Title : **Irregular Surface Monitoring Framework on Heterogenous Unmanned Aerial Vehicle Platform**

Armagan Elibol[1], Prarinya Siritanawan[1], Jessada Karnjana[2]

[1] Graduate School of Advanced Science and Technology, Japan Advanced Institute of Science and Technology (JAIST), Japan
[2] National Electronics and Computer Technology Center (NECTEC), Thailand
{aelibol,prarinya}@jaist.ac.jp and Jessada.Karnjana@nectec.or.th

Full name of Speaker : **Prarinya Siritanawan**

Institution : **Japan Advanced Institute of Science and Technology (JAIST)**

Project Title: Irregular Surface Monitoring Framework on Heterogenous UAV Platform

Background :

- **Unmanned Aerial Vehicles (UAVs): Powerful tool for different applications**
  inspection, monitoring, mapping, data collecting, disaster mitigation, landslide analysis and many more.

- **For some non-destructive measurements, sensors need to touch on a surface (e.g., coating thickness)**

- **Recent UAVs Capable of landing planar non-delicate surfaces**
  Dam, Wall, Bridge and similar others.

	Manual	UAVs
Non Contact Type		
Contact Type		

Non-Contact-Type	Contact-Type
optical sensors	e.g., Ultrasonic inspection
Disadvantage： The quality of obtained data is strongly affected by different parameters	Disadvantage： UAVs cannot land on curved and delicate surfaces (e.g., airplanes) and cannot have firmly interaction with the environment.

Targets:

Developing both hardware and software frameworks including

- **Efficiently 2D-3D mapping delicate, non-planar, textureless and/or repetitive-textured, static and/or floating (or moving) surfaces.**
- **Landing/touching to the challenging surfaces (non-planar, slanted and many others).**
- **Collecting different non-destructive measurements from the surface using a robotic arm attached.**

Proposed Method:

1. **Scientific and Technological points of view**

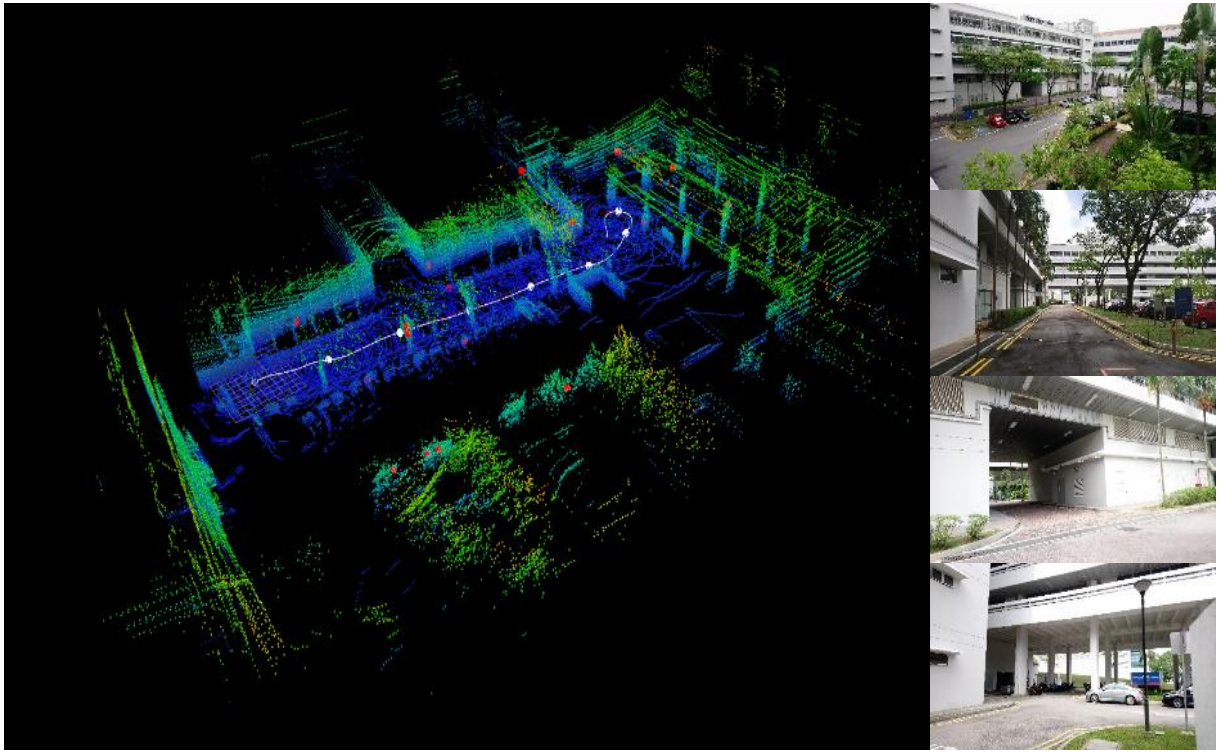
Design and develop a novel cooperative intelligent robotic tool with an arm attached.

