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Design and Implementation of Swimming Robot Based on Labriform Model

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***Abstract*— In this days, the field of designing swimming robot takes the interest of researchers due to its intervention in many applications that required diving processes. There are several modes of swimming mechanism like carangiform and labriform modes. In this paper, swimming robot has been designed and implemented based on labriform mode. The forward motion and control of robot direction in horizontal plane has been achieved by pectoral fins, while the swimming robot performs diving process by using center of gravity control system. Proposed swimming robot model has been graphically simulated by MATLAB, also this robot is implemented by KKmulticontroller V.5.5 development kit and several experiments have been performed in order to testing swimming robot.**

***Index Terms*— Swimming robot, Pectoral fins, Center of gravity control system, obstacle avoidance, KKmulticontroller.**

I. Introduction

Comes the increased interest of researchers in swimming robots are the result of increased use these robots in many applications including industrial, exploratory, scientific applications, military applications ... etc. Since underwater animals are highly maneuverable and power-efficient endurance swimmers, the better route toward designing submersible vehicles with similar capabilities is to understand underwater animal's physiological design and control strategies. The development of swimming robot and good performance can be achieved by studying the behavior of swimming animals and representing this behavior by physical model [1].

The hydrodynamics mechanism of swimming organisms, the perfect maneuverable in swimming, and the idealistic of mechanical structure of swimming organisms represent a perfect tools for designing efficient underwater robots [2][3].

Swimming organisms divided into two swimming modes; carangiform (or anguilliformes) mode and labriform mode which used in swimming robot design [4].

In carangiform mode, the body of swimming organism is effect on the swimming process for example, some of swimming organisms used the tail fin to generate forward thrust force while pectoral fins used for balancing and direction control. Some researchers developed a high performance swimming robots for public exhibition. These robots designed with simple mechanical configuration to swim in 3D and can interact with human motion [5-8].

In labriform mode, there is no effect of body in swimming motion; the forward thrust force is generated by fins only. Some of swimming robot achieved by researchers includes high performance robot, high steering performance, high swimming velocity and navigation in 3D environment. The motion and direction control of these robots are performed by pectoral and tail fins only [9][10].

In this paper, a swimming robot has been designed and implemented based on labriform mode. The motion control of robot is performed by pectoral fins and body center of gravity in 3D. The pectoral fins model simulates the motion in horizontal plane (x-y coordinates) while the center of gravity of body is used for controlling motion in vertical plane (z-coordinate). The robot model will be simulated graphically by MATLAB. Also the mathematical model has been implemented by KK-multicontroller V5.5 development kit, and three servo motors for fins motion and center of gravity control system while the obstacle avoidance is performed by four Infrared (IR) sensors.

II. Robot Design

The structure of swimming robot is shown in Figure 1, which is compound of two pectoral fins, body center of gravity controller, and robot eyes. The robot can swim in horizontal plane by thrust force that generated by oscillation of pectoral fins while the robot can be swim in vertical plane depending on change the body center of gravity. To ensure the forward motion of swimming robot, the pectoral fins must be concave shape and selecting suitable volume for pectoral fin. Four AA batteries have been used for robot power supply, also used as weight for center gravity control system. Four IR sensors that compound robot eyes have been fixed on the front of swimming robot head, which is used to achieve obstacle avoidance.

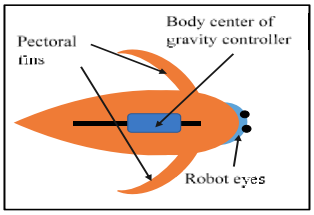

Fig.1 Swimming robot structure.