Location monitoring system for maritime security using RSSI technology

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Abstract: *One of the noteworthy attribute of wireless networks is localization. Distance between nodes can be estimated with the help of received signal strength indicator (RSSI).*

Using these parameters and with help of various position determining algorithms such as Trilateration localization and location detection is possible.

Keywords – RSSI, Vibration sensor, visual basic, navigation, location monitoring, UART, PIC

Introduction:

Location and positional monitoring is an important aspect in navigation and transportation especially in air and water transportation. The currently employed navigation system like GPS in maritime vessels such as small boats , fishery boats etc has its own drawbacks like positional inaccuracy , unreliable weak signals when it comes to working in situations like stormy or rainy weather etc. This becomes a serious issue as an inaccurate position may result in getting lost in open sea or sometimes may result in a potential border trespassing situation. To overcome this Received Signal Strength Indicator (RSSI) is used to locate the current position of a node.

RSSI estimates the distance between transceivers and these estimated distances can be used to determine the location of a node within the network. Here we present a platform based on XBee ZigBee wireless modules and Visual basic for visual monitoring.

Existing System:

The current system in place in the field of navigation is GPS.GPS is used to track and identify the position of the vehicles at a particular location. This uses electronic maps to provide navigation and localization detection .Some major drawbacks of this system include positional error of 5m-10m globally .The GPS signal is also unlikely to pass through very solid structures, dense clouds, under water and sometimes dense canopy of trees .It should also be noted that GPS accuracy depends on the quality signal reception. The larger the antenna the better is the quality of the received signal. So miniaturization of antenna leads to reception of a low quality signal thereby resulting in inaccurate position detection .So absolute miniaturization of antenna is no possible here.

Proposed system:

In the proposed system a three level virtual border is configured and saved in the controlling unit. Every vessel leaving the port will have a transmitter module transmitting a signal at radio frequency. A receiver module at the controlling unit will receive the vessel's transmitted signal. As mentioned earlier three virtual borders namely B1, B2 and B3 will be configured considering the received signal strength as a parameter. Depending on the strength of the received signal the location of the node can be approximated to what virtual border it is currently located in and depending on the border level different type intimation is given to the vessel in either an automated manner or from the control unit or from a nearby naval vessel. Say for instance if the vessel is in border 1 it will be intimated in the vessel's LCD. Same intimation is repeated once the vessel reaches the second border. Once the vessel reaches the third border a relay switch with automatically cut the engine off. Thus under ideal condition trespassing of neighbouring country's border becomes virtually impossible which is currently a major threat to the country's fishing community.

Hardware Implementation Transmitter unit:

The block diagram shown below gives the basic architecture of the transmitter unit consisting of microcontroller, LCD, vibration sensor, relay switch, motor and RSSI transceiver.

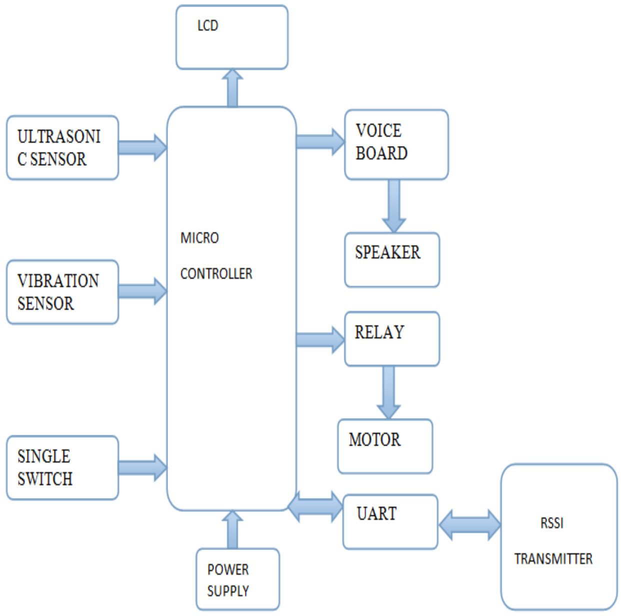

Fig -1: Block diagram of transmitter unit

The block diagram shown below gives the basic architecture of the transmitter unit consisting of microcontroller, LCD, vibration sensor, relay switch, motor, RSSI transceiver.

The micro controller that is being used here is PIC16f877a which is one of the most renowned micro-controller in the industry. This was chosen for its ease in programming and its usage of flash memory technology. It also features EEPROM which it possible to store certain information permanently such as transmitter codes, receiver frequencies and other related data. It has a 40 pin configuration with 33pins for inputs and outputs. A RSSI transmitter LT®5502 is used which has an IF frequency range of 70MHz and limiting IF gain of about 84dB. Its linear RSSI range is about 90dB. The component used in this particular system is 24 lead narrow SSOP package.

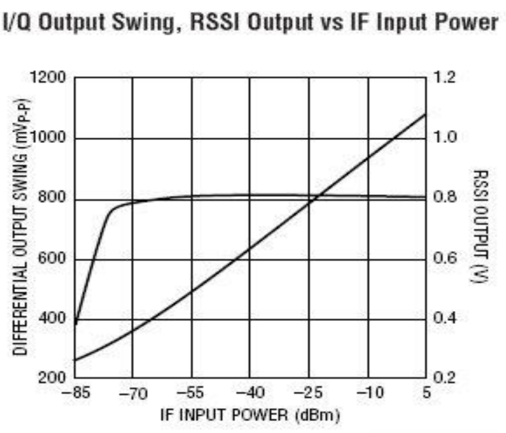

Fig-2: I/Q Output swing

A single pole single Throw switch is used in the system which will act as a SOS switch for the vessel at times of emergency to report to the control unit. It has a single input and can connect only to single output.

