A LONG ENDURANCE DRONE POWERED BY HYDROGEN FUEL CELL TECHNOLOGY WITH AI/ANALYTICS-ENABLED DETECTION CAPABILITIES

Project by:
Ong Shao Kai
Ye Jing Rui
Charith Wimalasire
Diploma in Mechatronics (Year 3)

COLLABORATION WITH:

Temasek POLYTECHNIC

PUB

PROJECT OBJECTIVES

To improve productivity and address the challenge of short flight endurance when using drone to inspect the water pipeline network across Singapore by PUB.

PROJECT SUMMARY

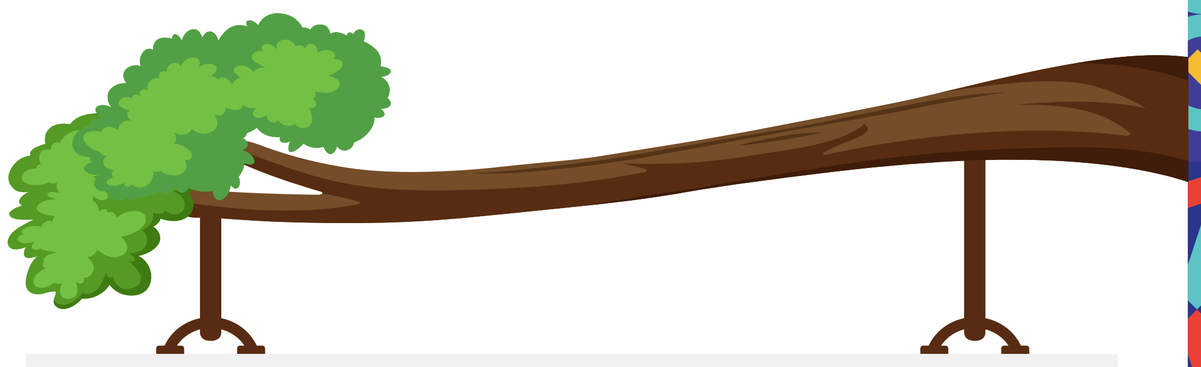
In this project, the team integrates a world-leading compact and light-weight fuel cell technology from Temasek Polytechnic (TP) with an in-house design drone to greatly increase its flight time. Meanwhile, an on-board edge computing system and a dual-lens camera system (vision and thermal), along with the corresponding data analytics algorithms, have been developed and integrated onto the drone. These advancements address the practical challenges faced by the PUB team and significantly enhance their productivity during routine inspection tasks, which are through flying the drone over Singapore's main water supply pipeline. The integrated system is capable of detecting and triggering alarm messages for various critical issues, such as pipe leaks, water stagnation, defects on the surface of water pipes, and illegal dumping.

Below are the project development and deployment summaries:

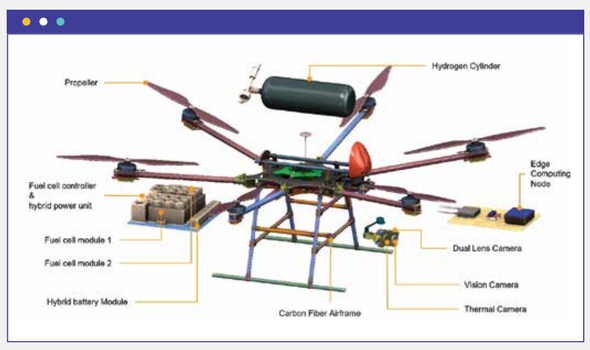
- **Dual-core power design for drone application**: A compact dual power core fuel cell system comprising two 1.8kW air-cooled fuel cell stacks and the corresponding control system.
- **Power hybrid technology with low-voltage drop power delivery**: As a power generator operating through chemical reactions on demand, fuel cell stacks inherently lack a good dynamic characteristic. To address this deficiency, the team has successfully developed and validated an efficient power hybrid technology.
- **Optimised airframe and on-board edge computing**: Implemented a customised airframe design and integrated an on-board edge computing capability into the drone platform, which includes: 1) Large efficiency gains in the airframe design; 2) On-board edge computing, along with custom-developed algorithms, which has been implemented for the detection of abnormal situations on PUB water pipelines. This include identifying issues such as pipe leaks, water stagnation, encroachment, and defects on the water pipes.

PROJECT OUTCOMES

- **Increase drone capability**: Boasting a flight duration of over 2 hours, this is about 2.5~3 times longer than off-the-shelf solutions powered by lithium batteries.
- **Productivity improvement**: The long flight endurance provides a one-shot flight solution instead of multi-swapping of the battery. Furthermore, the on-board intelligence enables automatic detection and alarming systems, eliminating the need for manual inspection.
- **Sustainable environment benefit**: The fuel cell power system provides high power density and promotes a sustainable environment. Integrating fuel cell technology onto the drone enhances performance, flight endurance, and aligns with our commitment to eco-friendly solutions.



Design Overview of the Smart Fuel Cell Drone



Practical Flight Test of the System

AI-Enhanced Fuel Cell Drone: Taking Flight with Sustainable Power

On-site Inspection Test Over a Water Pipeline

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