Human Machine Interfaces 1

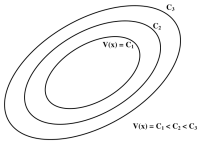
Chair *Luzheng Bi, Beijing Institute of Technology*
Co-Chair *Wei Meng, Wuhan University of Technology*

11:00–11:20 TuAT1.1

Lyapunov Observer/Controller for Stable Haptic Interaction

Aghil Jafari[1], Harsimran Singh[2], Harsha Karunanayaka[3], Jee-Hwan Ryu[4], Jj Chong[1] and Appolinaire C. Etoundi[1]
[1]University of the West of England, United Kingdom
[2]German Aerospace Center (DLR), Germany
[3]University of Bristol, United Kingdom
[4]Korea University of Technology and Education

- Passivity-based approaches suffer from the conservativism of passivity criteria
- LOLC has an improved transparency as it uses the Lyapunov boundedness theorem
- LOLC is not limited to haptic interfaces, and the proposed control methodology could be used to stabilize any control systems.

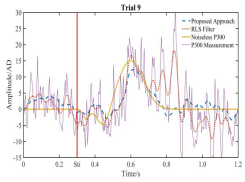


11:20–11:40 TuAT1.2

A Single-Trial Event-Related Potential Estimation Based on Independent Component Analysis and Kalman Smoother

Jingwei Zhang[a], Luzheng Bi[a], Senior Member, IEEE, Jinling Lian[a], and Cuntai Guan[b], Fellow, IEEE
[a] School of Mechanical Engineering, Beijing Institute of Technology, China
[b] School of Computer Science and Engineering, Nanyang Technological University, Singapore

- Extracting P300 wave in a single trial has become an important research question in the field of Brain-controlled Machines.
- A novel extraction algorithm of P300 wave in a single trial based on ICA and Kalman smoother is proposed.
- Results show that the proposed approach is very effective in the single-trial P300 wave extraction.

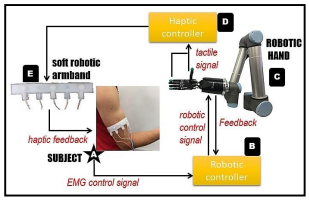


11:40–12:00 TuAT1.3

Armband with Soft Robotic Actuators and Vibrotactile Stimulators for Bimodal Haptic Feedback from a Dexterous Artificial Hand

Moaed A. Abd _1[1], Michael Bornstein _2[1], Emmanuelle Tognoli _3[1], Erik D. Engeberg _4[1]
[1]Ocean and Mechanical Engineering Department Collage of Engineering and Computer Science Florida Atlantic University_1,2,3,4

- The bimodal armband was designed to convey: 1.A sense of grasping pressure. 2.A sense of sliding contact.
- The goal of this study is evaluating the efficacy of the novel bimodal haptic feedback armband.
- Human subjects were able to:
  - Detect the direction of sliding contact efficiently.
  - Sense the applied force.

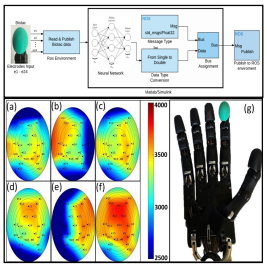


12:00–12:20 TuAT1.4

Direction of Slip Detection for Adaptive Grasp Force Control with a Dexterous Robotic Hand

Moaed A. Abd _1[1], Iker J. Gonzalez _2[1], Thomas C. Colestock _3[1], Benjamin A. Kent _4[1], Erik D. Engeberg _5[1]
[1]Ocean and Mechanical Engineering Department Collage of Engineering and Computer Science Florida Atlantic University_1,2,3,4,5

- Research Goals:
  - Detecting the direction of slip.
  - Investigate the utility of the slip direction detection for robotic reaction development.
- Research Contribution:
  - Development of an ANN classifier to detect the direction a grasped object slips in a dexterous robotic hand.
  - The use of slip direction detection for adaptive robotic grasp reflexes

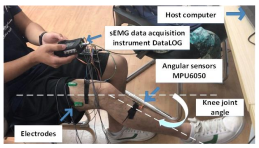


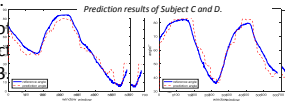
12:20–12:40 TuAT1.5

Knee Joint Angle Prediction Based on Muscle Synergy Theory and Generalized Regression Neural Network

Quan Liu[1], Liangyun Ma[1], Qingsong Ai[1] , Kun Chen[1] , Wei Meng[1,2*]
[1] School of Information Engineering, Wuhan University of Technology, Wuhan, China
[2] School of Electronic and Electrical Engineering, University of Leeds, LS2 9JT, UK

- A knee angle prediction system based on muscle synergy and generalized regression neural network was proposed.
- Muscle synergies & activation coefficients were extracted and a model developed based on GRNN & golden-section search.
- Experiment results show a good result of the activation model for each subject prediction, with a determination of 0.933.





*W. Meng is with School of Electronic and Electrical Engineering, University of Leeds, LS2 9JT, UK (w.meng@leeds.ac.uk)

Robot Dynamics and Control

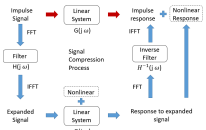
Chair *Courtney Morley-Drabble, The University of Queensland*
Co-Chair *Hideki Hashimoto, Chuo University*

11:00–11:20 TuAT2.1

Study on Robust Control of Industrial Manipulator for Assembly Based on SMCSPO

Min Gyu Jung, Jin Gon Yoon, Sun oh Park,, Min Cheol Lee*
Pusan national university, Korea

- 7DOF model's numerical solution
- Applying SMCSPO controller to 7 DOF robot arm.
- The signal compression method for getting motor dynamics of robot arm.
- Apply PID controller and SMCSPO controller to robot arm and compare the result .
- How to design SMCSPO controller

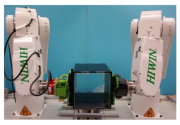


11:20–11:40 TuAT2.2

A Hybrid Control Strategy for Dual-arm Object Manipulation Using Fused Force/Position Errors and Iterative Learning

Bo-Hsun Chen, Yu-Hsun Wang, and Pei-Chun Lin*
Department of Mechanical Engineering, National Taiwan University, Taiwan

- The dual-arm system grasps and moves objects with various shapes using force/position hybrid control strategy
- The controller uses fused force and position measurement errors by Kalman filter
- The controller has Iterative learning feature

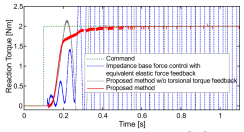

The Dual-arm system

11:40–12:00 TuAT2.3

Force Control in Time-delay Systems Based on Equivalent Torsional and Elastic Forces Feedback

Yuki Nagatsu and Hideki Hashimoto
Department of Electrical, Electronic, and Communication Engineering
Chuo University, Japan

- Force control will be important technology for human-support systems.
- Stability and performance of the force control system is deteriorated by time-delay.
- Force control based on integration of resonance-ratio control and representation by wave equation is proposed.
- Equivalent torsional and elastic force feedback realize the stabilization of the force control with time-delay.



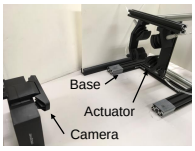
Simulation results of force responses by using the conventional and proposed method.

12:00–12:20 TuAT2.4

Precise In-Hand Motion Control of Objects Using Soft Actuators and Visual Feedback

Yoshiki Mori[1], Mingzhu Zhu[2], Hey-Jong Kim[1],
Akira Wada[1] and Sadao Kawamura[1]
[1]Engineering and Robotics, Ritsumeikan University, Japan
[2]Ritsumeikan Global Innovation Research Organization,
Ritsumeikan University, Japan

- We propose a new control method using visual feedback and soft actuators.
- Soft actuators are made using a multi-material 3D printer that can concurrently use materials with different elastic values.
- By using this proposed method, vertical plane manipulation of the grasped object is realized. As a result, position and orientation errors are about 0.30 mm and about 0.03 rad.



