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Design of Biomimetic Robotic Fish for Under Water Exploration with a Control of Arduino Micro Controller

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Abstract— Development of underwater vehicles becomes an important tool to explore the underwater life. Here a remotely operated under water vehicle is taken into consideration over Autonomous vehicle to overcome the unavoidable loss and it is highly maneuverable. This remote vehicle adopts the biomimetic approach in the design aspects. The appealing nature of biomimetic approach is helpful for the robotic fish model. The possible design shape is analyzed and embedded with electronic subsystem like sensors: PIR sensor, GPS, the actuation is provided by the servo motor. The maneuvers, kinematics and controllability of the robotic fish is compared with the biological fish and the escape responses is given to the robotic fish to avoid the obstacle. The brain of this robotic fish is an Arduino Uno microcontroller in addition to that wireless camera is interfaced with the board, placed in the area of mouth of the fish and the whole body is made up of foam which is suitable and reliable for the fabrication purpose. As the wireless camera is placed in front really useful for the surveillance and monitoring purpose. The oscillating tail as propeller to imitate the anatomical form of fish.

Keywords*:* Robotic fish, biomimetic, sensors, Arduino Uno and remotely operated vehicle.

I. INTRODUCTION

Under water robotics is an emerging field of robotics and a large portion of the earth is covered by water and yet not fully explored, so plenty of resources still remain unknown. According to the National Science Foundation, seven critical areas in ocean system engineering were identified as follows: system for characterization of the sea bottom resources; systems for characterization of the water column resources; waste management systems; transport, power and communication systems; reliability of ocean systems; materials in the ocean environment; analysis and application of ocean data to develop ocean resources. It was also concluded in the report that the area of underwater robotics should be supported in all of the above areas. It is obvious that all kinds of ocean activities, including both scientific ocean related research, and commercial utilization of ocean resources, will be greatly enhanced by the development of an intelligent, robotic underwater work system [1].

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The underwater vehicles are classified into two Remotely Operated Vehicle (ROV) and Autonomous underwater Vehicle (AUV) whereas the ROV is controlled by remote in a remote location of ship or in land and the AUV is autonomous vehicle and free of tethering and have an in-built power supply and own behavioral program.

The motion control algorithms and robotic fish design with oscillating foil as propeller with a fuzzy logic controller explained by [2]. Thruster operated under water robot are also one of the design and the speed and orientation control of this robot either autonomous or remotely operated [3] and it discuss about the shape of the hull that drives the vehicle.

The biomimetic design principles and implantation with help of simulator and function while avoiding the obstacles is an important concern in under water navigation [4]. The robot propelled by Ionic Polymer Metal Composite (IPMC) actuator with microcontroller and in-built communication module with autonomous navigation using temperature sensor is given by [5]. So In this, ROV model considered since it is highly maneuverable and controllability of the robot is within our hands.

This ROV model adopts the biomimetic approach of fish since the application of robot is under water. The bio inspired robotic fish has wide range of application including underwater scientific survey, underwater archaeology, in some extent underwater ice-survey and the military application includes mine detection with the help of sonars and landing site surveys.

Here the body shapes of robotic fish were first analyzed and then the shape is decided according to the biomimetic approach and components required for the robot. Various subsystem are included in the robotic fish to enhance its senses and for wide area of application of the robotic fish.

II. METHODOLOGY

A. Body Shape

It is very well known that the fish can maneuver efficiently in water. Extensive effort are mainly devoted to the shape of the robot and finally bio inspired fish like robots i.e. biomimetic robotic fish considered for the body design. Prior to describe about the design, review of some of the biological aspect of the fish is required necessarily.

Ichthyology is a branch of biology deals with the study of fish science. One of the well-known species of fish is shark which is a superorder of fish category. Shark is of three main

parts head, trunk and tail. In addition to tails, fins are main important part of a fish to propel through the water. The tail is the thrust providing part and the fins are used for glide through the water.

In general the fins are categorized into two modes BCF-Body Caudal Fin mode and MPF- Median and Paired Fin mode. This two modes are responsible for the propulsion purpose, as shown in fig.1.

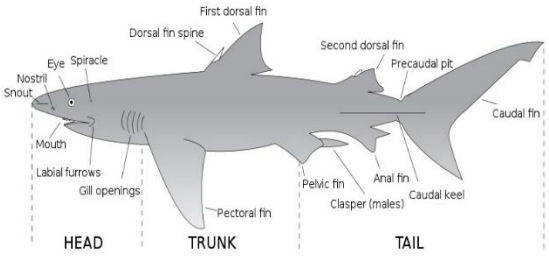

Fig.1. Shark anatomy [7].

The robotic fish adopts this anatomy includes the BCF mode and MPF mode i.e. body caudal fin and pectoral fins as a propulsion device. And various electronic subsystems are placed inside the body to generate the full model.

The performance of the robot fish is determined by the fish's both morphological parameters and kinematic parameters. By ichthyologic theories of propulsion, a framework taking into consideration of both mechatronic constraints in physical realization and feasibility of control methods is presented, where multiple linked robot fish propelled by a flexible posterior body and an oscillating tail fin can be easily developed.

