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A Proposal for Mitigating Fishermen Killing In Indian Sea Borders through Technology – Maritime Boundary Identification Device

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Abstract

The Tamil Nadu – Sri Lanka maritime boundary has been responsible for frequent controversies in the global front, due to fishermen from Rameshwaram and Ramanthapuram districts recklessly straying past Indian waters. Instances of Indian fishermen being captured and killed by the Sri Lankan navy have spun vivid images of violence and human rights violation among the masses. Social activists are desperate for an automatic alarm system to warn the fishermen when they are about to cross the border, and avert a possible impending crisis. The following discussion focuses on the design of an alarm signal system that could alert the fishermen on a periodic basis as they approach closer to the maritime boundary. Installing Global Positioning System (GPS) devices would pose several economic challenges. Instead of the conventional approach of using GPS devices to track location, a transmitter – receiver system exquisitely designed to send signals to the boat would be effective. This system helps in keeping a continuous track of the boats. It provides a reliable solution to alert fishermen before they could inadvertently exceed the boundary.

Keywords*: Maritime Boundary monitoring system, Transmitter, Receiver, Doppler Effect, Microcontroller, Global Positioning System (GPS)*

1. Introduction

Technology has been growing tremendously and the application boundaries have been expanded well. One such area is for the saftety of the fishermen and we have taken that area for researching and provided a solution which is feasible and frugal as well [1, 2, 7, 8, 9, 10, 11]. The Palk Strait, 64 to 137 kilometers wide, separating Tamil Nadu and Sri Lanka has been a major zone of conflict and dispute for more than three decades, with fishermen from both nations debating over their fishing rights and the coastguard and navy capturing foreign fishing boats that exceed their territories. Lack of convenient fishing zones within the permitted region has been Indian fishermen's excuse for entering Sri Lankan waters. On several occasions, fishermen claim their crossing of the international border line to be accidental and unintentional. An alarm system, to alert the fishermen when they are about to leave the safety zone and the navy when a boat from its state is beyond the bounds, would help in averting such intrusions.

2. Fundamental Principle of Operation

The maritime boundary monitoring system essentially consists of three transmission towers, strategically spaced apart and located on selected coastal regions, and receiver units placed on the fishing boats. A sine wave generator connected to the transmitter through a microcontroller unit, helps in transmitting waves at radio frequency, with suitable frequency modulation. Subsequent demodulation takes place in the receiver unit after reception. These radio waves help in the determining the position of the boat with respect to the coast. The combined data from the three transmitters help in specifying the overall position of the boat in terms of three coordinates. The microcontroller unit connected to the receiver in the boat contains a database of the marine border line, in terms of the three coordinates, for the entire

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border. It compares the received data with the data in its database. When the boat is dangerously close to the international border line, the received data triggers an alarm circuit to warn the fisherman prior to crossing the maritime boundary. The microcontroller unit at the transmission end makes time stamping possible. It is necessary to synchronize the clocks at the transmission end and receiving end to for an accurate tracking. The system behaves as marginally stable.

The main objective of this technology is to devise a system that can effectively replace GPS (Global Positioning System) in the maritime boundary tracking domain. This system would be economically feasible for implementing on all boats and provide better reliability as compared to GPS. GPS systems usually have a percentage error of 0.0000005%. The new technology has the potential of bringing about a similar accuracy rate. Considering the fact that it is to be installed in fishing boats, the system has been designed to be robust, waterproof and tamperproof. It requires nearly zero or minimal manual operation. The system would also provide sufficient warnings at two different stages, before the boat crosses the safety zone or maritime boundary.

3. Literature Survey

The existing systems proposed for maritime boundary identification make use of GPS (Global Positioning System) to track the boats and warn fishermen. A GPS receiver placed on the boat receives information from the GPS satellites. A computing device like a microcontroller or microprocessor on the boat is pre-stored with latitudinal and longitudinal extents of the maritime boundary. The data obtained from the receiver is compared with the available database on a regular basis. A data match triggers the alarm.

However, GPS suffers from several inconveniences. GPS receivers are too expensive to be installed in each boat. It is not the best option for a large scale implementation. Also, the GPS system consumes lots of power and the battery frequently gets drained. Hence, the reliability is low with this technology, as fishing boats will stay in the sea for days together, at times. An improved alternative with equivalent accuracy and better reliability is to be provided. Transmission and reception of radio signals of optimal frequency to communicate information to the boats would be a viable solution. The radio signals help in determining the distance between the boats and the transmitters. The position of the transmitters is taken as reference. The location of the transmitters is chosen so as to provide precise data.