Gripper with soft actuators and visual feedback system

12:20–12:40 TuAT2.5

Task-space cooperative tracking control of multi-robot systems with unknown parameters and time delays

Xinwu Liang[1], Hesheng Wang[1], Yunhui Liu[2],
Weidong Chen[1], and Le Xie[1]
[1]Xinwu Liang, Hesheng Wang, Weidong Chen and Le Xie are with
Shanghai Jiao Tong University, Shanghai, China
[2]Yunhui Liu is with The Chinese University of Hong Kong, Hong Kong

- A novel adaptive control approach was proposed to solve the task-space cooperative tracking control problem
- Task-space synchronization errors between neighboring robotic systems were introduced to define new task-space reference velocity/acceleration
- Adaptive laws without explicitly incorporating synchronization terms were presented to estimate unknown kinematic and dynamic parameters
- Stability analysis was given to prove asymptotical convergence of the task-space synchronization and tracking errors in the presence of time delays

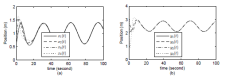


Fig. 4. Position trajectories of multi-robot systems in the task space. (a) The x components. (b) The y components.

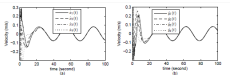


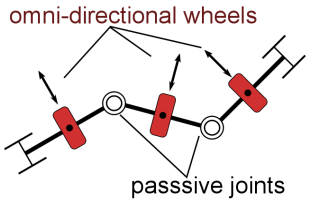
Fig. 5. Velocity trajectories of multi-robot systems in the task space. (a) The x components. (b) The y components.

12:40–13:00 TuAT2.6

Snake-Like Robot with Controllable Side-Thrust Links: Dynamical Modeling and a Variable Undulation Motion

Yuki TAKAGI, Yuichiro SUEOKA, Masato ISHIKAWA, Koichi OSUKA
Dept. of Mechanical Engineering, Osaka University

- Novel kind of **snake-like robot**, composed of serial links with **passive joints**
- Each link has active **omni-directional wheels**
- By undulating the links, the robot can move in the longitudinal direction; solution is derived from nonlinear controllability analysis



Identification and Estimation in Mechatronics 1

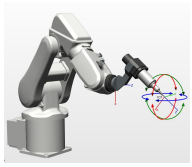
Chair *Rudolf Seethaler, The University of British Columbia*
Co-Chair *Ron Patton, University of Hull*

11:00–11:20 TuAT3.1

Enhanced Robot Calibration by Minimization of TCP Drifts during Reorientation

Bin Niu
ABB Robotics R&D Center
Shanghai, China

- Major robot calibration methods in market are reviewed, categorized into calibrations in joint level and arm level.
- Combining both levels together, an enhanced joint level calibration is implemented by the similar methodology as arm level calibration.
- The new method identifies the joint offset errors by minimization of TCP drifts during reorientation movement.



Reorientation movement of TCP

11:20–11:40 TuAT3.2

Dynamic Modeling and Load Identification of Industrial Robot Using Improved Particle Swarm Optimization

Jieyu Tao[1], Bosheng Ye[1], Yuanlong Xie[1], Xiaoqi Tang[1], Bao Song[1]
[1]Huazhong University of Science and Technology

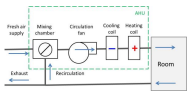
- Based on the theoretical deduction of load dynamics parameters, an IPSO method is introduced to estimate the robotic load dynamic parameters.
- Proposing IPSO can effectively avoid local optimum and improve the identification accuracy simultaneously
- Compared with the LSM method, the feasibility of IPSO is validated

11:40–12:00 TuAT3.3

On-line Parameter Estimation of an Air Handling Unit Model: Experimental Results Using the Modulating Function Method

Ana Ionesi and Jerome Jouffroy
SDU Mechatronics, University of Southern Denmark, Denmark.

- A good model can assist the well functioning of building's components such as HVAC.
- The modulating function is used to estimate the parameters for a reduced order model.
- The proposed method is applied on-line on noisy measurements, leading to satisfactory results.



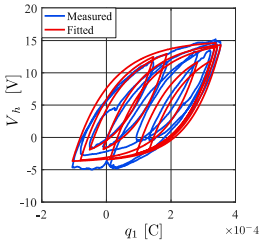
Air flow in a compact HVAC

12:00–12:20 TuAT3.4

A Simple Asymmetric Hysteresis Model for Displacement-Force Control of Piezoelectric Actuators

Sepehr Zarif Mansour[1], Rudolf Seethaler[1], Andrew Fleming[2]
[1]The University of British Columbia, Canada
[2]The University of Newcastle, Australia

- A simple hysteresis model for piezoelectric actuators.
- It can model asymmetric hysteresis loops.
- Does not require to be inverted for real-time implementations.
- it requires measurements of current rather than charge.



Measured and fitted Hysteresis loops

12:20–12:40 TuAT3.5

IEEE AIM 2018
Identification of Viscous and Coulomb Friction in Motion Constrained Systems

Ümit Yerlikaya
Weapon Systems Design, FNSS Defense Systems Inc., Turkey
Tuna Balkan
Mechanical Engineering Dept., Middle East Technical University, Turkey

- A simple and inexpensive method is developed in order to identify viscous and Coulomb frictions in systems with motion limitations.
- This method is used on a prototype. A series of tests are performed using position profiles with different speeds created according to motion limits in the systems.
- Using the data obtained from these tests, viscous and Coulomb friction characteristics are identified for both negative and positive motion directions.

Actuators 1

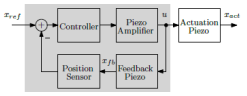
Chair *Chao-Chieh Lan, National Cheng Kung University*
Co-Chair *Kentaro Takagi, Nagoya University*

11:00–11:20 TuAT4.1

Similarity-based Feedback Control for Linear Operation of Piezoelectric Actuators

Mathias Poik, Dominik Kohl and Georg Schitter
Automation and Control Institute (ACIN), TU Wien, Austria

- Method for compensation of hysteresis in piezoelectric transducers is proposed and implemented
- Similarity of two transducers is used to linearly operate one of them without position sensor
- Positioning error due to hysteresis reduced from 9.2% to 0.3% of full actuation range



Actuation Piezo performs positioning task, Feedback Piezo is used for feedback control

11:20–11:40 TuAT4.2

Magnetostrictive Actuator for Chatter Vibration Suppression of Boring Bar

Chanbeom Bak and Hungsun Son
Mechanical, Aerospace and Nuclear Engineering, Ulsan National Science and Technology, South Korea

- This paper proposes magnetostrictive actuator for chatter suppression of boring process.
- The magnetostrictive material is applied as detecting the external vibration, and actuating the reduction of chatter.
- The capability of the developed magneto-strictive actuator is demonstrated in the experiment.

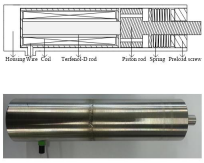


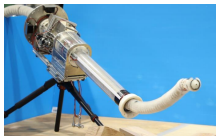
Figure: Design of magnetostrictive actuator

11:40–12:00 TuAT4.3

A Robotic Thruster that Can Handle Hairy Flexible Cable of Serpentine Robots for Disaster Inspection

Y. Yamauchi[1], T. Fujimoto[1], A. Ishii[1], S. Araki[1], Y. Ambe[1], M. Konyo[1],K. Tadakuma[1] and S. Tadokoro[1]
[1]Tohoku University, Japan

- The thruster aims to free the operator who handles the serpentine robot in disaster inspection.
- A proposed opposed flexible rollers can push the hairy snake robot without damaging its hair.
- We experimentally validate that a single operator can control the robot by using the thruster on debris test fields.



Active Scope Camera Thruster with Air Floating Active Scope Camera

12:00–12:20 TuAT4.4

Equivalent circuit and frequency response of the distributed eddy current in an electromagnetic transducer

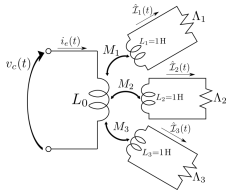
Toru Ikegame and Kentaro Takagi
Mechanical Systems Engineering, Nagoya University, Japan

- Eddy current models(1) have been proposed for sensitive application e.g. electromagnetic shunt damping
- By simultaneous diagonalization, the equation of the diagonalized eddy current model is given as

$$\begin{bmatrix} v_c(t) \\ 0 \end{bmatrix} = \begin{bmatrix} L_0 & \hat{M}^{\mathrm{T}} \\ \hat{M} & \hat{L} \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_c(t) \\ \hat{\mathcal{I}}(t) \end{bmatrix} + \begin{bmatrix} 0 & \mathbf{0} \\ \mathbf{0} & \hat{R} \end{bmatrix} \begin{bmatrix} i_c(t) \\ \hat{\mathcal{I}}(t) \end{bmatrix}$$

where $\hat{\boldsymbol{L}}$ and $\hat{\boldsymbol{R}}$ are diagonal matrices.

- The proposed equivalent circuit is simpler than the previous one.



