have been achieved.

Keywords: Clutch torque estimation, automated manual transmission, dual-clutch transmission, vehicle longitudinal dynamics.

ID 46 Conceptual Design of Boarding Simulator for Armored Robotic Systems

Dongbin Shin, Jonggeol Kim, Sanghyun Park, Juhyun Kim, Jinho Suh, Maolin Jin

Abstract: This paper proposes a conceptual design of a boarding-simulator for an armored robot system for complex disaster response. A boarding simulator consists of a monitoring system, chair, steering wheel, remote-control master device, dashboard, and hydraulic arm for testing various functions of an armored robot system on the ground before performing an actual vehicle test. The monitoring system consists of a panoramic view with a viewing angle of 360º in a smoke-filled environment and a hydraulic arm work-situation monitoring system. The user can freely manipulate the hydraulic arm using the remote-control master device in the form of an exoskeleton. In case of emergency, macro commands can be executed by using shortcut buttons so that frequently used operations or tasks can be easily executed. To elucidate the concept of the optimal boarding simulator, human element analysis was performed, and visualization of various data required for robot operation, selection of necessary information, and arrangement of operation interface components were obtained. The conceptual design of the final derived armored robot simulator was verified through a mission-based simulation.

Keywords: Conceptual design, Armored robot, Boarding simulator, Master control device.

ID 64 Study on the optimal management of power sources on the electric excavator

Hyeon-Seop Yi, Hun Choi

Abstract: Recently, the engine is removed in the field of vehicles and construction machinery and fuel cells, batteries, and super capacitors are emerging as alternative power sources. A battery-only electric vehicle has been mass-produced, and a fuel cell vehicle has been developed in which the fuel cell and the battery are hybridized. In the excavator, research and development are being done in a similar direction. The excavator is equipped with a super capacitor, which regenerates the upper braking energy to improve the efficiency of the engine. This paper deals with the energy management of environmentally friendly electric excavators using super capacitors. The power distribution profile of fuel cell, battery, and super capacitor is examined by using optimal control theory of required power profile of existing engine excavator. It was confirmed that the fuel cell efficiency of the excavator that added the super capacitor was higher than the fuel cell efficiency of the fuel cell-battery electric excavator which was the subject of the study. Such a simulation method and conclusion can be a basic research that will help to mass-produce electric excavators in the future.

Keywords: Electric Excavator, Fuel Cell, Battery, Super Capacitor, Dynamic Programming.

ID 65 Stress Relief Annealing of Automotive Springs by Using Electric Current

Van Loi Tran, In-Hye Kim, Sung-Tae Hong, Ji Ye Hong, Sung-Woo Jin, Heung Nam Han

Abstract: In the present study, stress relief annealing process for automotive springs is experimentally investigated by periodically applying electric current to a full size commercial automotive spring. The experimental result shows that the electrically assisted (EA) stress relief annealing is clearly more effective than a conventional process using a furnace, even with a significantly shorter process time

and less energy. Besides, the results of fatigue tests confirm that the spring annealed by electric current for 30 seconds shows similar fatigue life to that annealed in furnace for 40 minutes.

Keywords: Automotive spring; Electrically Assisted; Residual stress.

Session 5: Advanced Mechatronics 3

ID 12 A Robust Tracking Control Method for Uncertain Nonlinear Systems with Chattering-free Terminal Sliding Mode Control

Anh Tuan Vo, Hee – Jun Kang, Ngoc Hoai An Nguyen

Abstract: This paper suggests a chattering-free robust tracking control method for a class of second-order nonlinear systems with dynamic uncertainties and external disturbance. Due to the robustness against uncertain terms affecting the system and great characteristics such as non-singularity, quick convergence, high accuracy and small chattering behavior, the non-singular fast terminal sliding mode control has been adopted to develop the proposed controller. The proposed terminal sliding mode control is based on a new non-singular fast terminal sliding function, a continuous method (with an integral of a switching term), and an adaptive adjustment law. In comparison with other control methods, the suggested control method has the more capability to compensate dynamic uncertainties and external disturbances and higher accuracy to track the desired path. Finally, a position tracking computer simulation for a two link robot manipulator has been performed to confirm the effectiveness of the proposed method.

Keywords: Non-singular Fast Terminal Sliding Mode Control, a Class of Second-Order Nonlinear Systems, Adaptive Adjustment Law, Robotic Manipulator.

ID 18 Research on Electromagnet Motor for Hydraulic Valve

Guo Wenkang, Yin Yaobao, Lu Liang, Li Jing

Abstract: The reversing valve is developing in the direction of large flow, which requires it to have a large electromagnetic driving force, but there is a large attenuation in the present electromagnet moto r with displacement increasing. To solve this problem, this paper firstly analyses three typical electro magnet structures including solenoid electromagnet with flat armature, solenoid electromagnet with t apered armature and solenoid electromagnet with stepped armature and obtains their force-displacem ent characteristic curves. Solenoid electromagnet with flat armature which has poor mechanical prop erties is selected as the optimization object. By adding magnetic isolation ring, the magnetic circuit d istribution in the electromagnet is changed, and the mechanical properties of the electromagnet are ef fectively improved. The influence of the magnetic isolation ring under different parameters on the m echanical properties of the electromagnet is studied by simulation software. The results show that the proper position of the magnetic isolation ring and the magnetic separation angle can effectively impr ove the mechanical properties of the electromagnet, and the thickness of the magnetic isolation ring h as a certain influence on the value of output force.

Keywords: Electromagnet, Mechanical properties, Magnetic circuit analysis, Electromagnetic analysis, Structural optimization.

ID 20 **Influence of temperature on dynamic performance of electro-hydraulic reversing valve**

Yin Yaobao, He Chengpeng, Xie Shuaihu, Yuan Jiayang

Abstract: This paper studies the influence of extreme use temperature conditions on the dynamic characteristics of electro-hydraulic reversing valve. Multi-physics coupling mathematic model of the electro-hydraulic reversing valve is established. Parameters such as fit clearance in spool valve, electromagnet coil resistance, hydraulic oil viscosity and air gap length are calculated at three temperature (-40°C, 20°C, 80°C). And then simulate the mathematical model in MATLAB/Simulink software to acquire curves of coil current, ejector pin displacement, oil cavity pressure, and spool displacement varying with time. The simulation results show that at high temperature, the reversal time is shorter than at normal temperature while at low temperature, the reversal time is longer. The movement of spool is greatly affected by the viscous friction. Theoretical analyse results are consistent with practice.

Keywords: High temperature, Low temperature, Electro-hydraulic reversing control valve, dynamic characteristic, multi-physical field coupling.

ID 53 **A Gain Scheduling PID Controller for an Electrohydraulic Rotary Actuator**

Tri Cuong Do, Duc Thien Tran, Kyoung Kwan Ahn

Abstract: In this paper, a gain scheduling controller design technique is presented for position control of the electrohydraulic rotary actuator (EHRA) system under different working conditions. The proposed control combines PID control and LPV method. Firstly, PID controllers are designed at some specified conditions of EHRA system. Then, a gain scheduling law base on the LPV method is proposed to adjust the parameter of PID controller online. Some simulations and experiments are carried out by using co-simulation AMESim and Matlab and a real test bench. Finally, the results are compared to other controller to demonstrate the effectiveness of the proposed approach.

Keywords: Pump-controlled hydraulic system, Electro-hydraulic actuator, Gain scheduling PID, LPV.

Session 6: Smart Actuators 1

ID 07 **Development of a UV-curable PEDOT: PSS based flexible electro-rheological microvalve (FERV)**

Thapanun Sudhawiyangkul, Kazuhiro Yoshida, Sang In Eom, Joon-wan Kim

Abstract: This paper presents a UV-curable PEDOT: PSS based flexible electro-rheological microvalve (FERV). By using electro-rheological fluid (ERF), the FERV can control the flow rate and pressure inside the valve's flow channel by applying an electric field. The utilization of the UV-curable PEDOT: PSS offers short time fabrication processes without using a high-cost equipment. The FERV was designed and FEM simulation was conducted to demonstrate the bending stiffness of the FERV, which is corresponding to a 27 μm thick stainless steel cantilever. The FERV was successfully fabricated with 17×5×0.09 mm^3 in size. Then, the characteristics of the FERV were experimentally clarified. The results showed the possibility for utilization of the proposed FERV in soft microactuators.

