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Accident Prevention System for Boats in Maritime

Simhadri Angadi and S. Manikandaswamy

ABSTRACT

Ultrasonic (US) and sonar (PIR) sensors are broadly used in mobile applications for distance measurements. In this project, an obstacle detection system is built based up on these two types of sensors. The system is intended for use the elderly and people with vision impairment. The prototype developed has been tested to detect obstacles and shows accuracies of 95% to 99% for distance measurements if the sensor circuits are calibrated properly and their output liberalized. The system also demonstrates good detection for different obstacle materials (e.g., wood, plastic, mirror, plywood and concretes) and colors. In this project the sonar ranging sensor senses the distance between the searching object under the sea.

Keywords: Accident prevention, Boat, maritime, obstacle detection, sonar sensor, PIC microcontroller, vibration sensor.

I. INTRODUCTION

Ultrasonic (US) and Sonar (PIR) sensors are frequently used for mid-range distance measurements [1]. Typical applications of these sensors include navigation (human, mobile robot and vehicles) as obstacle avoidance, distance measurement, counting devices (e.g., wait watcher, product assembly), surveillance system, object detection, edge detection and military applications. Robustness, lightweight, inexpensive and fast response time makes these sensors suitable to be used in the development of navigation aids. In addition, the ability to gather information about the scene of action, localization, and mapping make the ultrasonic sensor suitable in detecting the obstacles. Furthermore, a ultrasonic sensor can detect all types of obstacle (e.g., wooden based object, metal concrete wall, plastics, rubber based product, transparent object, etc.) and it is not affected by poor lighting condition.

The sonar sensor was evaluated using three metrics: accuracy, robustness, and real-time performance [2]. The accuracy of the sonar sensor was evaluated by comparing the distances reported by the sensor with known distances. The robustness of the sensor was evaluated by comparing the sensor's accuracy under different noise and reverberation conditions in different environments. Finally, the sensor's real time performance was evaluated by measuring the time that it takes to process a signal and return a measurement when different optimizations are applied [3].

II. SYSTEM STRUCTURE AND METHODOLOGY

Basically, there are two main modules which include a control module that controls the communication of data and control over the channels, a microcontroller which is programmed to monitor and identify the obstacles and do necessary action, a sensor module which consists of all the sensors and a power module to provide the required power. The main functioning is to identify the obstacle and gives the information to the boat via Bluetooth in maritime and send the information to neighbor boat when the boat is damaged due to any obstacles under the sea.

* Department of Electronics and Communication Engineering, SRM University, Kancheepuram, India, *E-mail: simhadri.121@gmail.com; manikandaswamy.s@ktr.srmuniv.ac.in*

