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HEALTH MONITORING MASK WITH WEARABLE ANTENNA TECHNOLOGY

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ABSTRACT

The development of a health monitoring mask with wearable antenna technology is implemented in this paper. For the transmission and reception of data for systems connected to healthcare, wireless body area networks are employed, including the usage of wearable antennas. A micro strip patch antenna is designed which is integrated on the mask, this will help in transmitting the data. Also, a temperature sensor and a pulse sensor are integrated on the mask along with the antenna. These sensors are in turn connected to a Arduino UNO microcontroller, to which these sensors send the data and this microcontroller then sends this data to the transceiver to which a textile antenna is attached which transmits these data. At the receiving side, we use the same microcontroller to the receive the data transmitted by the antenna. Then the final output is displayed on a lcd display. Therefore, based on the performance of the designed system, it is concluded that the health monitoring mask has great potential in monitoring the health of a person and is very useful in very crowded places like malls, public events, schools, colleges, offices, Railway stations Airports, Hospitals etc.

KEYWORDS: Arduino UNO, High Frequency Structure Simulator (HFSS), LoRa Shield, Temperature Sensor, Pulse Sensor

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1. INTRODUCTION

Real-time health monitoring practices, wireless body area networks are deployed. Wearable antennas are used in these networks for data transmission and reception for systems related to healthcare. A wearable antenna is one that is incorporated into the wearer's clothing. Numerous uses for a wearable antenna include GPS navigation, military use, athlete fitness tracking, telemedicine, satellite communication, digital watches, and RFID. Intensive research is being carried out on body conformal antennas as a result of the recent rapid technological advancements in the field of wearable electronics. These days, due to their serious effects on human health, certain bodily vital signs like heart rate, blood glucose, blood pressure, and electrocardiogram (ECG) need to be constantly monitored. As a result, various sensors can be attached to the human body to track such vital signals. Body-worn sensors collect data on various physiological characteristics and transfer it to the wearable devices, which then send it to the nearest receiving node.

2. LITERATURE REVIEW

Textile-based antennas are essential given the industry's rapid development in wearable electronics. The anisotropic characteristic of textile-based antennas, in contrast to conventional inlay antennas, restricts electromagnetic wave propagation and degrades antenna performance. Wearable antennas, however, have a number of benefits over traditional antennas, including manufacturing flexibility, secure integration, compatibility, and flexibility. Due to their many uses in the military, health, fashion, sportswear, security, and material resource planning, wearable antennas have recently gained significant attention in the field of smart wireless devices and have been the subject of extensive study.

A successful technique relies upon the use of wearable antennas that can be fully integrated with clothing and can be utilised for remotely transmitting and receiving the sensor data. LoRa is a communication system which is part of the Low Power Wide Area Network (LPWAN) technology using ISM bands. It has long coverage ranges of up to 20 km or more with less than 14dB transmit power.

3. METHODOLOGY

The requirements for the mask have been identified based on the literature review. The design specifications have been developed based on literature review. Functional block diagram of the proposed system has been developed using design specifications. The antenna has been designed based on the required specifications using HFSS. Suitable material is selected for the design of the antenna for better performance.

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Microcontroller needed for the development is identified. The Software code is developed using embedded C/Assembly for the microcontroller which interacts with sensors and other devices. The developed software is compiled and executable is generated. The compiled executable is ported to target microcontroller. Microcontroller interfaces with sensors and other devices will be tested. The antenna connection between the transmitter and the receiver block is tested. Test cases are developed for the proposed system based on design specifications. The developed system will be tested for its functionality using the developed the test cases. Performance analysis of the implemented system will be carried out and optimization can be performed if required.

4. SYSTEM DESIGN

The overall block diagram of the proposed project model is as shown in the Figure 1.

The temperature sensor senses the body temperature. It generates voltage corresponding to the temperature. This value is then passed to the Arduino Uno microcontroller which stores the value for calculation. Similarly, the pulse sensor senses the pulse rate over a period of time say a minute which is then passed to the Arduino Uno microcontroller which stores the value for transmission as in figure 2. These values are now ready to be transmitted. The Arduino Uno now sends these data to the lora shield for Arduino which is a transceiver. To the lora shield for Arduino, the textile antenna is connected which will radiate these values for the receiver as in figure 3.

