Safety and Security System for House Boats

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Abstract— The paper proposes a comprehensive automatic safety system for house boats using PIC Microcontroller, ZigBee Pro and LabVIEW. The critical parameters relevant to the safety of house boats are measured and monitored locally and remotely. The house boat can be monitored from a PC based remote control station. The location of respective house boat is available in the remote station as well as in the boat by GPS navigational system. The Graphical User Interface is designed using Lab VIEW.

Index Terms— House boats, PIC, ZigBee, LabVIEW, GPS

I. INTRODUCTION

India, especially Kerala, 'God's Own Country', has immense scope in tourism, specifically ecotourism. One of the innovative and appealing aspects of ecotourism in Kerala is its house boats. The industry was thriving at a profitable level, but of late, frequent accidents that happened in house boats poised a serious challenge to this sector of tourism. Accidents major and minor occur frequently in house boat due to inadequate safety measures in house boats. Also the associated malpractices contributed a major share to the causes of accidents.

The main causes of accidents in house boats are due to overload, fire, alcohol drunken driver as well as passengers, obstacles, over speed, out dated house boats, short circuits etc. Table I given below shows a comparative analysis of various causes of accidents in house boats.

TABLE I: COMPARATIVE ANALYSIS OF VARIOUS ACCIDENTS' CAUSES IN HOUSE BOAT

CAUSES	PERCENTAGE
Over load	50%
Fire (gas leakage, short circuits, high temperature etc.)	15%
Alcohol drunken passenger	10%
Alcohol drunken driver	10%
Outdated boats	5%
Obstacles	5%
Sudden climate change	5%

An automatic system can meet the requirements for the safety of houseboats as well as the security of tourists. The system can employ Global Position System (GPS) based fleet tracking unit, to identify the location of a houseboat and transmit the spatial or geographic information to a control monitoring station over the wireless communication network. The GPS system will also help the effective navigation of the houseboat. A remote station can be developed for monitoring and controlling various relevant parameters which cause the problems towards the safety and security of house boats as well as the tourists. If any abnormal conditions occur, the system can produce warning along with audible and visual alarms and send the details to the control station. From the Human Machine Interface (HMI) device, arranged in the control room, the houseboat can be guided.

Figure (1) shows the general block diagram of the proposed

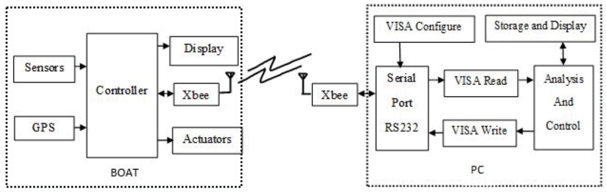

Fig. 1. Proposed System Block diagram.

The heart of the system is the PIC Microcontroller to which the measured data from the relevant sensors are given after proper signal conditioning. The command signals from the controller, which are derived by evaluating the measured data, are applied to the respective actuators for effective monitoring and controlling. The measured data are also available in the PC in the remote control room, of which GUI is designed using LabVIEW, situated in the remote control room, through the ZigBee communication network. Moreover any alerts from the weather forecasting centre can be communicated to respective house boats. GPS data are made available in the remote station as well as in the house boat for getting the exact location of house boat

A. *Related Work*

Automatic berthing system for ships and boats were developed based on Fuzzy Control System and GPS Navigational system [1], [2].The system provides necessary information regarding position, velocity, altitude, angular velocity and time, for the optimum berthing system. A control system model [3] was discussed for the analysis of a fully autonomous sail boat navigational system which allows to develop good routes while avoiding obstacles and environmental conditions such as winds, tides and currents.

A GPRS based system [4] for remote monitoring and online supervision of urban municipal swear gas was developed which includes modules for sensor, signal conditioning data transmission and supervision. An autopilot system [5] is designed for guiding the trajectory of a boat using charge coupled device camera. The measured angle is given to an Internal Model Control and hence the command signal is derived.

A Mechatronic system [6] for optimizing the operating conditions which maximizing the speed of a boat is designed and a model prediction controller is devised. A monitoring and command system [7] for the working boats' operation is developed based on GPS and GIS engine technology.