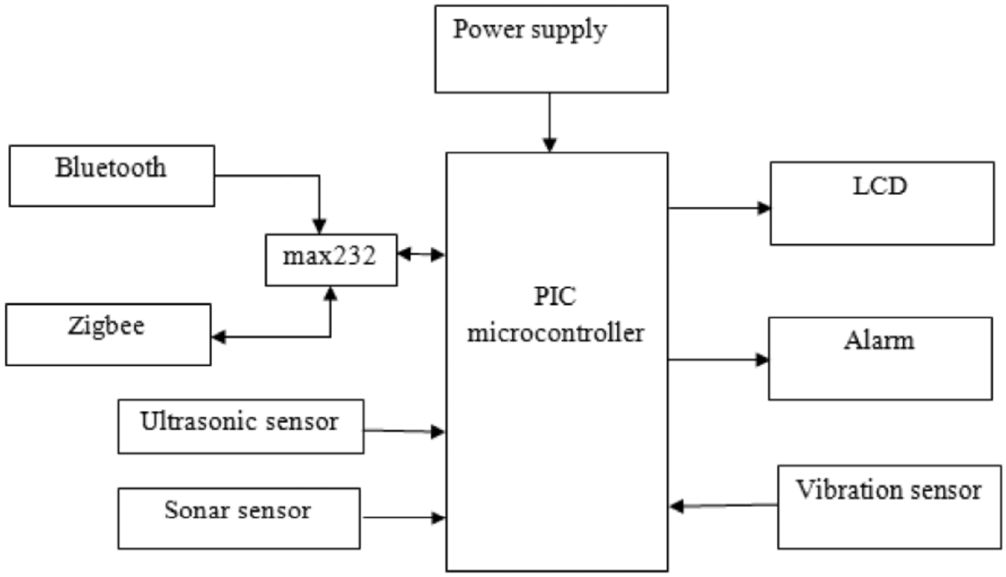

Figure 1: Block Diagram of Transmitter Section

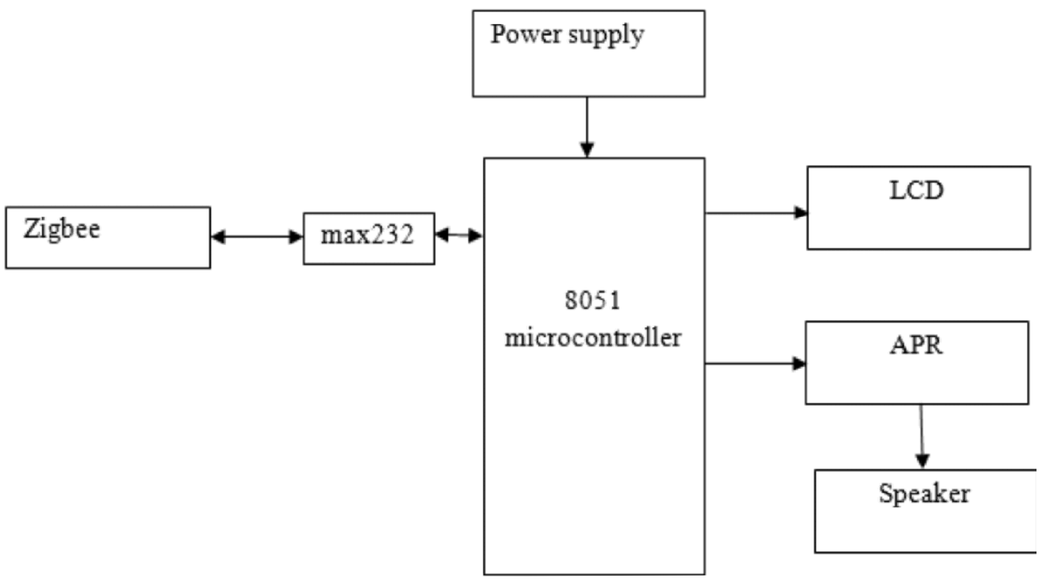

Figure 2: Block Diagram of Receiver Section

(A) Ultrasonic sensor

Ultrasonic sensors (HCSR04) are devices that use electrical to mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rare factions along the direction of wave propagation through the medium [4].

These sensors are categorized in two types according to their working phenomenon piezoelectric sensors and electrostatic sensors [5]. The ultrasonic sensor using the piezoelectric principle is in this project. Piezoelectric ultrasonic sensors use a piezoelectric material to generate the ultrasonic waves. Ultrasonic waves are longitudinal mechanical waves which travel as a succession of compressions and rarefactions along the direction of wave propagation through the medium [6]. Any sound wave above the human auditory range of 20,000 Hz is called ultrasound.

(B) Sonar sensor (passive infrared)

A Passive Infrared sensor (HCS-R501), sensor) is an electronic device that measures infrared (IR) light radiating from objects in field of view [7]. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects above absolute zero emit energy and is in reference is known as black body radiation. It is usually infrared radiation that is invisible to the human eye but can be detected by electronic devices designed for that purpose. The term *passive* in this instance means that the PIR device does not emit an infrared beam but passively accepts incoming infrared radiation [8]. "Infra" meaning below our ability to detect it visually, and "Red" because this color represents the lowest energy level that our eyes can sense before it becomes invisible. Thus, infrared means below the energy level of the colour red, and applies to many sources of invisible energy.

(C) Vibration sensor

A piezoelectric sensor (ADIS16220) is a device that uses the piezoelectric effect to measure pressure acceleration, force by converting them in to a electrical signal. Piezoelectric sensors have proven to be versatile tools for the measurement of the various processes. They are used for quality assurance, process control and for research and development in many different industries.

