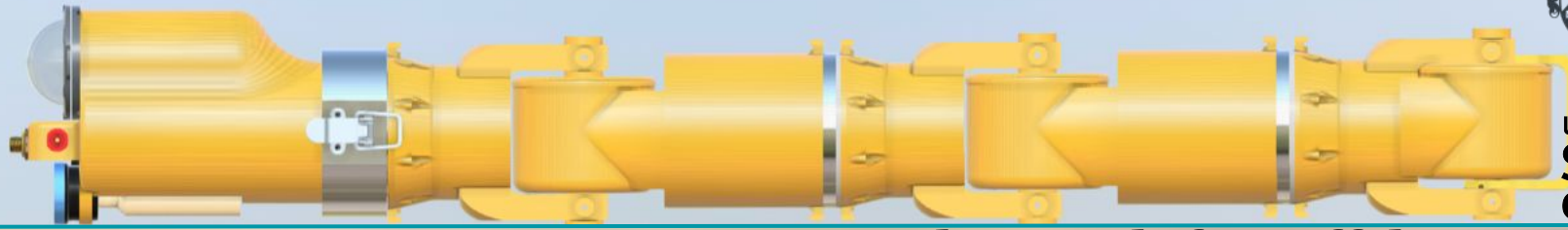

# Autonomous Biomimetic Robot-Fish for Offshore Wind Farm Inspection

# "RoboFish"

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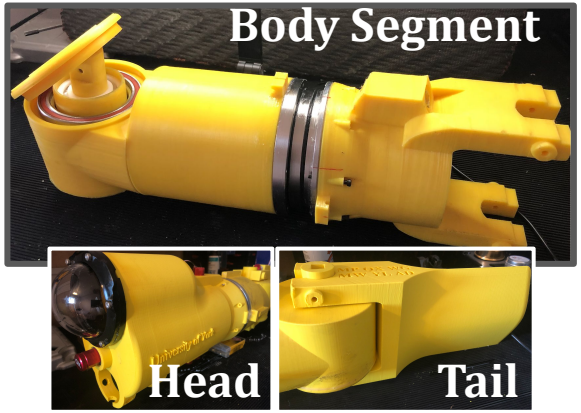
***Robofish*** is a biomimetic AUV capable of self-sufficient navigation about underwater structures

- It is intended for the purpose of locating and monitoring structural damage to wind farms.
- It moves like an eel/trout through full-body movement, allowing high agility in proximity.
- Its first 3D printed prototype could be spun out to a successful commercial product.



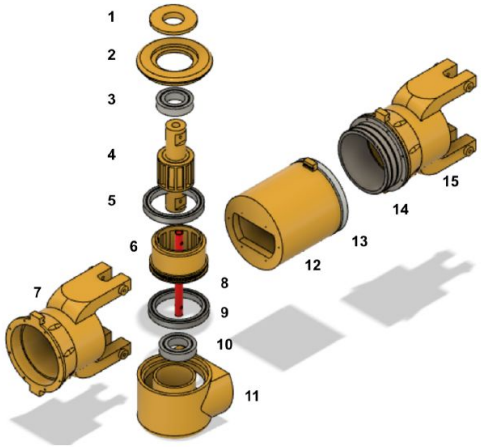
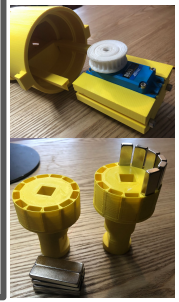




Fig. 4: All parts compromising one tested RoboFish segment: 1- Inner joint housing lid; 2- Outer joint housing lid; 3 & 10- Zirconia full ceramic bearing; 4- Driven shaft; 5 & 9- Stainless steel bearing; 6- Driving shaft; 7 & 15- Electronic housing; 8- Reinforcement Aluminum bar; 11- Joint housing; 12- Servo housing; 13- Female Stainless steel ring; 14- Male Stainless steel ring

