LIQUID MONOPOLE ANTENNA FOR SUBMARINE DATA COMMUNICATION

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ABSTRACT

This paper describes a design of sea-water monopole antenna at very high frequency band for maritime wireless communications. It consists of a feeding probe and a sea water cylinder held by a clear acrylic tube. The feeding probe is loaded with a disk on the top to improve the excitation of TM mode. Measurement shows that the proposed sea-water antenna has high radiation efficiency due to an efficient feeding structure. Meanwhile, due to the transparency and liquidity of sea water, the proposed antenna is almost optically transparent and can be easily reconfigurable. The center frequency of the antenna is tunable by lengthening or shortening the water cylinder, while the bandwidth of the antenna can be adjusted by widening or narrowing the water cylinder. Seawater monopole antenna is very efficient and it could be the reliable concept of sending data through salt water using tubular antenna.

Keyword: - *Monopole antenna, Sea-water, Transparent antenna, VHF band*

1. INTRODUCTION

The Monopole antenna is a class of radio antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a ground plane. The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feedline is attached to the lower end of the monopole, and the other side is attached to the ground plane, which is often the Earth. For a liquid antenna, the fluid that carries charged particles in the form of ions is used as the radiating medium. Due to the fluidity, the fluid can be pumped out or drained and the tube can also be removed, resulting in very small occupation space and Radar Cross Section (RCS).

Liquid antennas are a special type of antenna utilizing fluid to transmit and receive radio signals. They have attracted increasing attention due to a range of attractive features such as conformability and small radar cross section (RCS). A lot of efforts have been made to design liquid antennas and water-based liquid antennas. Liquid metal antennas are

typically fabricated by injecting liquid metal into an elastomeric substrate (e.g.poly-dimethyl-siloxane, PDMS) and therefore flexible and mechanically durable.

Some designs were proposed such as a flexible patch antenna incorporated with a liquid metal encased in an elastometer and a liquid metal alloy injected planar inverted cone antenna (PICA). The challenges associated with designing liquid metal antennas include the need for the nontoxic liquid metal with stable structure and high cost. Compared to liquid metal antennas, water-based liquid antennas are preferred due to their low cost, transparency, ready accessibility and ecofriendly features. A considerable amount of work has been carried out to study water-based antennas measurement. In particular, the permittivity of water with PG at various conditions is reported for the first time.

2. COMPONENTS USED

The hardware and software used

2.1 Hardware

- Sensors
    1. Thermocouple sensor.
    2. Thermistor sensor.
    3. Light Dependent Resistor.
    4. IR based sensor.
- Signal Conditioning Circuit
- PIC -16F877A Micro Controllers (2)
- Power supply Circuit
- Seawater Monopole Antenna
- RF –Transmitter module RF – Receiver module
- PC (2)

2.2 Software

- Visual Basic-6.0

3. WORKING OF THE SYSTEM

The working and the design of the liquid monopole antenna and its transmitter receiver section will be discussed.

Basic Description

The circuit receives a 230V A.C. supply. A 12V step-down transformer steps down the 230V to 12V. Now the bridge rectifier converts the A.C. to D.C. The output of the bridge rectifier may contain some component ac component or ripples in it. So a capacitor filter is used to remove the ac component and produce pure dc. An IC7805 voltage regulator is used to regulate the 12V dc to 5V since the circuit operation requires only 5V. The microcontroller use here is PIC 16F877A. The 5v supply is given to the controller. The transmitter side consists of a PIC controller, Signal conditioning circuit, 4 sensors interfaced namely Thermocouple sensor, Thermistor sensor, Light Dependent Resistor, IR based sensor that communicates with a PC, RF transmitter module (including RF transmitter and a 4- bit encoder) and Seawater Monopole Antenna. On the other hand, the receiver side consists of a PIC controller, RF receiver module (including RF receiver and a 4- bit decoder), that communicate to the PC at the receiver side.

4. Transmitter Section

The thermocouple sensor, Thermistor sensor, Light Dependent Resistor, IR based sensor are interfaced at port A of the microcontroller. The sensed outputs are given to the Signal Conditioning circuit in order to amplify the weak signals before reaching to the microcontroller. All these analog inputs given to the controller are converted into digital using ADC present in the controller that operates in 10 bit. The encoder in the RF transmitter module is connected to the data pins and transmission enable pin. The RS-232 which is in turn connected to the PC where the values of the thermocouple sensor, Thermistor sensor, Light Dependent Resistor, IR based sensor are displayed.

