Ensuring Maritime Border Security for Fishermen using Standalone Floating Station and RSSI

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***Abstract*— India has coast line on three sides open to the sea. Due to the vast area of coast line India is prone to more security threats. Safety, security, Maritime boundary violation and intrusion by fishing boats have been a huge concern in coastal countries across the world. Therefore, there arise a need to safeguard fishermen from the dangers which they are encountering in everyday life for their livelihood. Hence, keeping the above problem in mind, this paper proposes a system of constructing Standalone floating stations across the maritime boundary which would safe guard the fishermen from the potential dangers they might face by giving them prior warning in case of trespassing the boundary. The standalone device is self powered by making use of solar energy and wind energy. The different rangings are identified through Received Signal Strength Indicator (RSSI) technique.**

***Keywords*— boundary violation; standalone station; solar energy, wind energy; RSSI**

I. INTRODUCTION

In coastal countries like India fishing is one of the major sources of income and has an important role in economy of the country. The Palk Bay, a narrow strip of water separating the state of Tamil Nadu in India from the Northern Province of Sri Lanka, has historically provided rich fishing grounds for both the countries. However, the region has become a highly contested site in recent decades due to frequent poaching of Indian fishermen in Sri Lankan waters. The Sri Lankan forces regularly arrests Indian fishermen for crossing the International Maritime Boundary Line (IMBL) that demarcates Indian and Sri Lankan waters.

According to a report by Times of India dated Aug 18 2012, there had been 16 incidents of shooting on Indian fishermen by Sri Lankan navy between the years 1991 and 2011. As many as 85 fishermen had been killed and 180 injured in these incidents which took place within the Indian waters. The major reason for these disputes is lack of pre-warning systems and navigational tools for the fishing boats. These problems also persist in various other coastal countries of the world. The proposed system gives prior warning to fishermen when they cross the maritime border through voice alert rather than the existing buzzer system.

II. EXISTING SYSTEM

In the past years several methods have been adopted to help fishermen to track their locations in the sea. One of the most prominent method is using GPS (Global Positioning System), GSM (Global System for Mobile Communications), using GPRS (General Packet Radio Service), using weather balloons and using RADAR tracking systems. These systems require continuous monitoring of the fishing boats from the central control room. This system is ineffective as there is huge possibility for manual errors. If GPS is used on a battery operated device, there may be a battery failure and there arise a need for external power supply which is not always possible. Moreover, signal tower installation is a major problem in off shore region. Sometimes the GPS signals are not accurate during some extreme atmospheric conditions such as geomagnetic storms. Also the existing alarm system is ineffective for monitoring maritime border intruding boats. There is no specialized system for tracking certain circumstances like health hazard of the fishermen, vessel hazard and lack of fuel for the vessel (boats) which are essential during severe climatic conditions like cyclone, storm, etc. Hence, there arise a need for improvements in these systems, the major problem being cost and power consumption.

III. PROPOSED SYSTEM

In the proposed work, a wireless transmitter unit is placed in fishing boats and the floating station in the sea act as a receiver. The standalone floating station comprises of RF receiver unit, hybrid unit for power generation and embedded microcontroller for controlling operations. The standalone floating stations can be installed for every one kilometer across the maritime boundary between India and Sri Lanka, to give prior warning to the fishermen when they are about to cross the fishing border.

A. Hybrid Power System

The hybrid power system can combine different voltages having different current values generated from one or more different sources. The proposed system uses hybrid module for power generation by making use of solar panel and micro wind turbine. There is also possibility for using three different sources. The amount of voltage, current, power and net power generated through solar and wind energy can also be measured. The current generated from hybrid module is low and need to be amplified for metering purpose. Hence, the dual general-purpose operational amplifier (MC1458L IC) is used . Thus, the standalone floating stations in the sea are made self powered through hybrid power system. The Fig. 1 shows the block diagram for hybrid power system along with embedded controller and RS232 interface unit.