4. Proposed S

4.1. Transmitter

Oscillators are generally used to produce a uniform signal that can be used as a reference or a carrier wave. Harmonic oscillators are used to produce a uniform sine wave. Crystal controlled oscillators use a crystal resonator in order to closely control the frequency of the generated carrier wave. Communication systems of recent ages use a voltage controlled crystal oscillator (VCXO). Oscillators are excited through piezoelectric property of the crystals. The oscillator circuit consists of a varicap or a varactor and the frequency of the oscillator is changed by varying the dc bias voltage across the varactor. This is controlled by the crystal. The crystal is operating in the series mode. The capacitance increases the series resonant frequency and the inductance is chosen such that it is equal to the capacitance so as to make the series resonant frequency equal to that of crystal. Thereby the resonant frequency can be varied by voltage control. The crystal quality factor (Q) also remains high. The circuit frequency stability and the fixed frequency stability are close to each other. Frequency multipliers are used in order to make the crystals resonate at higher multiple of their basic resonant frequency. The humidity effect of the ocean air is overcome by hermetic sealing. The oscillator is placed in a temperature controlled oven in order to overcome the temperature effects. The block diagram of the transmitter is shown in Figure 1 [4-6].

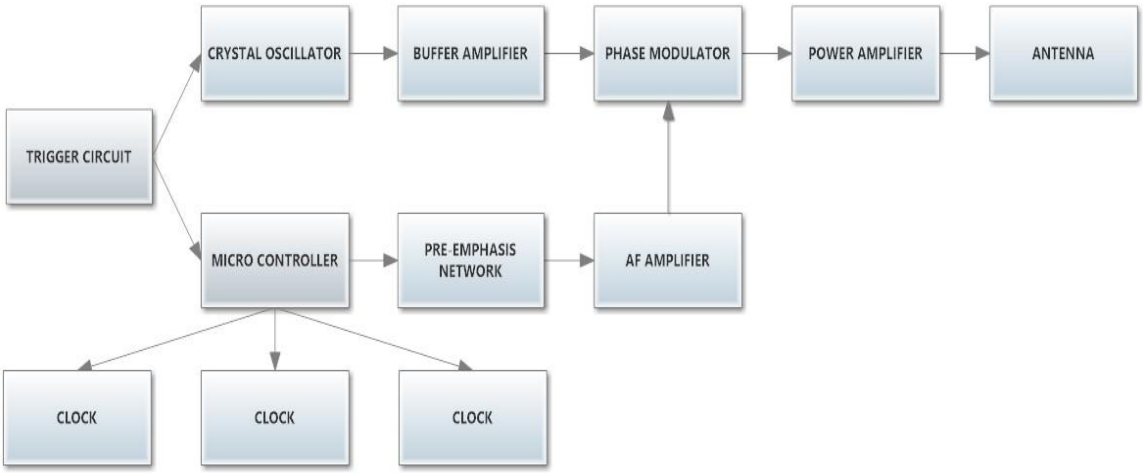

Figure 1. Transmitter

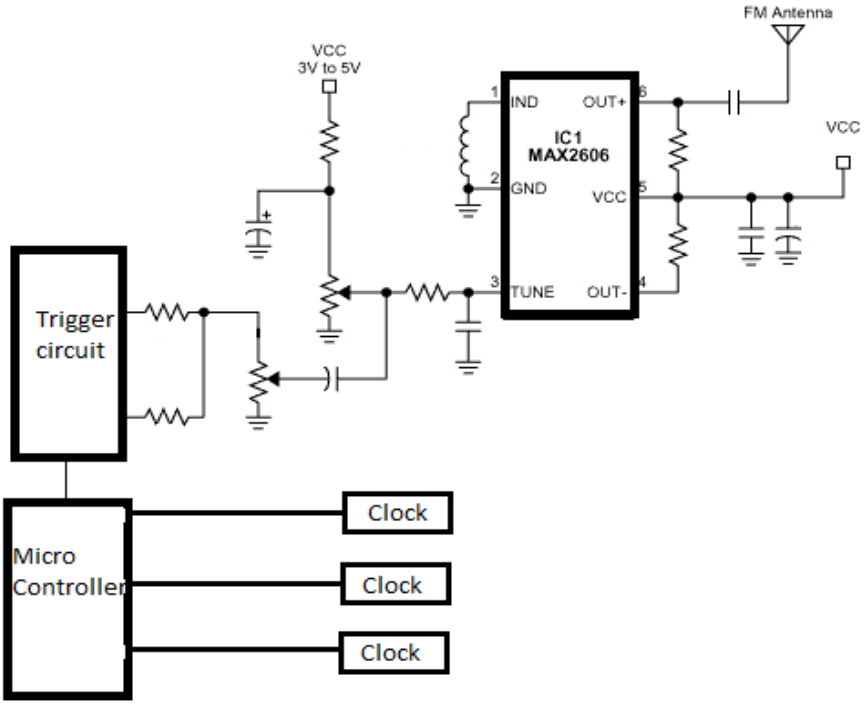

Figure 2. Transmitter circuit diagram

Mixer is basically a device to mix two signals. Mixer is used to produce a new frequency from the given two input frequencies. F1 and f2 are the given carrier wave frequency and the modulating wave frequency. The frequency mixer is used to modulate the carrier wave. This process is said to be heterodyning. The resultant wave is said to be a heterodyne. The new frequency may be the sum or the difference of the two frequencies. Double balanced mixer such as the ring diode mixer is used because of its high frequency range.

In order to avoid the changes in the carrier frequency because of the changes in the loading, a buffer amplifier is used. The circuit diagram of the transmitter is shown in the Figure 2.