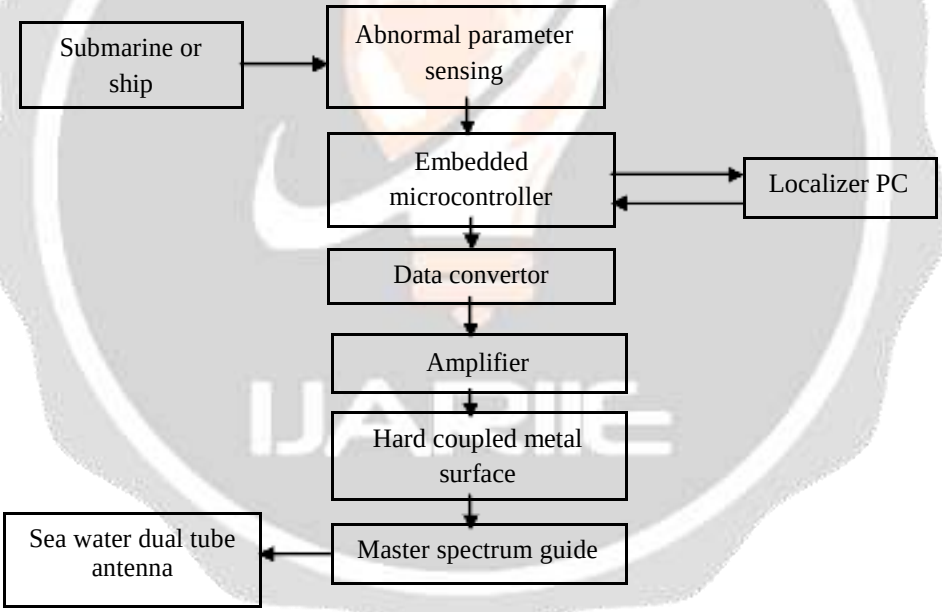

Fig 1: Block diagram of transmitter section

The values are passed to the Seawater acrylic tube and then data is transmitted by the wireless technique to the receiver antenna. Also, the status (normal or abnormal) of the 4 interfaced sensors is indicated at the transmitter section which is shown in fig 1. The RF transmitter transmits the encoded data to the receiver side.

5. WORKING MODULE

For design and implementation of Seawater Monopole Antenna, consists of 5 module

- Data acquiring system
- Data processing system
- Data manipulation system
- Design of wireless module
- Design of receiving module

6. Receiver Section

The RF receiver module receives the encoded data and also presents it to the decoder which is shown in fig 2. The data lines from the decoder are connected to the pins of the controller. The controller at the receiver side is programmed in a way that it indicates only the status (normal or abnormal) of the 4 interfaced sensors. The RS-232 is connected to the pins C6 (TX), C7 (RX) of port C from the controller. The controller which is then connected to the PC. The PC indicates the status (normal or abnormal) of the 4 interfaced sensors.