Proposed equivalent circuit diagram of the diagonalized eddy current model

(1) T. Ikegame et.al *Mechatronics*, vol.45, pp. 130-142, 2017

12:20–12:40 TuAT4.5

Design and Experiments of a New Type Pressure Proportional Valve

Bo Wang, Tao Wang, and Jinbing Chen
School of Automation, Beijing Institute of Technology, China

- A new type nozzle-flapper pressure proportional valve driven by a voice coil motor is designed.
- A voice coil motor (VCM) is used to drive the flapper to improve the dynamic response of pressure proportional valve.
- A fuzzy self-tuning proportion-integration-differentiation (PID) controller is designed to realize high performance.

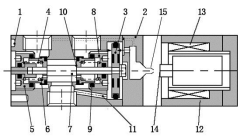


Figure 1 Internal structure diagram of designed pressure proportional valve

Design and Control of Micro and Nano Precision Mechatronic Systems

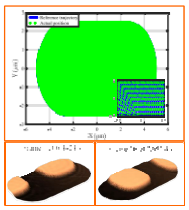
Chair *Michael G. Ruppert, The University of Newcastle*
Co-Chair *Hamed Sadeghian, TNO*

11:00–11:20 TuAT5.1

Sequential Cycloid Scanning for Time-resolved Atomic Force Microscopy

Nastaran Nikooienejad
Department of Electrical Engineering
Afshin Alipour, Mohammad Maroufi and S. O. Reza Moheimani
Department of Mechanical Engineering, University of Texas at Dallas, USA

- Sequential cycloid scanning with an optimal trajectory instead of triangular trajectory to reduce the peak of transient error
- Employing an internal model controller (IMC) to obtain high performance tracking results
- AFM imaging with a commercial AFM and MEMS nanopositioner as the stage to obtain a sequence of images at 12.4 frames per second

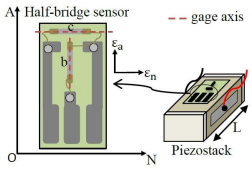


11:20–11:40 TuAT5.2

Independent Estimation of Strain and Temperature in Tee-rosette Piezoresistive Sensor

Meysam Omidbeike[1],Ben Routley[1], Andrew J. Fleming[1]
[1]School of Electrical Engineering and Computer Science University of Newcastle, Australia

- Tee-rosette piezoresistive strain sensor modeling.
- Solving modeled equations simultaneously to estimate strain and temperature independently.
- Minimization of the error between the estimated and true strain using local optimization process.



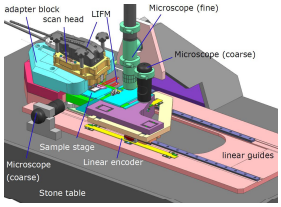
Tee-rosette half-bridge piezoresistive sensor mounted on a piezostack.

11:40–12:00 TuAT5.3

Design and simulation of atomic force profiling of high aspect ratio samples using 2D subresonant force spectroscopy

J.J. Benjamin Biemond, Rodolf W. Herfst, Samaneh Mashaghi, Bert Dekker, Tom Bijnagte and Hamed Sadeghian
Netherlands Organization for Applied Scientific Research, TNO, Delft, The Netherlands

- New subresonant mode in attractive force regime using 2D force measurements
- High aspect ratio samples
- High-speed scanhead design with laser interferometry measurement
- Reconstruction of lateral tip deflections
- Design and simulation



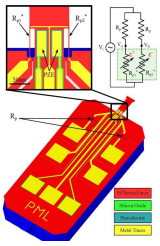
TNO innovation for life

12:00–12:20 TuAT5.4

Design of Hybrid Piezoelectric/Piezoresistive Cantilevers for Dynamic-mode Atomic Force Microscopy

Michael G. Ruppert and Yuen K. Yong
School of Electrical Engineering and Computing, University of Newcastle, Australia

- AFM cantilevers with on-chip actuation and sensing provide several distinct advantages over conventional cantilever instrumentation.
- Piezoelectric actuators and piezoresistive sensors to reduce actuator to sensor feedthrough.
- A torsional mode design allows for differential sensing with two active piezoresistors to increase sensor sensitivity and linearity.

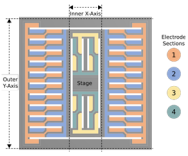


12:20–12:40 TuAT5.5

A Monolithic Serial-Kinematic Nanopositioner With Integrated Sensors and Actuators

Steven Ian Moore and Meysam Omidbeike and Andrew Fleming and Yuen Kuan Yong
The University of Newcastle, Australia

- The nanopositioner is fabricated from a single 0.5mm sheet of PZT-5H piezoelectric ceramic.
- The guiding flexures provide structural compliance, actuation, and sensing.
- A quartered electrode arrangement over each flexure facilitates in-plane bending.
- The serial-kinematic design improves the range and reduces cross-coupling.



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12:40–13:00 TuAT5.6

Robustness of atomically-resolved force measurements and a virtual instrument to standardize the calibration of AFM cantilevers

John Elie Sader
ARC Centre of Excellence in Exciton Science, School of Mathematics and Statistics, The University of Melbourne, Victoria 3010, Australia

- Standardising AFM force measurements
- Web-based virtual instrument
- A-coefficient enables standardisation
- Frequency modulation AFM
- Shape of interatomic force law controls robustness
- New condition for robust measurements

sadermethod.org

Artificial Intelligence and Machine Learning

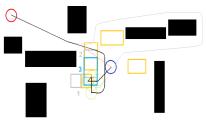
Chair *Minas Liarokapis, The University of Auckland*
Co-Chair *Ray Y Zhong, The University of Auckland*

11:00–11:20 TuAT6.1

Active Path Clearing Navigation through Environment Reconfiguration in Presence of Movable Obstacles

Zehui Meng, Hao Sun, Ken B. H. Teo and Marcelo H. Ang Jr
Department of Mechanical Engineering, National University of Singapore

- Local environment reconfiguration strategy to actively create clearances through manipulation of movable obstacles.
- Convolutional Neural Network (CNN) based perception module to update local environment knowledge
- Online space reconfiguration planning for local path clearing.
- 3-stage path clearing algorithm capable of dealing with ordered manipulations of multiple movable obstacles



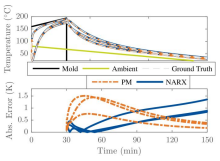
Local Space Reconfiguration

11:20–11:40 TuAT6.2

Comparative Study of Data-Driven and Model-Based Real-Time Prediction during Rubber Curing Process

Tobias Frank, Steffen Bosselmann, Mark Wielitzka, and Tobias Ortmaier
Institute of Mechatronic Systems, Leibniz Universität Hannover, Germany

- Handling of strict accuracy and real-time requirements for curing process prediction
- Large-scale FVM/FEM Model-based approach (spatial / time discretization, solving method)
- NARX neural network approach (datasets, architecture, delays, training)
- Comparison of different process scenarios



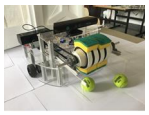
Curing test scenario

11:40–12:00 TuAT6.3

A Deep Learning Tennis Ball Collection Robot and the Implementation on NVIDIA Jetson TX1 Board

Shenshen Gu, *Member, IEEE*, Xinyi Chen, Wei Zeng, and Xin Wang
School of Mechatronic Engineering and Automation,
Shanghai University, Shanghai, China

- Tennis ball collection robot developed based on deep learning technology.
- Tennis ball recognition using YOLO (You Only Look Once) technique.
- Path planning is formulated to the Travelling Salesman Problem and implemented with Pointer Networks.
- NVIDIA Jetson TX1 board is applied to implement the deep learning methods.



Picture of the tennis ball collection robot.

12:00–12:20 TuAT6.4

Multiple RGB-D Camera-based User Intent Position and Object Estimation

Ki Hoon Kwon[1], Hyun Min Oh[1], Min Young Kim[1*]
[1]School of Electronics Engineering, IT College, Kyungpook National University,
80 Daehakro, Bukgu, Daegu 41566, Korea
kwons149@naver.com, comein29@nate.com, minykim@knu.ac.kr

- Point 1. Multiple RGB-D camera-based user intent position and object estimation algorithms are proposed.
- Point 2. Algorithmic procedures are 1) Multi RGB-D camera, 2) 3D Map generation, 3) Human detection, 4) Face detection, 5) 3D View tracking, 6) User intent position and object Estimation.
- Point 3. This method shows the possibility of 3D based user intent monitoring and tracking without any wearable device, widely applicable to a variety of applications.

