**Design and Development of an Intelligent Biomimetic Autonomous Robotic Fish**

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The area of biomimetics involves the study and application of methods and concepts found in nature to solve engineering problems. In recent years the development of robotic fish has generated significant interest in the field of autonomous underwater vehicles because of the potential benefits which may be accrued over traditional methods in terms of propulsion efficiency and manoeuvrability.

**Aim and Objectives:** The aim of this research project is to construct a biologically inspired robotic fish using innovative design methods together with novel navigation, guidance and control techniques. Such robotic systems will be able to be employed to undertake environmental surveys in the oceans, and monitor the health of fish in aquaculture farms in an unobtrusive and friendly way to all marine life. Also it is envisaged that the technology developed will allow for replica models of rare and extinct sea fish/mammals to be manufactured for public interest in aquariums. A range of sensors are planned, including vision, lateral line and conductivity, temperature and depth (CTD) supplied by our industrial partner Valeport Ltd. In order to achieve this aim the following objectives are:

1. Design and analyse the different sections of the robotic fish using Solidworks and COSMOS.
2. Integrate existing compact sensors for vision and.
3. Develop a novel electric-field sensing lateral line sensor for proximity detection and 3D mapping of the local environment.
4. Design a fish behavioural algorithm, using sensory input, and based on novel artificial intelligence and evolutionary computational techniques.
5. Test the available sensors, servos and microcontroller on the available humanoid robot.
6. Integrate above to build a biomimetic autonomous robotic fish and trial under different conditions.

**Methodology:** Research will be undertaken to study the biomimicry behaviour of real fish and investigate other robotic fish that have been developed worldwide. In order to keep the cost low, much of the electronics will be common with the humanoid bipedal robot platform (developed by the Faculty of Technology for teaching and research) including the vision sensors, servos and micro-controllers. The robot fish will be designed and analysed using Solidworks and COSMOS, and a prototype will be constructed to verify the actual structure. The final fish system will be constructed using room temperature vulcanising rubber which is waterproof and flexible weighing between 2kg to 3kg with a length between 50cm to 100cm, and capable of achieving a top speed of half a knot. The head of the fish will be constructed using transparent Perspex and insulating oil will be used inside the fish to provide insulation between electronics and water, which with careful design will make the fish neutrally buoyant. The outer surface of the fish will be decorated to mimic the real fish. Lithium polymer battery will be used as it offers the best

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weight/size to energy density ratio of the battery chemistries commercially available today. Servos will be connected in different fashions to produce and mimic the real forward and turning movements. The combination of sonar and vision techniques will be utilised to sense and avoids any objects in the water. The fish will communicate to the external computer network (and internet) via a compact acoustic link. It is feasible to offer control via the internet as part of a technology outreach programme to schools. The resulting autonomous robot will have the potential to monitor its environment, interact with siblings and will be the focus of swarming research in shoals of fish. Further funds will be sought from NERC and EPSRC to investigate shoal-based environment monitoring, allowing large volumes of water to be monitored for CTD in a low cost manner.

**Deliverables:** (1) An intelligent biomimetic autonomous robotic fish capable of undertaking environmental surveys, and fish health monitoring missions, (2) A marine science and technology demonstrator for public engagement, (3) The advancement and integration of biomimicry ideas with artificial intelligence and evolutionary computational techniques, and (4) A PhD thesis and at least three high quality journal papers.

For an informal discussion on the project please contact: Dr Sanjay Sharma, sanjay.sharma@plymouth.ac.uk.