Keywords: Soft actuator, Electro-rheological fluid (ERF), MEMS, ER valve.

ID 08 Modeling and Simulation of a 3-Stage Proportional Flow Control Valve

Haroon Ahmad Khan, So-Nam Yun

Abstract: This study investigates a throttling valve which consists of a proportional 3-stage actuation method with a mechanical feedback mechanism. The valve is to provide a certain amount of flow rate. The input is magnetic force of solenoid. Theory of fluid dynamics is utilized to build a mathematical model of the valve which is then solved using Simulink in time domain using ODE45 method. The response of the valve, obtained through Simulation, is discussed in this paper and then compared with the experimental value to validate the model.

Keywords: Flow control valve, valve dynamics, feedback mechanism, solenoid force, proportional control

ID 16 Fatigue Prediction and Structure Optimization of the Hydraulic Actuator

Yin Yaobao, Zhang Zhiheng, Yuan Jiayang

Abstract: The current hydraulic component structure becomes more complicated, and when it is widely used in high-pressure and high-flow working conditions, the stress concentration of the components such as holes and grooves will occur. Under the cyclic impact load, these weak parts with large concentrated stress will cause fatigue damage and affect the overall working characteristics of the components. Therefore, it is important to check the strength of the hydraulic components and calculate the fatigue life. In this paper, the finite element analysis method is used for checking the static pressure strength of a new hydraulic actuator with hole-in-wall structure, and the fatigue life under impact load cycle is obtained. Further, a structural optimization method using elliptical structure holes and increasing the radius of each chamfer is proposed. It is proved that the fatigue life of the optimized structural model under impact pressure cycle is significantly improved based on the calculation results. This method for checking the weak areas of hydraulic components and calculating its life provides theoretical basis for component structure optimization.

Keywords: Hydraulic actuator, Holes in wall, Structure optimization, Stress concentration, Fatigue prediction.

ID 54 A Study on the Wheelchair-Mounted Assistive System of the Vehicle Trunk

Young. Jae. Kim, Seong. Won. Choe, Na. Seon. Jun, Tae. Un. Kim, Yong. Suk. Kim, Soon. Yong, Yang

Abstract: For a long time, wheelchair users have been classified as People vulnerable to transportation. Nonetheless, the welfare or social system that helps them with their transportation has usually been limited to public facilities. as time goes by, Wheelchair users' their car penetration rate, as well as public transportation use, have also increased. However, there is a problem that they must have to put a wheelchair in the car to use the car. In the case of a sedan, the trunk is mainly used, but

it is difficult to load a wheelchair in the trunk without the help of others. To solve this problem, we develop a system for uploading wheelchairs in the trunk. and then we will study the means of transporting wheelchairs from the driver's seat to the trunk to complete a fully automated wheelchair upload system.

Keywords: Wheelchair-mounted Assistive system, Sedan trunk, Kinematic design, Controlled by Arduino.

Session 7: Advanced Mechatronics 4

ID 21 An Application of Cascade Neural Network for Compensation of Non-Geometric Errors in Industrial Robots

Phu-Nguyen Le, Hee-Jun Kang

Abstract: In order to enhance the accuracy of the robotic system being affected by some substantial non-geometric error sources, including friction, gear backlash, gear transmission, temperature variation. etc., the elimination of all these non-modelled errors is important as well as those of kinematic parameter errors. This paper proposes a hybrid method of the robot kinematic calibration and Cascade Neural Network compensation technique to improve robot positional accuracy. Following the scheme, the kinematic parameters are identified first by using the conventional robot kinematic calibration. Then, a Cascade Neural network is employed for further compensating for the robot residual position errors. Finally, an implementation is performed with Hyundai HH220 robot to demonstrate the effectiveness of the proposed method.

Keywords: Non-geometric error; robot manipulator; least squares method; Cascade Neural Network.

ID 25 Combining Homomorphic Filtering and Color Compensation for Underwater Image Enhancement

Chenggang Dai, Mingxing Lin, Xiaojian Wu, Dong Zhang, Zhiguang Guan

Abstract: – Underwater images suffer from poor visibility resulting from attenuation of propagated light, due to the absorption and scattering effects. Degraded underwater images show some limitations when they are used for analysis and display. Because the turbidity of water changes and underwater photographing depth of scene varies, the thickness of haze and color deviation of images captured underwater is various. Traditional defogging algorithms appear to be limited for such images with varying thickness of haze and color deviation. The combining homomorphic filtering and color compensation for underwater image enhancement is proposed to tackle this problem. First, the color compensation based on the bright channel is carried out on raw image to derive a color-compensated image. The raw image is then subjected to contrast stretching to obtain a clear image with high contrast by using the homomorphic filter. Finally, the multi-scale fusion strategy is adopted to fuse the color-corrected image and the contrast-stretched image to output a high-quality image. Qualitative and quantitative comparisons, as well as color recovery tests are conducted to evaluate performance of the proposed method. Our validation reveals that the algorithm proposed is characterized by a wider range of application for multiple underwater degraded images. Moreover, it can effectively improve contrast and restore color of underwater images without any prior information.

Keywords: Underwater image enhancement, Homomorphic filtering, Color compensation, Image fusion.

ID 26 A Boundary Control Scheme for Suppressing Vortex-Induced Vibrations of a Flexible Rod Transported in Water

Umer Hameed Shah, Keum-Shik Hong

Abstract: This paper presents a boundary control scheme for suppressing the vortex-induced vibrations of a flexible rod transported under water. Control actuation only at the top boundary of the rod is utilized in suppressing the vortex-induced vibrations of the rod under the influence of distributed hydrodynamic forces. The effectiveness of the proposed control scheme is demonstrated through simulation.

Keywords: Boundary control, Lyapunov stability, vortex-induced vibrations, hybrid ODE-PDE systems

ID 33 A Novel Modeless Robot Calibration Method for Improving the Positioning Accuracy in 3D Workspace Based on Neural Network and Hand-eye Vision

Chi-Tho Cao, Van-Phu Do, Byung-Ryong Lee

Abstract: In this research, we developed the method that improving the overall positioning accuracy of manipulator in working space without knowing about the actual kinematic model and base frame position of robot. A noncontact method using a single camera system attached to the end-effector robot arm is utilized for providing measurements of calibration pose in 3D space, and a neural network needs to build up mapping the desired and actual positions of the end-effector. By controlling the end-effector of robot moving to the working space, the errors of the end-effector are compensated directly. The results show that the positioning error of the robot arm is less than 0.02 mm, which verified the feasibility of the method. At the same time, because it was unnecessary for this method to know the transformation matrix from the robot base to the calibration plate, it reduced the complexity of the calibration model, which benefited to improve the calibration accuracy.

Keywords: Robot calibration, absolute accuracy, neural network Introduction.

ID 85 Conveyor-type Triboelectric Nanogenerator for Energy Harvesting

Chau-Duy LE, and Kyoung-Kwan AHN

Abstract: In this paper, a simple triboelectric nanogenerator (TENG) based on the mechanism of belt conveyor to convert mechanical energy into electrical energy is introduced. The two working modes of this TENG, single-electrode mode and attached-electrode mode, were analyzed and compared with the other. The maximum peak-to-peak open-circuit voltage for the single-electrode mode and attached-electrode mode can reach the value of 7.5 V and 12 V; corresponding to the maximum peak-to-peak short-current values of 0.8 μA and 1.2 μA.

Keywords: Triboelectric Generator, Single-electrode, Attached-electrode.