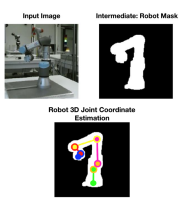
<User intent position & object estimation>

12:20–12:40 TuAT6.5

Robot Localisation and 3D Position Estimation Using a Free-Moving Camera and Cascaded CNNs

Justinas Mišeikis, Kyrre Glette, Ole Jakob Elle, Jim Torresen
Department of Informatics, University of Oslo, Norway
Patrick Knöbelreiter*, Inka Brijacak, Saeed Yahyanejad
Joanneum Research - Robotics, Klagenfurt am Wörthersee, Austria
*Institute of Computer Graphics and Vision, Graz University of Technology, Austria

- Deep learning approach aimed at removing the need for Hand-Eye calibration
- Based on Cascaded Convolutional Neural Networks
- Input is a simple 2D camera image
- Estimates robot mask and 3D positions of robot base and all robot joints

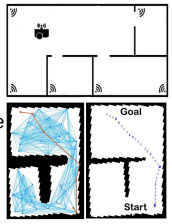


12:40–13:00 TuAT6.6

Autonomous Guided Robotic Systems in Regulating Indoor Environmental Quality

Wen-Yang Wu and Yen-Chen Liu
Department of Mechanical Engineering,
National Cheng Kung University,
Tainan, Taiwan

- An autonomous guided robotic system is proposed for appliances to regulate indoor environmental quality (IEQ).
- Wireless sensors mounted in the indoor spaces provide environmental information so that the guided robots can autonomously navigate to the best location for regulating IEQ.
- Simulation and experiment results are presented to show the efficacy of the proposed system.



Medical Robotics & Biomechatronics

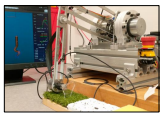
Chair *Felix Orlando Maria Joseph, Indian Institute of Technology Roorkee*
Co-Chair *Andrew McDaid, The University of Auckland*

14:00–14:20 TuBT1.1

Simulation of muscle-powered jumping with hardware-in-the-loop ground interaction

Enrico Eberhard and Christopher Richards
Structure and Motion Laboratory, Royal Veterinary College, UK

- *Reverse Haptics* augments a forward dynamics simulation with real-world contact forces.
- Feedback between a force-sensing 3-DoF manipulator and a biologically inspired musculoskeletal model.
- Simulated muscle-powered jumping performance was tested on a range of real-world substrates.
- Intrinsic muscle properties may compensate for substrate dynamics without active control.

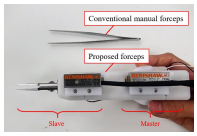


14:20–14:40 TuBT1.2

Identification Method of Environmental Stiffness using Haptic Forceps for Brain Surgery

M. Aoki[1,3], T. Shimono[2,3], T. Matsunaga[3], T. Mizoguchi[3], S. Shibao[4], H. Sasaki[5], and K. Ohnishi[3,6]
[1] Graduate school of Engineering, Yokohama National University
[2] Faculty of Engineering, Yokohama National University
[3] Kanagawa Institute of Industrial Science and Technology
[4] Department of Neurosurgery, Ashikaga Red Cross Hospital
[5] Department of Neurosurgery, Keio University School of Medicine
[6] Haptics Research Center, Keio University

- A technique of transmitting haptic sensation improves quality of surgery.
- This paper proposes a master-slave integrated haptic forceps for brain surgery.
- The experiments showed that the proposed forceps may identify the stiffness of healthy tissue and tumor.



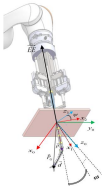
Overall view of proposed forceps

14:40–15:00 TuBT1.3

Development and Kinematic Analysis of a Redundant, Modular and Backdrivable Laparoscopic Surgery Robot

Alaa Alassi[1], Nural Yilmaz[2], Merve Bazman[2], Berke Gur[1], Ugur Tumerdem[2]
[1]Department of Mechatronics Engineering, Bahcesehir University
[2]Department of Mechanical Engineering, Marmara University

- Modular Architecture
- 6-DoF kinematic control
- Software based Remote-Center-of-motion
- Force estimation

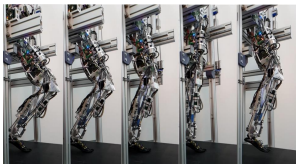

Visualization of the RCM virtual joints

15:00–15:20 TuBT1.4

Coordination of the Biarticular Actuators Based on Mechanical Output Power in Explosive Jump

Atabak Nezhadfard and Steffen Schuetz and Patrick Vonwirth
Computer Science, University of Kaiserslautern, Germany
Krzysztof Mianowski
Faculty of Aeronautical Engineering, Warsaw University of Technology, Poland

- Biarticular Actuators are used in Compliant Leg Robot
- Actuator coordination based on the mechanical power
- Top-down power transfer as shown in human
- Reduction in negative energy production
- Increase in efficiency of movement up to 11%

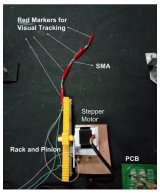

Jump snap-shots

15:20–15:40 TuBT1.5

Design, Fabrication and Control of a Smart Flexible Needle for Minimal Invasive Surgical Procedures

Aman Malhotra[1], Prasant Shekhar Singh[1], Krishna[1]
Felix Orlando Maria Joseph[2]
[1]Senior Students, Btech Electrical Engineering Department, IIT Roorkee, India 247 667.
[2]Faculty, Electrical Engineering Department, IIT Roorkee, India 247 667.

- Developed a Shape Memory Alloy Actuated Active Flexible Needle.
- Controlled using vision feedback for tracking a given desired trajectory.
- Ensures high flexibility and maneuverability.



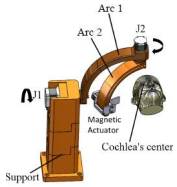
Smart Flexible Needle for Percutaneous Interventions.

15:40–16:00 TuBT1.6

A Novel Remote-Center-of-Motion Serial Manipulator for Inner Ear Drug Delivery

Manel Abbes[1,2], Mouna Souissi[3], Karim Belharet[3], Hassen Mekki[1] and Gerard Poisson[2]
[1]are with Laboratoire NOCCS, Univ. de Sousse, Tunisia.
[2]are with the Laboratoire PRISME, Univ. Orléans, France.
[3]are with Laboratoire PRISME, Hautes Etudes d'Ingénieur, campus Centre.

- Inner ear drug delivery.
- Robotic manipulator for steering magnetic microrobot throughout the cochlea.
- The serial kinematics is based on two rotations and one translation which axes intersect at the center of the cochlea that is the remote center of rotation (RCM).



The serial manipulator.

Motion, Vibration and Noise Control

Chair *Toru Namerikawa, Keio University*
Co-Chair *Jaspreet Dhupia, The University of Auckland*

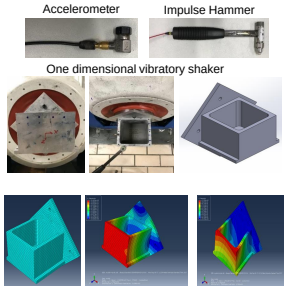
14:00–14:20 TuBT2.1

Modal Analysis on Laboratory Scale Vibratory Bowl

Govind Gour[1], Zhang Jing[1], Tegoeh Tjahjowidod[2] , Yeo S. H.[2] and Sylvie Castagne[3]

[1]Rolls-Royce@NTU Corp. Lab, C/o School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore.
[2]School of Mechanical and Aerospace Engineering, Nanyang Technological University, Singapore.
[3]Department of Mechanical Engineering, KU Leuven, Leuven, 3001, Belgium; Member Flanders Make, Leuven, Belgium.

- The study is undertaken to understand the dynamic characteristic of laboratory scale vibratory bowl.
- The dynamic characterization of vibratory bowl using numerical modal and experimental modal analysis.
- Natural frequencies of vibratory bowl are extracted numerically and experimentally and associated modes shaped are determined via FE tool ABAQUS/Standard.
- Later, harmonic analysis is carried using extracted natural frequencies.
- The study indicated that natural frequencies for the vibratory bowl is higher than the operational frequency. During the operation, the bowl structural will not have resonance condition and would not experience the excessive stresses and possible deformation.



14:20–14:40 TuBT2.2

A Command Shaping Approach for Suppressing Scattered Responses on Servo Systems with Rolling Friction

Yoshihiro Maeda and Makoto Iwasaki
Dept. of Electrical and Mechanical Eng., Nagoya Inst. of Tech.