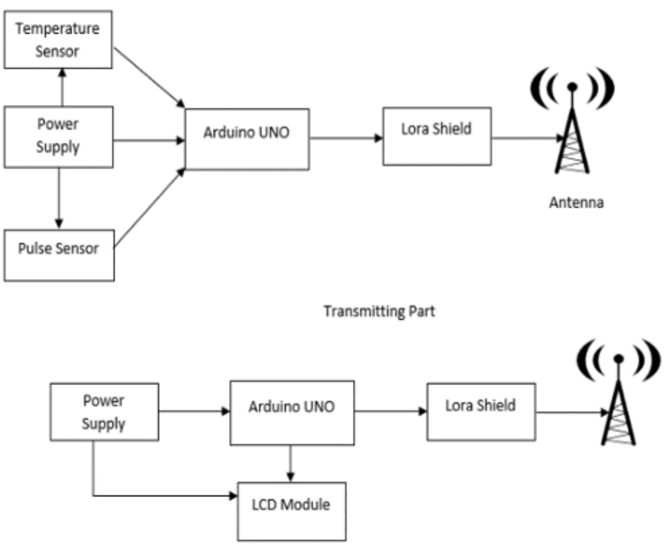

Figure 1: Block Diagram of transmitter and receiver

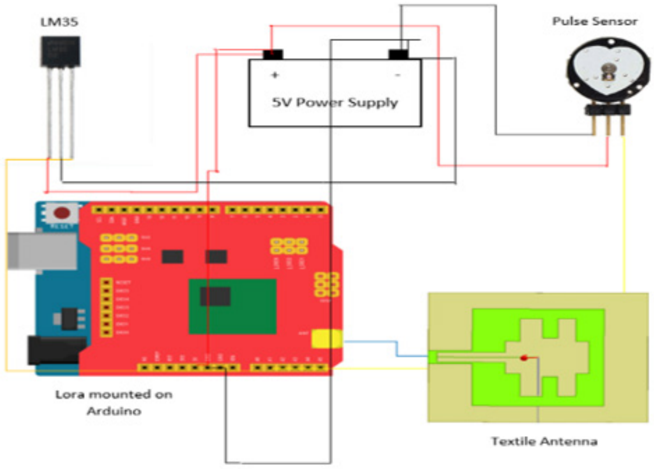

Figure 2: Circuit Diagram – Transmitter

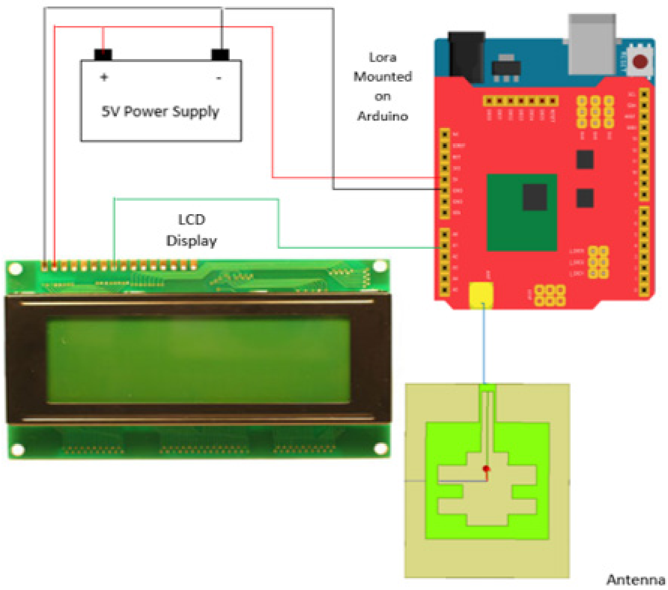

Figure 3: Circuit Diagram – Receiver

The Lora shield for Arduino on the receiver side receives the transmitted data. It sends these data to the Arduino Uno and then displays the same on the lcd display or computer terminal which is ready for being monitored.

