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Embedded System for Sea Buoy to Locate, Detect and Collect Data about Marine Systems

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ABSTRACT: Sea buoy play an important role in the marine system. It is of great significance to design it that ensures continues monitoring, tracking, alerting and controlling of marine systems. The objective of this paper is to design the sea buoy that locate and track the underwater devices using sonar, protecting the fishermen from crossing the boundary (other country) using security alert system, monitoring the marine environment using different sensors, avoiding loss of equipments and the human beings and developing the efficient underwater communication. Three technologies have been used to design the entire system. First, underwater acoustic communication technology is used to detect the underwater device. The buoys equipment communicates with underwater device through the underwater acoustic channel Second, different sensors (temperature, pressure and humidity sensors) are used for marine environment monitoring. Finally, wireless communication technology is used to communicate sea buoy with the control system. The sea buoy system and other equipments, connects with the control centre via the wireless network to transmit data and receive instructions from the control unit.

KEYWORDS: Sea buoy, underwater acoustic communication, Sensors, Wireless communication technology.

I. INTRODUCTION

Nowadays, there are many problems occur in the marine region that includes difficulties in detecting the underwater device using underwater wireless communication, frequently heard about that the fishermen get arrested, imprisoned and even killed by the other country because of crossing their sea border and finally without knowing the environmental changes entering into the sea. These will leads to the loss of equipments and loss of valuable human being's life. In order to avoid these problems, it is hereby developed a system that locate, detect and collect data about marine environment and take the necessary action if required.

Underwater acoustic communication is a technique of sending and receiving messages under water. There are several ways of employing such communication but the most common is using hydrophones. Underwater acoustic communication technology can effectively be used for development of marine equipment monitoring systems. It is widely used in many applications such as marine environment monitoring, three dimensional monitoring of underwater equipments through multimedia communication, underwater mobile carrier navigation and positioning of underwater vehicles, marine resources detection, remote control of submarine mapping and offshore drilling industries. The sea buoy system and other equipments, connects with the control centre via the wireless network to transmit data and receive information from the control centre. The buoys equipment communicates with each other through the underwater acoustic channel. GPS/GSM modules are used in sea buoy which can detect the location of underwater devices. Additionally, the system can give an alert to the fishermen boats by alarm signal when a fisherman navigates beyond the country's border. Also, the environmental parameters like temperature, air pressure and humidity are monitored using wireless sensor network.

Under water communication is difficult because of some factors such as multi-path propagation, time variations of the channel, small available bandwidth and strong signal attenuation, especially over long ranges. There are low data rates in underwater communication when compared to terrestrial communication, since underwater communication

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uses acoustic waves instead of electromagnetic waves. As electromagnetic waves propagate poorly in sea water, acoustics provides the most effective medium to enable underwater communications.

Underwater acoustic communications are rapidly growing field of research and engineering applications. To maintain signal transmission, but eliminate physical connection of tethers, enables gathering of data from submerged instruments without human intervention, and unobstructed operation of unmanned or autonomous underwater vehicles (UUVs, AUVs). Acoustic waves are not the only means for wireless transmission of signals under water, but radio waves that will propagate any distance through conductive sea water are the extra low frequency wave (30Hz-300 Hz) which requires large antennae and high transmitter powers, and also there is high absorption of radio waves by water. Optical waves do not suffer so much from attenuation, but affected by scattering. Consequently, transmission of optical signals requires high precision. Acoustic waves remain the single best solution for communicating through under water.

II. RELATED WORK

Previously, underwater wireless communication technology is used for detecting the underwater device. The essential difference between underwater acoustic communication and wireless communication is their propagation mediums [1]. Due to the characteristics of high consumption of radio waves in the water, it is very unrealistic to use the wireless communication technology in underwater communication. Underwater wireless communication has been the obstacle of “sea, land and air” three-dimensional interconnection for a long time. So a lot of maturity program of the wireless communication cannot be directly applied in the underwater acoustic communication. Also, there is individual system used for track the underwater device, monitor the marine atmosphere and for protect the fishermen from crossing border.