- **Friction-model-free** friction comp. through command shaping (CS)
- **Overshoot suppression strategy** considering rolling friction property
- **Easy to combine** with conv. friction comp. (e.g., friction model-based FF + linear FB)

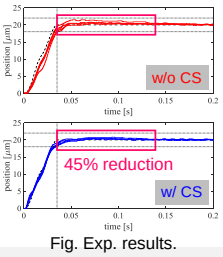


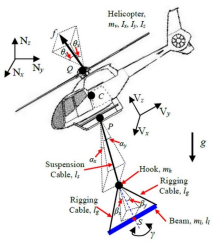
Fig. Exp. results.

Nagoya Institute of Technology

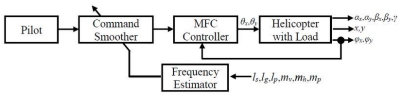
14:40–15:00 TuBT2.3

Dynamics and Oscillation Control of Helicopters Carrying Large-Size Loads

Yifan Zhang, Jie Huang, Jay Katupitiya
Beijing Institute of Technology, China & University of New South Wales, Australia



- **Helicopters--using as aerial cranes.**
- **Helicopters with slung loads--attention to the dynamics and control of large-size load twisting.**
- **Helicopter carrying a distributed-mass beam with double-pendulum dynamics model--using the Lagrange method.**
- **A combined controller --controlling helicopter's attitude, load swing and load twisting.**

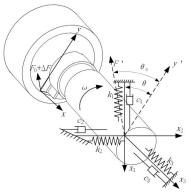


15:00–15:20 TuBT2.4

A calculation method for the stability lobes of 3-DOF Boring

Zhihang Lin, Pingfa Feng, Jianfu Zhang*, Dingwen Yu, Zhijun Wu
Department of Mechanical Engineering, Tsinghua University, China

- A model of the 3-DOF boring process was established.
- The relationship between the dynamic cutting forces and displacements was deduced using a cutting force model and the geometric relationship between cutting thickness and displacement.
- Using the calculation method proposed in this work, the stabilities of boring bars with different parameters were analyzed and the results matched with those of experiments.



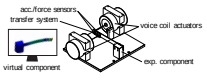
3-DOF boring model

15:20–15:40 TuBT2.5

An Adaptive Approach to Coupling of Vibration Tests and Simulation Models with Harmonic Excitation

Andreas Bartl, Johannes Mayet and Daniel Rixen
Chair of Applied Mechanics, TUM, Germany

- background: coupling of test rigs with virtual boundary conditions
- approach: adaptive feed forward filter with harmonic basis function
- experiments with beam test rig
- results: robust synchronization with multiple DoF interface



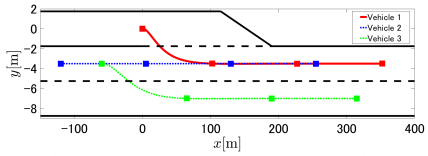
Test Setup

15:40–16:00 TuBT2.6

Merging Control for Automated Vehicles using Decentralized Model Predictive Control

Yasuhiro Hayashi and Toru Namerikawa
Department of System Design Engineering, Keio University, Japan

- Merging control of automated vehicles using decentralized model predictive control is proposed.
- A highway model which has two main lanes is considered.
- Terminal constraints and feasible conditions for the stability of the proposed control method are mentioned.



Vehicle trajectories near a merging section on a highway

Motion, Vibration and Noise Control

Chair *Toru Namerikawa, Keio University*
Co-Chair *Jaspreet Dhupia, The University of Auckland*

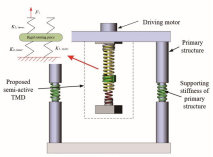
16:00–16:20 TuBT2.7

A novel semi-active tuned mass damper with tunable stiffness

Li Zhang[1], Liu Hong[1], Jaspreet S. Dhupia[2], Shane Johnson[3], Zeeshan Qaiser[3] and Zude Zhou[1]

[1] School of Mechanical and Electronic Engineering, Wuhan University of Technology
[2] Department of Mechanical Engineering, University of Auckland
[3] University of Michigan and Shanghai Jiao Tong University Joint Institute, Shanghai Jiao Tong University

- This study presents a novel semi-active tuned mass damper, capable to extend its working frequencies through the stiffness tuning.
- The stiffness tuning is realized through a compact mechanism, which varies the stiffness by changing the number of active coils of springs in parallel and in series configurations.
- The stiffness of the proposed tuned mass damper is capable to be tuned in the real-time.



The scheme of the proposed semi-active tuned mass damper

Sensors and Sensing Systems 1

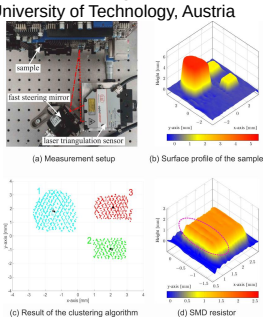
Chair *Hungsun Son, Ulsan National Institute of Science and Technology*
Co-Chair *Kazuhiro Shimonomura, Ritsumeikan University*

14:00–14:20 TuBT3.1

Feature detection and scan area selection for 3D laser scanning sensors

Johannes Schlarp, Ernst Csencsics and Georg Schitter
Automation and Control Institute, Vienna University of Technology, Austria

- Demands for flexible measurement systems are constantly growing
- Apply machine vision to optical scanning triangulation system for increasing flexibility
- Features detected with agglomerative clustering algorithm
- Rescan each feature with adapted trajectory to increase resolution



Measurement setup and results

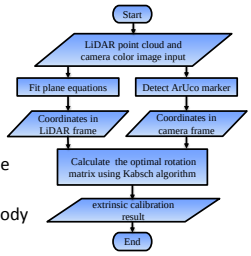
14:20–14:40 TuBT3.2

A novel method for LiDAR camera calibration by plane fitting

Ziqi Chai, Yuxin Sun, and Zhenhua Xiong
School of Mechanical Engineering, Shanghai Jiao Tong University, China

Bullet Point

- Propose a novel LiDAR camera calibration method;
- Detect features in LiDAR frame by plane fitting;
- Detect correspond features in camera frame by ArUco marker;
- Apply Kabsch algorithm to cover the rigid body transformation.



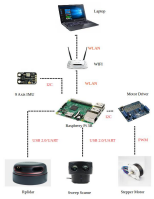
Flowchart of the proposed calibration method

14:40–15:00 TuBT3.3

3D Reconstruction & Assessment Framework based on affordable 2D Lidar

Xueyang Kang
Real-time Computer system, Technical University of Munich, Germany
Yinlong Fen
Institute for Cognitive Systems, Technical University of Munich, Germany

- 2D Lidar measurement principle
- 3D Reconstruction:
  3D scanning at fixed locations,
  kinematic scanning along movement
- Octomap based Metric:
  IoU
  Logged ratio
  Correlation
- Results

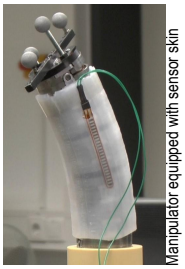

System overview

15:00–15:20 TuBT3.4

Design, Production and Integration of a Shape Sensing Robotic Sleeve for a Hyper-Redundant, Binary Actuated Robot

Svenja Tappe[1], Pinar Boyraz[2], Helge Korz[1], and Tobias Ortmaier[1]
[1]Leibniz Universität Hannover, Institute of Mechatronic Systems, Hanover, GER
[2]Chalmers University of Technology, Dept. of Applied Mechanics and Maritime Sciences, M2, Göteborg, SWE

- Novel concept of a silicon sheath for hyper-redundant, binary actuated manipulator…
  - for sensing manipulators configuration
  - as a safe interaction interface to the environment
  - to add further damping to the system
- Experimental evaluation of the applicability of a piezoresistive sensor for capturing multiple actuator states under the influence of transverse bending

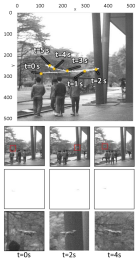

Manipulator equipped with sensor skin

15:20–15:40 TuBT3.5

Real-time Multicopter Detection Using Pixel-level Digital Filters for Frame-Interpolated High-frame-rate Images

Kohei Shimasaki[1], Mingjun Jiang[1], Takeshi Takaki[1], Idaku Ishii[1]
[1]Department of System Cybernetics, Hiroshima University, Japan

- we propose a fast algorithm for vision based vibration source localization.
- Our algorithm can significantly reduce the computational complexity of pixel-level digital filters by virtually adjusting the sampling rate to twice the target's vibration frequency using downsampled HFR images with frame interpolation.
- Our algorithm can robustly localize a vibrating object with pixel-level high-pass filters for the downsampled images.



the experimental results of real-time vibration source detection

15:40–16:00 TuBT3.6

Robotic bolt insertion and tightening based on in-hand object localization and force

Kentaro Nozu and Kazuhiro Shimonomura
Department of Robotics, Ritsumeikan University, Japan

- We propose multimodal tactile sensing with an optical device that can perform in-hand object localization and force sensing.
- The proposed tactile sensor composed of two layers of soft elastomer and monocular camera. Tactile information is obtained as an image through a camera.
- We applied this sensor to a manipulation task, inserting a bolt into the target hole and tightening the bolt, based on these tactile information.

