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Underwater Mini Drone "Kingfish"

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Abstract:

Our world is covered one-third with oceans hence exists numerous things to be explored, which create a greater necessity for specialized research platforms underwater. Designing such a platform is not easy. Constraints such as waterproof shielding, weight, buoyancy design and control mechanism of the platform should be considered. This paper describes a low cost cuboidal underwater Drone (UWD, KINGFISH) made of PVC controlled via remote using wireless communication is designed. The remote uses radio frequency to control the robot wirelessly to overcome the problems in wired communication. For underwater wireless communication, the frequency range should be selected suitably to provide effective communication, hence the frequency used for this underwater mini drone is 434 MHz. The robot is made waterproof by plastic shielding and is able to navigate in cardinal direction with obstacle avoidance. Thus an underwater research platform is designed and experimented in shallow water. Finally the evaluation of the experiment is presented to verify the basic motions of underwater mini drone. The experimental results demonstrates that the motion characteristics of the drone in the presented paper are acceptable, and the design is worthy of further research and application.

Keywords: Propellers, Underwater Vehicles, Wireless Motion Controls, Bilge Pump, Surveillance, PVC pipes.

I. INTRODUCTION

A robot is an automatic mechanical device. It can also work in harsh environments. Various kinds of robots have been developed parallel with the progress of computer and information processing technology. Robotics has been always one of the most key area of research and development. Robotics in itself is a huge domain and one part of its wireless robotics study and application has been in recent trends. In this paper one such application, Underwater Mini Drone, "KINGFISH" is presented for the purpose of underwater surveillance, controlled wirelessly using RF frequency for receiver (Rx) and transmitter (Tx). The basic functioning of the KINGFISH will be to provide the video of the surface under the water. It will be controlled by using RF frequency remote whose Rx will be mounted on the KINGFISH inside a waterproof hull containing other electronic equipments as well.

There is a great need for these kinds of robots in challenging cases especially in underwater. Applications of underwater robots and vehicles have increased enormously in recent years. Though most of the underwater vehicles are developed for scientific underwater investigation purpose, there is an also commercial and military application. The submarine accidents and investigations are performed with the help of these underwater vehicles, the Gas and Oil industry uses underwater robots to subside pipelines etc. To perform underwater robotic research, a felicitous platform is required. First of all it must be watertight. Even a single unit of water has the ability to stop the whole system from operating, so it must be provided with the complete shield to prevent the entry of water into the system. The weight of the platform is also one of the most significant factor while designing the system is taken into account. If the structure is too heavy, the platform will sink into depths and it would be not possible to get it back. If the structure is too light it will be hard to sink. Hence design of the outer frame must be made carefully. The shape and size of the outer frame plays a significant role. This project forth puts a solution for the above problem in an efficient manner for the proper working of the underwater vehicles. Authors in [1] have claimed to cover 500 ft. but in this work, range of approximately 15 meters deep in the water is covered with better controllability and communication between the transmitter and receiver module. Authors in [2] has described about an autonomous drone whereas the total control of the drone presented here is wireless.

II. METHEDOLOGY

The methodology adopted step by step to complete this work is as follows.

- Online research for deciding the components to be used.
- Study of the structure of the drone.
- Designing the structure of the drone.
- Deciding the thrusters and propellers.
- Fabricating the printed circuit board (PCB) for the control circuitry.
- Testing the drone in the water tank.
- Make the required adjustments after the trial run.

Details of all these points are mentioned in the following sections.

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III. SYSTEM DESIGN AND IMPLEMENTATION

For designing the drone the PVC pipes are used as shown in figure 1. Whole body is made from the pipe only by using the joints of the same material. The shape of KINGFISH is cuboidal frame. The proposed system has two shielding in which the components which are readily affected by water like 434MHz RF transceiver module and batteries are placed in the upper part of the structure and the propellers are exposed to water which are placed on the lower part of the structure. There is a waterproof camera that will be mounted at the front end of the structure for the underwater surveillance.

It should be designed carefully as even a single drop of water can damage the whole structure functioning because the transceiver and batteries are prone to water. These shielding are usually made by waterproof plastic sheets such as HDPE (high density polyethylene), acrylic sheets, moulded plastics etc. The cuboidal shaped structure of KINGFISH Drone made up of PVC pipes having motors bounded on its sides for navigation and movement control and waterproof hulls for keeping receiver and batteries inside the water.

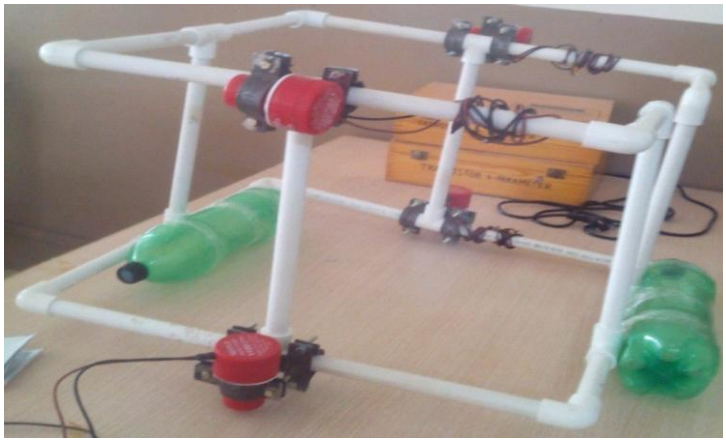

Fig. 1 Underwater Mini Drone "KINGFISH"