1. Design Specifications of the textile antenna –

The following table shows the parameters and values used to design the textile patch antenna.

Parameter	Size (mm)	Parameter	Size (mm)
W	40	L	50
W_1	30	L_1	30
W_{P1}	10	L_{P1}	3
W_{P2}	24	L_{P2}	4.1
W_{P3}	12	L_{P3}	3.5
W_{P4}	24	L_{P4}	5.1
W_{P5}	10	L_{P5}	3.4
W_F	3.028	L_F	17.5
H_1	1	H_2	0.035

Table 1: Antenna Details

The antenna is designed according to the table 1 and Fig. 4

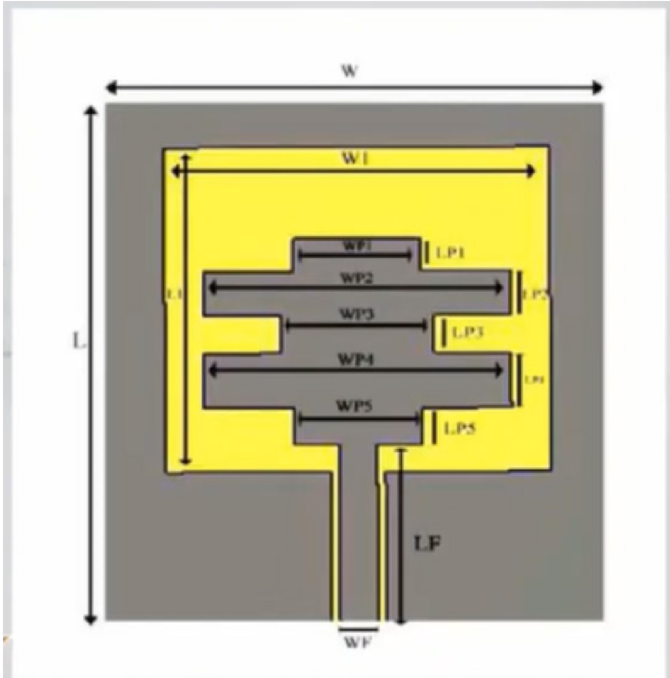

Figure 4: Antenna specifications

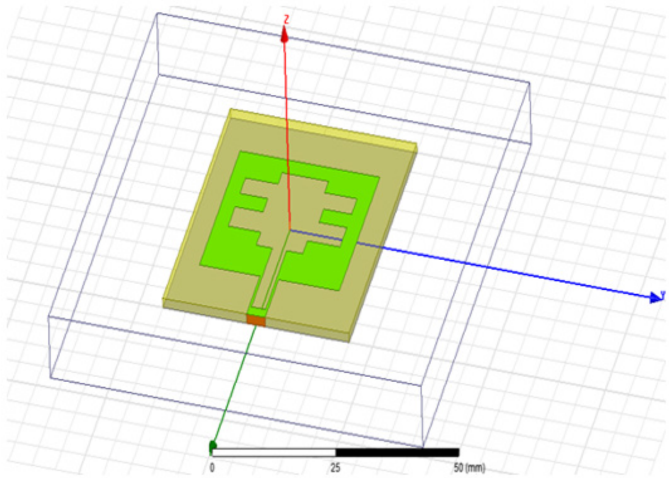

Figure 5: Antenna as designed in HFSS

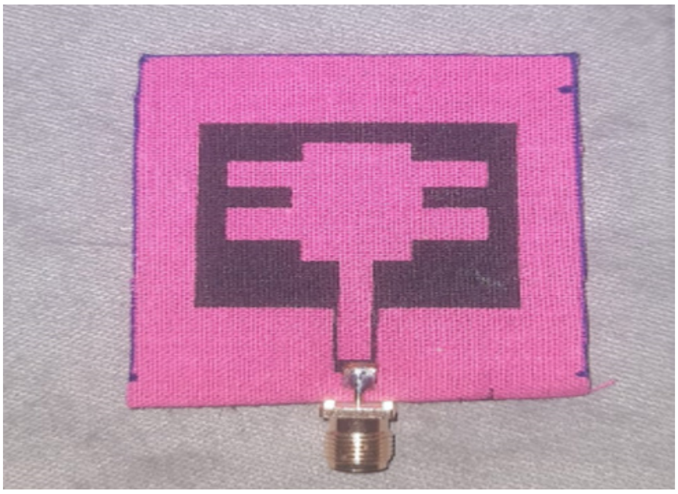

Figure 6: Textile Antenna after fabrication

The designed antenna after simulation and fabrication is as shown in Figure 5 and 6.