Automatic traffic and safety management systems [8], [9] for ships were designed and developed with respect to the key aspects such as ships, navigational environment, people and safety management. Automatic systems 10], [11], [12], [13] for automobiles' location, anti-theft and guidance were devised using GPS navigational systems, GSM module and embedded systems.

Arduino and Xbee based systems [14], [15] for environment monitoring, were presented for the energy management of factories where the environment is harsh and the scale is within the kilometers around. A smart sensor platform [16] was developed which includes sensor hardware interface and system integration framework.

System for obstacle detection based on LabVIEW and Laser measurement principle [17], was proposed for an intelligent vehicle. ZigBee based intelligent systems [18], [19], [20], [21], [22], [23] for different applications such as energy monitoring, lighting control and fire alarm control were presented. PIC based systems [24], [25], [26], [27], [28], [29] were developed for motor control, efficiency control of wireless sensor network, critical parameters' control of server room, location control of vehicle, latitude and longitude control for hiking, climbing and sailing activities, and power factor correction.

An Intelligent Transport System [30] was proposed for practical vehicle speed estimation with a single multifunction magnetic sensor.

On completion of thorough review of available related literature, it is evident that a comprehensive automatic system, for the safety of house boat as well as security of tourists, is not yet even been designed. Only manual or semiautomatic systems are found, which are inefficient and ineffective in harsh and adverse conditions, generally prevalent in house boats. Fully automatic systems are available for ships, especially for their berthing, are not suitable for the application in house boats.

II. DESIGN SCHEME

A. *Flow Chart*

Figure (2) shows the flow chart of the design scheme. The methodology to carry out the proposed system is designed by considering the shortcomings of existing systems, which are either manual or semiautomatic to certain extend.

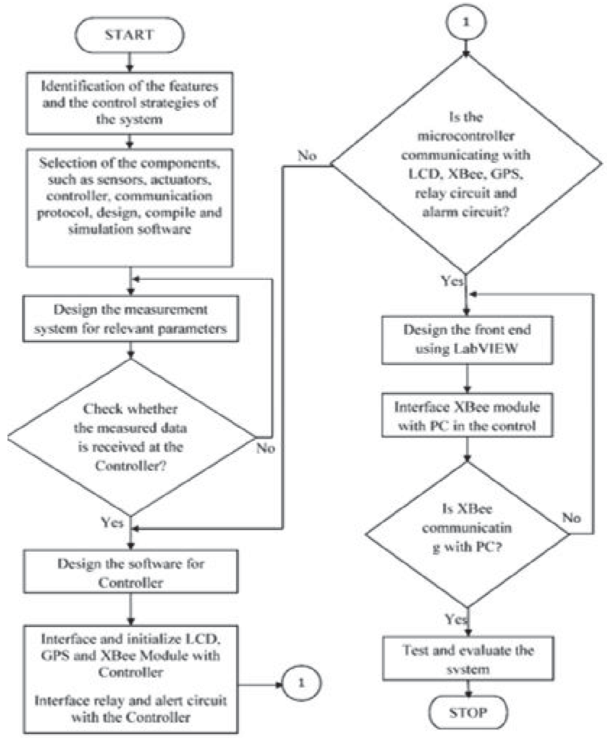

Fig. 2. Flow Chart of the Design Scheme.

The basic and most important step here is the selection of relevant sensors and actuators. Also the selection criteria for controller (PIC) and communication protocol (Xbee Pro) are again critically important. Moreover due importance has to be given to ensure the availability of data for all relevant parameters, which are critical for the safety of house boat as well as the security of tourists, at the input pins of PIC, after proper signal conditioning.

Next and foremost important step is to design the software for the PIC. During programming of the PIC, the interfacing and initialization of various peripheral modules such as LCD module, Xbee Pro, GPS module, relay module, Alarm circuit etc. are to be addressed. Also the effective communication of PIC with above mentioned modules has to be assured. The programming of the PIC, with desired features and requirements is achieved using MikroC.

After the programming of PIC, design the front end of the PC in the remote control room using LabVIEW. Ensure the proper interfacing of XBee with the PC. After this finalize the front end design. Finally test and evaluate the system by varying various input data and corresponding output data such as display, record and control. Also check the position of the house boat with GPS navigational system.

