Underwater Robot for Data Collection Using Optical Transceiver

Ms. S. Preethy and Mr. B. Arivu Selvam

***Abstract* – This paper studies the utilization of an autonomous underwater robot (AUR) to collect data from an underwater environment. The 3-D simulation can be done by using subsim AUV simulator to observe and overcome the problems in an underwater. Unlike the most existing underwater data collection systems that focus on radio frequency communication and acoustic modem this paper focuses on optical modem communication that provides an interaction between the user and an underwater robot so that the robot can be controlled from land surface. In this paper the design and experimental results of a system to control an underwater robot in real-time using optical modem link is presented.**

***Index Terms* – *A*utonomous underwater robot, Optical modem.**

I. INTRODUCTION

An underwater vehicle is a mobile robot which travels under water with the input from the operator, designed for a aquatic work environments. Here remote control is carried out through optical cables. A human operator on the base station watching a display that shows what the robot "sees". The operator can also maneuver the robot. Sophisticated underwater robot incorporates telepresence to give the operator a sense of being in the place of the machine.

A wire remote control of an underwater robot is turned into optical remote control. This optical communication remote enables to control an underwater robot from land surface. The robot is demonstrated with a human input device using the optical link remote control. Here the design and experimental results of a system to control an underwater robot in real-time sing optical modem link is presented.

For awareness about underwater operation 3D graphic simulation is done using subsim environment to monitor and overcome the problem in the underwater environment which makes more comfortable in the real time implementation. The 3D graphic object is created by using visual C++ and the result of simulation is shown. The various parameters are wall following, depth, floor measuring and so on.

The working of robotic motor is also shown in simulation by using proteus tool. Embedded c is coded for robotic motor control so that if problem occurs during real time implementation the coding is debugged in proteus software.

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II. RELATED WORK

Several approaches have been proposed in literature for underwater robot for underwater environment monitoring and data collection.

Geoffrey A. Hollinger and Sunav Choudhary [1] have proposed that ultrasonic acoustic modems are the most commonly used underwater communication system but it is extremely slow due to reflections and relatively slow speed of sound under water. Thus it is not possible to dynamically control under water vehicles remotely using acoustic communication in real time.

Detweiler C and Vasilesce I [2] have proposed that underwater vehicles are typically operated using a tether or a slow acoustic link. An underwater optical communication system that enables a high-throughput and a low-latency link to an underwater robot. The optical link allows the robot to operate in cluttered environments without the need for a tether.

Vu Minh Hung and Kyungnam Masan Uhn Joo Na [3] have proposed a method of underwater robot using two acoustic transducers, while radio waves are not used because it is strongly attenuated in complex environments as water. Underwater robots can be controlled by cables limited by distance, environment conditions, and are not flexible. Therefore it is necessary to develop a remote control system for underwater robots.

Section I of this paper is a background introduction. Section II discusses a brief literature review of underwater data collection methods. Section III describes data collection using optical modems. Section IV presents experimental results. Concluding remarks and a scope for further research are given in Section V.

III. PROPOSED SYSTEM

This system consists of optical modem which overcomes the problems of the previous method (ie) by using radio frequency communication and by acoustic modems. This system has several advantages in case of sparks it can avoid sparks which is important in flammable or explosive gas environments.

It is resistance to corrosion due to non-metallic transmission medium. It consists of high electrical resistance. The use of optical modems can avoid crosstalk. It also supports high bandwidth, high speed, low latency and good efficiency. The following is the schematic flow diagram of the system operation. Fiber optic cables have a much greater bandwidth than metal cables. This means that they can carry more data. Fiber optic cables are less susceptible than metal cables to interference. Fiber optic cables are much thinner and lighter than metal wires. Data can be transmitted digitally (the natural form for computer data) rather than analogically.

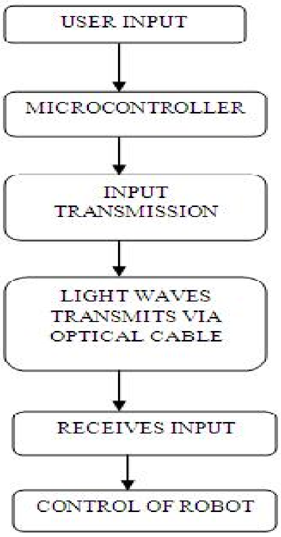

Fig. 1 Flow diagram of system operation

IV. EXPERIMENTAL SETUP

SOFTWARE:

Proteus software tool is used to simulate the robot. The design is created using the proteus tool. The components are selected from PIC component selection dialog box. It can be debugged at any time by selecting properties edit dialog box.