The last stage of the transmitter chain is a power amplifier. It is a class C amplifier. It is also a push pull type. This is called as high level modulation. A maximum efficiency can be obtained. The amount of RF power developed is then delivered to the antenna.

Antenna are diverse in type. Many factors such as length, maximum antenna gain, radiation intensity and antenna gain have been taken into account. It should also be economical.

Emphasis is a process of increasing the amplitude to frequency characteristics. The noise in the system is parabolic. Hence when the modulating frequency is increased, the noise gets squared to the increase. Pre emphasis network increases the frequency magnitude of the modulating signal with respect to the frequency magnitude of the carrier signal. This helps to increase the signal-to-noise ratio and thereby minimizing the attenuation distortion. It also equalizes the modulating signal power in terms of frequency modulation index. This kind of a pre emphasis network can be achieved by the use of a calibrated filter. This reduces the noise of the received signal.

4.2. Receiver

The receiving antenna is used to receive the incoming signals. The incoming signal is combined with the voltage from the local oscillator with the help of a frequency mixer. The signal is converted to a lower frequency. This process is called as heterodyning. This frequency is called as the immediate frequency. This signal contains the original data from the carrier wave. This wave is then amplified and reproduced for detection. The local oscillator and the mixer used in the receiver are similar in construction to that of the transmitter. With the help of capacitive tuning the frequency difference between the local oscillator and rf circuit is maintained constant.

The immediate frequency amplifier raises the signal level to the level which can be used by the circuit. It removes the adjacent channel interference. Hence only the desired signals pass through. Composite IF transformers are used here.

The block diagram of the transmitter is shown in Figure 3 while the circuit diagram is shown in Figure 4.

A Limiter is used to allow only the signals that are within the mentioned power limit. It attenuates the remaining by performing dynamic range compression. This process is called the capture effect.