Session 8: Precision Measuring 1

ID 04 Five-point Error Separation Technique for Cylindricity

Wenwen Liu, Juensen Fu, Hongtao Wang, Shanlin Liu

Abstract: Five probes target three cross-sections of the cylinder and sense mixed errors in the fixed left and right as well as the middle cross-sections of the cylinder respectively. The spatial curved median line of the cylinder is accurately determined with the special model of error separation. A cylindrical profile conforming to the mathematical definition is reconstructed for exactly evaluating cylindricity. It is verified in theory that the spindle's radial and tilt error motions as well as the probe carriage's straightness error motions are all removed. This innovative technique has achieved full harmonic error separation and is suitable for in situ measurement and reconstruction of cylindrical profile.

Keywords: Error separation technique, Cylindricity, Shape error, Measurement, Reconstruction.

ID 13 Minimization of Spring-Back in L-bending Process of Oil Tempered Wire

Da-Woon Jo, Kwang-Hee Lee, Chul-Hee Lee

Abstract: Oil-tempered wire has a high tensile strength and is mainly used for high-precision mechanical springs. Mechanical springs sometimes require special shapes, therefore various machining methods are required. The L-bending process is a one of the manufacture method of springs with various shapes, and a high-precision manufacturing process is required to reduce defective assemblies. The spring-back phenomenon has the greatest influence on the accuracy of the manufacturing process. In this study three design parameters are analyzed to reduce the spring-back phenomenon and the error in the target angle, compared with the normal L-bending method, which only pushes the wire in the horizontal direction.

Keywords: L-bending, Oil tempered wire, Spring-back, Parametric analysis.

ID 19 A low-frequency accelerometer for micro-vibration

Zhenxin Chang, Ruijun Li, Yingjun Lei, Peng Xu, Zhenying Cheng, Kuangchao Fan

Abstract: A cantilever type low-frequency optical accelerometer based on DVD pickup head is proposed in this paper. The accelerometer is composed of a sensor, a cantilever type spring and a signal processing system. The sensor is modified from DVD pickup head. An elastic cantilever type spring is used to sense the vibration, which is analyzed and optimized using ANSYS software. The optimal parameters of the structure design were thus obtained. To validate the performance of the optical accelerometer, a high-precision eddy current sensor with resolution of 0.07nm is used as a

standard for calibration. The experimental results showed that the accelerometer has a sensitivity of 9.2613 V/g and the measuring range of 3 ~ 10 Hz.

Keywords: Micro-vibration, Low frequency, Elastic cantilever, DVD pick-up head, Low cost.

ID 29 **Frequency response function measurements utilizing the radial excitation force generated by a built-in motor**

Ren YANG, Wataru TSUNODA, Dong HAN, Tadahiko SHINSHI

Abstract: In order to improve the long-term reliability, stability, and durability of rotating systems, we propose a condition monitoring method using a built-in motor. We verified the efficacy of this method which utilizes a radial excitation force generated by motor windings to enable the frequency response function (FRF) to be measured from the displacement of the rotor. The test rig which has a bearingless motor (BELM) can simulate the various dynamic characteristics of a rotor system with static eccentricity. We compare the FRF measured utilizing excitation by the motor windings of the BELM with the FRF measured using the suspension windings to prove the feasibility of the proposed method.

Keywords: Condition monitoring, Frequency response function, Motor winding, Static eccentricity, Radial excitation force, Bearingless motor.

ID 87 **Experimental Study on the Influence of Working Media on the Performance of Axis Piston Pump**

Yinshui Liu, Hao Pang, Yipan Deng, Defa Wu

Abstract: With the development of water hydraulic technology, water hydraulic axis piston pump (WHAPP), as a power source, become more and more important. WHAPP utilizes water as working media and all the friction pairs are lubricated by water. As we all known, there are great influence of working media on pump performance. However, few literatures investigated the effect of using water and mineral oil as working media on pump performance. In comparison with oil hydraulic axis piston pump (OHAPP) at same operating condition, the performance of WHAPP and OHAPP is quite different, mainly in the flow, efficiency, noise and vibration. In order to research the performance of axis piston pump, this paper experimentally researches the characteristics of pressure, flow, efficiency, noise and vibration of a water hydraulic axis piston pump using water and mineral oil as working media. Measurements of pressure ripple, pump efficiency, noise and vibration are carried out at various outlet pressure. The reasons for the difference in performance of pump using water and mineral oil as working media are analyzed. The experiment results show that the flow of the pump is rarely different, but the pressure ripple, efficiency, noise and vibration are quite different.

Keywords: Water hydraulic, oil hydraulic, Axis piston pump, Noise, Vibration, Pressure ripple.

Session 9: Advanced Mechatronics 5

ID 05 **Development of a Printer with a Fixed Head and Motion Stage Using the Tripod Parallel Mechanism**

Natsumi Hosoda, Yutaka Tanaka

Abstract: This study aims to develop a system for printing on three-dimensional (3D) surfaces with a small installation area and high work efficiency. One of the solutions for the motion stage of such printers is the tripod parallel mechanism, comprising three legs translating on the ground. Furthermore, the rotational set-up of this mechanism has a large motion space and great tilt angles. Herein, a prototype printer based on the tripod parallel mechanism with rotary and linear actuators is designed and fabricated. The object to be printed is placed on the motion stage of the tripod and the printer head is fixed over it. A control system for the six actuators of the motion stage also developed. The motion paths of the actuators are calculated via the MATLAB/Simulink and SimMechanics block model of the tripod parallel mechanism using inverse kinematics. Finally, the capability of the proposed system to accurately print figures on inclined and curved surfaces is experimentally verified.

Keywords: Parallel mechanism, Printer, Fixed printer head, Inverse kinematics

ID 36 **A Study on Singularity Prediction of Robot Manipulator**

Seong Youb Chung, Han Sol Kang, Hyun Joong Yoon, Myun Joong Hwang

Abstract: When the robot manipulator is applied to the manipulation work and performs task space motion in various areas, it is necessary to predict and to avoid the kinematic singularity for stable operation. The unintended fast joint movement can happen when the robot configuration is near the singularity posture. In this paper, we propose a simple method to check the possibility of approaching singularity configuration before executing motion in 6-DOF manipulator.

Keywords: Kinematic singularity, Jacobian, Manipulator.

ID 38 **Neural Network Sliding Mode control for 3-DOF manipulator**

Hoai Vu Anh Truong, DucThien Tran, Kyoung Kwan Ahn

Abstract: The manipulator, in most cases, work in not well-known and changeable conditions. With the large external variations, the demand for stability and robustness must be ensured. This paper proposes a new-trial Neural Network sliding mode control (NNSMC) to cope with uncertainties and improve the behavior of the robotic manipulator in the presence of the external payload. The proposed method is applied to the 3 Degree of freedom (DOF) manipulator. Some comparisons between the conventional and the proposed algorithm are given to prove that the designed control can achieve a higher accuracy in tracking motion.

Keywords: Sliding mode control, Neural Network, Robotic Manipulator.

ID 39 **A Study on Hydraulic System Simulation of Small Hydraulic Crane**

for Marine Engine Room

Seong Woong Choi, Dong Wook Joo, Chan Se Jeong, Sang Hoon Lee, Soon Yong Yang

Abstract: In Marine engine room, there are many works to carry small equipment for maintenance. Mainly use lifting lugs to transport small equipment in a narrow Marine's engine room. However, in the case of lifting lugs, operators must install and dismantle them manually. This often causes safety accidents. To prevent such accidents, we developed a small hydraulic crane for transporting small equipment in a narrow Marine engine room. In this paper, a hydraulic circuit and a simulation model of a small crane are designed and simulated using SimulationX. Simulation results confirm the hydraulic characteristics of hydraulic cylinders of small crane.

Keywords: Marine Engine Room, Hydraulic Crane, Hydraulic System, Hydraulic Simulation, SimulationX.