The circuit to be simulated is shown here, consisting of a PIC16F877 microcontroller unit (MCU), input push buttons and output LEDs which will display a binary count.

The ISIS user interface is shown here, consisting of edit; overview and object select windows, with edit toolbars. Components are added to the object list from the libraries provided, dropped onto the schematic, and connected up using virtual wiring. Components can be labeled and their simulation properties are can be modified.

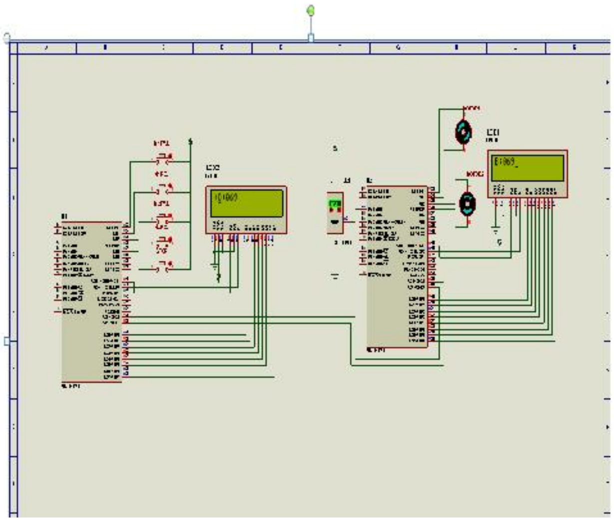

Fig.2 Simulation result of robotic motor control using proteus

SUBSIM:

3D graphic simulation of robot is developed in subsim environment. Application design, controller tuning, mission simulation, and the fault-tolerance can all be tested with the simulator. Subsim supports features like, three dimensional dynamic simulation of an AUV and the underwater environment with different kind of additional objects, simulation controlling, slow motion and time laps effects, feature for debugging the controller program, application programming interface that is compatible with C and C++, extensible through C++ model.

The subsim user interface can be divided into five parts:

1) Menu bar

The menu bar allows loading a simulation file and gives access to the plug-in and help system. Some features from the control panel can be found here as well.

2) World panel

The world panel consists of a main window for the visualization surrounded by sliders for camera navigation. The user's viewpoint is controlled by a visual camera which is taking continuous pictures of the scene. The position, orientation and zoom of the camera can be controlled either by mouse, keyboard or GUI sliders.

3) Control panel

The control panel consists of several parts to control the simulation or change visualization.

Simulation control

Start/pause/ and stop the simulation can be controlled by three buttons on the top, where as pause interrupts just the simulation, stop resets it as well. The simulation speed slider allows decelerating or accelerating the simulation. Be aware that slowing down or fasting up the execution may effects on the simulation results.

4) Information panel

The information panel holds a set of pages to get information about the simulation, world or active objects.

5) Status Bar

The main status bar (along the bottom of the main window) gives useful information about the status of the simulation. The status bar is divided into fields. The left-most field is for generic text and application messages. The field after "Threads" denotes the number of user programs currently running. The next field to the right shows the simulation status. This field will read either STOPPED, PAUSED or RUNNING depending on the simulator state. The next field to the right shows the simulation time in seconds. The right-most field shows the frames-per second render rate.

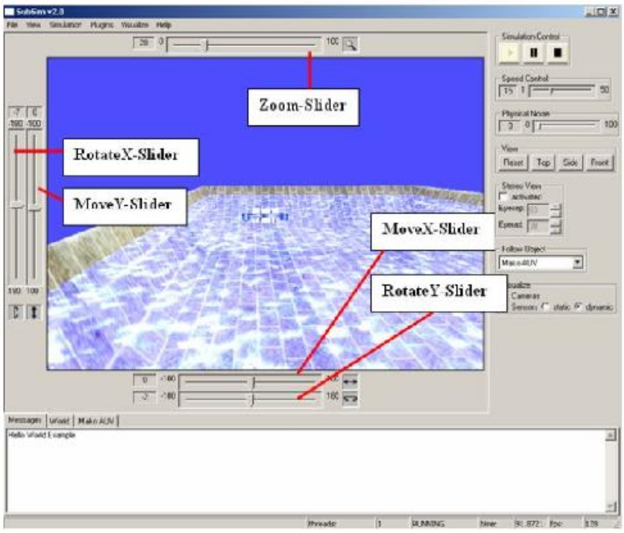

Fig. 3 Experimental result of subsim

HARDWARE:

i) Transmitter and receiver functions

The robot is allowed to monitor underwater environment in the submarine which is designed to have the receiver section with it and the motor that used in the robot is DC motor. The user input is given through the keypad to the microcontroller in the control room which is then given to the encoder decoder module then the output is transmitted via optical cable to the receiver section that is designed in the robot. After receiving, the same process happened in the receiver section again and the DC motor rotates according to the user input and the robot reacts according to the input.