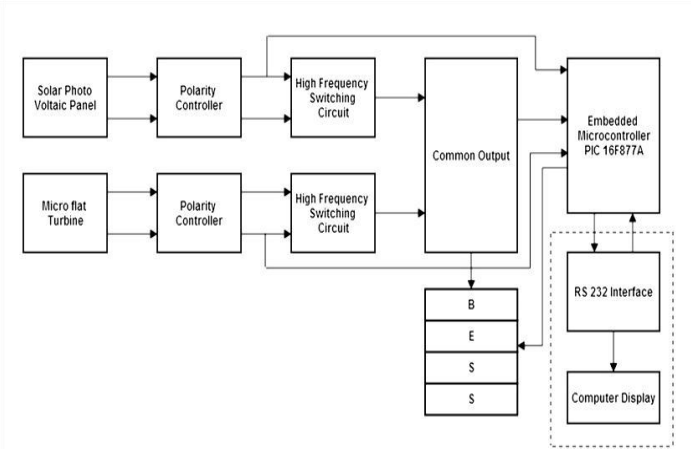

Fig. 1 Block Diagram for Hybrid Power System

1) Photovoltaic Panel: A solar cell or photovoltaic cell is a p-n junction diode that converts the energy of light directly into electricity by the photovoltaic effect. The solar cell is made up of amorphous silicon wafers. A typical p-n junction solar cell, consists of a shallow p-n junction formed on the surface of a substrate, having front ohmic contact grids, back ohmic contact grids and an antireflection coating on the front surface. When sunlight hits the semiconductor junction of the diode, an electron springs up and is attracted toward the n-type semiconductor. This causes more negatives in the n-type and more positives in the p-type, thus generating a higher flow of electricity. Individual solar cells can be combined to form solar panels. A 12V 10W solar panel is used in our project. Solar cells are usually connected in series and parallel circuits in modules, creating an additive voltage.

2) Micro Wind Turbine: The wind energy forms a major source of the hybrid power system during night time and during cloudy days. A 230V 70W wind turbine comprising of double fed induction type generator is employed here. The turbine is rotated at a speed of 60rpm to generate an output of 230V AC. This output is given to the step down transformer. Then it is given to the power supply unit comprising of rectifier and filter circuits to produce DC output.

3) Polarity controller: The polarity controller circuit is designed using a set of high capacity power diodes (IC5408) for each of the source to serve as a powerful interlocking system between different sources. The main purpose is to allow the flow of electric current in one direction, thus avoiding the flow of reverse voltage to the devices. In power diodes the junction is formed between a heavily doped P^+ layer and a lightly doped N^- layer which is epitaxially grown on a heavily doped N^+ layer. Thus the increased thickness of depletion region or the space charge region in the power diodes helps to block larger reverse biased voltage.

4) High frequency switching circuit: If continuous pulses are applied to a battery heating problem arises which limits the life time of the battery. Here 555 timer and IRF540N MOSFET are used as a high frequency DC switching circuit to generate discontinuous pulses which improves the life time, thereby avoiding periodic replacement of the battery. The 555 works as an astable multivibrator, an oscillator circuit in which output oscillate at a particular frequency and generate pulses in rectangular wave form and MOSFET act as a switch. The source of the MOSFET is grounded and pulsed output is obtained from drain of the transistor.

5) Ultra capacitor storage: The advancements in the study of nanomaterials such as graphene has resulted in ultra capacitor storage. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, as they store energy in the form of electric field. They can accept and deliver charge much faster than batteries and can tolerate many charge and discharge cycles than rechargeable batteries. They have low internal resistance so they work close to 100% efficiency. They are lighter than the conventional batteries and there is no toxic chemicals or metals. The battery energy storage system (BESS) consists of number of storage branches in series and parallel combinations. Each storage branch has low voltage breaker and storage unit. The storage unit has battery pack up, battery management system and power conversion system. The BESS is used in the floating stations.