5. RESULTS

1. Simulation result of wearable patch antenna:

The proposed wearable patch antenna is simulated in HFSS antenna simulation tool using simulation parameters tabulated in TABLE 1. The antenna is characterized by 50 Ω input impedance. The scattering parameters (S11) return loss of the simulated antenna is illustrated in Figure 7. For the planned antenna operating at 2.45 GHz, the lowest return loss curve value obtained is -11.0248 db. The 3D gain of the simulated antenna is shown in Figure 7.9. The peak gain was achieved at 2.45 GHz in the z-axis, which is perpendicular to the antenna. The far-field region of the planned textile antenna is where this radiated power is analysed. Applications for health monitoring can use the values derived from the simulation results. The antenna's main lobe can be seen to radiate the majority of its power at the front, indicating that it has a high front to back ratio.

The Return Loss obtained is -11.0248 dB as in figure 7 and figure 8

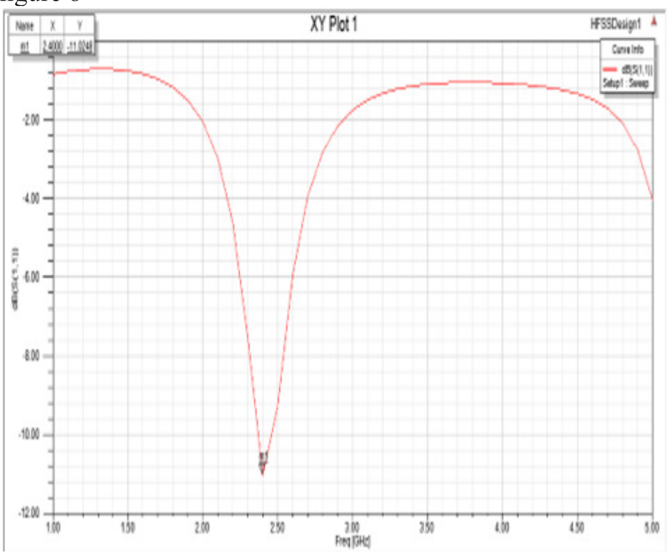

Figure 7: Return Loss of the antenna – Simulation Result

The simulated radiation pattern is as shownin figure 9 and figure 10. Simillarly the directivity and gain patterns of the simulated antenna design is as shown in fig11 and figure12.The frequency achieved after fabricating is 2.4GHz and gain is -3db which is similar to the simulat ed design and gain enhancement. In addition, it can be seen that the antenna has minimal minor lobes, which are very good for wearable applications.

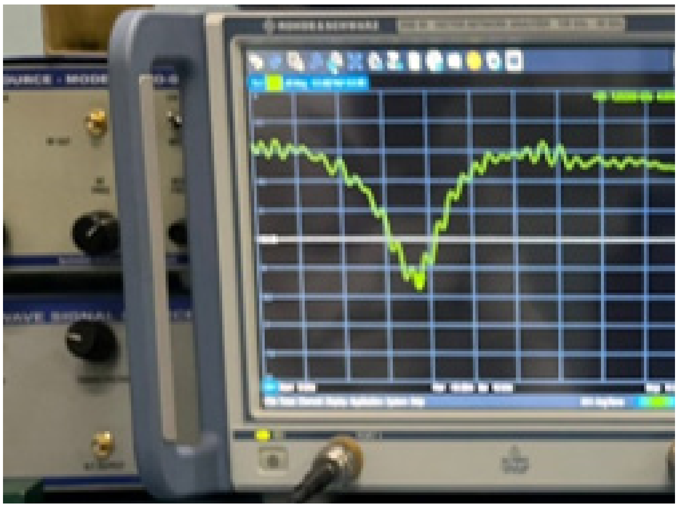

Figure 8: Return Loss of the antenna – Fabrication Result

Parameters	Simulated Result	Fabricated Result
Operating Frequency	2.4 GHz	2.4 GHz
Return loss	-11.0248 dB	-3 dB