Specifications

- *Structure Specification*: 4 bilge pump of 1100 GPH, for wireless communication, we are using 434 MHz RF transmitter and Receiver module, the Power supply required is 12V 1amp, two Motor driver IC L293D ,plastic shielding for waterproof chamber which is required for the protection of the electronic components.
- *Motors' Specifications:* The proposed model consists of 4 bilge pump of 1100 GPH as shown in figure 2. Thrusters are designed [3] and these motors are responsible for upward, downward, left, right, forward and backward motion. Due to its wide application in marine areas and advantageous characteristics of controlling speed this motor is preferred. This pump is used as thrusters for the purpose of navigation and control.
- *RF transmitter receiver module:* We are using wireless communication. The basic modes are electromagnetic, optical and acoustic communication. Acoustic communication uses very low frequency by which low data rate are provided. In optical communication, the devices are pricey if the data rates are increased, the power consumption also rises. To hone the performance, the robots are needed to properly allocate its available resources based on the quality of channel which can be done by using RF range. Underwater communication also depends on air-water boundary, therefore, electromagnetic waves are preferred because it gives various frequency bands and a large range of data rates. In RF band the low frequency standard is 434MHz RF Transmitter Receiver module.

Fig. 2 1100 GPH Bilge thruster

- *Specific features of this Underwater Drone:*
- Coverage range - 15 meters (b) Modulation Technique – A S K Modulation (c) Data Rate – 8 kbps (d) Supply voltage - 5-12v (e) No. of channels - 4

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IV. COMMUNICATION SYSTEM USED IN UWD

Transmitter Module: In transmitter module as shown in figure 3, the available low RF frequency of 434 MHz is used as it allows peer to peer communication with multi channel facility. Printed circuit board for both transmitter and receiver module for drawing and fabrication. In transmitter side there are four switches which are used to control the movement on the receiver side which is connected with the transmitter control IC. The transmitter has encoder IC HT12E and. This is connected to the wired antenna and which helps to transmit these signals. This transmitter module is using IC 7805 and encoder ICHT12E.

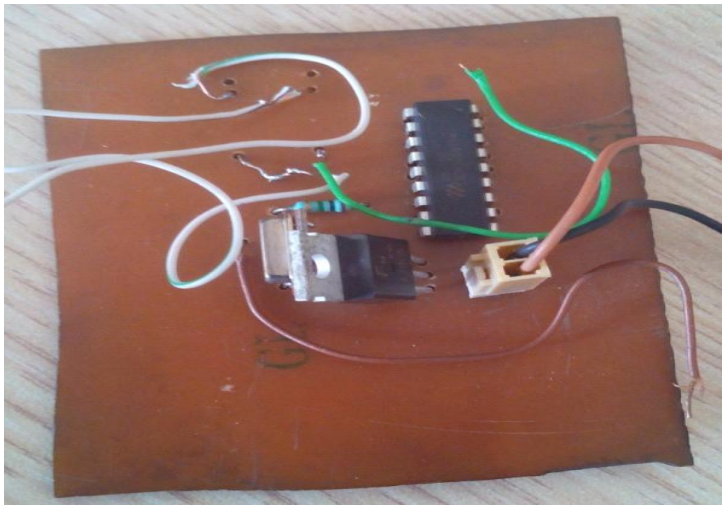

Fig.3 434 MHz transmitter module with IC 7805 and encoder IC HT12E

Receiver Module: Receiver with the same frequency of 434MHz is used at the receiver side as shown in figure 4.. The receiver has decoder IC HT12D which decodes the data from the transmitter side.

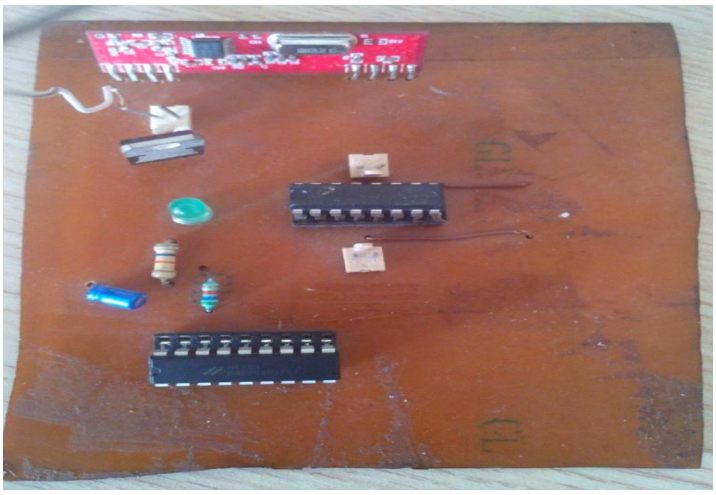

Fig. 4 .434 MHz Receiver module with IC 7805, IC HT12D and motor driving IC L293D.

Control Module: For navigation purpose by the robot according to the signals given by the remote and to avoid the errors, a circuit must be provided to control the functioning of motors and propellers. Reference [6] was considered for the actual idea of using the desired components. This work can be done by the control circuitry as it consists of motor driver circuit, motors and propellers. Motor driver circuit consists of a motor driver IC L23D. It is a 16 pin IC and capable of driving two DC motors simultaneously in any direction.

V. CONCLUSION AND FUTURE SCOPE

The final research platform has four propellers with two for forward, backward, right and left and two propellers for upward and downward motion. This system is designed to operate on remote controls from the transmitter side remote model. It can also be controlled by tethering.

It can be used in the fields like Defence, Ocean temperature monitoring, Homeland security, Ship wreck investigations, Ocean mining, Navigation, searching of black box of the aircrafts, submarine accidents etc.

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[3] homebuiltruvs.com for specification of motors.

[4] Proteus software for making the printed circuit board.

[5] wikipedia.org for gaining information regarding controllability.

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