It has been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a pressure sensor in the touch pads of the mobile phones. In the automotive industry, piezoelectric elements are used to monitor the combustion when developing internal combustion engines. The sensors are either directly mounted into additional holes into the cylinder head or the spark/glow plug is equipped with a built in miniature piezoelectric sensor.

Table 1
Technical specifications of the vibration sensor

Principle	*Strain Sensitivity [V/μ^*]*	*Threshold [μ^*]*	*Span to threshold ratio*
Piezoelectric	5.0	0.00001	100,000,000
Piezoresistive	0.0001	0.0001	2,500,000
Inductive	0.001	0.0005	2,000,000
Capacitive	0.005	0.0001	750,000

Execution flow of the system firmware is shown in the Figure 3. In this the threshold value for vibration sensor is fixed. The threshold value for vibration sensor is fixed as 22 KHz sensor resonance. If the contamination level exceeds the threshold value send the intimation to the neighbor boat and the warning alarm will be switched ON.

(F) Execution Algorithm

Step 1: Start.

Step 2: Poll sensors

Step 3: If obstacle is identified message send to boat

Step 3: Initialize threshold value 't' for the vibration sensors.

Step 4: Check the sensor output.

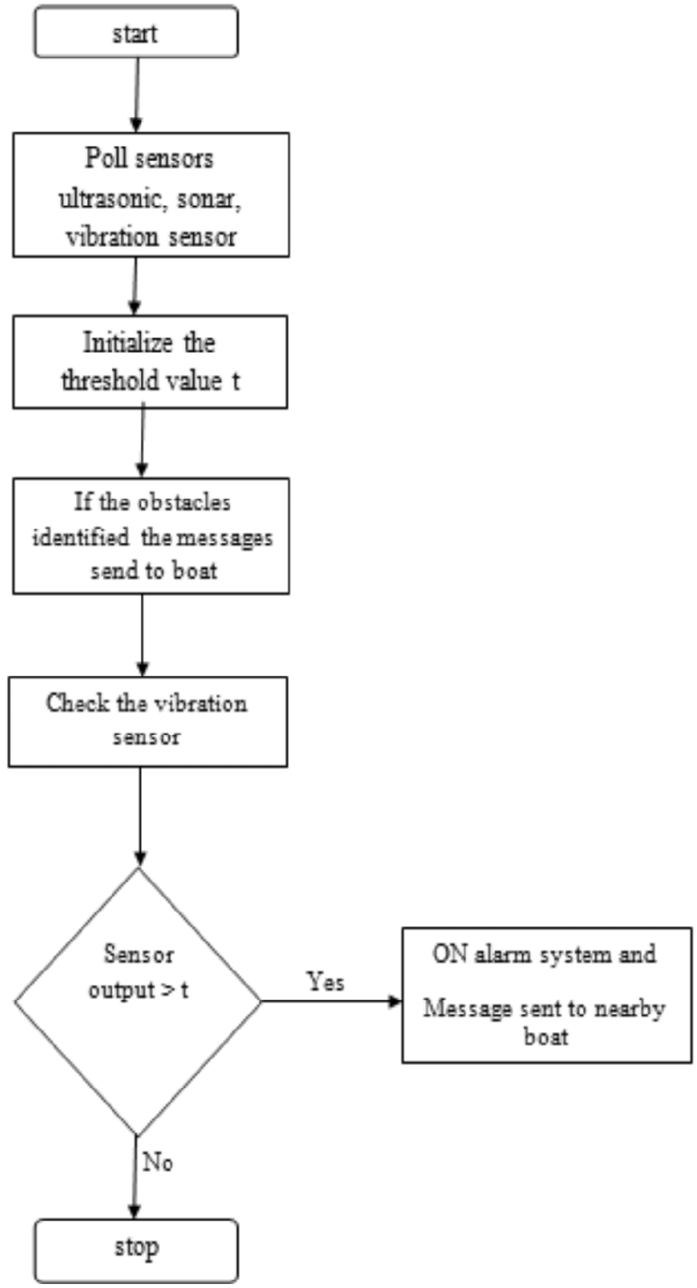

Figure 3: Flow Chart of accident prevention system

Step 5: If the sensor output is greater than't' then alarm system will be ON

Step 6: Send the intimation to the neighbor boat while boat is damaged

Step7: stop

III. IMPLEMENTATION OF ACCIDENT PREVENTION SYSTEM

(A) Accident prevention system Implementation in Proteus environment

Accident prevention system is implemented in Proteus 8.1 ISIS environment at circuit level. The sensor characteristics are replaced with electrical equivalent using variable resistors. The control signal is indicated by turning ON the LED. Firmware is loaded in 16f877a micro controller and simulated for various sensor signal inputs.

(B) Hardware Implementation

Hardware implementation of accident prevention system in maritime using various sensors which are interfaced to PIC microcontroller for monitoring and identifying the obstacles under the water. Whenever the obstacle is identified it will give intimation to the boat. If damage is occurred the intimation send to the neighbor boat using zigbee.

IV. RESULTS AND DISCUSSION

(A) Proteus Simulation Result

Obstacle detection monitoring has been done in Proteus ISIS 8.1 software. This software does not support for a sensors, thus equivalent electrical output is provided by using variable resistor. Once simulation starts run in first time, the LCD will displays text, ‘obstacle high or low’ and then reads the sensors and displays the values in their respective units. Shown in below figures.

