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Semi Autonomous Underwater Surveillance Robot

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Abstract

This paper describes a semi autonomous under water remotely operated robot that can transmit data such as live video and pictures from under the water to an end user as it moves through the environment. This project is aimed to help monitor aquatic ecosystem like coral reefs so that it can be protected against depletion due to anthropological sources. In this work a robotic system is designed whose direction of motion can be controlled by a simple Radio Frequencymodule. The receiver of Radio Frequency module is placed on the surface of water tethered to the robot while the transmitter is on the shore. These robots will also have to provide the omni directional information about the environment. Video Transmission from under water to the surface is done using beagle bone black, asimple open source hardware wirelessly to an end user which isa laptop or a personal computer. A temperature sensor mountedon the robot monitors the temperature. A zigbee module is used to transmit and receive the readings of temperature wirelessly.

Keywords: Underwater surveillance robot, Beagle Bone, Arduino.

1. Introduction

One of the most rapidly advancing fields in technologyspectrum is robotics. Robots are employed in various places, starting from industries to medical fields. The need of systemsto work in hostile environments, those humans cannot workeasily like the deep sea environment or natural disaster affectedenvironments led to the development of remotely operatedrobots. Underwater robots are nowadays used by treasure hunters, underwater forensics, rescue workers, underwater archaeologists, fishermen, nature

videographers, underwater oilrig repairmen, tsunami scientists, fishery operators, spy robot, cave divers and so on.

Earth is an abundant supply of water. Oceans, seas etc. constitute an enormous 95 percent of the earth's total terraintype. Every week or so, there is news that people or technically archaeologists have unearthed artifacts or discovered a mine. Ifeven, after all this time the land holds so many mysteries, andthen we as humans must consider the possibility of discoveringthe mysteries beneath the ocean. This is because the ocean is ahuge reservoir of minerals, petroleum and artifacts which have withstood the tests of time. Humans have already thought onthis idea and have invented various technical marvels like the submersibles etc. But there is still one concept which is still in its dark age. This concept is that of underwater vehicles [1]. The advantages of underwater vehicles are many and they can be used for scientific, military and commercial applications [2, 3].

The paper is organised as follows: Section II describes the proposed methodology of the underwater robot. Section III explains the construction of the bot, section IV gives the features of the robot which includes video transmission and temperature detection under water. Section V presents the results and conclusion.

2. Proposed Methodology

The remotely operated underwater vehicle system consistsof two parts, the hardware part and software part. The hardwarepart consists of the structure of robot, the camera, the beaglebone black[4], Radio frequency module, motors for themovement of the robot, the Wi-Fi module for communicationand LM35 integrated circuit for temperature sensing. Thesoftware part consists of Ubuntu for the beaglebone black and the code for microcontroller for temperature sensing.

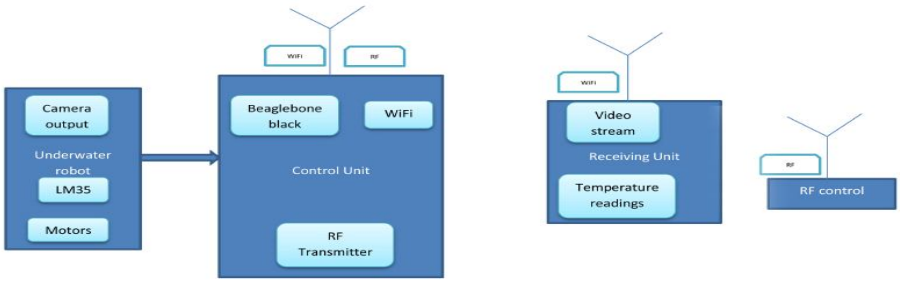

Fig. 1: Block Diagram of the proposed methodology.

The camera placed on the robot is connected to the beagleboneblack. The embedded device i.e. the beaglebone blackhas a WiFi module connected to it. The camera placed on therobot captures a video and this video is streamed from thebeaglebone black to the surface using WiFi module and the visuals can be viewed. The user can use a laptop with a WiFimodule to view the live video stream. The movement of therobot can be controlled by using the radio frequency module.