Session 10: Construction Machine 1

ID 51 **Research on Energy Saving of an Electric Forklift System**

Ying Xiao Yu, Kyoung Kwan Ahn

Abstract: This paper proposes a novel hydraulic hybrid forklift for energy saving. The hydraulic accumulator is used in the system to store the potential energy. Then the energy could be reused in the next cycle of work. The maximum energy saving efficiency could reach to 56%. The system could save much energy with low cost.

Keywords: Energy saving, System performance and Control strategy.

ID 80 **A design of potential energy saving system with accumulator on mobile crane**

Hwang Hun Jeong, Jong Il Yoon, Ji Hwan Lee, Sechang Park and Dong Jin Seo

Abstract: The heavy equipment is a system that needs more equipment's operating cost than its purchase price. And energy saving method was researched in this equipment to reduce the operating cost with saving potential energy or improvement on hydraulic system. A mobile crane is one of the heavy equipment and this mobile crane's purpose is carrying a heavy burden. In this case, a potential energy on burden was wasted into the air.

This study tries to save a potential energy on mobile crane and to improve its fuel efficiency. For this purpose, firstly, hydraulic circuit of energy saving system was designed. And then, specifications of main part were selected by calculations. Finally, potential energy saving system was verified by experiment.

Keywords: Mobile Crane, Potential Energy Saving System, Accumulator, Energy Efficiency.

ID 81 **Flow Characteristics of Safety Valve According to Opening Displacement of Valve**

Kyongjun Lee, Sang-Won Ji

Abstract: Safety valve are widely used to protect people and equipment in various fields. Especially, the demand for hydrogen supply safety valves for automobile hydrogen stations has been further increasing. Since the hydrogen supply safety valve operates at very high pressures, it is essential to understand the flow characteristics inside the valve for proper control. In this regard, the present study conducted the flow analysis by using ANSYS CFX to understand the flow characteristics and the flow force according to the displacement of the poppet inside the valve. This study is expected to provide important information that will be useful for designing high pressure safety valve.

Keywords: Safety Valve, CFD, Flow-induced Forces, Pressure Drop

ID 82 Analysis of Structural Safety of the Reducer for a Large Scale Crane Using the Finite Element Analysis

Se-Chang Park, Jong-Il Yoon, Myeong-Cheol Kang, and Hyunah Lee

Abstract: The hydraulic winch unit of a large scale crane is constructed with a hydraulic motor and a speed reducer. The reducer consists of various gears. The purpose of this research is to verify the structural safety of the components in the reducer based on the finite element method. For this, the power flow in the hydraulic winch unit is investigated and the force and torque interacted with the components are calculated. These force and torque are applied as the external loading conditions when the structural analysis is performed with the components of the reducer.

Keywords: Reducer, Winch unit, Structural analysis, Finite element method, Safety factor

Session 11: Renewable Energy 1

ID 28 New Approach of PMSG-based Wind Turbine Control Using Advanced Hybrid Fuzzy Model Reference Control

Cao Van Kien, Ho Pham Huy Anh, Truong Quoc Thanh, Pham Quoc Khanh

Abstract: This paper proposes an advanced hybrid control technique in the field oriented scheme to control the machine side converter (MSC) of PMSG-based wind turbine. This type of control uses a Fuzzy Logic Control FLC in current and speed circuit to improve the rotor speed variation during variable wind speed. At the same time, setting values of rotor speed and direct axis current are also adjusted to satisfy the principle of maximum capturing power from the wind and maximum torque at low current during nonlinear PMSG based wind turbine operation. Eventually further improvement has been made using a combination of Fuzzy Logic Control FLC with model reference MRAS to obtain Advanced Fuzzy Model Reference Control AFMRC which addressed as a novel control scheme to improve the performance of uncertain nonlinear PMSG-based wind turbine system.

Keywords: PMSG-based wind turbine, Field-Oriented Control (FOC), Fuzzy Logic Control FLC, model reference MRAS control, Advanced Fuzzy Model Reference Control AFMRC, machine side converter (MSC) control.

ID 44 Heat transfer and friction factor correlations for a novel solar air heater

Nguyen Minh Phu, Phan Ha Nhu Ngoc, Ngo Thien Tu, Phan Thi Thanh Huong

Abstract: The paper presents the effect of Reynolds number, relative roughness height and relative roughness pitch on heat transfer and pressure loss in a solar air heater. The novel absorber plate having metal shavings from turning a steel shaft is employed to reduce the cost of production and be available in the manufacturing industry. The parameters studied ranged from 5000 to 25000 for Reynolds number, relative roughness pitch (P/e) from 4.7 to 9.4 and relative roughness height (e/D_h) from 0.63 to 0.8. The results show that there are some characteristics that are different from the published studies. The optimum e/D_h is 0.72 to get the highest thermo-hydraulic parameter and the parameter increases with decrease in P/e. Within the scope of the study, the maximum thermo-hydraulic parameter is approximately 1.5. The correlations of Nusselt number and friction factor are developed based on experimental data. Results from the correlations and from the experimental data are fairly in agreement.

Keywords: Heat transfer enhancement, Solar air heater, Artificial roughness, Metal shavings.

ID 55 **Experimental investigation on variable-pitch Darrieus hydrokinetic turbine in water pipe channel**

Jin Hwan Ko

Abstract: In this study, a variable-pitch Darrieus turbine with slot structures is developed, fabricated and experimented in a water pipe channel. It is shown from the experiments that the variable-pitch Darrieus turbine increases the mechanical power efficiency as well as lessens the blockage effect as compared to the fixed-pitch Darrieus turbine.

Keywords: Darrieus hydrokinetic turbine, Variable-pitch, Water pipe channel, Experiment.

ID 67 **Supplementary Inertia Control of a Wave Energy Converter with Mechanical PTO**

Tri Dung DANG, Minh Tri NGUYEN, Cong Binh PHAN, Kyoung Kwan AHN

Abstract: This paper proposed a new method to achieve the resonant behavior of a point absorber floating buoy type of Wave Energy Converter (WEC) system. By using the inertia characteristic of a hydraulic flywheel-accumulator to change the corresponding supplementary mass of the floating buoy, the total mass of the buoy is near to match the relatively low frequency of the wave, so that the buoy is at resonance with the wave. The specification of the hydraulic flywheel-accumulator system is proposed and studied. The working principle is analyzed. The mathematical model is then derived in order to investigate the operation. Numerical simulation using Matlab/Simulink has been done to evaluate the operation of the system.

Keywords: Floating buoy, Resonance, Hydraulic flywheel-accumulator.

Session 12: Advanced Mechatronics 6

ID 56 *(Invited paper)* **Study on the small size LVDT sensor**

Dongown Yun

Abstract: In this study, LVDT sensor widely used as a displacement sensor was studied. The LVDT sensor is basically a displacement sensor that operates on the same principle as a transformer. The LVDT sensor is a sensor whose characteristics are determined by the electromagnetic field generated around the coil and the core. Therefore, since the performance of the sensor varies depending on the characteristics of the coil, the applied current, and the core, accurate analysis results can be obtained by considering all of them when analysis is conducted. In this paper, we analyze the LVDT sensor with the desired performance considering these various factors.

Keywords: LVDT, sensor, displacemen, FEM.

ID 75 **A Design Concept and Operation Mechanism for a Cleaning Tool of a Window Cleaning Device**

Kyoon-Tai Kim, Young-Hun Jun

Abstract: Most of the conventional cleaning devices attached to an exterior window have a wiper, which needs water to perform cleaning. However, to provide water, a water supply facility must be prepared on the side of a building, which may be at risk of freezing and bursting during winter, as well as being associated with an increased construction cost. The alternative is to equip the cleaning device with a water tank, increasing its weight. In either case, providing water becomes a limitation. To overcome this limitation, a design concept of a cleaning device using rain water is derived, and its operation mechanism is presented. The performance of the cleaning tool presented in this study will be analyzed through a simulation and a mock-up test.