Picture of the robot equipped with the proposed tactile sensor.

Sensors and Sensing Systems 1

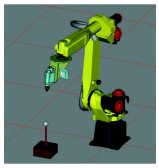
Chair *Hungsun Son, Ulsan National Institute of Science and Technology*
Co-Chair *Kazuhiro Shimonomura, Ritsumeikan University*

16:00–16:20 TuBT3.7

Hand-eye calibration of a laser profile scanner in robotic welding

Jindřich Liška and Ondřej Vaníček and Michal Chaluš
Department of Cybernetics, University of West Bohemia, Czech republic

- Welding processes require high positioning precision of the whole robotic system
- Our method performs the calibration of the profile sensor using a standard sphere
- The algorithm is verified by multiple simulations and a real experiment
- Simulations show accuracy satisfying the requirements of the process allowing the deviation of 0.1 mm maximum



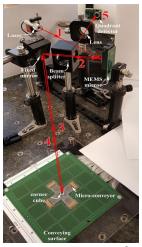
Robotic laser welding system and the calibration object

16:20–16:40 TuBT3.8

Optical localization and open loop tracking of a micro-conveying system

Saly Malak, Hani Al Hajjar, Erwan Dupont, Muneeb Ullah Khan, Frédéric Lamarque
Roberval laboratory FRE-CNRS 2012, Sorbonne University, University of Technology of Compiegne, France

- An optical localization and tracking method of a mobile micro-conveyor is proposed.
- A MEMS mirror controls the light direction to track a corner cube placed onto the micro-conveyor.
- The corner cube reflects the light in the same incident direction towards a photo-detector
- An open loop tracking of the mobile micro-conveyor is achieved while monitoring the detector signals.



Experimental setup for localization and tracking system

Flexible Manipulators and Structures 1

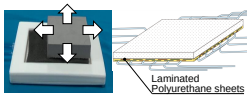
Chair *Chao-Chieh Lan, National Cheng Kung University*
Co-Chair *Harish Devaraj, University of Auckland*

14:00–14:20 TuBT4.1

Flexible Sheet Actuator That Generates Bidirectional Traveling Waves

Masahiro Watanabe
Department of Mechanical and Control Engineering,
Tokyo Institute of Technology, Japan
Hideyuki Tsukagoshi
Department of Systems and Control Engineering,
Tokyo Institute of Technology, Japan

- Soft sheet actuator capable of generating traveling waves is presented.
- It is able to produce wave motion in both the X and Y directions.
- It can convey objects at 28.5 mm/s with a sheet thickness of 11 mm.



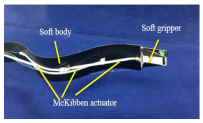
Sheet actuator conveying objects in two directions

14:20–14:40 TuBT4.2

Soft manipulator using thin McKibben actuator

Ahmad Athif Faudzi[1,3], Nor Iskandar Azmi [2], Mostafa Sayahkarajy [2], Wong Liang Xuan[2], Koichi Suzumori[3]
[1]Centre of Artificial Intelligence and Robotics, Universiti Teknologi Malaysia, Malaysia
[2]Faculty of Engineering Technology, Universiti Teknologi Malaysia, Malaysia
[3]Department of Mechanical Engineering, Tokyo Institute of Technology, Japan

- The structure is inspired by the snake body structure using a redundant arrangement of the thin McKibben actuator without rotational joints
- The robot has 16 unique phase for each right and left side.
- The robot successfully demonstrates smooth snake-like motions with different time delays and performs pick and place experiment.



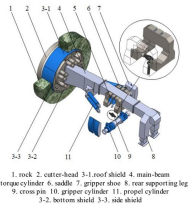
Soft Manipulator

14:40–15:00 TuBT4.3

Rapid Finite Element Modeling Method of TBM Gripping-thrusting-regripping Mechanism

Fei Wang, Longzhen Chen, Kai Wang, Yuhu Yang and Xianzeng Liu
School of Mechanical Engineering, Tianjin University, China

- GTRM enables TBM to implement tunneling operation continually
- The rapid modeling method is an efficient way to model in a few tunneling positions
- Modeling steps: divide the mechanism into various sub-modules, define their FE attributes, and combine the sub-modules
- Merit: utilize the FE models of sub-models repeatedly, avoiding wasting time on their modeling

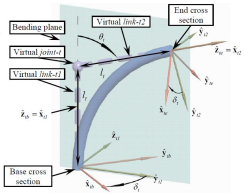

Structural composition of GTRM

15:00–15:20 TuBT4.4

FABRIKc: an Efficient Iterative Inverse Kinematics Solver for Continuum Robots

Weihao Zhang[1], Zhixiong Yang[2], Tianlai Dong[2] and Kai Xu[1*]
[1] School of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, China
[2] UM-SJTU Joint Institute, Shanghai Jiao Tong University, Shanghai, China

- A heuristic approach to solving the inverse kinematics problem of a continuum robot is proposed.
- Virtual joint and links are used to characterize a continuum segment for implementation of the algorithm.
- Two examples are presented to demonstrate the efficacy of the algorithm.



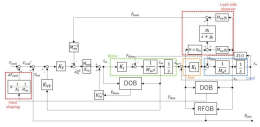
A continuum segment characterized by virtual joint and links

15:20–15:40 TuBT4.5

Accurate Force Control of Flexible Manipulator based on Mismatch of Stiffness in Load Side Observer

Akiko Nakamura
Graduate School of Engineering, Yokohama National University, Japan
Tomoyuki Shimono
Faculty of Engineering, Yokohama National University, Japan

- Vibration generation problem during operation caused by weight reduction of robots must be solved.
- We propose a new robust force control method for flexible manipulators.
- The effectiveness of the method is considered in simulation and experiment in different contact environments.

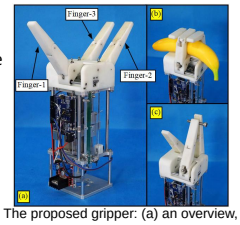

Block diagram of the proposed method

15:40–16:00 TuBT4.6

A Single-Actuator Gripper with a Working Mode Switching Mechanism for Grasping and Rolling Manipulation

Huan Liu[2], Zhaoyu Zhang[2], Tianlai Dong[2], Xiangyang Zhu[1] and Kai Xu[1*]
[1] School of Mechanical Engineering, Shanghai Jiao Tong University, Shanghai, China
[2] UM-SJTU Joint Institute, Shanghai Jiao Tong University, Shanghai, China

- A newly proposed Continuum Differential Mechanism (CDM) was used with underactuated fingers to generate adaptive grasps.
- A switching mechanism was designed to change the gripper's working mode between grasping and rolling manipulation under the actuation of the same motor.
- Experimental results verified the effectiveness of the proposed design.



