NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Institute for Media Innovation

# IMI RESEARCH SEMINAR

**Tuesday 24 November 2020 10:30 am – 12:30 pm**
**Institute for Media Innovation Seminar Room**

Research Techno Plaza, XFrontiers Block, Level 03-01, 50 Nanyang Drive, Singapore 637553

**** Attendance is on first-come first-served basis, up to 35 pax*** ***+ Lunch bento will be served***

**10:30am – 10:50am**
*15 mins presentation, 5 mins Q&A*

**Tian Li**
***Research Associate***
***Institute for Media Innovation***

## Natural Grasping with a Humanoid Robotic Hand

In recent years, the highly biomimetic robotic hand which has a structure close to human hand bones is proven as a promising way to design an anthropomorphic robotic hand. However, although the importance of the hand soft tissue in grasping is well-known, there is still a lack of method to create the soft part of the robotic hand. Inspired by the human hand anatomy, we propose a new design for a robotic hand, which is made of both 3D printable rigid and soft materials.

***About the Speaker***

Tian Li is a research associate at Institute of Media Innovation (IMI), NTU. He received both his B.Eng. and M.Sc. at NTU, in 2010 and 2012 respectively. He has 5-year firmware engineer work experience in Toshiba and Fuji Xerox and is currently working on the area of social robotics under supervision of Prof. Nadia Magnenat Thalmann. Tian Li is also pursuing his part-time Ph.D. degree at NTU with Assoc Prof Zheng Jianmin as his supervisor.

**10:50am – 11:10am**
*15 mins presentation, 5 mins Q&A*

**Sinha Anoop Kumar**
***IMI-MAE PhD Student***
***School of Mechanical and Aerospace Engineering***

## Prosthetic Hands: Design Concepts, Sensorization and Interfacing Techniques

Human hand is the foremost part of the body and serves to perform daily social activities. Any disfigurement affects a person's quality of life due to reduced dexterity, sensory perception, and unnatural appearance. Although modern prosthetic hand(s) restore vital mobility, sensorimotor functions and interfacing methods for more intuitive behaviour is still a challenge. This talk explores the modern prosthetic hands with the capability of providing human hand-like sensory perceptions, interfacing techniques, and challenges associated with it. Most recent improvements with soft materials for sensing have been reviewed and inspiration has been drawn for developing a sensorized prosthetic hand for our on-going research.

***About the Speaker***

Anoop Kumar Sinha is currently a Ph.D. student at Institute for Media Innovation (IMI), NTU. He completed M.Tech., majoring in Mechatronics Engineering from the Indian Institute of Technology (IIT) Patna, India and B.Tech. in Mechanical Engineering from Uttar Pradesh Technical University Lucknow, India. His research interests include human-robot interaction, soft robotics, and smart materials for robotic applications.

Supervisor: Assoc Prof Cai Yiyu, School of Mechanical & Aerospace Engineering
Co-Supervisor: Prof Nadia Thalmann, Director, Institute for Media Innovation

**11.10am – 11.20am**
*7 mins presentation, 3 mins Q&A*

**Sim Bing Rui**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## Development of a Robotic Hand Controlled via Electromyography Data

Modern prostheses are usually complex and built from rigid materials. In contrast, a prosthetic hand must be compliant. This ensures the safety of the object as well as the robotic hand during manipulation. This talk explores the possibility of a hybridized prosthetic hand where soft, compliant materials are used in conjunction with rigid materials. This increased flexibility and adaptability would aid the accomplishment of motor functions while improving safety as compliant materials will prevent damage to object during grasping. In addition, the performance of various Surface Electromyography (SEMG) sensors used to collect data is evaluated. Thereafter, various machine learning techniques applied to classify gestures will be assessed. The results will contribute to the development of a highly dexterous, non-invasive prosthetic hand, aiming to retain the quality of life of users.

***About the Speaker***

Bing Rui is a Year 3 Mechanical mainstream student serving Internship at Institute for Media Innovation (IMI), NTU. He received Diploma in Mechanical Engineering from Ngee Ann Polytechnic in 2017. His interests include building projects revolving robotics and automation as well as 3D designing of mechanisms. Currently, he is working on a prototype Internet of things (IOT) mini greenhouse system.

Supervisor: Assoc Prof Lin Rongming, School of Mechanical & Aerospace Engineering

**11.20am – 11.30am**

*7 mins presentation, 3 mins Q&A*

**Tao Jia Lin**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## Anthropomorphic Robotic Hand Dexterity Test with GRASP Taxonomy

This study tests and compares the dexterity of the anthropomorphic robotic hand with the human hand through the analysis of grasping actions in GRASP taxonomy. Photographs of both robotic and human hand grasping the same object are taken and data points are recorded for comparison. With these data, the extent of similarity in grasp motions between the biomimetic hand and human hand is assessed and limitations of the biomimetic hand is explored.

***About the Speaker***

Jia Lin is an intern at Institute for Media Innovation (IMI), pursuing B.Eng (Mechanical Engineering) in NTU. His current project includes finger workspace for anthropomorphic robotic hand and the design of biomimetic hand using one type of material.

Supervisor: Assoc Prof Seet Gim Lee, Gerald, School of Mechanical & Aerospace Engineering

**11:30am – 11:40am**

*7 mins presentation, 3 mins Q&A*

**Wang Qi Fa**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## In-hand Manipulation of Biomimetic Robotic Hand

In-hand manipulation is a process in which fingers interact with the object. As a robotic hand usually has many joints and Degrees of Freedom (DOF), the cooperation and interaction could be complicated. The challenge in in-hand manipulation of the robotic hand is in maintaining its position while changing the position of its fingers. To overcome the challenge, a series of in-hand manipulation actions are broken down into different and simpler poses, achieved individually, and then combined to complete the entire in-hand manipulation.