Keywords: Construction Automation, Window Cleaning, Cleaning Robot, Maintenance, Cleaning Tool.

ID 61 **A Study on the Development of a Dual Arm Humanoid Robot**

Dakarimov Sayat, Le Quang Hoan, Seonjun Na, Hyung Gyu Park, Soonyong Yang

Abstract: Using open source at inmoov site and 3D printer humanoid robot was made. The hardware was designed using a servo motor and angle sensor. The mathematical modeling of Kinematics and Inverse Kinematics theory was made in MatLab. Controller for robotic arms with 5-DOF was designed and the control system was implemented using Arduino. Kinematics and Inverse Kinematics were used to set the path for robotic arms in MatLab. As a result, the experiment confirmed whether a real person's actions could be reproduced.

Keywords: 3D Printer, Humanoid, Robot, Dual Arm, Manipulator

ID 69 **Design and simulation of Guinea fowl jumping robot**

Myeong-Jin Kim, Dongwon Yun

Abstract: The limb structure of the Guinea fowl was analyzed to make the leg of the jumping robot and the mechanism for transmitting the force was suggested. In addition, the jumping test was conducted through the dynamic simulation, and the jump height of jumping robot was 15.5cm.

Keywords: Limb angle, Linkage structure, Power transfer structure, Jumping simulation

ID 70 **Soft Robotic Gripper with Triple Chambers**

Khulan Batsuren, Dongwon Yun

Abstract: In this paper, a novel soft robotic gripper design is presented, with three soft bending fingers. Each finger has three chambers, which are located asymmetric along the central axis of finger. With novel soft robotic finger design, we can achieve a wide range of positions by inflating each chamber. We conduct a simulation using ANSYS Workbench software, considering material properties and environment condition. Also, the reliable control for the gripper is presented. The data from simulation and experimental data are compared, showing that experimental result is higher than analytical model's result a little bit. Also, we can see that according to novel design, each chamber has different performance.

Keywords: Soft robotics, Pneumatic control

ID 71 **Analysis of Electromagnetic Actuator for Hot Embossing Process**

Jaewon Ahn, Dongwon Yun

Abstract: Existing hot embossing techniques have shortcomings in changing pattern. For availability of changing pattern, impact-type hot embossing processing is suggested. To design the actuator for this process, analysis of electromagnetic actuator is needed. To analyze the actuator, modeling on mechanical field and electrical field was studied, and after that, Simulink program is used for simulating the system that is derived.

Keywords: Hot embossing, Electromagnetic Actuator.

Session 13: Smart Actuator 2

ID 35 *(Invited paper)* **Mathematical Modeling and Analysis of a Flexure-based Bridge-type Piezo Amplifier**

Kee-Bong Choi, JaeJong Lee, GeeHong Kim, HyungJun Lim, SoonGeun Kwon, Sang-Chul Le

Abstract: In this paper, a mathematical model for bridge-type piezo amplifier was proposed. The mathematical model was expressed by an equivalent stiffness and mass based on matrix equation. The characteristics of the mechanism were analyzed using the mathematical model. The proposed mathematical model was verified by FEM.

Keywords: Bridge-type flexure mechanism, Flexure hinge, amplification mechanism, Piezo actuator, Equation of motion.

ID 17 **Structure Optimization of First Stage in a Deflector Jet Servo Valve**

Yin Yaobao, Li Shuanglu, Wang Yu

Abstract: The deflector with V-shaped groove of a deflector jet servovalve has low energy utilization efficiency and limited load capacity. In order to solve these problems, the deflector with a funnel shaped groove is proposed, and the first stage's pressure characteristic and flow characteristic under different structure parameters are analyzed by using the finite element method. The simulation results show that the optimized funnel shaped groove restrict the jet flow, enhance the energy utilization, so that it can effectively improve the load pressure and recovery flow, improve the performance of the first stage. The cone angle funnel shaped groove has a significant effect on first stage than the width. This basic study is important for improving the performance of servo valves.

Keywords: Deflector jet servo valve, First stage, Funnel shaped groove, Load pressure, Recovery flow.

ID 23 Two-DOF MEMS Actuator Employing Microball-bearings and a Multi-pole Permanent Magnet

Dong HAN, Noriei AZUMA, Tadahiko SHINSHI, Kenichi SUZUKI

Abstract: In this paper, we propose a novel micro electromagnetic actuator to be used as an optical image stabilizer in cell phone cameras. Stacked multi-layer microball bearings offers stable support for a multi-pole permanent magnet in the non-driving direction and enable it to be guided to realize two-DOF in-plane motion. Each layer of the Si guideway plate was fabricated by anisotropic chemical etching and deep dry etching. Micro coils were processed on each side of a silicon substrate by anisotropic chemical etching and screen printing. In the driving experiments, two-DOF in-plane motion of the proposed micro actuator was verified.

Keywords: MEMS, Electromagnetic actuator, Multi-layer Microball bearing, Multi-pole permanent magnet.

ID 42 Fundamental Investigation into the Use of Cryogenic Double-Insulation Bellows in LNG Bunkering

Min-Soo Kwon, Chang-Myung Seo, Sung-Cheol Jang, Hyoen-Chul Jeong, Jeong-Pil Eom, Jung-Ho Park

Abstract: When STS LNG bunkering is performed, the fuel is supplied at an extremely low temperature of -162℃, which stiffens the installations and results in fatigue accumulation and failure of the flexible hose. Accordingly, consideration of the height difference between the vessels and waves involved in or affecting STS bunkering requires that safety concerns such as fatigue failure of the flexible hose be addressed. Thus, structural analysis was conducted in this study to improve the problems related to deformation and fatigue failure, which are attributable to the waves and a height difference between vessels during STS bunkering operation. Additionally, a fundamental experiment was conducted to examine the cryogenic insulation performance of double bellows.

Keywords: STS LNG bunkering, Structural Analysis, Cryogenic Insulation Performance

ID 47 **Temperature Insensitive Electrostrictive Coefficient in Lead-Free Bi-Based Piezoelectric Ceramics**

Jae-Shin Lee, Hyoung-Su Han

Abstract: The electric field-induced strain (EFIS) properties of $Bi_{1/2}(Na_{0.82}K_{0.18})_{1/2}TiO_3$ (BNKT) ceramics modified with $BaZrO_3$ (BZ) were investigated as a function of composition and temperature. Unmodified BNKT ceramics revealed a typical ferroelectric butterfly-shaped bipolar S–E loop at room temperature, whose normalized strain (S_{max}/E_{max}) showed a significant temperature coefficient of 0.38 pm/V/K. However, 5 mol% BZ-modified BNKT ceramics showed a typical electrostrictive behavior with a thermally stable electrostrictive coefficient (Q_{33}) of 0.025 m^4/C^2, which is comparable to that of $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN) ceramics that have been primarily used as Pb-based electrostrictive materials.

Keywords: Lead-free piezoelectric, Actuator, Ferroelectric, Perovskite compound.

ID 40 **Dual characteristic BNO-SPI-TENGs for robust contact electrification by vertical contact separation mode through ion and electron charge transfer**

Ravi KumarCheedarala, Chau Duy Le, Kyoung KwanAhn

Abstract: Contact-electrification is a conventional triboelectrification technique for generating current through charge transfer when two different polarized materials are brought into contact. For the first time, in-built alternate hydrophilic and hydrophobic nano channels were developed where both ionic and electronic charge transfer mechanisms were realized through contact separation mode between BNO-SPI films and PTFE. In this paper, we examined the dynamic interaction between these materials and observed adequate output performance. The novel BNO-SPI-TENGs (i.e. SO3H.BNO-SPI-TENG, SO3Li.BNO-SPI-TENG, and SO3H.TEA.BNO-SPI-TENG) produced 75 V and 1 µA, 43 V and 0.6 µA, and 9 V and 0.13 µA of open-circuit voltages (Voc) and short-circuit currents (Jsc) at 6 Hz, respectively. Particularly, the SO3H-BNO-SPI was dramatically boosted up the performance of TENG, up to 733% of Voc and 669% of Jsc, with respect to the SO3H.TEA-BNO-SPI because the mobility of H+ ions is very high on the device surface compared to the other two Li+ and TEA bulky ions. The developed dual characteristic BNO-SPI-TENGs are very good candidates for fulfilling the need for alternate contact separation mode TENGs

Keywords: Sulfonated polyimides, Contact-electrification, BNO-SPI-TENGs, Ion transfer mechanis m, Nnano channels.