The proposed gripper: (a) an overview, (b) the gripper in the grasping mode and (c) in the manipulation mode

Power MEMS for Intelligent Internet of Things

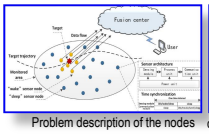
Chair *Kai Tao, Northwestern Polytechnical University*
Co-Chair *Fei Wang, Southern University of Science and Technology (SUSTech)*

14:00–14:20 TuBT5.1

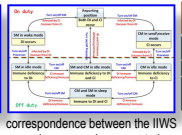
Low power-cost, Self-organized and Reconfigurable Control Strategy of Multi Sensors Inspired by Biological Mechanism for Target Detection

Q. Shen[1, 2], J. Zhou[3], J. B. Xie[1], S. J. Huang[2], J. P. Lai[2], L. Qiu[2]
[1]MOE Key Laboratory of Micro and Nano Systems for Aerospace, Northwestern Polytechnical University, China
[2]Research & Development Institute of Northwestern Polytechnical University in Shenzhen
[3]MOE Key Laboratory of Information Fusion Technology, Northwestern Polytechnical University, China

- Modeling of Infection-Immunity Strategy
- Correspondence Between Sensors Wakeup and Infection-Immunity Model
- Simulation and Analysis



Problem description of the nodes control strategy



correspondence between the IIWS and sensor wake-up control

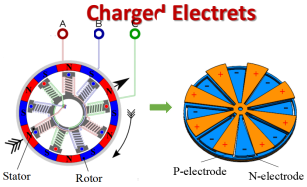
	Total energy cost	Estimation error of target position
DIDM method	285	18.4
IIWS method	142	14.2
Reduction percentage	49.8%	77.2%

Comparison of power cost and target position estimation

14:20–14:40 TuBT5.2

Binqiao Wang, Yixin Chen, Kai Tao*, Jin Wu, Lihua Tang and Honglong Chang

Enhanced Performance of a Rotary Energy Harvester with Bipolar Charged Electrets

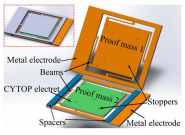


14:40–15:00 TuBT5.3

Two Mechanical Tuning Schemes to Improve the Bandwidth of Electret-based Electrostatic Energy Harvester

Yulong Zhang, Xinge Guo, Zong Liu, Anxin Luo, and Fei Wang
Department of Electrical and Electronic Engineering,
Southern University of Science and Technology, Shenzhen 518055, China

- Electrostatic energy harvester (E-VEH) based on out-of-the-plane scheme is fabricated with single resonator packaged at low air pressure;
- The bandwidth of e-VEH is increased to 30 Hz at the pressure of 4 Pa;
- E-VEH with dual resonant masses are used for bandwidth tuning from mechanical collision;
- A decent power output (1.06-3.24 μW) at a broad frequency range of 49 Hz (142-191 Hz) is achieved.



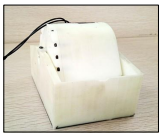
E-VEH with dual resonant proof masses

15:00–15:20 TuBT5.4

Design and experiment of an electromagnetic ocean wave energy harvesting device

Qiyu Guo, Ming Sun, Huicong Liu, Tao Chen and Lining Su
School of Mechanical and Electric Engineering, Jiangsu Provincial Key Laboratory of Advanced Robotics, Collaborative Innovation Center of Suzhou Nano Science and Technology, Soochow University, China
Xin Ma and Zhaohui Chen
Physical Oceanography Laboratory, Ocean University of China, China

- An electromagnetic ocean wave energy harvesting device with dimension of $100mm \times 64mm \times 80mm$
- 122mW for maximum output power and $0.24\ mW/cm^3$ for output power density
- A device consisting of a rack, a swing body, transmission gears and electromagnetic power module
- Used to power low-power components in

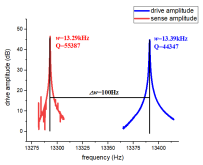

Fabricated ocean wave energy harvesting device

15:20–15:40 TuBT5.5

Vibrational Energy Loss Analysis of a MEMS Disk Resonator Gyroscope

Jianbing Xie, Jin Yang and Jinqiu Zhou
MOE Key Laboratory of Micro/Nano Systems for Aerospace, Northwestern Polytechnical University, China

- Reducing energy loss can effectively improve the quality factor of μDRG.
- The simulated Q of thermoelastic damping and anchor loss of the designed μDRG are 65,937 and 17,154,000, respectively.
- The maximum Q of the fabricated μDRG is 65,884.
- So, the energy loss of the designed MEMS Disk Resonator Gyroscope comes mainly from thermoelastic damping.



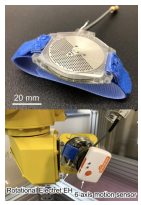
Amplitude-frequency response of the fabricated μDRG

15:40–16:00 TuBT5.6

Low-profile Rotational Electret Energy Harvester for Battery-less Wearable Device

T. Miyoshi[1], M. Adachi[1], Y. Tanaka[1] and Y. Suzuki[1]
[1] Department of Mechanical Engineering, The University of Tokyo

- Rotational electret energy harvester (EH) is prototyped utilizing flexible print circuit board (PCB) technology and metal ball bearing.
- The maximum thickness is as thin as 3.3 mm and output power up to 80 μW has been obtained from arm swing during walking.
- The power generation performance also has been investigated by using a multi-axis robot as first trial to realize standard evaluation method for arm-equipped wearable EHs.

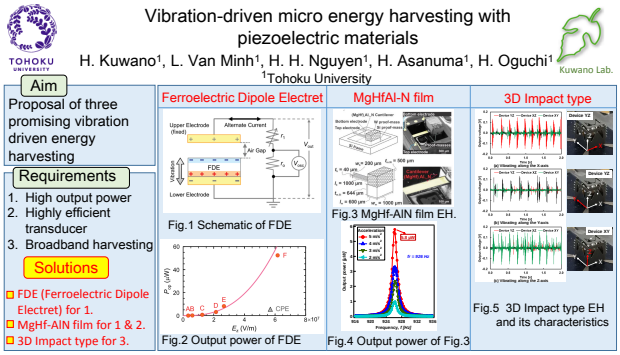


Rotational electret energy harvester

Power MEMS for Intelligent Internet of Things

Chair *Kai Tao, Northwestern Polytechnical University*
Co-Chair *Fei Wang, Southern University of Science and Technology (SUSTech)*

16:00–16:20 TuBT5.7



Modeling, Design & Optimization in Mechatronics 1

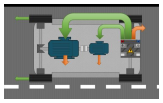
Chair *Geoff Chase, University of Canterbury*
Co-Chair *Ron Patton, University of Hull*

14:00–14:20 TuBT6.1

Data-Driven Optimal Power Flow Management in an Electric Dual-Drive Topology

Arne De Keyser
EEMMECS, Ghent University, Belgium
Guillaume Crevecoeur
EEMMECS, Ghent University, Belgium

- Limited range of electric vehicles hinders widespread integration in transportation.
- A dual-drive topology is proposed, allowing two distinct electric drives to cooperate.
- Control complexity is tackled by a tailored power flow-based reformulation.
- Computationally efficient control with possible energy savings of up to 19.9%.



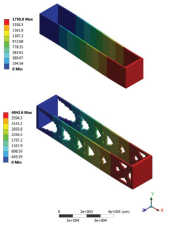
Optimal control problem for an electric dual-drive.

14:20–14:40 TuBT6.2

Topology optimization of leaf flexures for stiffness ratio maximization in compliant mechanism

Joshua Pinskier and Bijan Shirinzadeh
Robotics and Mechatronics Research Laboratory,
Monash University

- Leaf-Flexures are widely used to guide linear motions in compliant mechanisms
- Topology optimization designs structures computationally to improve performance, with resulting structures now able to be 3D printed
- By reducing stiffness in desired directions relative to parasitic directions, the range of motion of optimized structures increases by 1.5-4 times



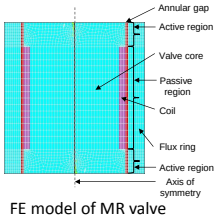
Displacement of leaf flexure and optimized flexure parallelograms.

14:40–15:00 TuBT6.3

Modeling and Optimization of Non-Linear Herschel-Bulkley Fluid Model Based Magnetorheological Valve Geometry

Manjeet Keshav and Sujatha Chandra Mohan
Department of Mechanical Engineering, Indian Institute of Technology Madras, India

- Herschel-Bulkley (H-B) fluid model: most suitable model to describe the Magnetorheological (MR) fluid behavior.
- Modeling and analysis of MR valve used in damper of any semi-active suspension using H-B fluid model.
- Finite element (FE) modeling of MR valve for electromagnetic analysis in ANSYS-APDL.
- Multi-objective geometric optimization of MR valve using Genetic Algorithm in MATLAB® environment.