B. Hardware Design

The system has two areas of operation, one in the field (house boat) and other in the control room.

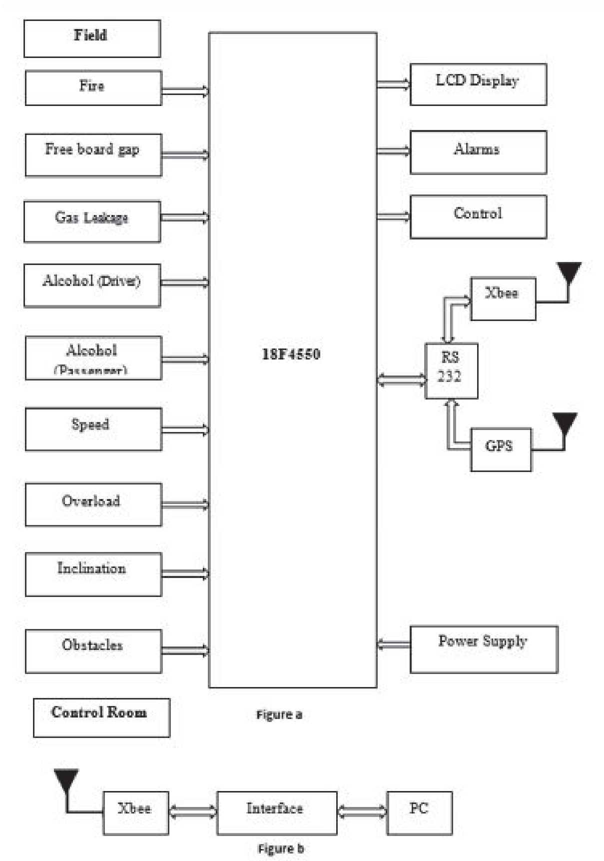

Fig. 3.Block diagram of Safety & Security System for house Boats.

B.1 The Field

Fig 3(a) shows the block diagram of the system in the field. As per the Table1(1), the critical parameters that adversely affect the safety of house boat are overload, obstacles, fire, alcohol consumed driver as well as passengers, inclination, level etc. These parameters are measured by proper transducers and the measured data are given to the PIC after proper signal conditioning. These data are compared with the set points by the PIC and the derived control signals are applied to the respective output units such as display unit, alarm unit, actuator or transmitter. A brief description of various sensors and output devices are given below.

B.1.1 Overload-Strain gauge with load cell

When a force is exerted on an object, the length of the object will change. The ratio of the change in length to the original length is called strain. A strain gage is a small section of very fine wire that changes electrical resistance when its dimensions are changed.

B.1.2 Obstacles- Laser measurement principles

A time-of-flight laser sensor operates by emitting a concentrated laser energy pulse. The pulse travels away from the sensor, strikes a surface, and returns. A clock measures the time elapsed between the beginning of the pulse and the leading edge of the return pulse from the receiver. For under water obstacles, Sonar can be used where the ordinary Laser is not effective.

B.1.3 Fire –Temperature sensor (LM 35), Smoke sensor (MQ135)

Fire can either be sensed by sensing the resultant temperature or by sensing the smoke. Temperature is sensed by **LM35** precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.**MQ-135** performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam. The conductivity of the gas sensor raises along with the concentration of the polluting gas increases.

B.1.4 Gas (LPG) Sensor-MQ2

The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gases and are used indoors at room temperature.

B.1.5 Alcohol Sensor- MQ3

When the alcohol molecules in the air meet the heated electrode, the ethanol burns into acetic acid and more current is produced.

B.1.6 Free-board gap (Level)-Float & Potentiometer

Free board gap is the level difference between the body surface and water surface. This is measured by an arrangement of Float and potentiometer assembly, set up on either side of the house boat. When the level changes, the float, attached to the moving contact of the potentiometer, moves and the output voltage changes. Taking the average of the voltages of the potentiometers on either side of the boat, the free board gap is obtained.

B.1.7 Inclination- Float & Potentiometer

Taking the difference between the voltages of the potentiometers on either side of the boat, the free inclination the boat is obtained.