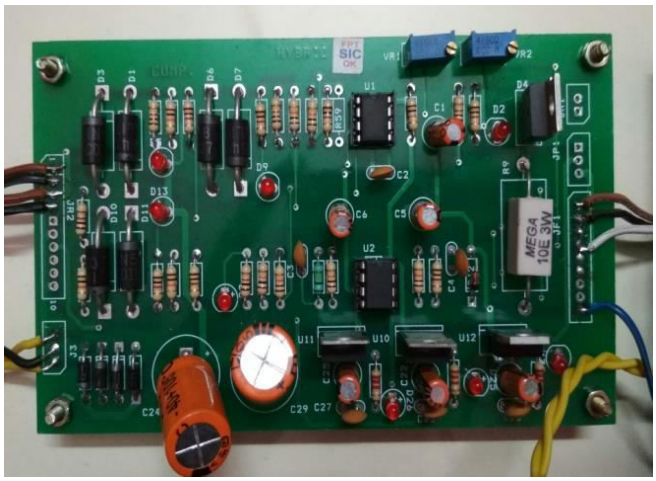

Fig. 2 PCB design for Hybrid Power System

B . Embedded Hardware Kit

The embedded board design is divided into four circuits

1) Power supply circuit: Irrespective of the technological growth one must construct a reliable power source for embedded controller. The theme of the power supply unit is to generate a stable DC output irrespective of the varying input voltage. It consists of step down transformer, bridge rectifier, Low Pass Filter, LM7805 voltage regulator, ripple filter and LED indicator.

2) Clock circuit: The 10 MHz crystal made up of Quartz is used as a resonator to produce constant frequency for an operating Baud rate of 9600 bits/sec. The frequency can be further divided inside the microcontroller as per the requirement of operation to achieve exact timing. The crystal may produce abnormal clocking at some conditions, which can be eliminated by using appropriate low pass filter capacitors coupled across crystal and connected to ground. The crystal is connected across pin no 13 and 14 of the microcontroller.

3) Reset circuit: The reset circuit is connected across MCLR pin of the microcontroller (Pin no 1). This is the memory clear pin and thus the memory is cleared and is ready for use as soon as the power is switched on. SW1 is the synchronous switch which is also used for the same purpose and for PC and PIC synchronous operation and to ensure low to high transition when the power is switched on. During dumping operation the peak programming voltage of 12.5V is used.

4) RS-232 circuit: The embedded board is connected to the PC via RS-232 interface. The RS-232 interface consists of MAX232 IC and 9 pin connector. MAX232 performs voltage attenuation without attenuating the frequency. PIC has a build in USART which can send and receive serial data. The microcontroller transmit and receive data in TTL (Transistor transistor Logic) wave from and standard PC works on RS-232 level wave form. So to transfer data from microcontroller to PC we need to convert data from TTL to RS-232 level and if we want to send data from PC to microcontroller we have to convert data from RS-232 to TTL which is performed by MAX232 and it is full duplex communication method so that the data can be sent and received at the same time.

C . Programmable Interface Controller (PIC)

To perform various operations and to monitor the devices a microprocessor, a microcontroller or an embedded controller is needed. The embedded controller selected for this project is PIC16F877A, an 8-bit controller which can act as a timer, serial communicator, oscillator etc. It has built in watch dog timer, A/D converter, D/A converter, RAM, ROM, Input Output ports, USART (Universal Synchronous/Asynchronous Receiver/Transmitter). This leads to lesser space occupation by the circuit. PIC has an inbuilt voltage and temperature sensing and can withstand high temperature and is highly economical. It has five IO ports named A, B, C, D and E which can be used as an input or output port. Ports B, C and D are always digital and Port A and E can be used as analog or digital. Every port has two buffers named data buffer and TRIS buffer. The internal program fed to the microcontroller enables it to control other devices as required.