At present, there are few existing systems that help to identify the current location of the fishing vessels using RADAR Navigation system. The accurate position information becomes even more critical and also there may be manual error made to find the boats crossing our boundary [6]. But this system provides the fastest and most accurate method to navigate, measure speed and determines location. Another system is GPS72H which is widely used by the fishermen. It is battery based power supply which stands only for 18 hours but the fishermen may be unfortunately missing their backup batteries will lead to danger.

In the paper “A System for Monitoring Marine Environments based on Wireless Sensor Networks [3]”, a wireless sensor network is used for monitoring a coastal shallow water marine environment. The sensor nodes take the oceanographic data and send them to the sink node using wireless communication. But it does not suited for coastal deep water marine environment.

III. SYSTEM DESIGN

The block diagram consists of three units. They are Sea buoy unit, Fishermen unit and Control room unit. The sea buoy is interfaced with sonar, GPS, GSM and different sensors like temperature, humidity and air pressure sensor through raspberry pi microcontroller which is shown in the Fig.1. Here, sonar detects the underwater device. Sensors are used to detect the temperature, humidity and air pressure of sea buoy atmosphere. GPS (Global Positioning System) is used for locating and positioning the both underwater and surface water devices. GSM (Global System for Mobile Communication) transmits and receives the data between sea buoy unit and control room unit. RF transmitter is used to transmit the signals to fishermen unit.

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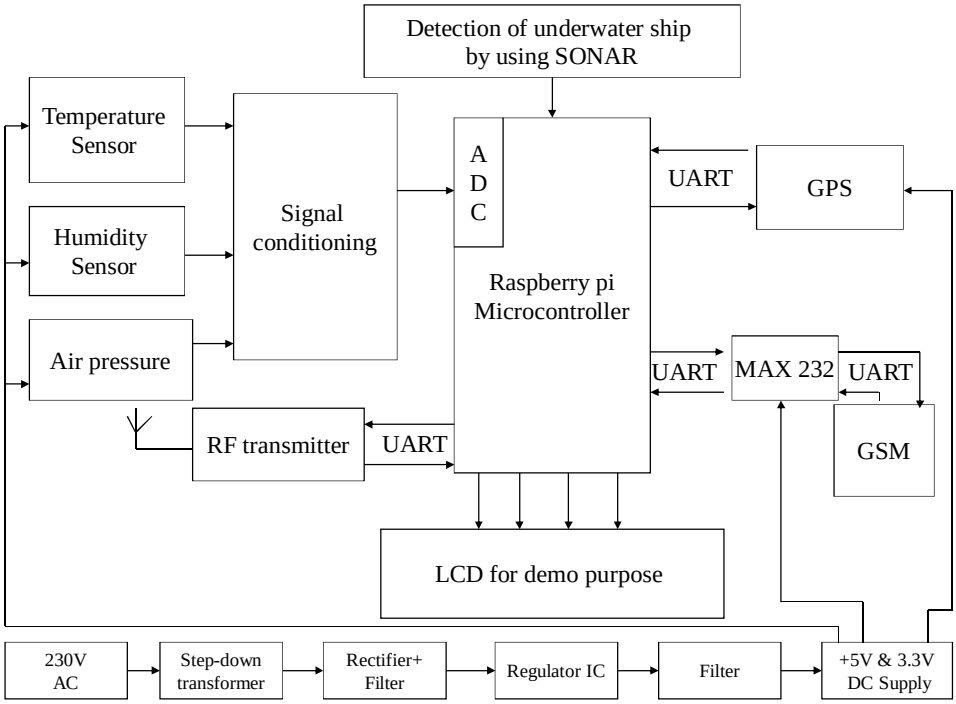

Fig.1 Sea Buoy Unit

If it is detected that the fishermen is going to cross the border of other country using GPS then the RF receiver receives the signal from the sea buoy and the alarm will be indicated in the fishermen unit using alarm system.