Three key components will be developed:

A) **Sensing:** Inferring surface geometry through available sensor(s) data (Lidar, ToF, RGB-D camera, Thermal Sensor, ...) using 3D-SLAM

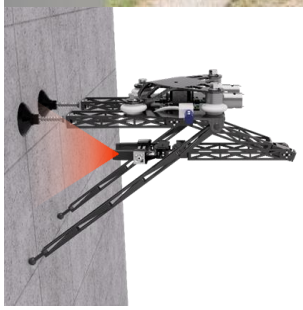
B) **Landing:** Finding optimum landing setup for its legs using the surface geometry and reinforcement learning by cooperating with the UAV control system

C) **Planning:** Trajectory/Path Planning for Robotic Arm to obtain measurements from the surface



Our 3D SLAM capability on an autonomous robot in outdoor environment using LiDAR sensor

Proposed Method:



Some example scenario images from initial design studies at JAIST

Proposed Method:

2. Implementation:

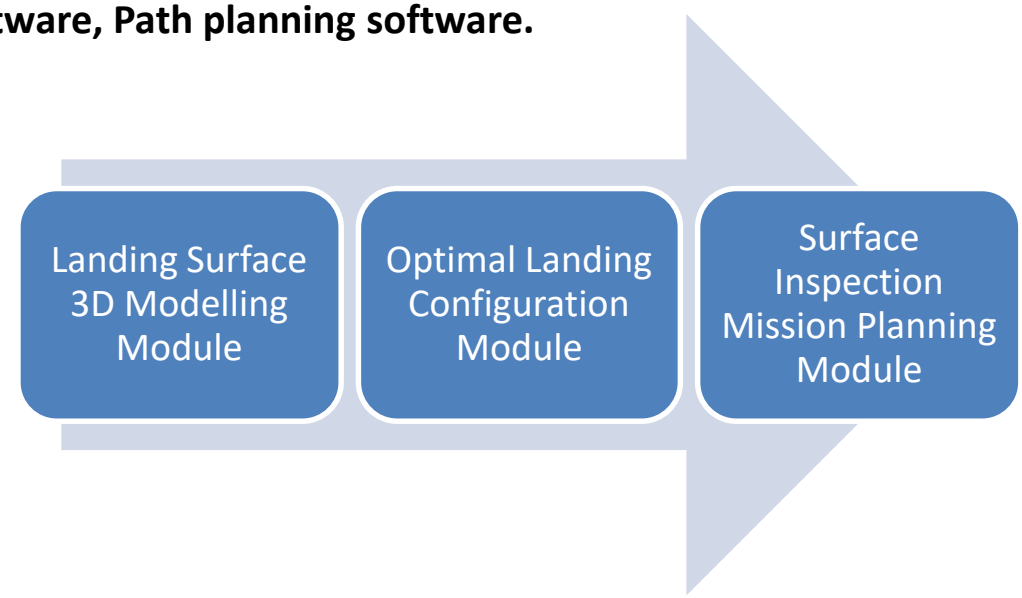
Designing, developing and testing different prototypes

Hardware:

- **Design development and computer simulations for developed designs**
- **Scalable model development through 3D printing technology avaiable at JAIST and evaluate performance in Lab. Environment**

Software:

- **ROS, 3D-SLAM, Sensor fusion**
- **Landing software, Path planning software.**



Proposed Method:

3. Experiments

- **Lab. Environment**

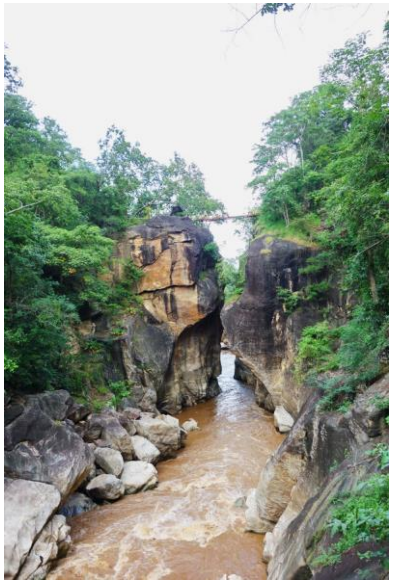
  Some 3D printed surfaces to be used as testbed in Lab. Environment

- **Real Environments**

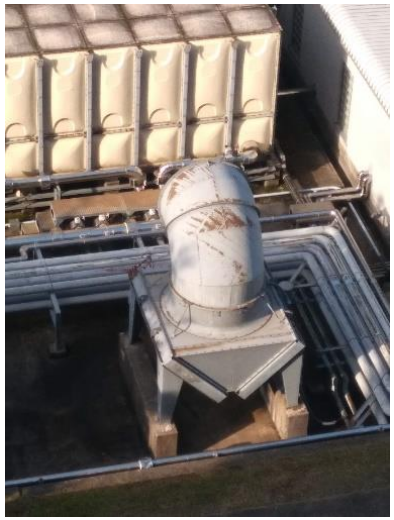
  Rock Fall/Landslide Analysis in Chiang Mai Thailand

  Inspection of Industrial Facilities within the School of Material Science at JAIST

  Ogoya Kouzan Museum Komatsu Japan



Chiang Mai Thailand



Industrial Facilities

Ogoya Kouzan Museum

Impact:

1. **Scientific and Technological**
   - **Efficient hardware and software tools for UAVs**

2. **Societal**
   - **Make UAVs more powerful for different applications such as**

     Search and Rescue (of buried survivors due to natural disasters or accidents at work),
     Mine search and clean,
     Detailed inspection of any type of surfaces (e.g., solar panel, aircraft and many more)

3. **Collaborative**
   - **Establish sustainable international relationship between JAIST (Japan) , NICT (Japan), NECTEC (Thailand) and potential partners from other ASEAN countries.**

Output/Outcome:

1. **Scientific**
   - **Modular, compact, attachable novel design robotic tool to improve the capabilities of UAVs**
   - **Efficient Mapping Methods for difficult surfaces (textureless, delicate, non-planar etc...) using Multimodal information fusion**
   - **Efficient Methods to collect data from irregular surfaces using a Robotic Arm**
2. **Societal**
   - **Different technological tools to be available and used**

     for and by different Humanitarian organizations, Companies and Science communities, e.g., Engineering, Geological Sciences, Environmental Sciences and many others.
3. **Collaborative**
   - **Strengthen and improve ties between JAIST and Institutions in ASEAN Countries**
   - **Drawing more attention to ASEAN IVO programs within JAIST**

Conclusion:

Targets:

Developing both hardware and software for a Cooperative intelligent robotic tool enabling UAVs

- **to sense the shape of challenging surfaces and to create their map**
- **to land on non-planar surfaces**
- **to use contact-type sensors**

Method:

- **Developing different legged platform designs**
- **Developing mapping methods through fusing heterogeneous sensors data**
- **Developing path/mission planning methods for obtaining contact-type measurements using Robotic Arm**

Scientific and Societal Impact:

- **Enlarge and enhance both capabilities and application areas of UAVs for better environment and human life.**