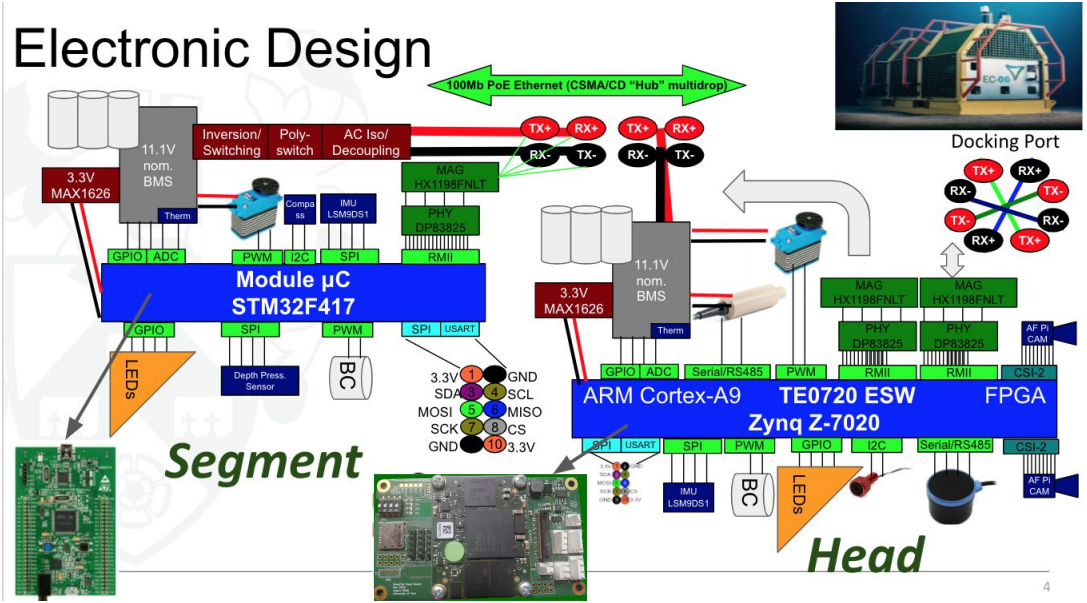


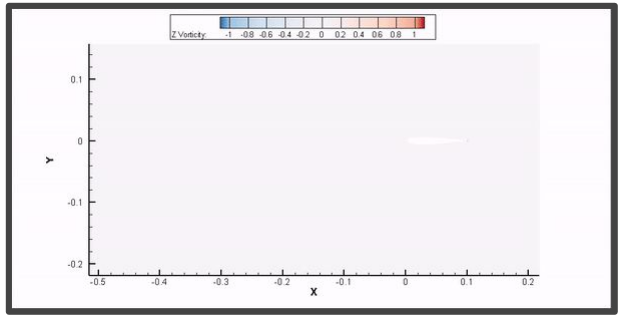
**Magnetic joint** technology was developed as a solution for a watertight jointed and 3D printed body.

- The design avoids dynamic interfaces and rotary seals.
- Magnetic blocks bond a free rotating inner shaft and a driven outer shaft for the joint to work.
- To provide 3D printed parts with the toughness and tolerance that O-rings need, two stainless-steel rings are incorporated in each segment as an intermediate connection and to allow disassembly.

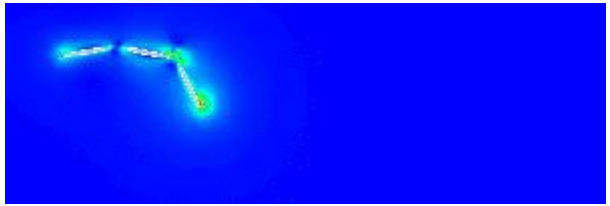
***Modular System*** RoboFish uses a modular software and hardware architecture.

- Each segment is self-contained and includes self-managed battery power, and actuator control using a low-cost microcontroller.
- Communications and power transfer between segments is through Ethernet and ZeroMQ messaging.
- The head segment contains a powerful Xilinx Zynq SoC that serves as a master control node, communications router, and FPGA-accelerated vision platform
- An acoustic rangefinder adds obstacle and target ranging to monocular vision.
- An acoustic modem provides low-rate communications at medium range for remote control, telemetry, and inter-vehicle coordination.