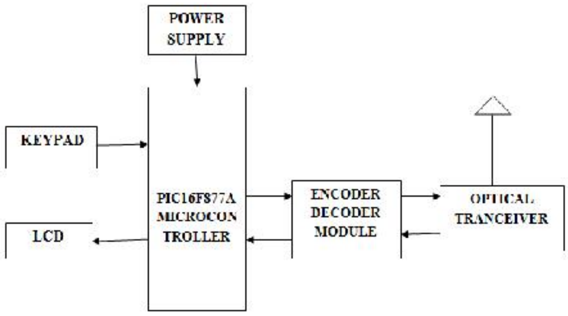

Fig. 4 Transmitter functional architecture

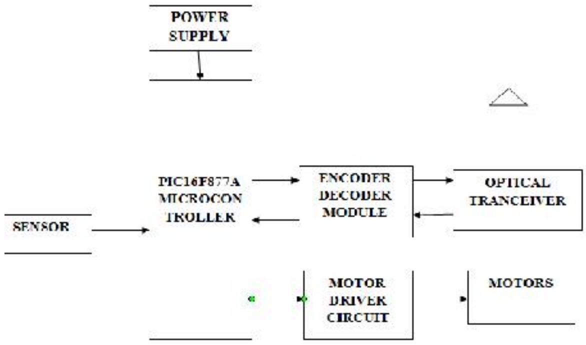

Fig. 5 Receiver functional architecture

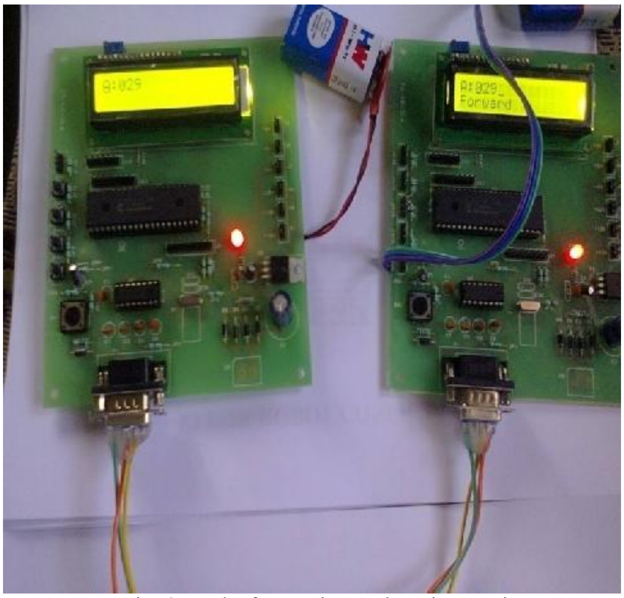

Fig. 6 Result of transmitter and receiver section

V. Conclusion and Future Work

The system software developed in Embedded C language has the ability of collecting, processing and sending data to control the operation of the motor and to display the sensor value. Thus by controlling the DC motor the movement of robot is controlled and the temperature sensor will be transmitted by the microcontroller through serial communication.

The control of robot is shown in simulation part, in future it can be extended into demonstration, and the idea behind this is to turn a wire remote control of an underwater robot into optical remote control. An underwater optical modem is to be developed and the design of system to control an underwater robot in real time using optical modem link is planned to be done.

REFERENCES

[1] Geoffrey A. Hollinger, Sunav Choudhary, Christopher Murphy, gaurav S. Sukhatme, Milica Stojanovic. "Underwater Data Collection Using Robotic Sensor Networks", in june 2012.
[2] Detweiler C, Vasilescu, I. Rus D, "Using Optical Communication for Remote Underwater Robot Operation", in oct 2010.
[3] VU MINH HUNG, KYUNGNAM MASAN UHN JOO NA, "Remote control system of 6 DOF Underwater Robot", in oct 2008.
[4] Singh S, Webster, S.E, Freitag l, Whitcomb L.L, "Acoustic Communication Performance Of The Nereus Vehicle to11,000 M Depth",in oct 2009.
[5] Camilli R, Bowen, A, Farr N, "Bright Blue: Advanced Technologies for Marine Environmental Monitoring and Offshore Energy", in may 2010.

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