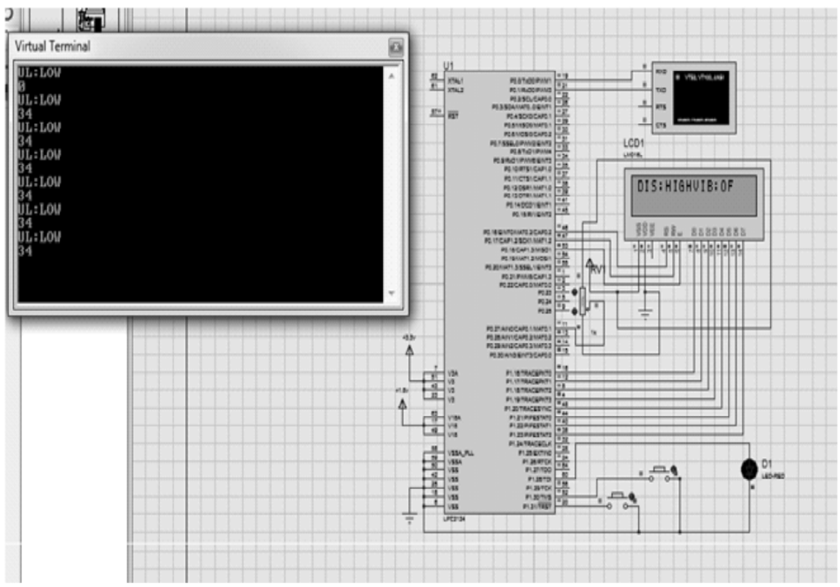

Figure 4: Proteus output of transmitter section

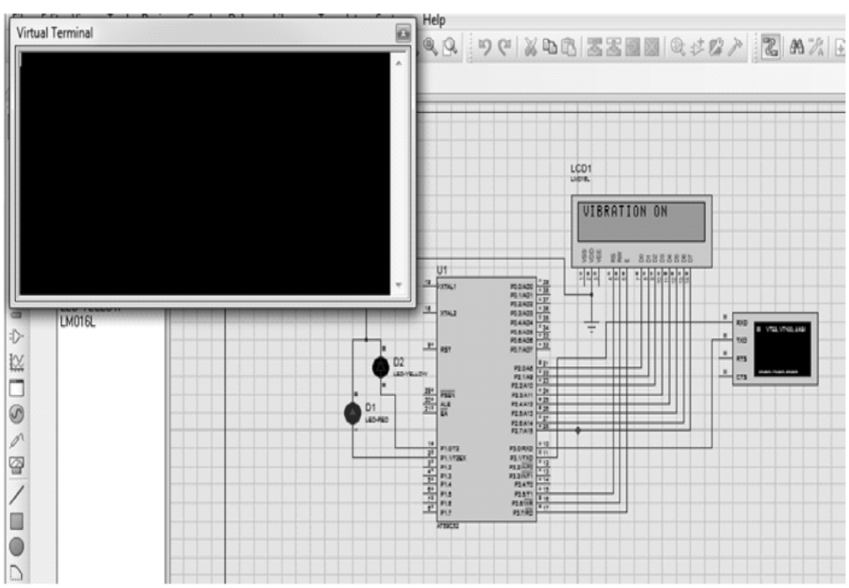

Figure 5: Proteus output of receiver section

(B) Hardware Result

Here using sonar sensor (PIR sensor) identify the obstacles under the water and ultrasonic sensor identifies the obstacles surrounding the boat and send the message to the boat using Bluetooth. And then alarm system will be ON. In case of damage is occurred due to obstacles vibration sensor detected and zigbee automatically sends the intimation to the neighbor boat. Shown in the below figures.