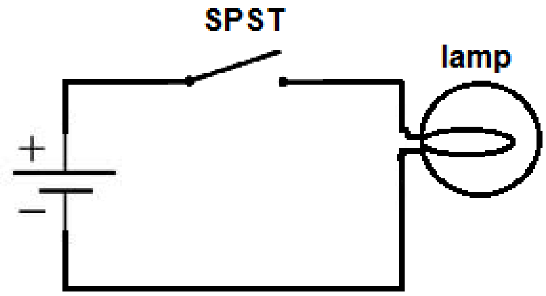

Fig-3: Circuit diagram for simple switch

Another attribute of the system is its ability to find obstacle under water via an ultra sonic sensor. It works on the principle similar to that of SONAR or RADAR. It basically generate high frequency sound waves and evaluates the echo which is received back by the sensor is being employed here as a vibration sensor to detect high waves or potential tsunamis in the region.

Fig-4: Ultrasonic sensor

The sensor design is of a metal disk with piezo material which is commonly used to measure pressure and acceleration.

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

Table-1: Strain sensitivity to threshold comparison

A relay switch is used to automatically shut off the engine once the vessel crosses the third level of virtual border. Current flowing through the coil of the relay creates a magnetic field which attracts a lever in order to change the switch contacts.

Receiver Module

The major blocks of the receiver unit consist of a LCD, UART and RSSI receiver module. A LCD should be prepared properly before the required character can be displayed. A number of commands had to be given to the LCD before inputting the required data

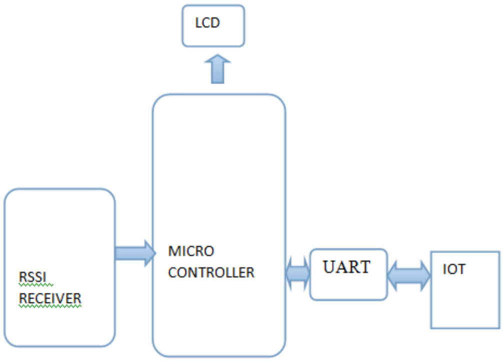

Fig-5: Block diagram of receiver unit

LCD cannot differentiate between data and command that is being supplied to its data bus and it is the user's responsibility to specify to the LCD whether it is the

data or a command. For this a particular combination of 0s and 1s are inputted in the control lines when the command is inputted and another particular combination of 0s and 1s for data input.

A universal asynchronous receiver/transmitter is a type of asynchronous receiver/transmitter module which is essentially a piece of computer hardware capable of translating data between serial and parallel forms. It is one of the key components in serial communication.

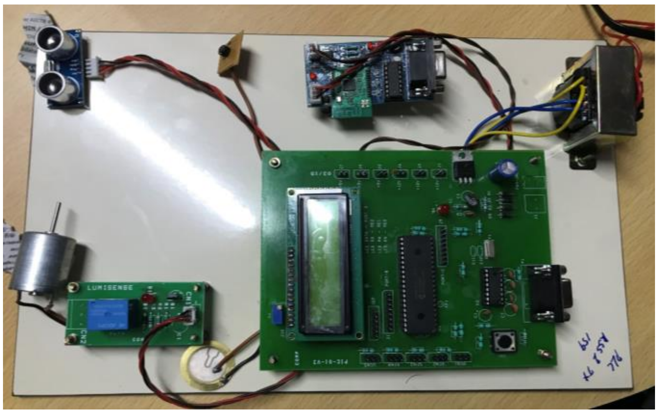

Fig-6: Experimental Hardware module

Result and Conclusion:

The software simulated output of the system is shown in the figure below. A graphical user interface is developed with the Microsoft visual basic for the control unit's monitoring purposes.

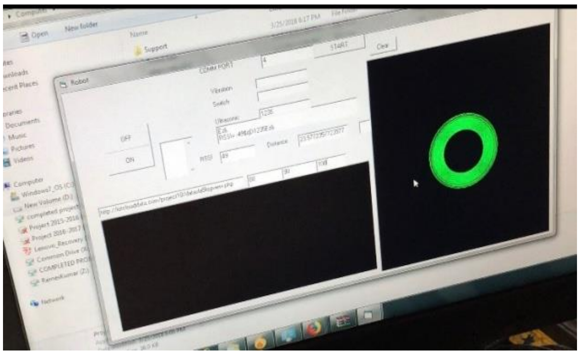

Fig-7: Software Simulation for the system

The proposed system eliminates the drawbacks in the present GPS technology and under ideal conditions it also eliminates the chances of border trespassing due to inaccurate location detection. The system's additional attributes such as tsunami detection and obstacle detection gives the system an edge over the present system in place since it acts as an advanced navigation system than just location detection.

The system can also be further enhanced by adding certain features of cloud and IOT and can also incorporate current navigation technology in place to have a more sophisticated navigation system for maritime vessels.

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