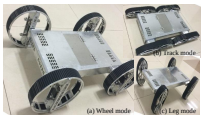
FE model of MR valve

15:00–15:20 TuBT6.4

Comparison Analysis of A Transformable Wheel

Faliang Zhou, Xiaojun Xu, Haijun Xu, Xiang Zhang
Department of Intelligent Machinery and Instrument,
National University of Defense Technology, China

- Geometry configuration analysis of the transformable wheel
- Transformation approach design of the foldable rim
- Performance contrast analysis of two different design
- Initial experiments and future work of our research



Robot based on a transformable wheel

15:20–15:40 TuBT6.5

Six DOFs Motion Platform using Omni-Spherical Wheels

Seong-Min Lee and Hungsun Son, *Member*, *IEEE*
Mechanical, Aerospace and Nuclear Engineering, Ulsan National Institute of Science and Technology, South Korea

- This paper presents the development of a six DOFs motion platform based on omni-spherical wheels
- The motion platform is to the existing. capable unlimited rotational motion
- It has symmetric design and offers large workspace for linear motion, simplicity for control, and safety in operation

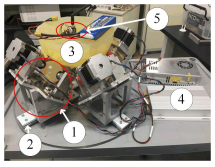


Fig. omni-spherical wheels motion platform

15:40–16:00 TuBT6.6

Development of Vacuum Suction Unit Using Flame Extinguishment

Ting Han and Xin Li
State Key Laboratory of Fluid Power and Mechatronic Systems,
Zhejiang University, China

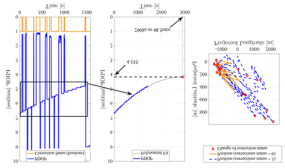
- Extinguishment can generate a negative pressure in order of tens of kilo Pascals
- Chemical reaction and cooling contribute little to formation of negative pressure
- Condensation of gaseous fuel molecules is the main cause of the negative pressure
- A vacuum suction unit of lifting an object weighing 51 kg is built

Suction unit based on the flame extinction process

Precision analysis of an RTCM2.3-augmented consumer-grade multi-constellation GNSS receiver

Nathanael Esnault[1], Dr. Nitish Patel[2] and, Dr. Jon Tunnicliffe[3]
[1&2] Faculty of Engineering, Electrical and Computer Engineering, The University of Auckland
[3] Faculty of Science, River Science, The University of Auckland

- Analysis of dilution of precision (PDOP) and position
- Ublox M8T as Rover, Trimble Net R8 as NTRIP caster / CORS
- Result: Precision of uncorrected multi-constellation mode > RTCM2.3 corrected, and by extent mono-constellation, mode

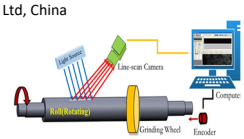


PDOP and projected position over time, the drop outs of the correction are visible

Machine Vision-based Intelligent Roller Surface Inspection System

Depeng Shi[1], Jiehan Zhou[2] , Jirui Xu[3], Jun Yang[3], Xuekun Li[3], Zeming Zhao[4], Junchuang Chen[4], Yiming Rong[1]
[1]Southern University of Science and Technology, China
[2] University of Oulu, Finland [3] Tsinghua University, China
[4] HIECISE Precision Equipment Co. Ltd, China

- Question: it is difficult to capture subtle optical defects on roller surface. it requires an effective algorithm for defect identification, segmentation and classification.
- Method: propose an improved method for roller surface defect segmentation; propose a defect classification model by introducing a penalty term and a convolution kernel.
- Result: the segmentation time is slightly increased; classification time is greatly shortened. the accuracy is greatly improved, which can meet the requirements of on-site roller inspection.

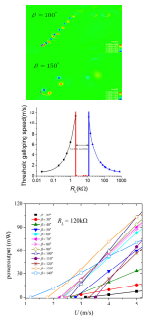


On-site machine vision-based roller surface inspection

A galloping based piezoelectric energy harvester

Junlei Wang[1], Liya Zhao[2*], Lihua Tang[3]
[1]Zhengzhou University, China; [2]University of Technology Sydney, Australia; [3]The University of Auckland, New Zealand

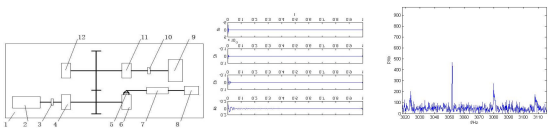
- For vertex angle β <140°, triangle bluff body is suitable for galloping-based piezoelectric energy harvesting. For β >140°, velocity and vorticity patterns are not sensitive to the incoming wind → not good for energy harvesting.
- With strong coupling strength, galloping might not occur in certain range of wind speeds with certain R_L. The threshold galloping speed varies with the R_L.
- Vertex angle affects the performance significantly. β = 130° is optimal: relatively low threshold galloping wind speed & reasonably high power output.



Research on the Fault Diagnosis of Gears Based on Wavelet Transform and Envelope Spectrum Analysis

Pengfei Liang, Chao Deng*, Jun Wu, Chaoqun Duan, Jinxuan Zhu

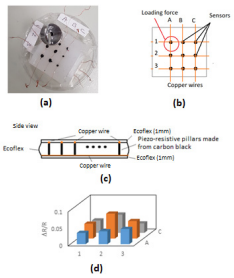
- The problems in the fault diagnosis of wind turbine gears
- Wavelet decomposition and reconstruction
- Hilbert signal envelope analysis for fault diagnosis
- Simulation verification
- Experiment validations



Soft and Flexible Pressure Sensor based on Piezoresistive Pillars

Mahtab Assadian, Harish Devaraj, Timothy Giffney, Kartik Yellapantula, Kean C. Aw*, Member, IEEE

- A pressure/force sensor containing an array of extruded carbon-elastomer composites in a flexible elastomer substrate.
- The use of these pillars can accommodate more sensors in a given surface area.
- This array of pressure/force sensors allows a pressure/force map to be produced.



High Accuracy Track Tracing for Rice Drill Seeder on Uneven Paddy Fields

Yan Zhang[1], Yanming Li[1], Yixiang Huang[1], Xiangpeng Liu[1], Chengliang Liu[1]
Shanghai Jiao Tong University

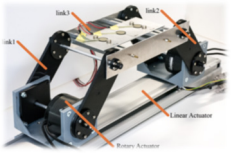
- Autonomous rice drill seeder on paddy fields
- Combining lateral deviation and heading angle deviation as feedback
- Nonlinear steering control model

Rice Drill Seeder

Development of Shear Force Measurement and Its Feedback Mechanism by Linear Actuators

Daichi Miyamoto[1], Hiroshi Igarashi[1]
[1]Department of electrical and electronic engineering, Tokyo Denki University, Japan

- The major cause of bedsore is pressure and shear force.
- Force measurement and force feedback are required to improve bedsore.
- Proposal of a force feedback system by the parallel link mechanism.
- Measurement forces are estimated using DOB and RFOB that realize sensor-less.

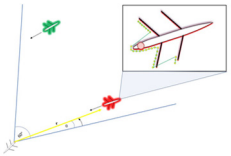


Overview of developed system

Learning Based Collision Detection using EUPOC Clustering Algorithm for Safety in Rowing

T.W.G. Hallwright[1] and W.M. Guest[2]
[1]Department of Mechanical Engineering, University of Auckland
[2]Department of Electrical Engineering, University of Auckland

- Rowing is a dangerous sport that is performed in a collision prone environment.
- The EUPOC Clustering Algorithm developed facilitated lightweight shape recognition of collision threats.
- The developed system identified objects and calculated if a collision was imminent.

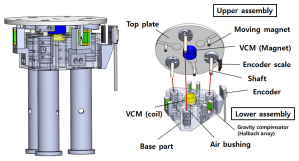


EUPOC Clustering Algorithm identifying objects based on radial distance spacing.

High-speed electromagnetic force compensation precision balance using magnetic springs

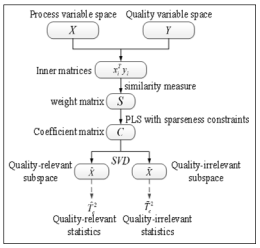
Sung-Ryong Park[1], Moon Gu Lee[1], Kyung-Taek Yoon[1], Hyun-Ho Lim[1], Jaehwa Jeong[2], Young-Man Choi[1]
[1]Ajou University, Suwon, Republic of Korea
[2]Korea University, Sejong, Republic of Korea

- A new EMFC weighing balance with air bushing guides and magnetic springs
- Replace conventional flexure mechanism and counterweight
- A Halbach magnet array is optimized to form a magnetic spring with extremely low stiffness



proposed EMFC balance

Improved Weighted PLS for Quality-Relevant Fault Monitoring Based on Inner Matrix Similarity

Xiwei Bai[1,2], Xuelei Wang[1], Jie Tan[1], Wei Sun[3], Zhiyong Zhang[3], Zhonghao Zhang[1]
[1]Institute of Automation, Chinese Academy of Sciences [2]University of Chinese Academy of Sciences, Beijing [3]Zhejiang Tianneng Energy Technology Co., Ltd.

- An improved weighted PLS (IWPLS) is proposed
- Two forms of weight matrix are given for different situations based on inner matrix similarity
- fault monitoring scheme is performed with additional sparseness constraints and decomposition operation