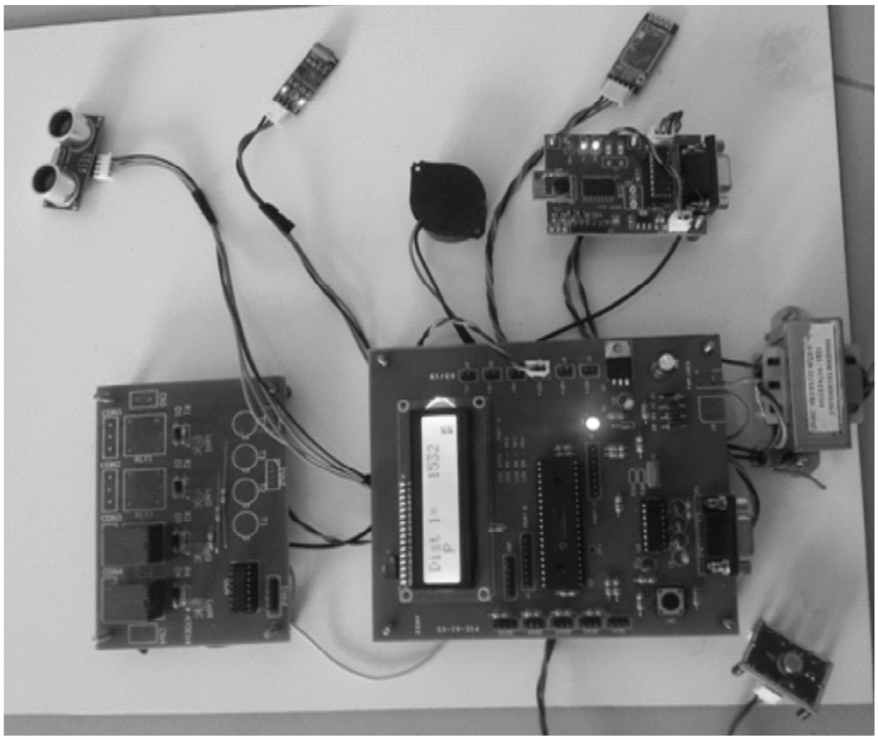

Figure 6: Hardware output of transmitter section

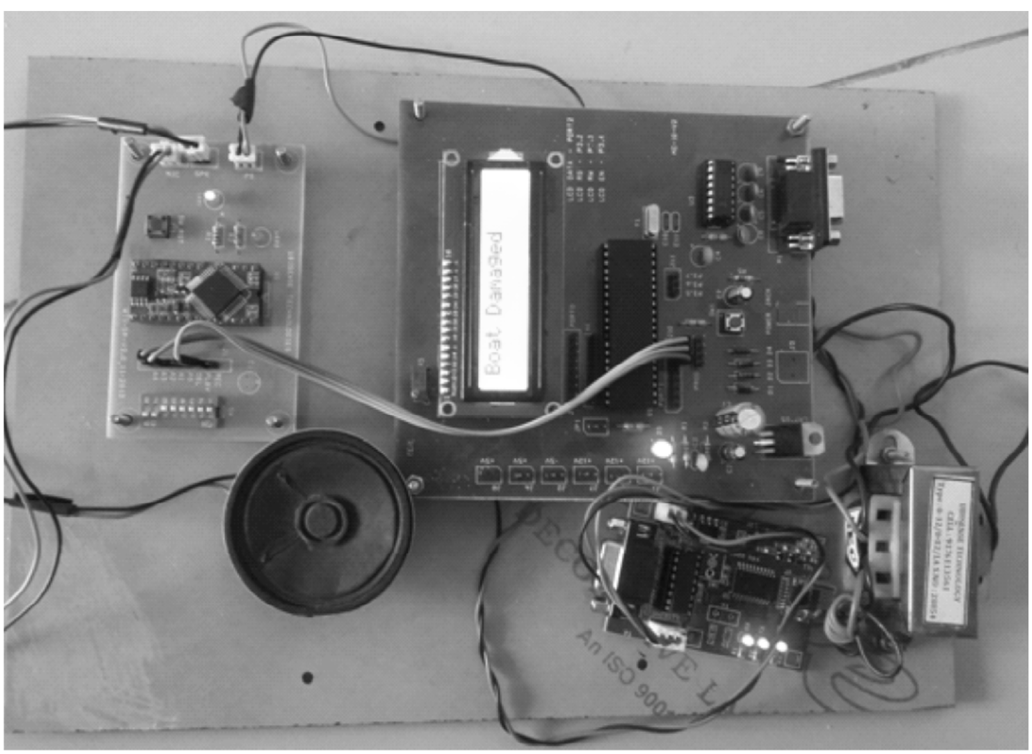

Figure 7: Hardware output of receiver section

Output of the bluetooth it will receives the message whenever the obstacles identified by the sensors and displays the distance of the obstacle. Shown in the below figure.

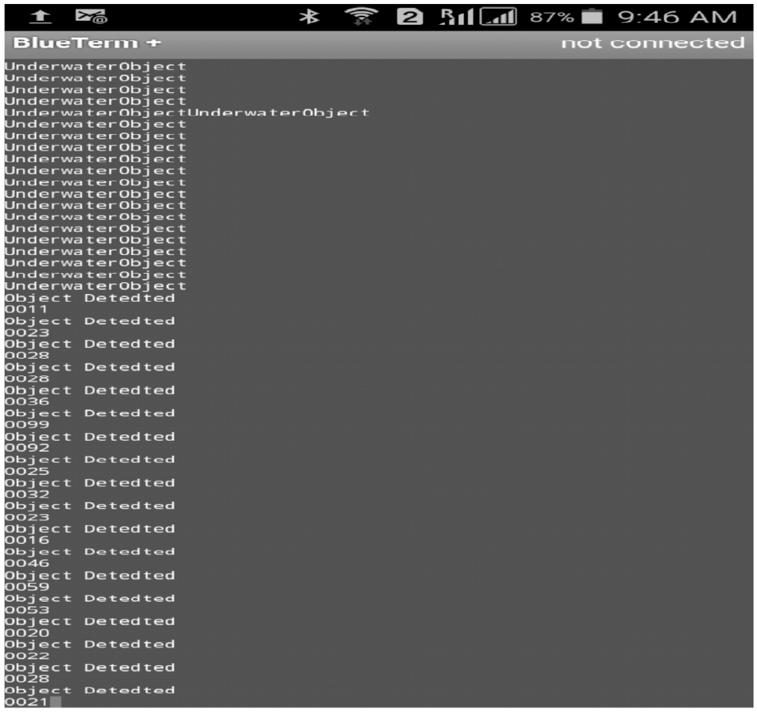

Figure 8: Output of bluetooth

V. CONCLUSION

Accident prevention system for boats in maritime was developed. The system proposed in this paper not only identifies the obstacles and it will take necessary action immediately. This system developed using PIC microcontroller using various sensors like sonar (HCS-R501), ultrasonic sensor (HCSR04) and by damage detection using vibration sensor (ADIS16220) and sends the intimation to the neighbor boat using zigbee respectively are used in simulation implementation. Firmware is loaded in PIC16F877A microcontroller and this system is implemented in proteus environment. And in future we have to replace the GSM instead of Bluetooth for fast communication. And GPS for locating the position of the boat.

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