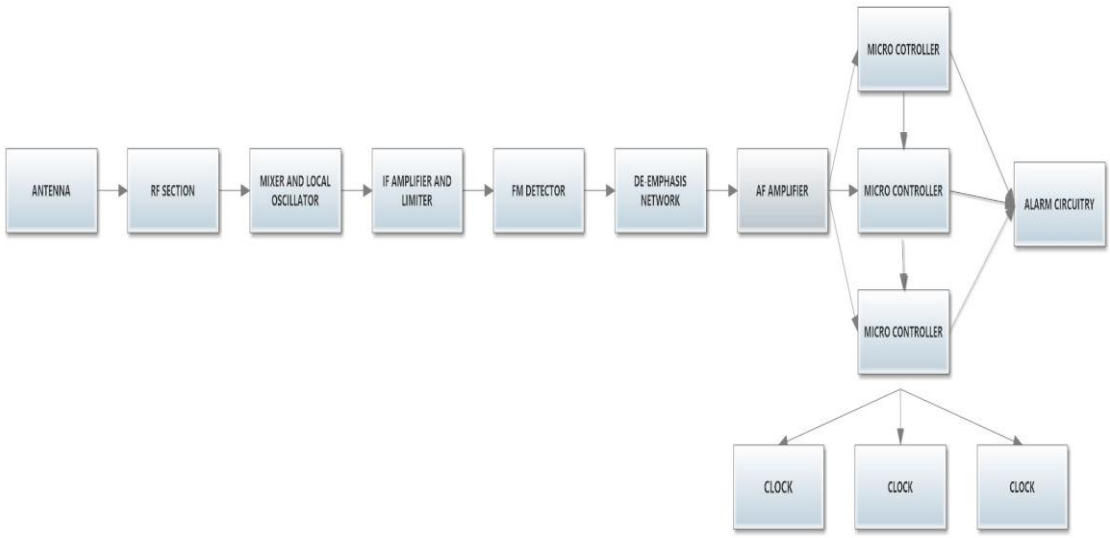

Figure 2. Receiver

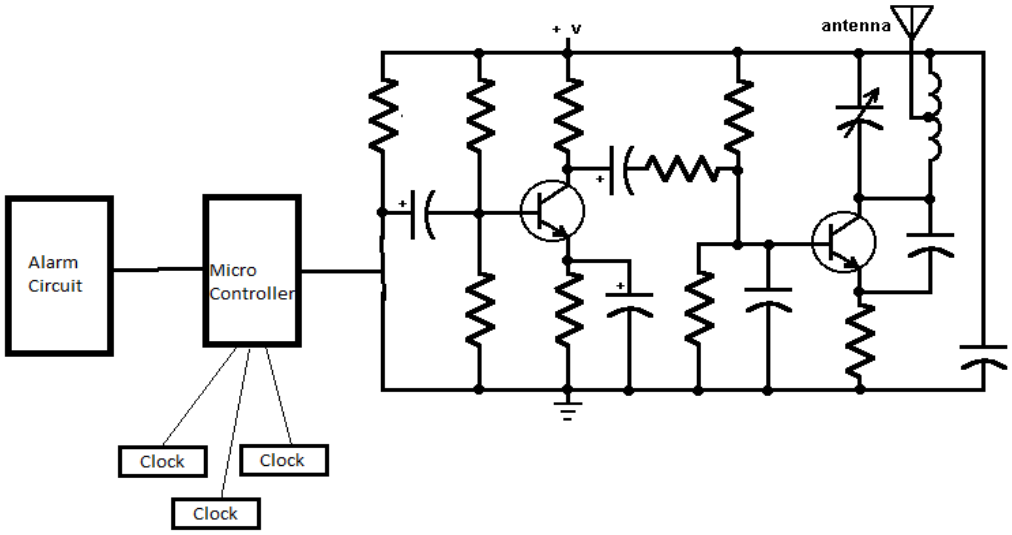

Figure 3. Receiver circuit diagram

De-emphasis network does the complement of pre emphasis network. The operation done by the pre emphasis network at the transmitter is compensated by the operation of the de-emphasis network. The frequency response is returned to the normal level by the De-emphasis network. This network reduces the magnitude of the frequency of the incoming signal to the lower frequency. This helps to improve the signal to noise ratio. The overall response of the system gets flat.

The signal from the De-emphasis network is then amplified with the help of an AF amplifier. The amplified signal is then fed into the microcontroller which controls an alarm circuitry. When the fishing boat crosses the border the microcontroller triggers the alarm thereby notifying the fishermen.

The microcontroller used here is MSP432P401x of Texas instruments. This is an efficient ultra-low power mixed signals MCU. It contains ARM Cortex-M4 processor.

The algorithm uses timestamp which is the present time of an occurrence that is recorded by the microcontroller. The microcontroller maintains accurate time through a mechanism called Network Time Protocol (NTP). The time maintained by the microcontroller is accurate to the minute fractions of seconds. This precision of the microcontroller helps it to effectively communicate to the other nodes and junctions.

The set up makes use of lower mid-range frequency of about 433 MHz .The lower frequency signals have an advantage of having higher energy and hence they can travel further. The lower frequency signals have higher penetration capabilities.

5. Geographic Survey

The border between India and Sri Lanka, shown in Figure 5, extends from the Gulf of Mannar to the Bay of Bengal through the palk bay historic waters boundary. The boundary is shown in the map. The green points show the Gulf of Mannar boundary. The red points mark the palk bay historic waters boundary. The blue points marks the Bay of Bengal boundary.

