NUS-developed manta ray robot swims faster and operates up to 10 hours

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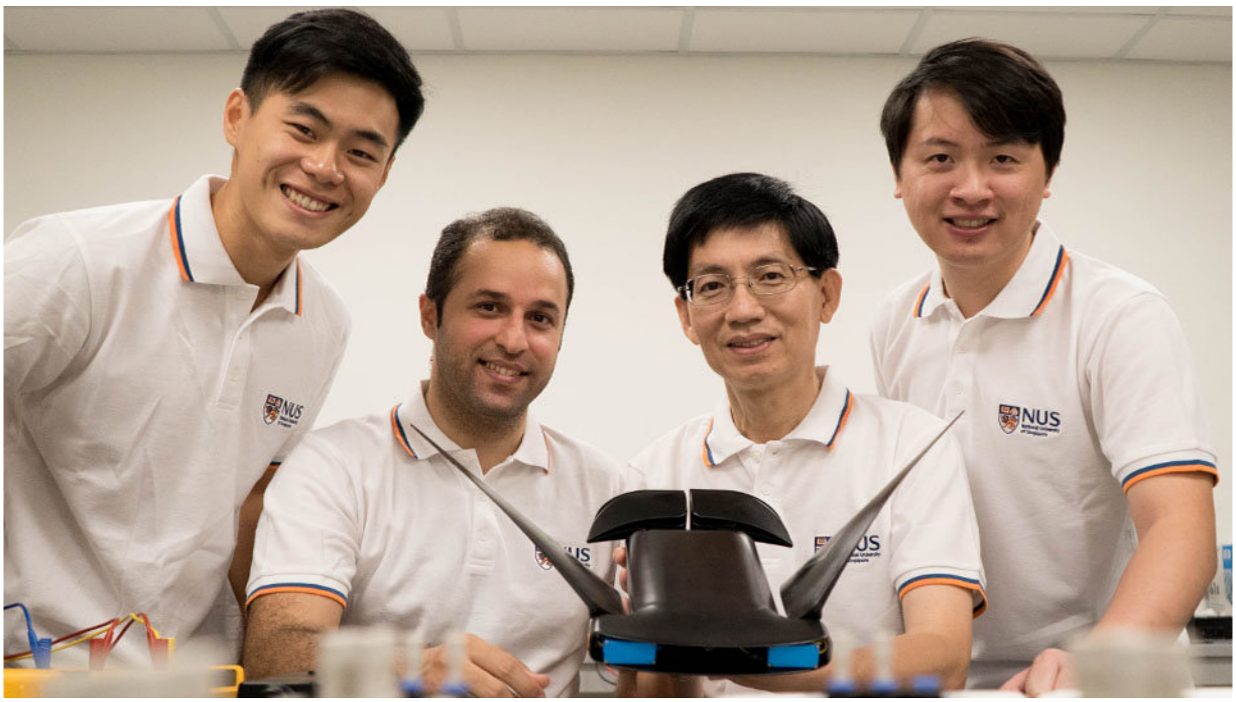

The research team from the NUS Department of Mechanical Engineering developed MantaDroid, a robotic manta ray that can swim at the speed of twice its body length per second for up to 10 hours . Credit: From left to right: Mr Gunawan Sun, Research Engineer; Dr Soheil Arastehfar, Research Fellow; Associate Professor Chew Chee Meng; and Dr Lu Hao, Research Fellow

Researchers from the National University of Singapore (NUS) have created MantaDroid, an aquatic robot that emulates the swimming locomotion of manta rays. The robotic manta ray, which swims at the speed of twice its body length per second and can operate for up to 10 hours, could potentially be employed for underwater surveillance in future.

Manta rays are considered one of nature's most graceful and efficient swimmers. Unlike most underwater species, manta rays possess a unique propulsion mechanism that enables them to cruise through turbulent seas by flapping their pectoral fins effortlessly. This distinctive feature has sparked great interests in understanding the science behind the mechanism and to incorporate similar mechanisms into autonomous underwater vehicles (AUVs).

Motivated to develop a bio-inspired AUV, a research team led by Associate Professor Chew Chee Meng from the Department of Mechanical Engineering at NUS Faculty of Engineering developed MantaDroid, which resembles a juvenile manta ray. Measuring 35cm in length, 63cm in width and weighing only 0.7kg, MantaDroid can swim at a speed of 0.7m per second, which is twice its body length, for up to 10 hours.

MantaDroid was designed and optimised over two years after an in-depth study of fluid dynamics and multiple experiments which included testing of 40 different fin designs. The fins that were eventually installed on the robot are a pair of flexible pectoral fins made using PVC sheets. The fins achieved good manoeuvrability and swimming capability when tested in the pool.

"Unlike other flapping-based underwater robots that replicate manta ray's flapping kinematics by using multiple motors to achieve active actuations throughout the fins, MantaDroid is powered by only one electric motor on each fin. We then let the passive flexibility of the fins interact naturally with the fluid dynamics of the water to propel the subsequent motions," explained Assoc Prof Chew.

MantaDroid makes a promising alternative to traditional propeller-based thrusters used in conventional AUVs, and could potentially operate for a longer range. Like the real manta ray, MantaDroid also has a flat and wide body that can accommodate a range of sensors and be utilised for different purposes such as studying marine biodiversity, measuring hydrographic data and performing search operations.

The NUS team will be testing MantaDroid in sea environment next, to investigate its swimming capability at different depths and its ability to withstand underwater current. The team is also working to incorporate more modes of movement in the robot's fin mechanism.

Provided by National University of Singapore

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