B. Block Diagram

An overall block diagram is shown in Fig.2 & 3 and the system consists of various electronics parts. The system includes brain of the fish, Arduino Uno microcontroller, and PIR sensor, wireless camera, GPS device and finally servo motors for actuation.

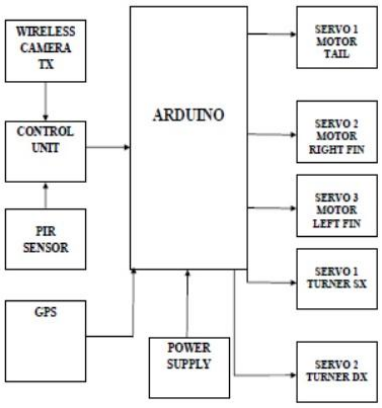

Fig.2. Transmitting side block diagram.

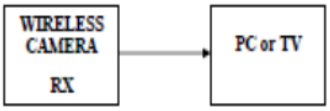

Fig.3. Receiving side block diagram.

The speed of swimming fish can be adjusted by changing oscillating frequency, oscillating amplitude and its orientation is tuned by different joint's deflections. By using the sensors obstacle avoidance is done. Sensors will sense the object and give the signal to the motor and the robot will eventually move away.

C. Arrangement Of Components.

The proper arrangement of components is also an important factor while maintaining the C.G of the robotic fish while the weighed components are placed lower body and other are placed above.

The Arduino microcontroller at the head part, all the connections are of wired. The camera is mounted at the mouth and the three servo motors are placed. One for the caudal fin at the tail and other two for the pectoral fins at right and left part of the trunk, whereas the GPS is placed at the trunk.

D.Simulation And Interfacing.

The simulation of motors for actuating fins is done through Proteus 8 professional software and the coding is done in Arduino software.

The interfacing details is as follows the three servo motors are connected to the output pin (9, 10, 11) of micro controller board. The PIR sensor is used to avoid the obstacles since it can sense the heat generated by the objects in underwater so it is most suitable for this application. This sensor is connected to the pin (7). The GPS is connected to the pin (o) and camera transmitting side to pin (2) while receiver side to (3).

For simulation, Arduino Uno library have to import first into the display and then sensors & motor have to be imported. As pin configuration is stated above the connections are made in the software. Later the program is loaded into the microcontroller for the simulation. The simulation is shown in fig.4.

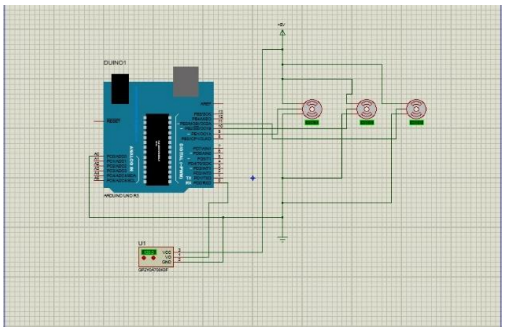

Fig.4. Simulation of motors with Arduino microcontroller.

E. Design Of Robotic Fish Model

The conceptual design of robotic fish model is done through the Pro-E software. The dimensions are considered as

per the components included in the block diagram. A 2D schematic view is shown in fig.5. All dimensions are in mm.

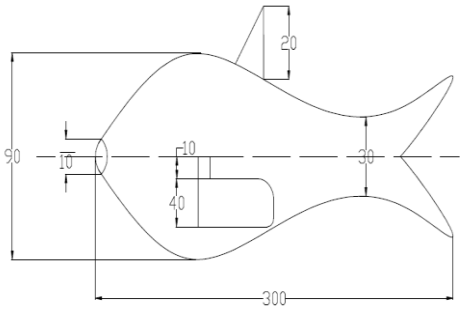

Fig.5. Specifications of the fish model.

Later a 3D model is developed and all three views of the robotic fish model is shown in fig.6.

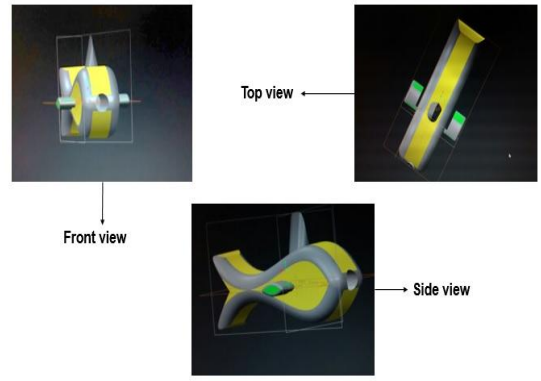

Fig.6. All three views of the 3D robotic fish model.

III. CONCLUSION AND FUTURE WORK

This paper has described overall design for biological fish inspired robotic implementation. This robotic fish is less expensive, robust and it is a helpful tool for the underwater archaeology department for scientific survey, surveillance and monitoring purpose. The hydrodynamic drag force simulation is in the next phase of project and on the research side, the robotic will built as an educational tool for students. The ongoing and future work is concentrated on the improvement of body design by implementing the multi-link body joints to attain the enhanced fish body wave motion. With rapid advancement in technology and sensing application, the model can be used for emerging concept of swarm robotics. In some extent of military purpose it can locate the mines with help of advanced Sonar.

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