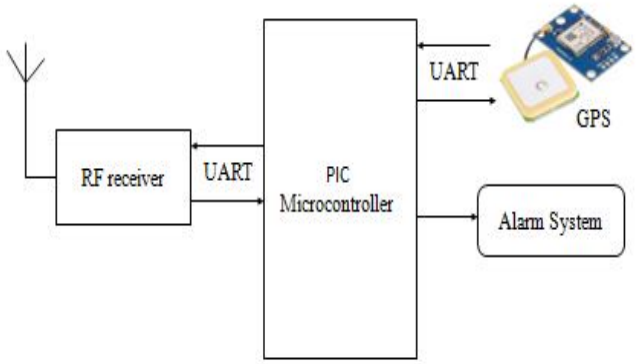

Fig .2 Fishermen Unit

In the control room unit, the marine environment is monitored using PC and the data collected through GSM from the sea buoy are displayed in the PC.

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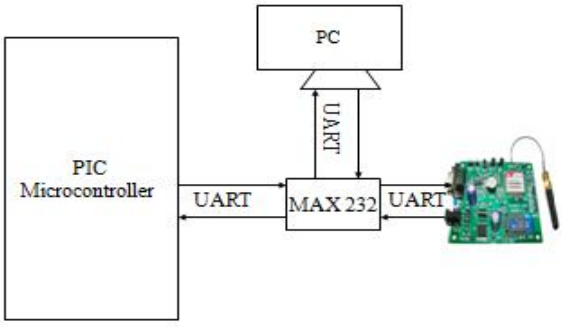

Fig.3 Control Room Unit

Surveillance is a key factor to ensure safety in various fields; here fishing boats in ocean/sea are monitored for illegal intrusion in other nation's boundary. Hence an effective scheme is designed here to overcome this threat with Global positioning system (GPS) which provides dynamic location of fishing vessel in water and microcontroller which compares GPS location and predefined boundary locations to determine whether the boat have crossed the border or not.

IV. THE HARDWARE DESIGN OF THE SYSTEM

A. SONAR

SONAR is used to detect the underwater device. I2CXL-MaxSonar-WR/WRC series is used here because I2CXL-MaxSonar-WR series is the first MaxSonar ultrasonic sensor to feature the I2C interface. The sensors have high acoustic power output along with real-time auto calibration for changing conditions (voltage and acoustic or electrical noise) that ensure users receive the most reliable (in air) ranging data for every reading taken. The I2CXL MaxSonar-WR low power 3V – 5.5V operation provides very short to long-range detection and ranging, in a tiny and compact form factor. The I2CXL-MaxSonar-WR will typically detect objects from 0-cm to 765-cm (3-cm to 625-cm for the WRC) and provide sonar range information from 20-cm out to 765-cm with 1-cm resolution. Objects from 0-cm (3-cm for the WRC) to 20-cm typically range as 20-cm.

B. SENSORS

There are mainly three sensors are used to monitor the marine environment. They are temperature sensor, pressure sensor and humidity sensor. Temperature sensor used is LM35 (precision centigrade temperature sensor) which has an operating range of -55 to 150 degree Celsius. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. Pressure sensor used is MP3V5050 (Integrated silicon pressure sensor On-chip signal conditioned, temperature compensated and calibrated). Its pressure range is 0 to 50 kPa (0 to 7.25 psi) and its output range is 0.06 to 2.82 V. Humidity sensor used is EMD 2000. It senses the amount of water vapour present in atmospheric air. The following table shows the normal sea level pressure, temperature and humidity value,

S. NO	PARAMETERS	VALUES
1.	Pressure	101 kpa
2.	Temperature	15 degree Celsius
3.	Humidity	Zero percent

Table.1 Normal sea level pressure, temperature and humidity value

C. RASPBERRY PI

The Raspberry Pi is a low cost, credit-card sized computer developed chip in the UK by the raspberry pi foundation. It plugs into a computer monitor or TV, and uses a standard keyboard and mouse. The Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SoC), which includes ARM1176JZF-S 700 MHz processor Video Core IV

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GPU 256 megabytes of RAM Upgraded (Model B & Model B+) to 512 MB. The system has Secure Digital (SD) or MicroSD (Model B+) sockets. Model B raspberry pi is used which is as shown as follows:

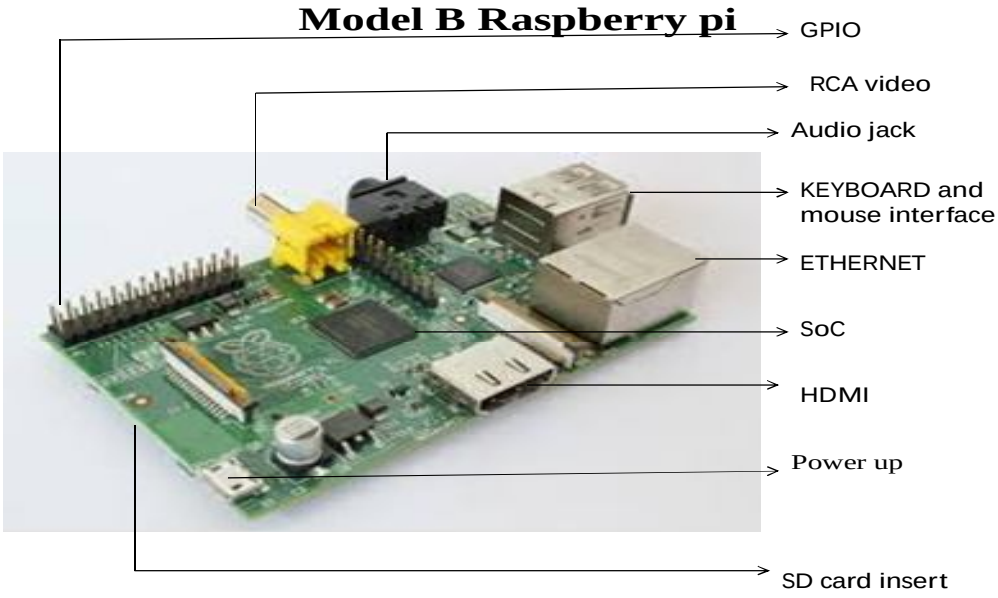

Fig.4

Raspberry pi Model B

D. GPS/GSM

GPS (Global Positioning System) satellite positioning used for tracking and positioning both the underwater and surface water. It gives the exact position of latitude and longitude anywhere on earth and in works under all weather conditions. Hence it is used in this paper which provides a position of fishermen boat at all instances. GSM (Global system for mobile communication) used for data transmission between sea buoy and control centre.

E. RF TRANSMITTER AND RECEIVER

RF transmitter and receiver transmit and receive the alert signal to the fishermen unit and from the sea buoy unit. The alert signal is transmitted through RF signal at very high frequency (30-300MHz)range which covers wide area.

F. PIC MICROCONTROLLER

PIC microcontroller used in both the fishermen and control unit is PIC16F887. The PIC16F887 is one of the latest products from Microchip. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc. Its operating range is 20 MHZ frequency. The features includes in the PIC16F887 are 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 14 channels of 10-bit Analog-to-Digital (A/D) converter, 1 capture/compare/PWM and 1 Enhanced capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and an Enhanced Universal Asynchronous Receiver Transmitter (EUSART). Microcontroller in control room unit compares the received GPS location of fishermen vessel and predefined boundary locations to determine whether the boat have crossed the border or not.

G. PERSONAL COMPUTER

PC used here mainly for monitoring the sea buoy unit and fishermen unit. The received data from the sea buoy unit through the GSM are collected and stored in the PC.

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V. RESULT AND DISCUSSION

A. HARDWARE IMPLEMENTATION OF THE SEA BUOY UNIT

The following figure shows the hardware implementation for monitoring the sea buoy atmospheric parameters. Here, raspberry pi is connected with the developer board through GPIO bus. The atmospheric parameters like temperature, air pressure and humidity can be measured through sensors like temperature sensor, air pressure sensor and humidity sensor which is interfaced with the developer board.