***CFD/FSI model of bio-inspired robotic fish created in the project***



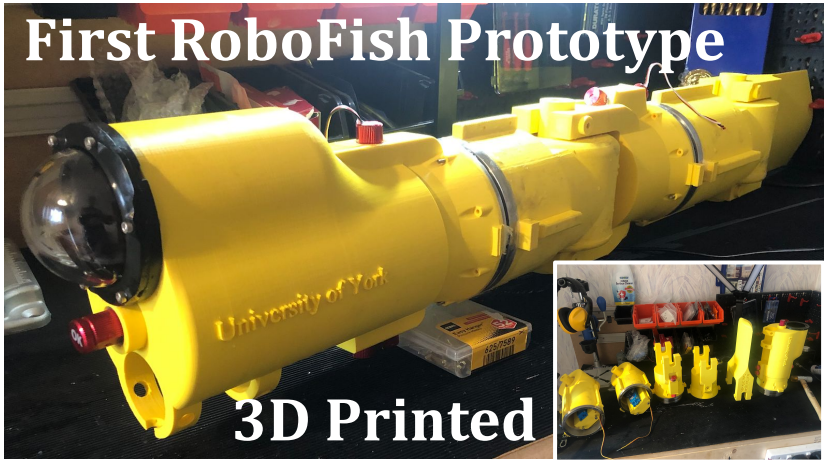
***Hydrodynamic Control*** is accomplished through control derived from CFD/FSI study of swimming movement.

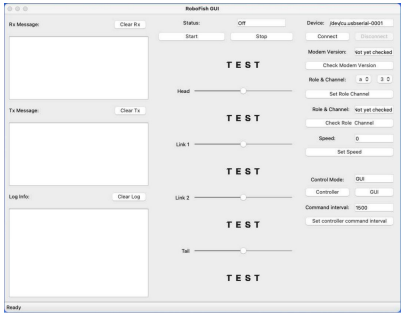
- Various swimming gaits are possible
- High agility, mitigates risk of fouling
- High efficiency in placement of the head can be achieved for docking

***Field tests*** proved water-tightness, joint functionality, body propulsion, acoustic communication. FPGA-accelerated visual software & hardware, head main board and segment boards electronics, wireless docking and charging have been initially tested and are ready for further field tests.

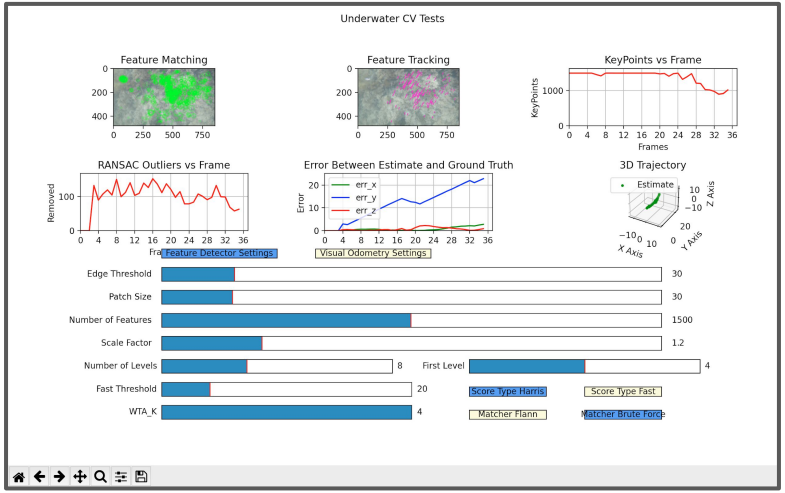
***Future:*** The use of modular electronics & actuation, networking architecture, 3D printing approach, and most of all the magnetic joint design are novel contributions to the state of the art that will enable new opportunities and future research projects.

New versions of a smaller size RoboFish, with particular focus on modularity, provide a flexible platform for numerical data validation & experimental investigation within a towing tank, providing further insight to disseminate the hydrodynamic performance under different flow conditions, to especially support the targeted underwater docking.

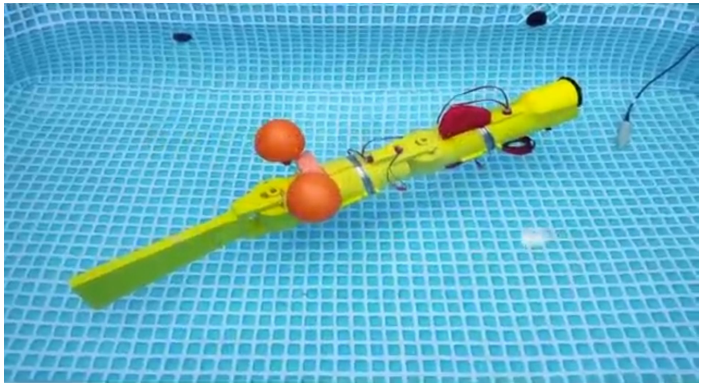



**GUI to acoustic modem interface for manual remote control**




**Testing an accelerated visual perception for underwater environments (YORK_UNI_DATASET)**



**Fourth test for RoboFish; body is watertight & actuating with slow propulsion**