Session 14: Precision Measuring 2 & Renewable Energy 2

ID 83 *(Invited paper)* **Electrohydrodynamic Jet Nanoprinting and Nanodevices**

Xiaojun Zhao, Dazhi Wang, Kai Li, Xudong Kang

Abstract: Controlled patterning of nanostructures at desired positions is of great importance for high-performance M/NEMS devices. Here, we demonstrate a high-resolution, high-speed and cost-effective fabrication method, named coaxial focused electrohydrodynamic jet nanoprinting, to print functional nanostructures. A coaxial needle was designed and developed; a functional ink and high viscosity

liquid are applied in the inner and outer needle, respectively. Under optimised conditions, a stable coaxial jet is formed; then, the electrical shearing force and electrical field induce viscous shearing force and internal pressure that are jointly applied on the inner functional ink, focusing the inner jet on the nanoscale. Using this stable coaxial jet with a nano-jet inside it, nanostructures with highly aligned nanowire arrays, nano-freebeams and nano-cantilever beams down to the scale of 40 nm were directly printed. The needle size was 130 μm, and the ratio of the sizes of the needle and the printed structure was as high as 3250/1. This technique realizes the controllable printing of nanoscale structures with the use of a one hundred micrometer-sized needle. The printed PZT nanostructures exhibit pure perovskite structures and distinct piezoelectric responses

Keywords: Coaxial focused electrohydrodynamic jet, printing, PZT, nanowire, nanobeam.

ID 30 Embedded Hall Sensors for Two-Degree of Freedom Spherical Joint Angle Sensing

Hu Penghao, Dang Xueming, Hu Yi, Liu Shanlin

Abstract: Precision spherical joints are widely employed in parallel mechanisms, but its rotation orientation and angle can not be known in its passive motion. Measurement of multi-dimensional angular displacement will be very of great significance in the prediction, feedback and control of motion errors of parallel mechanism. Based on the magnetic effect, a new method to identify the orientation and rotation angle with Hall sensors array matched by permanent magnet is proposed. The basic idea is embedding a permanent magnet(PM) in the ball head and several hall sensors are distributed in the ball socket. When the ball head carrying the permanent magnet rotates together, the Hall sensors array will detect the variation of magnetic induction intensity, and then the angle can be calculated by mathematics model. An embedded prototype is developed after finishing the theoretical modeling, simulation calculation and feasibility experiment, the real-time measurement of the spherical hinge rotation angle has been realized and improved by optimizing the inverse algorithm and the signal redundancy calculation**.** The experiment results indicated that the average error of single axis is about 0.21°in the range of ±10°, and the average error is about 0.39°in ±20°. The main error source has been smelled out from the experiment data, and a new way to further improve performance of the spherical joint has been found. The measuring accuracy is very likely to reach or exceed 15" in nearly future, which will be helpful for the measuring method to apply in the precision engineering.

Keywords: Hall sensor, Angle measurement, Spherical joint.

ID 59 Deformation of The Material During Bending in Cold-Stamping Method

Hoang Quoc Hung, Luu Thanh Tung

Abstract: Today sheet-metal forming technology is widely used in the mechanical industry, which requires a very high precision of the product. Especially the bending process, the bend-allowance calculations are important to achieving the finished products. The bend allowance refers to the elongation of the sheet during bending. Therefore, it is necessary to have an algorithm to accurately predict this factor. Any inaccurate calculation can lead to an incorrect development of the length of the sheet. In this paper, the method to determine the bend allowance within acceptable accuracy during bending process with different kind of materials.

Keywords: Bend allowance, Neutral fiber, Unstretched fiber.

ID 79 Tribological Characteristics of Cobalt-chromium-molybdenum Alloy

Ngoc-Phat Huynh, Tuan-Em Le, Koo-Hyun Chung

Abstract: A cobalt-chromium-molybdenum alloy exhibits remarkable wear resistance. In this work, friction and wear characteristics of cobalt-chromium-molybdenum alloy were quantitatively assessed by using pin-on-reciprocating tribo-tester. The result of this work is expected to be helpful to expand application of a cobalt-chromium-molybdenum alloy as wear resistant materials.

Keywords: Dry lubrication, pin-on-reciprocation tribo-tester, Cobalt-chromium-molybdenum alloy.

ID 73 Harvesting of Eco-energy through a Silicone-Pipe Fluid Triboelectric Nanogenerator

Quang Tan NGUYEN, Ravi Kumar CHEEDARALA, Kyoung Kwan AHN

Abstract: Fluid TENGs are the very important field of energy harvesting technologies to provide the high amount of voltage and currents. For the first time, we used a flow type eco-friendly technique through a flexible silicone pipe for generation of constant voltage and currents at ambient conditions. For that, we used a molecularly engineered super-hydrophobic Teflon (shTeflon) surface, bottled drinking water (BDw) and DI water (DI) as liquid reservoirs to effectively convert mechanical energy into electrical energy. Here, commercial pristine nanoporous Teflon (pTeflon) was used as a control electrode material. Readily available commercial acrylic thinner that contains PMMA spacer is deposited on pTeflon to generate shTeflon. Higher open-circuit voltage (Voc) and short-circuit current (Isc) were achieved from shTef-flowTENGs over pTef-flowTENGs due to the presence of dissolved mineral salts (i.e. Na+, Mg2+, and Ca2+) in BDw than DI those are playing the critical role for enhancing of Voc and Isc. The experimental results were confirmed that the generated output peak-to-peak Voc and Isc are 13V and 883nA from BDw-shTef-flowTENG and 9.9V and 848nA for BDw-pTef-flowTENG, respectively. The BDw-shTef-flowTENG attributed the higher output Voc of ~58% than that of DI-pTef-flowTENG, which verifies the pivotal role of superhydrophobicity in water-based TENGs.

Keywords: Green-energy, Bottled Drinking water (BDw), DI water (DIw), pristine nanoporous Teflon (pTeflon), superhydrophobic Teflon (shTeflon), flowTENG.

ID 76 Using Minimum Quantity Lubrication to consideration of Tool Wear and Surface Roughness in Turning C45 Steel

Jong Il Yoon, Tran Trong Quyet, Ho Triet Hung, Tran Nguyen Duy Phuong, Truong Quoc Thanh

Abstract: In metal cutting process, the effects of cutting fluids to health, environment, productivity and quality in machining operations have been discussed. Effects of Minimum Quantity Lubrication (MQL) are green technology which is gradually applied in mechanical processing. This paper presents of the MQL parameters optimization approach in which the multi-response outputs based on Taguchi's

L9 orthogonal array method is used. During the turning C45 steel, the cutting temperature, the maximum of tool wear, and the surface roughness were measured. The MQL parameters which are ratio of soluble lubricant and water, pressure of spray head, flow volume of emulsion were simultaneously optimized by taking the multi-response outputs using Taguchi based Grey Relational Analysis (GRA) into consideration. Here, three mathematical models were created using response surface regression methodology. The experiments had been done to investigate the effect of the MQL parameters to the turning process. As the results, the set of optimal MQL parameters had been pointed out to simultaneously minimize the cutting temperature, the tool wear and surface roughness.

