RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

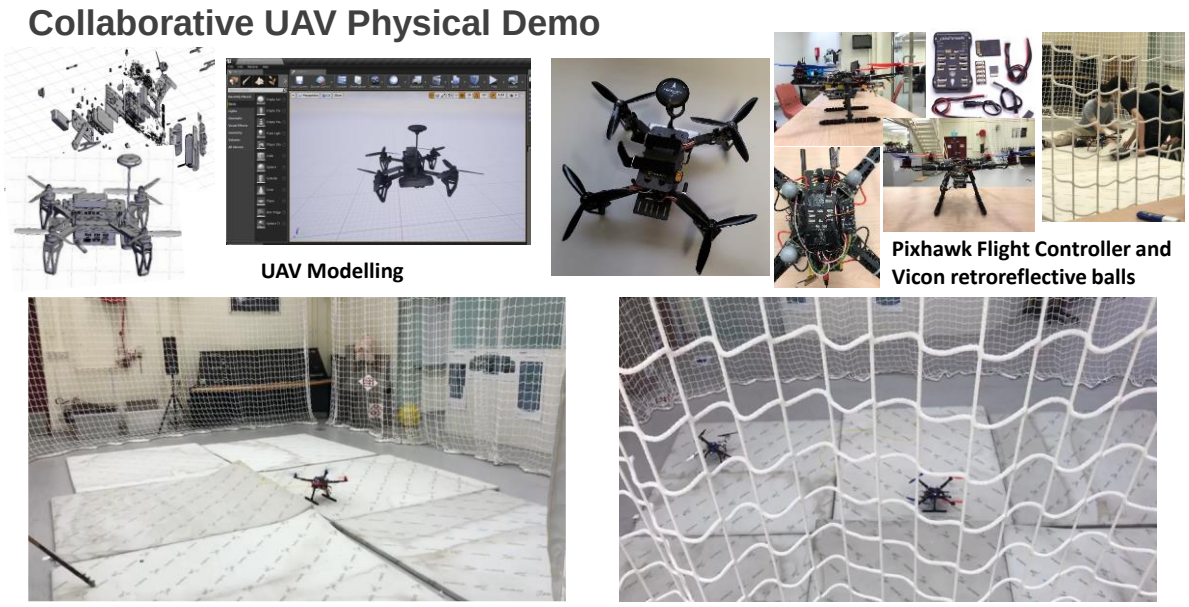
News Article for RISUD Emerging Frontier Area (EFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Li-Ta Hsu	AAE
2.	**Name of EFA:**	Safety of Unmanned Airborne System	
3.	**Project Title:**	Resilient Urban PNT Infrastructure to support safety of UAV remote sensing in urban regions	

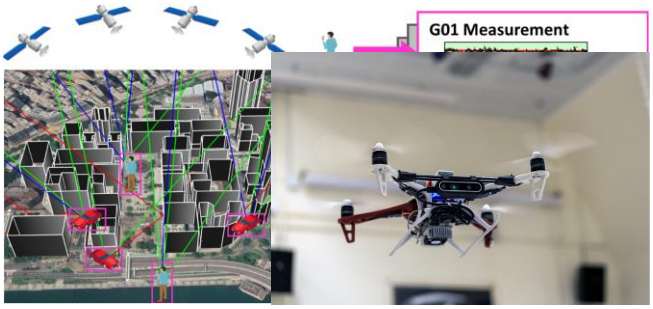
4. **Annual Progress/Achievement**

To develop safe and robust UAV to support the sustainability of smart cities, the capability to safely test the innovative UAV positioning and control algorithms is required. To achieve this goal, this year we focused on the preparation of the UAV platform in both hardware and software.

Hardware: the self-assembly quadcopter with an operation manual to be submitted to HK Civil Aviation Department. See the figure below for the reference.



Software: the Digital Twin of the multi-agent UAV in urban canyons. Please find the YouTube Link below for the detail. https://www.youtube.com/watch?v=2ynQnzerOck and https://www.youtube.com/watch?v=1OpyZEihxJ8



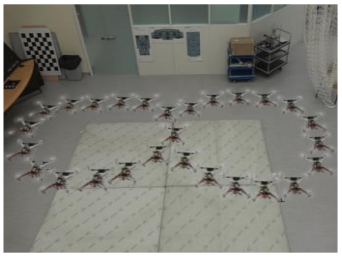
The digital twin we wish to develop is not only the model and the environments. We need to make sure the hardware we used can be realistically tested in the digital environment we built. Thus, we encounter one scientific challenge which is the simulation of the GNSS signal in urban areas. To deal with the challenge, we propose a GNSS Realistic Urban Multiagent Simulator (RUMS) based on the 3D city models that we purchased from the Land Department of Hong Kong and the ray-tracing simulations that popularly used in computer science study. The paper is published in a SCI journal (*Remote Sensing*). The graphical abstract can be found below. Zhang G., Xu B.^, Ng H.F., **Hsu L.T.*** (2021) GNSS RUMS: GNSS Realistic Urban Multi-agent Simulator for Collaborative Positioning Research, *Remote Sensing* 13(4):544

A Learning-Based Autonomous UAV System for Electrical & Mechanical Device Inspection

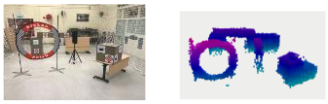
UAV inspections have become an increasingly popular choice in almost every industry in the last decade. Our department has developed an on-board real-time visual inspection system which can be implemented on small UAV platform for public infrastructure maintenance. This system relies on learning-based detection for perception, multi-sensor fusion for localization, state estimation of the target device and path planning for fully autonomous inspection. It utilizes spatial information generated by 2-D object detector for region proposal, which is fused with depth measurement for object state estimation. The developed system does not require any prior information about the location and category of the target device and can finished the visual inspection work much more efficiently than traditional methods. Feng, Y.R., Tse, K.W., Chen, S.Y., Wen, C.Y., Li, B.Y., "Learning-Based Autonomous UAV System for Electrical and Mechanical (E&M) Device Inspection," Sensors, Vol.21, 1385, pp. 1-23, Feb., 2021.

Vision-Based UAV Localization and Mapping System

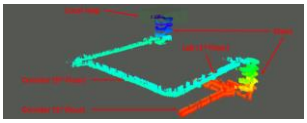
The visual perception and Simultaneous Localization and Mapping (SLAM) technology enhance UAV application scenarios from the typical GNSS-enabled environments to GNSS-denied environments. Our department started the perception research in 2018 and has developed a serial of SLAM systems, including a localization kit (feedback-feedforward loops based stereo inertial system, FLVIS), a ToF camera-based pose estimator (ToF-VIO), and a multilayer mapping kit (MLMapping). With the help of these SLAM stacks, the UAV can localize itself in the unknown environment and reconstruct the surrounding. AAE also developed an end-to-end SLAM simulator it has been used in teaching.



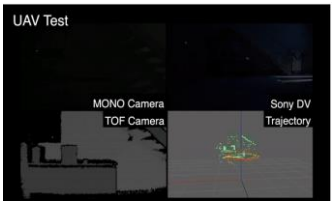
UAV flying '8' trajectory with FLVIS



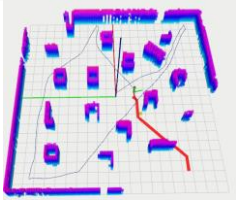
Environment and reconstructed map



Mapping in the large scale environment



Localiation in dark environment (ToF-VIO)



Click and fly level autonomyin simulator