B.1.8 Speed-Tachogenerator

The engine speed can be measured by Tachogenerator. However the actual speed of the boat is not the same as the engine speed since it is seriously depends on the nature of water such as its density, direction of water flow, other small obstacles etc. Hence actual speed can be measured by any positive displacement type flow meter.

If any abnormal conditions occurred, audible and visual warnings are provided. Also the required precautionary measures are taken. The various actions taken in different abnormalities are shown in Table II below.

TABLE II: PARAMETERS & CORRESPONDING ACTIONS.

Sl.No.	Parameter	Expected Actions
1	Fire	Indication, Alarm, Transmission ,Control@
2	Overload	Indication, Alarm, Transmission, Control#
3	Alcohol (Driver)	Indication, Alarm, Transmission, Control*
4	Alcohol(Passenger)	Indication, Alarm, Transmission, Control^
5	Free board gap	Indication, Alarm, Transmission
6	Obstacles	Indication, Alarm, Transmission
7	Speed	Indication, Alarm, Transmission
8	Inclination	Indication, Alarm, Transmission
9	Gas leakage	Indication, Alarm, Transmission

@ Automatic cut of main supply, emergency standby supply in line, Auto start of fire extinguisher (actions depends on the intensity of fire)

#Engine cannot be started.

* Engine cannot be started

^Entry of tourists to the upper deck is blocked.

All the warnings and indications in the field are also available in the remote control room. This is achieved by using RS 232 serial communication and XBee wireless communication network (up to 1500m). For large distance communication, GPRS or satellite communication can be used. Moreover the location of respective house boat is made available in the boat by GPS navigational system.

B.2 Control Room

Fig 3(b) shows the block diagram of the system in the control room. The transmitted data from the house boat are made available in the PC, installed in control room, by RS 232 serial communication and Xbee transceiver. The front end of the PC is designed using LabVIEW simulation software. Also any alerts from weather forecasting station can be send to respective houseboat.

B.3 Programming Flowchart for PIC

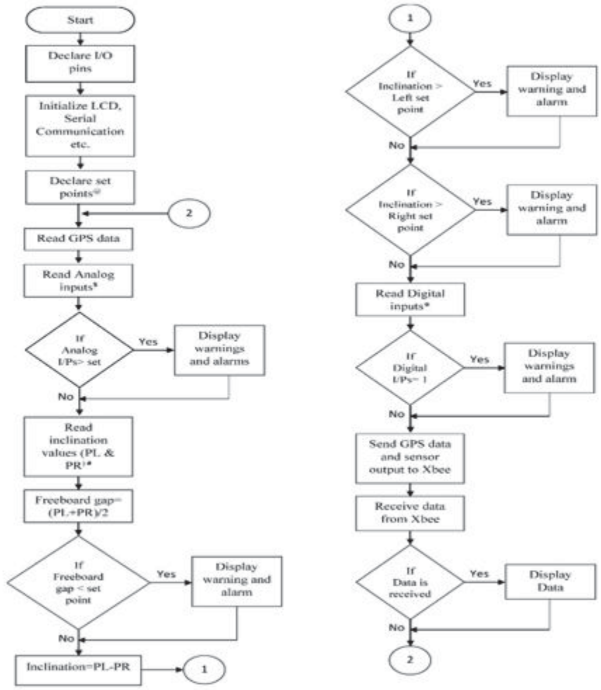

Fig. 4.Programing Flow chart for PIC.

@ Temperature, overload, speed, inclination, freeboard gap, Alcohol
$ Temperature, overload, speed, Alcohol
# Left and right potentiometer readings
* Gas leakage, smoke, Obstacle

C. Software Design

Following steps are included in the software design for the control room

- Data from the Xbee transceiver, through the serial communication, which are in coded form, are read by preconfigured VISA READ.
- The data are decoded and given for further analyzing by LabVIEW.
- Display these data and warnings in the control room.
- The warnings, if any, are send to the boat, in the coded form through VISA WRITE and serial communication.

Figure (5) shows the LabVIEW front panel designed for the remote monitoring station, where all the sensed values are displayed.