3. Construction of the robot

The central frame of the robot is built using PVC pipes. The motors are waterproofed using electrical tape and wax. After the shaft of the motor is attached with the propeller, the thrusters are mounted on to the vehicle frame. The thrusters will each be held onto the Remotely operated Vehicle [ROV] frame using two large blue heavy duty tie wraps.

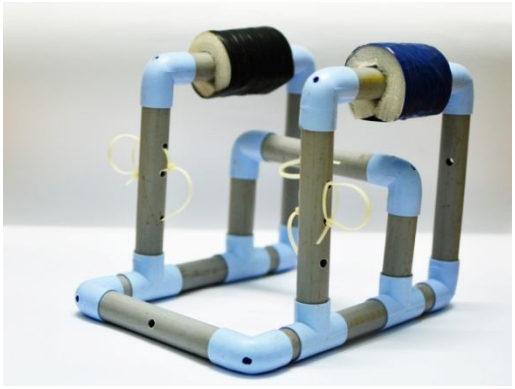

Fig. 2: Construction of the robot.

Motor controller driver. The underwater vehicle has two DC motors with 25000 RPM for locomotion. The motors are arranged in differential drive configuration i.e. the motors can move independent of each other. Using this configuration, the robot can move or rotate with zero turning radiuses. This is done by rotating one motor in clockwise direction and the other in anti-clockwise direction.

The robot motors are controlled with the help of L298Dmotor controller driver IC.A single motor driver IC can controlup to two motors. DC motors rotation direction depends on thepolarity of its power supply (ex. +/- forward, -/+ backward). Soif the polarity of power supply applied to motor is controlled, the rotation direction can also be controlled.

There are many ways to strengthen signal so that it's strongenough to drive a large load like motor. Transistor H-bridgecircuits, buffer chips and dedicated motor driver circuits canall be used. In this project IC L298D is used as it has all thefeatures for a good motor driver including thermal shutdowni.e. it will slow down and stop if overloaded and it is alsopreferred over L293D as this can handle more current (4A)than the previous one.

Navigation. A radio frequency (RF) module is a small electronic circuitused to transmit and receive radio signals on one of the manycarrier frequencies. This RF module comprises of an RF Transmitterand an RF Receiver. The transmitter/receiver (Tx/Rx)pair operates at a frequency of 434 MHz .An RF transmitterreceives serial data and transmits it wirelessly through RFthrough its antenna connected at pin4. The transmission occursat the rate of 5 Kbps .The transmitted data is received by anRF receiver operating at the same frequency as that of thetransmitter. The RF module is often used along with a pairof encoder/decoder. The encoder is used for encoding

paralleldata for transmission feed while reception is decoded by a decoder. When a key is pressed by the user it is transmitted withthe help of radio frequency transmitter. The radio frequencyreceiver which is attached to the motor driver IC receives thesignal and in turn controls the movement of the motor.

4. Features of the Robot

Video Streaming using Beagle bone. Vide Lan ClientVLC was initially developed for streaming the MPEG videosfrom one system to another. It is always better to stream videosusing the Graphical User Interphase of the VLC. The video from the beagle board that isbeing captured with the help of the Webcam is streamed to the destination address.

Temperature sensing using LM35. To measure temperature LM 35 integrated circuit sensors areused. The LM35 series are precision integrated-circuit temperaturesensors, with an output voltage linearly proportional tothe Centigrade temperature. Thus the LM35 has an advantage over linear temperature sensors calibrated in Kelvin, as theuser is not required to subtract a large constant voltage fromthe output to obtain convenient Centigrade scaling. The LM35does not require any external calibration or trimming to provide typical accuracies of C at room temperature and cover a full55C to +150C temperature range.

The output from the LM35 is 0.1V/'C. So, when temperaturesensed is 61'C, the output voltage is 0.61V. This analog voltageis read by the PIC 16F877A microprocessor and processedto display the corresponding temperature value on the laptopusing the zigbee module. The temperature range for this circuitis 0'C to 150'C[5, 6].