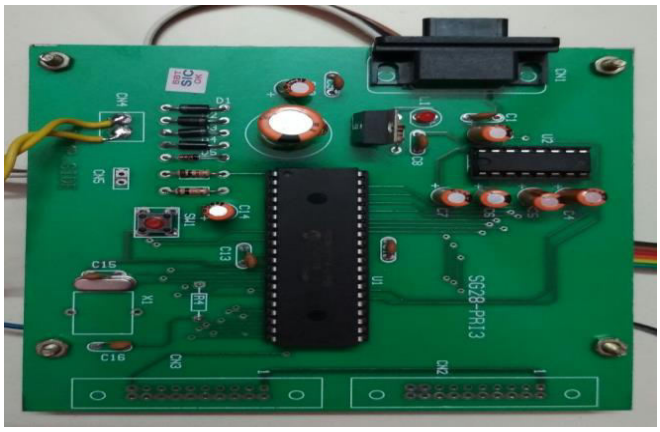

Fig. 3 Embedded Board

D . RF Transmitter Unit

The transmitter unit consists of an RF Transmitter module, HT12E encoder IC and four switches. The wireless data transmission is done using 433.92MHz radio frequency signals and is used as a carrier. The signal is modulated using Amplitude Shift Keying (ASK) Modulation technique. Each Boat is provided with different modulating frequency. The encoder generates Unique Identification Code (UID) for every boats and can be used to track illegal trading boats. The transmitter unit uses four different channels for tracking out of which one is used to get RSSI value. Remaining three channels are used for tracking health hazard of the fishermen at 37 KHz, for vessel hazard at 38 KHz and for fuel low condition at 39 KHz.

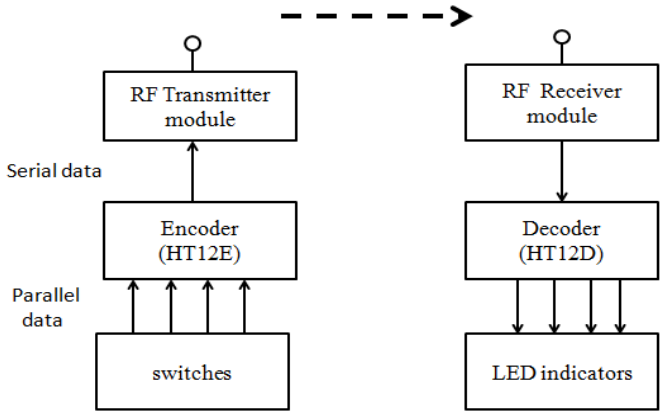

Fig. 4 Communication between RF Transmitter and Receiver Unit

E . RF Receiver Unit

The receiving unit comprises of RF receiver module , HT12D decoder and LED indicators. The input frequency from transmitter is received using Frequency demodulation. The RSSI indicator calculates the strength of the received signal. RSSI stands for Received Signal Strength Indicator. In general, it is a measure of power level that a RF device is receiving from the radio infrastructure at a given location and time. For instance, the power level a laptop is detecting from a nearby access point. It is similar to signal strength indicators on mobile phones. RSSI is usually expressed in decibels. If the strength is close to maximum voice alert is given. If the strength reaches full level, it indicates that the boat is close to the border and the message will be given to coastguard through wireless technology like Zigbee or data can also be transferred through IOT in order to take necessary actions. The RSSI value is measured as a function of distance between the transmitter and receiver in our project. If RSSI value is zero it indicates that the boat is near to the boundary and the warning is issued.