Keywords: Minimum Quantity Lubrication (MQL), temperature cutting, tool wear, surface roughness, Grey Relational Analysis (GRA)

Session 15: MEMS/NEMS 1

ID 11 Bionic Microsuction Cup Actuator Using Functional Fluid Power

Eishun NAKAMURA, Yutaka TANAKA, Taku KINJO, Kazuya EDAMURA, Shinichi YOKOTA

Abstract: Microrobots have gained considerable attention in various fields involving rescue robots, inspection robots, and medical robots because microrobots exhibit an ability to access considerably narrow spaces. Several studies have focused on biomimetic or soft actuators for microrobots; these actuators can mimic natural creatures because they contain functional locomotion systems. Electro-conjugate fluid (ECF) is a kind of functional fluid that produces a jet flow when a high DC voltage is applied to a pair of electrodes dipped in this fluid. In this study, we propose a novel microsuction cup actuator having a flexible rubber film and sucker that is driven by the ECF jet flow between electrodes. The small ECF flow generator for the fluid power source is fabricated and integrated into the microsuction cup actuator. The actuator mechanism imitated the adhesive mechanism of an octopus sucker. We verify the adhesive mechanism by fabricating a 2.4 g prototype that is 23.7 mm long and 11 mm wide. The proposed actuator can be useful for performing noninvasive surgeries and drug deliveries.

Keywords: Biomimetic, Electro-conjugate fluid, Functional fluid, Octopus, Soft actuator, Sucker.

ID 58 Proposal on manipulating droplets by a cantilever check valve operated by an ECF micropump

Zebing Mao, Kazuhiro Yoshida, Joon-wan Kim

Abstract: For manipulating droplets in the microfluidics (such as trapping, sorting or selecting), rubber-based membranes are widely utilized and operated by pneumatic power sources. However, this manipulation system has limitations of miniaturization due to a bulky air compressor external to the micro devices and those of easily-swelled material like PDMS. Aiming to overcome these limitations, we propose to operate a cantilever by using an ECF (electro-conjugated fluid) micropump for manipulating water-based droplets inside oil. Compared with the air compressors, the ECF micropumps composed of tiny electrode pairs can be easily integrated in the microfluidic devices. Instead of PDMS, epoxy-based photoresist (SU-8) is utilized to form a cantilever and microfluidic

channels. We fabricate a fully-overlapped cantilever check valve and an ECF micropump on a chip and investigate the performance of this system.

Keywords: ECF micropump, droplets, cantilever check valve.

ID 60 Proposal on an effective removing method of micromolds in UV-LIGA by combining CO_2 laser engraving with O_2/CF_4 plasma etching

Dong Han, Kazuhiro Yoshida, Joon-wan Kim

Abstract: SU-8 micromolds are preferable for high-aspect-ratio metallic microstructures by UV-LIGA, but their difficult removal remains a critical issue. To solve this problem, we propose a novel removing method to combine CO2 laser engraving with O2/CF4 plasma etching. The CO2 laser engraving is utilized as the main process to remove most of SU-8, while the O2/CF4 plasma is adopted as the post-treatment to remove rest of SU-8 on the surface. We fabricated the grating microstructures with different widths and successfully realized its maximum aspect ratio of five. This achievement verified the fast, non-swelling and complete removal of SU-8 for high-aspect-ratio microstructures.

Keywords: UV-LIGA, SU-8 removal, CO2 laser engraving, high aspect ratio.

ID 68 Study of superhydrophobic aluminium alloy surface fabricated by laser texturing and post-process

Ji-Hun Kim, Doo-Man Chun

Abstract: Fabrication of superhydrophobic metal surfaces by laser texturing and post-process has been developed. After laser texturing, the metal sample needed chemical coating or aging for relatively long period of time at ambient air to achieve superhydrophobicity. Simple heat treatment could promote wettability transition from hydrophilic to superhydrophobic without using additional chemical treatment. In this study, a grid pattern was fabricated on aluminum alloy by UV nanosecond pulsed laser and then an additional heat treatment at 200℃ for 6 hours was applied. The fabricated aluminum samples showed superhydrophobicity with contact angles greater than 150° and slip angles less than 10

Keywords: Superhydrophobic surface, Aluminium alloy, Laser texturing, Post-process.

ID 62 Development of Au-ITO composite wiring for the back UV-LIGA

M. Ogawa1, K. Yoshida, J.-w. Kim

Abstract: In this paper, we propose and develop a novel Au-ITO composite wiring for the multilayer UV-LIGA process with back UV exposure (called as the back UV-LIGA). Thanks to the self-alignment of back UV exposure, it was reported that the back UV-LIGA is effective to get high-aspect-

ratio microstructures. The back UV-LIGA requires UV transparent electrodes for wiring. However, there have been no adequate materials for this purpose due to the high resistance of transparent indium tin oxide (ITO) and non-transparency of metals. To solve this problem, we propose a novel method to form a UV transparent wiring with low electrical resistance by combining transparent ITO with thin gold (Au) lines for the back UV-LIGA. We successfully form Au-ITO composite wiring on the glass wafer by using MEMS fabrication. It was confirmed that the electric resistance of the Au-ITO composite wiring is 63% smaller than that of the only ITO wiring.

Keywords: HARM (high aspect ratio micromachining), back UV exposure, UV-LIGA.

ID 57 **Single electrode mode flexible silicone tubing Flu-TENG with micro-porous PVDF membrane for harvesting water stream energy**

M.Shahriar, Ravi Kumar Cheedarala, Kyoung Kwan Ahn

Abstract: Harvesting ambient mechanical energy from water through the triboelectric effect is environmentally friendly. Scavenging electrical energy from a continuous stream of water flowing through a flexible silicone tube is a unique technique for cost-effective nano-scale power generation. This work presents a triboelectric nano-generator based on flow contact electrification with a micro-porous PVDF membrane as (a tribo-material) an electrode and water stream through a silicone tube (fP-TENG). The efficiency of the fP-TENG was evaluated using deionized water (fP.DIw-TENG), tap water (fP.Tw-TENG) as reservoirs. The open-circuit voltage (Voc) and short-circuit currents (Isc) are superior in fP.Tw-TENG, in particular, the maximum peak to peak values of Voc and Isc are 48.8 V and 3.1 μA, respectively, over DIw-TENG. The fP.Tw-TENG shows greater efficiency than fP.DIw-TENG, due to presence of dissolved free mobile ions which can enhance the power output.

Keywords: fP.TENG, PVDF membrane, DIw water, Open circuit voltage, short circuit current.

Session 16: Production System & Sustainable Automotive 2

ID 24 *(Invited paper)* **Response Characteristics of Proportional Valve for Pressure Reducing Control**

So-Nam Yun, Young-Bog Ham, Jung-Ho Park, Yoshito Tanaka

Abstract: In this study, an electro-hydraulic pressure reducing (hereinafter EPPR) valve for an independent metering valve (hereinafter IMV) system of the excavator which consists with a proportional solenoid actuator, a sleeve and a spool actuator which also has a different spool land diameter for controlling the second pressure. An electro-magnetic forces characteristics and step response variations are discussed through the experiment.

Keywords: Electro-hydraulic Pressure Reducing Valve, Independent Metering Valve, Spool Actuator, Electro-magnetic.

ID 03 **Design of Auto-Loading Sequence Circuit for Compressed Gas Needle Free Injector**

Mojiz Abbas Trimzi, Young-Bog Ham, Byeung-Cheol An, Jung-Ho Park, Kwang-Nyeong Lee, So-Nam Yun

Abstract: Needle-free drug delivery can be realized using the principle of jet injection, whereby a liquid drug is pressurized and accelerated through a small orifice, creating a narrow, high-speed fluid jet of sufficient velocity to penetrate skin and tissue. Currently available devices employ a variety of power sources, including, electrical, mechanical, electromagnetic, laser, spring, and compressed gas. Current research is about design of an automatically reloading sequence circuit which drives a compressed gas-powered needle-free injector. The mechanism of circuit connecting the compressed gas cylinder with pressure intensifier is designed. A 3-port 2-way pilot operated pneumatic valve, in addition with small orifice, is introduced in the circuit, which enables automatic sequence control of needle free injector. A sequence delay of 2 seconds for automatic control is achieved between two consecutive injections using compressed gas as power source of the needle free injector.