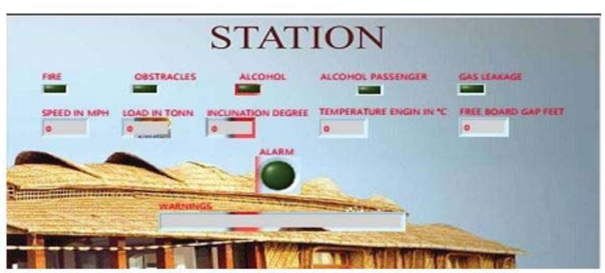

Fig. 5.LabVIEW Front Panel for Remote station.

LabVIEW simulates the functions that PIC microcontroller has done in the boat. It also produces the required alarms and warnings, which are displayed when there is any abnormal conditions occurred in the boat.

Figure 5(a) shows the LabVIEW block diagram for processing the sensed values, which are send from Xbee transceiver through the serial communication.

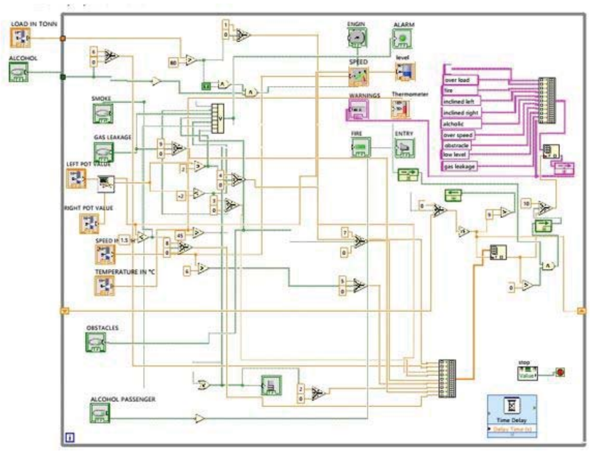

Fig. 5. (a)- Block Diagram for Data Processing.

Figure 5(b) shows the LabVIEW block diagram for the display of the processed data in the front panel of LabVIEW as shown in Figure (5).

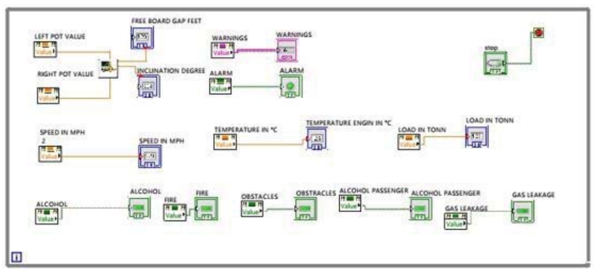

Fig. 5. (b)- Block Diagram for Display of Processor Data.

III. CASE STUDY

Fig.6 shows the LabVIEW front panel, indicating an abnormal condition. Here an abnormal condition, fire, is simulated and corresponding audio and visual alarms as well as display is shown.

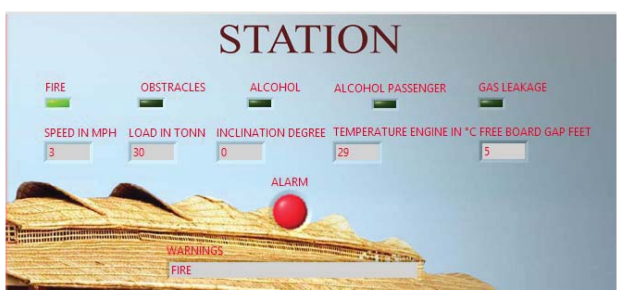

Fig. 6. LabVIEW Front Panel for Case Study.

IV. CONCLUSION

By implementing automatic control system for the safety and security of houseboats, which includes computer and wireless communication network, the house boat tourism will get a new face. Also by incorporating proper networking, all information regarding safety measures, rate/day, capacity etc. of respective houseboat can be made available to the targeted tourist and hence malpractices prevailing in this field can be reduced drastically. Moreover any alerts from the weather forecasting centre can be communicated to respective house boats. Thus tourists, who are more concerned about safety and quality of systems, will be attracted more to this field of tourism and thereby increase the revenue to the Government and this in turn beneficial to the society at large.

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