News Article for RISUD Strategic Focus Area (SFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Xingjian Jing	ME
2.	**Name of SFA:**	Robotics for urban infrastructure	
3.	**Project Title:**	Robotic Technology for Underwater Infrastructure Inspection	

4. **First Year Progress/Achievement (***in layman's language, no more than two A4 pages***)**

Monitoring underwater environments is a challenging problem for several reasons. Being underwater for long periods of time is inherently dangerous for humans, and there are strong limitations on duration and depth of dives. Even if an underwater robot is used, the lack of high bandwidth wireless communications underwater makes it difficult to remotely operating a vehicle underwater. However, many examples can be easily seen, strongly requiring effective technologies for underwater tasks, including long distance deep drainage tunnel inspection in HK, underwater inspection and maintenance of business-critical infrastructures such as cables or piping systems, natural sources inspection, or coastline monitoring etc. A reliable and innovative solution is thus in a great demand, which has not been well explored in the literature.

This project is aimed to present a unique bio-inspired robotic system equipped with desired powerful functions for underwater infrastructure inspection. To this aim, various fundamental technical issues would be addressed both in theory and methods. A novel robotic system will be developed with a unique bio-inspired structure design to ensure sufficient mobility and stability in dynamic underwater environments; and robust adaptive and fault tolerant control will be particularly investigated considering special underwater environment with limited visibility, potential complicated vortex or turbulence, and limited and inaccurate sensor information. Moreover, underwater navigation and localization will be preliminarily investigated potentially with robotic group coordination and communication regulation, and feasible fault detection and diagnosis with potential discontinuous and lost data records will also be preliminarily studied as well for underwater structural inspection application.

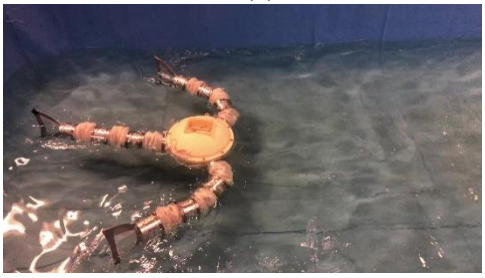
After one year investigation, a prototype of a novel bio-inspired omni-directional swimming three-tail robot (BIODTTRot) are designed and tested in a swimming pool. It is shown that this BIODTTRot is a unique design of fish-like robots, of high mobility, high agility and high stability in water environment, which can achieve multiple motion modes mimicking different aquatic animals, including

(1) Fast rotation without turning radius;

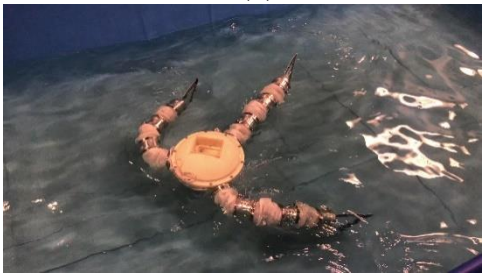
(2) Omini-directional movement in 3-D environment;
(3) Free switching among single-tail with two tails as steering, double-tail with one tail f steering, or triple tail propulsion modes;

(a)

(b)



(c)



(d)

(4) Diving or suspension in the water like an octopus or jellyfish;
(5) Potentially movement with 3 tails as legs on semi-dry ground.

As a summary of the unique features of this novel robot,

i) It is the first bio-inspired underwater robot with a three-tail design;
ii) It is able to achieve omnidirectional motion due to the three multi-DoF tails;
iii) It is able to mimic different aquatic species;
iv) High maneuverability and agility, compared to one-tail design;
v) Ability to move in different environments, including dry, water surface and underwater environments;
vi) It is a new energy-saving design, compared to classical-propelled underwater robots.

All the above moving capabilities are unique features that the BIODTTRot can achieve simultaneously, and which are also critically helpful for the robot to conduct underwater infrastructure inspection in dynamic and complex underwater environments.