The proposed system can also be used to solve the India Pakistan maritime trespassing in the state of Gujarat. Most of the violations occur due to the lack of proper navigation instruments. The maritime boundary between India and Pakistan is shown below in the Figure 6.

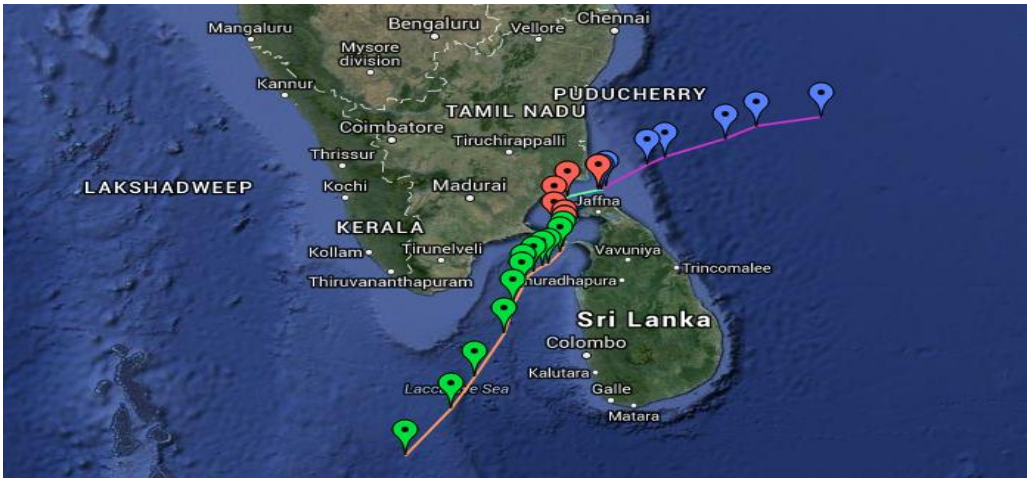

Figure 4. India-Sri Lanka Maritime Boundary

Figure 5. India-Pakistan Maritime boundary

6. Algortithm

The data from the three transmitting towers id fed to three different microcontrollers. All the microcontrollers are involved in the process of matching the incoming data with the available database. This process of comparison is speeded up by first splitting the value into its place value. It is then compared with border place value. Border place value is the available database split into a two dimensional array. When a single value matches, an LED glows. The alarm goes off, when all the three values match.

1. Start.
2. Get the input and store it in array input1.
3. Perform modulo operation on input1 by variable 10 and store the output in array place value1.
4. Divide the variable input1 by 10 and go to step 5.
5. Increment array value of the array placevalue1.
6. Check if input1 is greater than 10. If yes go to step 3. Else go to step 7.
7. Store the value of array input1 in array place value1.
8. Check if value in array place value is matching with the data from array border place value. If yes go to step 9 else go to step 11.
9. Increment the value of 2nddimension in array border place value and decrement value of place value1 and check if array value is less than zero. If yes go to step 10. Else go to step 8.

10. Make the output pin of the alarm high.
11. Check if array value is less than zero. If yes go to step 12. Else increment the value of 1stdimension in array border place value and go to step 8.
12. Wait till we get another input.

7. Technical Challenges and Future Scope

Doppler Effect is one predominant problem encountered during transmission and reception of radio waves, when the distance between the source and the receiver is not a constant. The frequency of the received radio waves is lower than that of the sent radio waves, when the receiver moves away from the source. As the distance of the boat from the transmitter keeps increasing, the received frequency is also much lower. Radio waves get unexpectedly attenuated due to a phenomenon called multi-path propagation. This can be avoided by appropriate Doppler Effect estimation at the receiving end making suitable modifications to the waveform. This change could be introduced in the algorithm.

Future recommendations

The proposed system alerts the fishermen in the boat when they cross the national border. The system can be enhanced by giving alerts to the coast guard when a fishermen crosses the border. This will serve to protect the life of the fishermen. This will also prevent voluntary crossing of the border. This will prevent the violation of the regulation of fishing by foreign vessels rules, 1982. In order to implement this enhancement, a transmitter should be implement in the fishing boat along with the receiver.

8. Conclusion

This technology facilitating an alarm system for fishermen, to prevent them from crossing the safety of Indian maritime boundary, has high potential. It would come quite handy in resolving the problems faced by fishermen at Sri Lankan waters. It could also help in stopping the Indian boats from trying to penetrate beyond border limits, by suitably alerting the Coast Guard. This technology is economically feasible, and could be easily implemented on a large scale basis by the government.

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