Keywords: Auto-loading, needle-free injector, compressed gas driven, sequence control, pilot pneumatic valve.

ID 27 A Study on Process Planning for Multi-tasking Machine Tools Dealing with Complicated Machining Operations

Y. Inoue, K. Nakamoto

Abstract: Manufacturing industry tends toward high-mix low-volume production in recent years. High efficiency by using multi-tasking machine tools has been attracted attention in the field of machining. There are a lot of different kinds of multi-tasking machine tools that have both functions of turning and milling. Therefore, machining operations are generally complicated, and it takes a great deal of time and labor to generate NC programs. This study aims to develop a computer aided process planning (CAPP) system for multi-tasking machine tools dealing with the complicated machining operations. From the result of a conducted case study, it is found that the developed CAPP system has a potential to be effective for complicated machining operations on multi-tasking machine tools.

Keywords: Computer aided process planning, Multi-tasking machine tool, Machining operation, Machining feature.

ID 66 Electrically Assisted Pressure Joining of High Entropy Alloy CrMnFeCoNi

Thi Anh Nguyet Nguyen, Sung-Tae Hong, Ju-Won Park, Heung Nam Han

Abstract: In the present study, the electrically assisted pressure joining (EAPJ) of high entropy alloy (HEA) is experimentally investigated. The electric current and pressure with a constant displacement rate of 4 mm/min are simultaneously applied to CrMnFeCoNi sheets with a 1.2 mm thickness. The CrMnFeCoNi HEA is successfully joined by EAPJ in solid-state. The effect of electric current on the microstructure and mechanical properties of the joint are briefly evaluated.

Keywords: Electrically assisted pressure joining, High entropy alloy, CrMnFeCoNi, Solid-state joint.

ID 77 A Study of Dynamic Response Characteristics of an Electric Regulator

Nguyen Ba Hung, Yujin Kang, Jaekwang Kim, Ocktaeck Lim

Abstract: A simulation study is conducted to examine the dynamic response characteristics of an electric regulator. The simulation models including mechanical and electrical models are built to describe the operation of the electric regulator based on the specifications of an actual electric regulator. Effects of key parameters, such as initial compression of the spring and number of coil turns, on the dynamic response characteristics of the electric regulator are investigated. The simulation results show that the dynamic response of the electric regulator could be easily optimized when the initial compression of the spring and number of coil turns are suitably selected.

Keywords: Electric regulator, Dynamic response, Spring.

Session 17: Advanced Mechatronics 7 & Construction Machine 2

ID 37 A Hybrid Planning System using Q-Learning for Multi-Rescue-Robot

K.-M. Yang, J. I. Lee, S. J. Lee, K.-H. Seo, J.-H. Suh

Abstract: In this paper, we introduce a hybrid planning system based on Q-learning that can achieve tasks for multi-rescue-robot. The multi-robot consists of a lot of reconnaissance robots, transfer robots and firefighting robots who cooperate with each other to achieve rescue goals in disaster accidents. To accomplish the rescue goals, the high-level planners and the low-level planners encompassed in the proposed reactive planning system were developed to select the best actions by predefined task models. In particular, to generate adaptive task plans in diverse emergency situations, both planners receive user's feedback about the performance result of the robots and improve two types of task models using the Q-learning method. The task plans in the high-level planning are to separate large goal to small ones and selects an optimal robot to do. The task plans to achieve small goals in the low-level planning are to decide robot's actions. To evaluate the performance of the proposed system, we made the Gazebo simulator with three turtlebots in the ROS environment. Lastly, we are going to test the hybrid planning system in a real environment.

Keywords: Reinforcement Learning, Q-learning, Multi-Robot System, Rescue Robot, Reactive Planning.

ID 72 Development of a prototype of two-fingered gripper

Jeongseok Kim, Bongsub Song, Dongwon Yun

Abstract: Recently there have been increasing demands of collaborative robots that can interact with humans safely at the factories. There are many technological issues regarding collaborative robots and one of the most important issues is how to increase versatility of a gripper. In this paper we suggested a two-fingered gripper which grasp an object by coulomb frictional force. By calculating required torques, we selected and designed proper motors and power transmission components. Experiments were conducted to validate the performance of the gripper and it could hold 1.5kgf box.

Keywords: Gripper, Coulomb frictional force.

ID 74 **Analysis of 4WD crawler system using hydraulic load sensing system**

Bomoon Seo, Yanghun Im, Eunjin Jeong, Kyoung Kwan Ahn

Abstract: In this paper, 4-Wheel Drive crawler using load sensing system is analyzed using AMESim, a commercial tool for hydraulic analysis. The hydraulic circuit is modeled by modeling the main components of the hydraulic system such as the pump, the main control valve, and the traveling motor. The load sensing system is applied to simulate the 4 WD crawler. It can be seen that even if the load is different for each wheel, the same flow rate can be supplied with using the load sensing system to ensure the straightness.

Keywords: Hydraulic System, Load-sensing, Straightness, AMESim, Simulation.

ID 78 **A methodology of mobile crane fuel consumption test with a position energy regeneration function**

Jihwan Lee, Kwangho Lim, Jongil Yoon

Abstract: The fuel consumption test method for mobile cranes currently lacks international standards. Enactment of fuel consumption test method is required based on various operation modes of mobile cranes and frequency of use. In this research, we defined a fuel consumption test method for mobile cranes equipped with a potential energy regeneration function, which is currently developed trend. Measurement time for each working mode in the actual work environment of the mobile crane was measured, and the usage frequency for each mode was defined. Based on this process, we define the fuel consumption test method, and we propose manufacturers to refer to this test method in the future.

Keywords: Mobile Crane, Energy Saving, Fuel Consumption Test, Energy Regeneration, Operation Mode

ID 88 **Experimental Study of Autoignition Characteristics of gasoline/biodiesel blends using a Rapid Compression Expansion Machine**

Ardhika Setiawan, Kyeonghun Jwa,Vu Dinh Nam, Ocktaeck Lim

Abstract: In this study, the ignition delay characteristics of Gasoline/Bio-Diesel blended fuel were experimented using a rapid compression expansion machine(RCEM). Ignition characteristics were investigated according to injection timing and Compression ratio of RCEM. The experimental conditions are focused on improving the auto-ignition characteristic of gasoline direct-injection compression ignition(GDCI) combustion strategies under low load and cold start. The ignition delay was calculated from the pressure trace. The results showed that a higher Compression ratio helps to obtain shorter ignition delay. From the experimental results, it is possible to confirm the injection timing at which the ignition delay time is short and at the same time the rapid pressure rise occurs after the TDC.

Keywords: Rapid Compression Expansion Machine, Gasoline biodiesel blended fuel, Ignition delay

VII. SPEAKER INSTRUCTION

Please note the following information on your presentation details:

1. Schedule of your presentation:

You should come to your session's room at least 10 minutes prior to the session for the pre-session meeting with the chairs. The chairs will inform you of the scheduled time and so on. You are strongly recommended in advance for the connection test of the equipment.

If you are presenting a concurrent session – go to the room before your presentation starts. This will allow you to introduce yourself to the chair of the session (and reassure them that you attend), as well as checking your presentation has loaded correctly.

It is a good idea to stay in for the other presentations in your session stream, especially if you are second or last but this isn't mandatory.

2. Language

The official language is English. No interpretation is provided during the session.

3. Time allotment

Each presentation is allotted 20 minutes including 5 minutes discussion. Please be punctual with the presentation to keep the timetable of the session.

4. Presentation style

Each technical session room will be set with a projector and PC. All presentations should be loaded onto the PC before the start of the session. Please do this at least 10 minutes before the start of the session and check that it works.

All presentations must run on the Windows operating system. Conference computers will run on at least Windows 7. Please prepare your presentations as a single file to run on PC as a Microsoft PowerPoint format or Adobe PDF format.