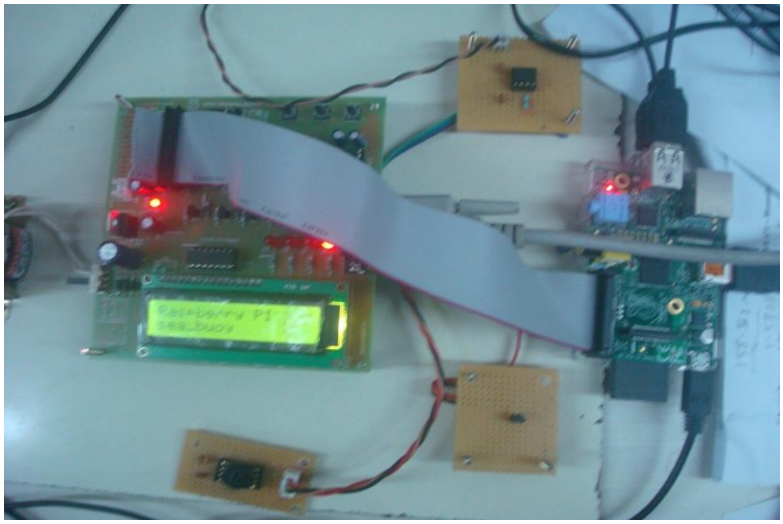

Fig. 5 Hardware implementation of monitoring the sea buoy environmental parameters

The software implementation of the above work is done using python. The following steps will be done while working with the python.

1. Connect raspberry pi model B with the system. And make all the connection necessary for the system design before power ON the supply.
2. Now ON the system and the python script run on the window. In that window enter the login id as pi and password as raspberry,
3. Open IDLE, select file→new window →write the program code in that window and save it with the extension py.
4. Execute the program in Lx terminal.
5. Open Lx terminal and enter sudo python/path of the program file and then click enter. The program automatically compiled and executed.

B. SIMULATION RESULT

The pressure, humidity and temperature values measured by the sensors are shown in the following figure. The simulation is done using Python.

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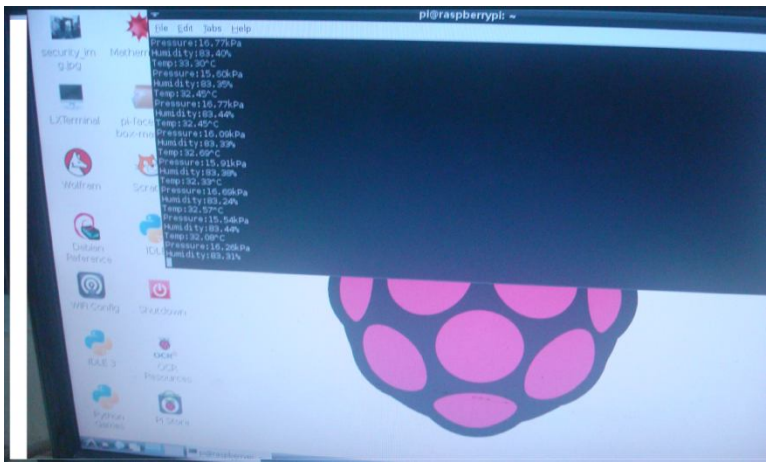

Fig. 6 Software implementation of monitoring the sea buoy environmental parameters

Measured parameter values like pressure, humidity and temperature changes from time to time are shown in the following table.

PARAMETER	MEASURED VALUES				
Temperature (Degree Celsius)	30	45	45	69	33
Pressure (kpa)	16.77	15.60	16.77	16.09	15.91
Humidity (%)	83.40	83.35	83.44	83.33	83.38

Table.2 Measured Parameter Values Changes from Time to Time

My paper contains three applications. They are

1. Monitoring the environmental parameters like temperature, air pressure and humidity in the marine region.
2. Detecting underwater device using Sonar.
3. Developing fishermen security alert system to avoid crossing the border of other country.

One of the application is done here i.e. the environmental parameters of the marine region are monitored. Temperature, pressure and humidity sensors are interfaced with the raspberry pi and the simulation is done using python.

Other parts will be done in the future. Sonar, GPS, GSM, RF transmitter, RF receiver and PIC microcontrollers are used for detecting underwater device and alert system for fishermen.

VI. CONCLUSION AND FUTURE WORK

The design of sea buoys that uses various technology ensures continues monitoring, tracking, alerting and controlling of marine systems. It can achieve real-time location of underwater communication devices and route tracking to avoid the loss of the device, as well as assist to retrieve the lost device. The proposed system also detects the maritime boundary of the country and exact location of the fishermen boat to avoid the loss of device and human beings where the long time dispute between Sri Lanka and India still exists. It indicates the fishermen that he has crossed the boundary by an alarm system. In future, the underwater device will be detected using sonar and the security alert system will be developed for fishermen boat to avoid them to cross the border of other country.

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