***About the Speaker***

Qi Fa is a Year 3 Mechanical Engineering student, currently working as an intern in Institute for Media Innovation (IMI). His research interest is on the design and prototyping of biomimetic robotic hand, with focus on in-hand manipulation.

Supervisor: Assoc Prof Lin Rongming, School of Mechanical & Aerospace Engineering

**11.40am – 11.50am**

*7 mins presentation, 3 mins Q&A*

**He Zi Jing**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## Application of Minimum Jerk Algorithm on Humanoid Robot with 7 D.O.F Arm and 6 D.O.F Hand to Achieve Object Grasping

The smoothness of movement is important while controlling movement of robots. Thus, trajectory generators are necessary in control systems when we want to move robot smoothly from initial position to target position. Minimum jerk algorithm is a simple method of trajectory generation of robot manipulators, which is based on an optimal control problem formulation. Our research intends to achieve a smooth movement of the robotic arm, together with the robotic hand, to complete an entire grasping motion from initial rest position to final object-grasping position. This talk will explain the application of minimum jerk algorithm on humanoid robot with seven D.O.F arm and six D.O.F hand (i.e. Nadine robot) to achieve object grasping.

***About the Speaker***

Zi Jing is currently an intern at Institute for Media Innovation (IMI), NTU and is also a Year 3 Mechanical mainstream student. She received Diploma in Mechatronics Engineering from Nanyang Polytechnic in 2019. Her research interests include jerk minimization of humanoid robotic arm and grasping of robotic hand.

Supervisor: Assoc Prof Lin Rongming, School of Mechanical & Aerospace Engineering

**11.50am – 12.00pm**

*7 mins presentation, 3 mins Q&A*

**Du Xue Zeng**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## Design of the Cable Driven Bio-mechatronic Hand

Conventional anthropomorphic robotic hands focus on functionality with human-like “organic” feeling of motion compromised. This study explores a simplified design that can perform most human hand grasping gestures, and can eventually be incorporated in Nadine, or other humanoids. The design aims to build a fully controlled hand with high degree of freedom. The design is kept simple while achieving as much bionic features as possible. The hand will consist of the equivalents of bones, tendons, ligaments, soft tissue and skin, to achieve a balance between functionality and structure dexterity. The design is then validated with 33 grasping gestures and the Kapandji test.

***About the Speaker***

Xue Zeng is currently serving his Internship at Institute for Media Innovation (IMI), NTU. He is also a Year 3 Mechanical mainstream student. He received Diploma in Aeronautical Engineering from Singapore Polytechnic in 2019. His interests span across various domains in mechanical engineering, especially in the area of robotic and mechanical design.

Supervisor: Assoc Prof Ang Whye Teong, School of Mechanical & Aerospace Engineering

**12.00pm – 12.10pm**

*7 mins presentation, 3 mins Q&A*

**Low Soon Hing**
***IMI Intern***
***School of Mechanical and Aerospace Engineering***

## Inverse Kinematics Computation and Obstacles Avoiding Path Planning Algorithm for a 7 D.O.F. Humanoid Arm

Inverse kinematics and path planning are very common topics for the design and control of the robot arm's movement. Given the position of the target, inverse kinematics to be computed to obtain the required joint angles for the robot's arm to reach the target. To solve the inverse kinematics for Nadine's 7 degree of freedom arm, 'Forward and Backward Reaching Inverse Kinematics' is implemented. It is a simple, fast and low computational cost iterative method in solving inverse kinematics problem. After all the joint angles are obtained, a trajectory for the motion will be planned. In face of obstacles, the path planned needs to avoid the obstacles so that the robot arm does not collide with them when reaching the target. Rapidly-exploring Random Tree algorithm is used for the path planning to actively avoid obstacles while reaching target.

***About the Speaker***

Soon Hing is currently serving his Internship at Institute for Media Innovation (IMI), NTU. He is an undergraduate from NTU in School of Mechanical and Aerospace Engineering, specializing in Mechatronics stream.

Supervisor: Assoc Prof Ang Whye Teong, School of Mechanical & Aerospace Engineering

**12:10pm – 12:20pm**

*7 mins presentation, 3 mins Q&A*

**Jordan Chong Sia**
***IMI Intern***
***School of Computer Science and Engineering***

## Designing a Highly Biomimetic Anthropomorphic Finger

Since the Stanford JPL hand was created in 1987, researchers have continued to push boundaries and achieve new heights in trying to replicate the dexterity, functionality, and appearance of the human hand. Many of such robotic hands have complex structures made up of multiple materials and are thus incredibly hard to replicate. Often, the detailed components of the finger are also overly simplified to increase robotic hand strength but at the cost of its motion range. With more and better 3D printing materials being developed, a single-material 3D printed finger with an intricate design is proposed. This novel anthropomorphic finger closely mimics the anatomy of the human finger in hopes of replicating its dexterity and motion range while ensuring ease of fabrication.

***About the Speaker***

Jordan is currently working as an intern at the Institute for Media Innovation (IMI), NTU. He is studying Computer Engineering at the School of Computer Science and Engineering in NTU as an undergraduate and is set to graduate in 2022.

Supervisor: Assoc Prof Lu Shijian, School of Computer Science and Engineering

**12:20pm – 12:30pm** — **Discussion & Closing Remarks**

**12:30pm** — **End of Research Seminar**