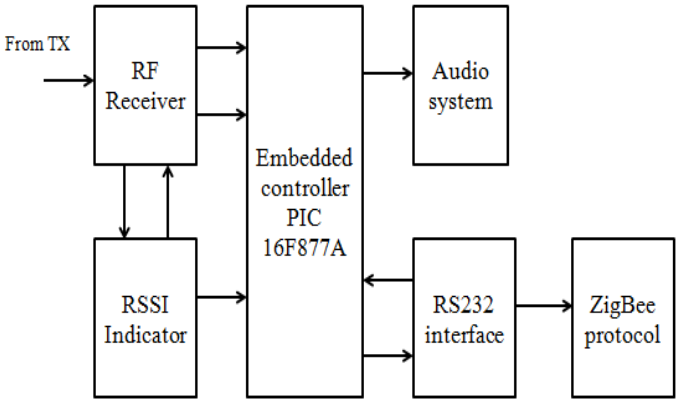

Fig. 5 RF Receiver unit with microcontroller

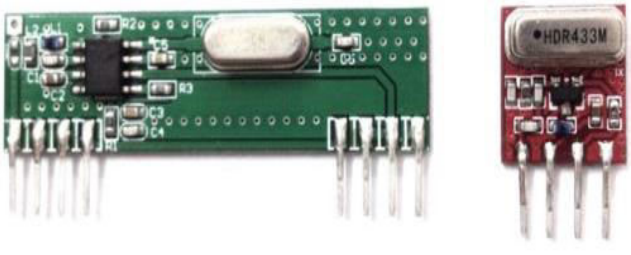

Fig. 6 RF Receiver and Transmitter module

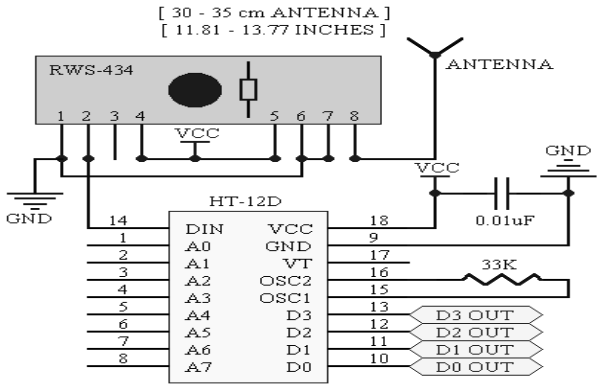

Fig. 7 RF Receiver module with decoder

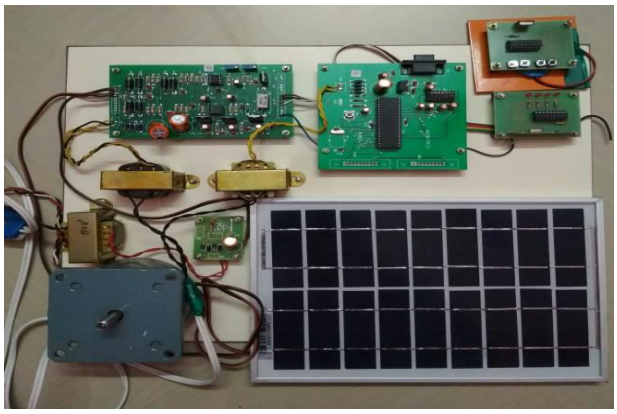

Fig. 8 Completed Hardware kit

Fig. 9 Overall Mechanical Model

The floating station is supported on Nitrogen inflation mat and is anchored to depth of the sea. Nitrogen filled mats typically lose no pressure from permeation even over many months of use. So, by inflating the mats with high purity nitrogen, they will remain at their proper operating pressure much longer than the air filled sheets.

F . Visual Basics

Visual Basic is a third-generation event-driven programming language and Integrated Development Environment (IDE) from Microsoft for its Component Object Model (COM) programming model first released in 1991 and declared legacy during 2008. It is an extension of the BASIC programming language that combines BASIC functions and commands with visual controls. Microsoft intends Visual basic to be relatively easy to learn and use. It enables rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using data Access Objects, Remote data Objects or ActiveX Data Objects and creation of ActiveX controls and Objects. A programmer can create an application using the components provided by the Visual Basic program itself. Program written in Visual basic can also use the Windows API, but it requires external function declarations. Version 3 of Visual Basic was a commercial success, and many companies offered third party controls greatly extending its functionality.

The graphical user interface (GUI) allows the developer to drag and drop objects into the program as well as manually write program code. The Visual Basic language is designed to be "human readable", which means the source code can be understood without requiring lots of comments. The Visual Basic program also includes features like "IntelliSense" and "Code Snippets," which automatically generate code for visual objects added by the programmer. Another feature, called "AutoCorrect", can debug the code while the program is running.

Unlike many other programming languages, Visual Basic is generally not case sensitive though it transforms keywords into a standard case configuration and forces the case of variable names to conform to the case of the entry in the symbol table. String comparisons are case sensitive by default. The Visual Basic compiler is shared with other Visual Studio languages (C, C++), but restrictions in the IDE do not allow creation of some targets (Windows model DLLs) and threading models. Through visual basic programming language, the data is monitored in a closed environment. In practical case, zigbee can used as a wireless technology for sea border monitoring or the data can be transferred through IOT also.

Fig. 10 Simulated Window in Visual Basics software with India –Sri Lanka Border Marking

IV. CONCLUSION

This paper proposed a novel method for monitoring and controlling of maritime border intruding boats across India-Sri Lanka coastal border and to give prior warning to the fishermen in case of intrusion. The solution is to construct standalone floating stations across the border to provide alert to the fishermen. The PIC controller is used as a central processor in controlling the system. The major challenge remains in constructing the floating stations in the sea which remains as a future scope of work.

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