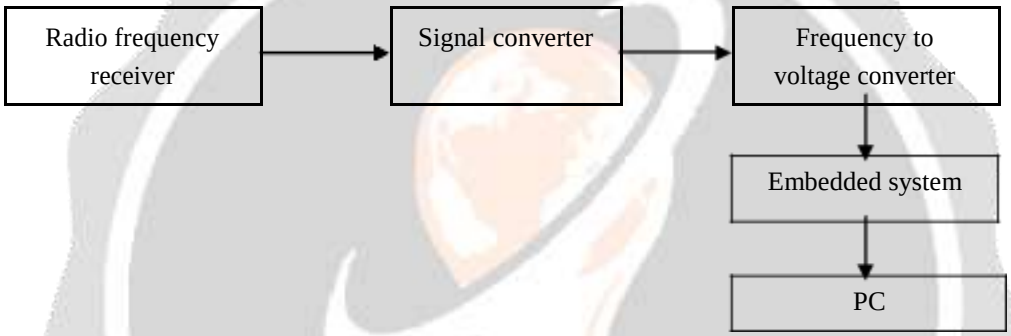

Fig 2: Block diagram of receiver section

7. RESULT

Fig 3: Transmitter module and antenna section

Fig 4: Transmitter and Receiver section

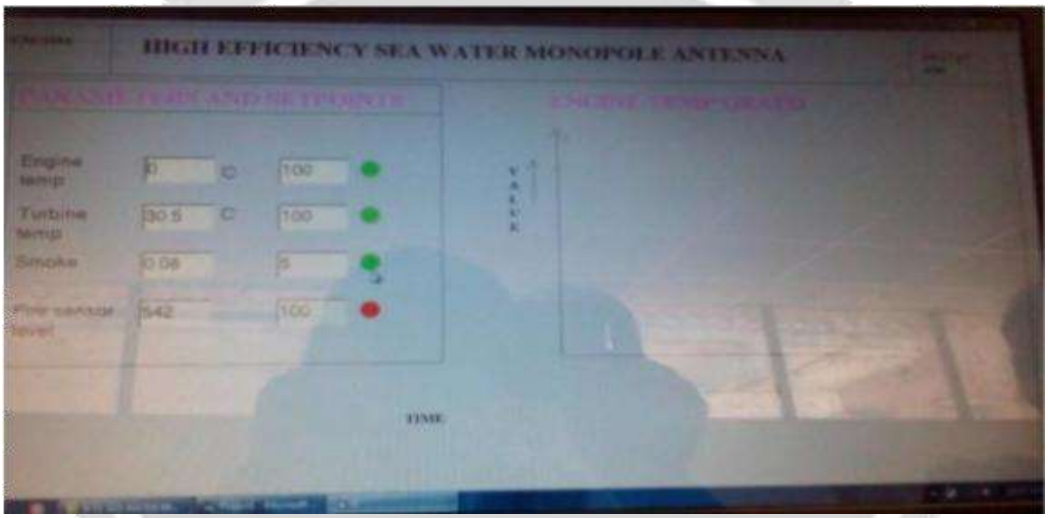

Fig 5: Sensed value displayed at the transmitter section

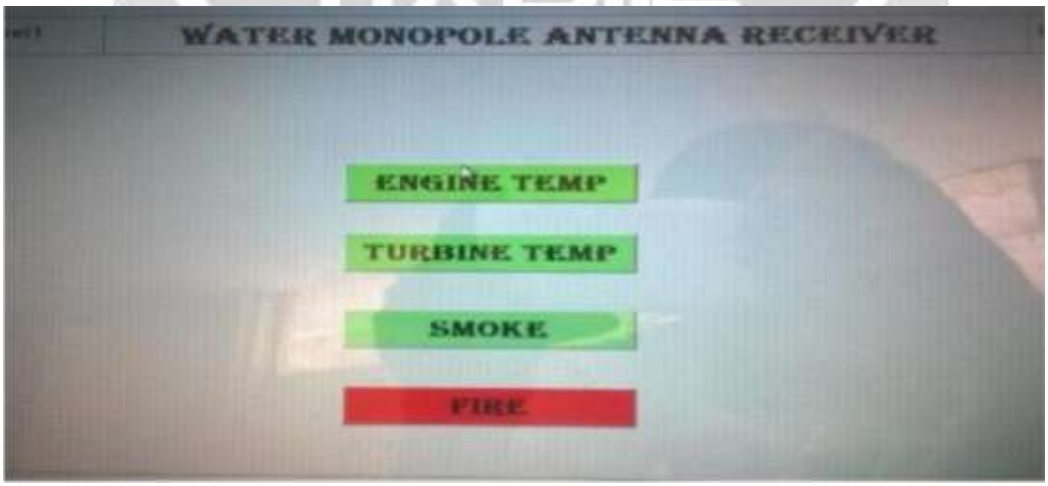

Fig 6: Abnormality status at the receiver

Fig 3 and Fig 4 represents the snapshot of the transmitter and receiver kit designed with the liquid monopole antenna. Fig 5 and Fig 6 represents the sensed value at the transmitter and the abnormalities detected at the receiver.

8. CONCLUSION

Thus this project provides an efficient and reliable concept of sending data through salt water using tubular antenna. The concept is to save the fuel, time and life of submarine and water bound vehicles. It can be implemented easily and comparatively the result is obtained in low cost. The system can send variables of submarine to the external world and Virtual instrumentation on the receiving side will be possible. Also, by the use of serial

communication using RS-232, the concept is enveloped. In this project four sensors are used to sense various submarine parameters such as engine temperature, turbine temperature smoke, fire. The values that are sensed are displayed at the transmitter side for monitoring purpose of the submarine. If needed, they are sent to another receiver who is supervising the parameters regularly. Instead of providing the set of sensed values to the receiver, so it provides only the status (normal or abnormal) and there is no further analysis required by the supervisor to distinguish the values within the acceptable range and out of range. We are using a simple software tool to represent the data.

7. REFERENCES

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