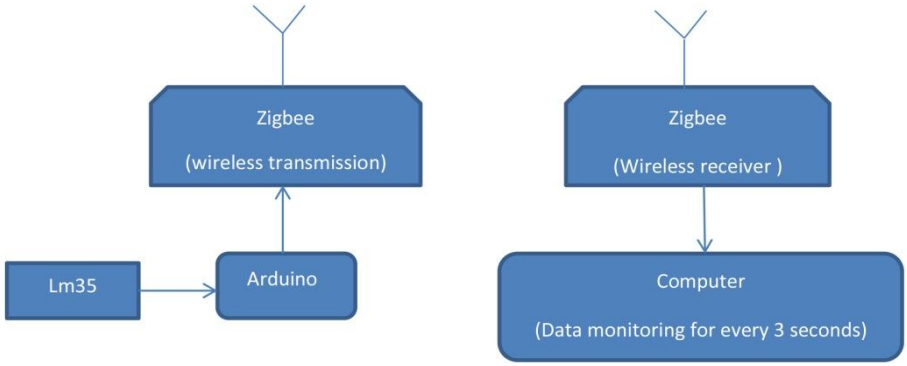

Fig. 3: Flow chart of the temperature sensor.

5. Result and Conclusion

The underwater surveillance robot developed has been tested in water pool with a depth of 5m. The robot performed well transmitting the captured video sequence to the user. It also detected the temperature change and updated the change dynamically at the remote computer.

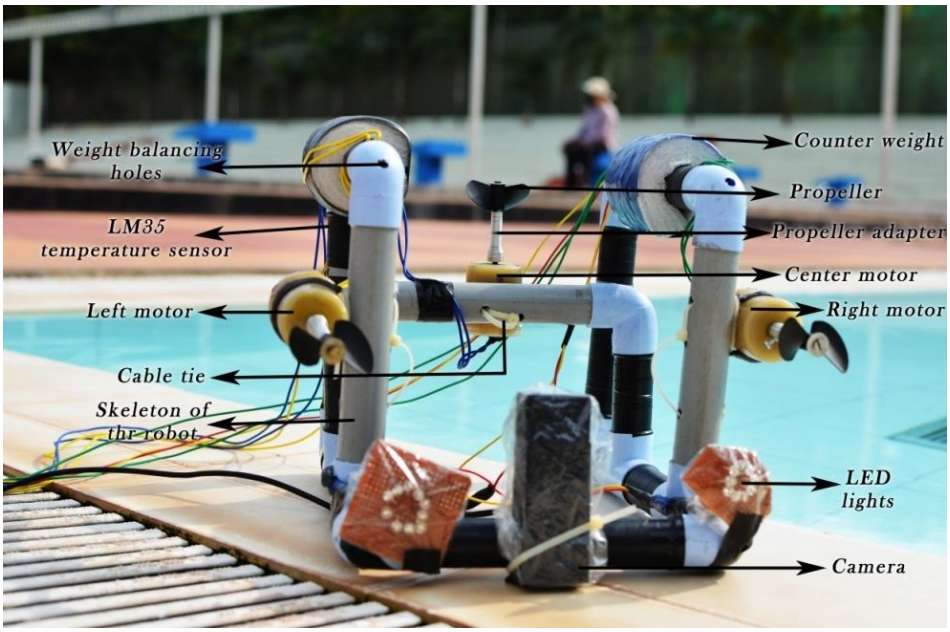

Fig. 4: Final setup.

The navigation of robot in an environment and the collectionof environmental details are very important tasks as far assurveillance applications are concerned. In such applications, the environment details are collected by video streaming theenvironment to an end user wirelessly and the end user inturn controls the robot wirelessly.

This approach of controlling the robot wirelessly using the video streamed from the robotwas done and the cameras position was controlled omnidirectionally as per the requirement by the end user. Thevideo was also streamed wirelessly from the robot using theBeagle Board with a LINUX platform. Thus, these robotswhich could be controlled wirelessly and which could transmitvideo wirelessly can be sent as first information givers forsurveillance applications.

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