Table 2: Result Comparison Table

After the fabrication, the antenna isworking at the desired frequency which is 2.4 GHz. The simulation result of the antenna matches with the fabrication result. The difference in result is due to the thickness and material of the fabric as hown in Table II.

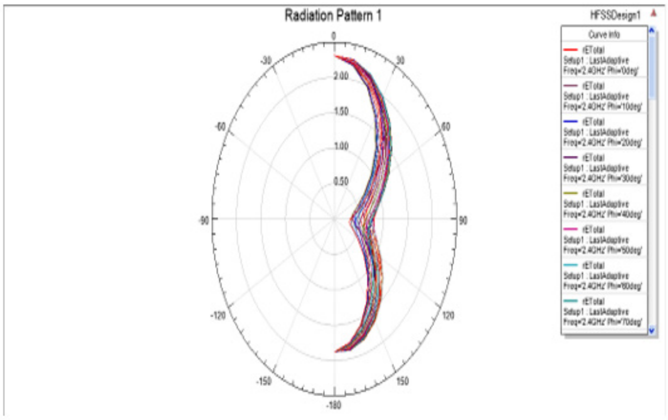

Figure 9: Radiation Pattern of the antenna

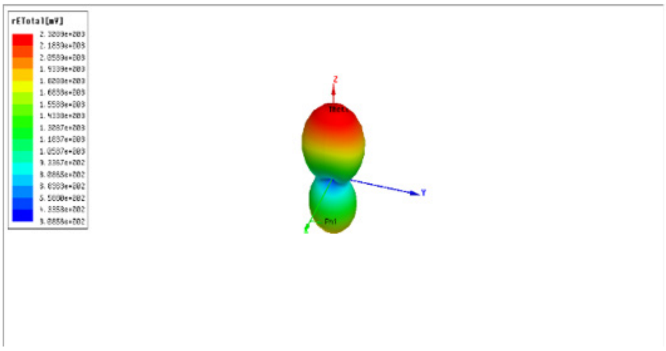

Figure 10: 3-D Radiation Pattern of the antenna

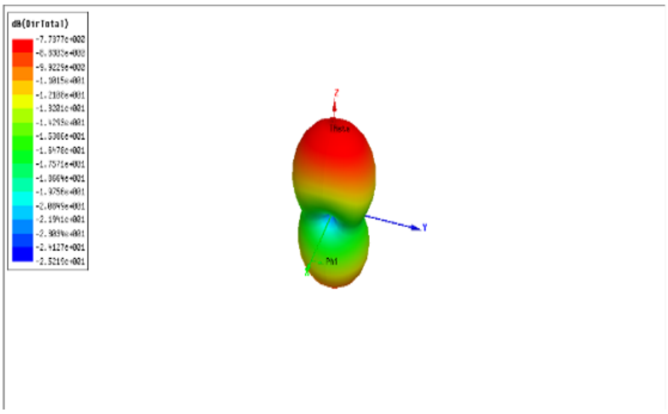

Figure 11: Directivity

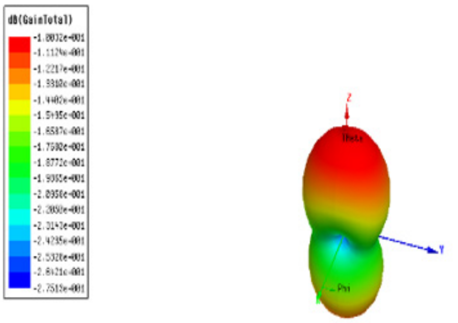

Figure 12: Total Gain

2. Implementation Result

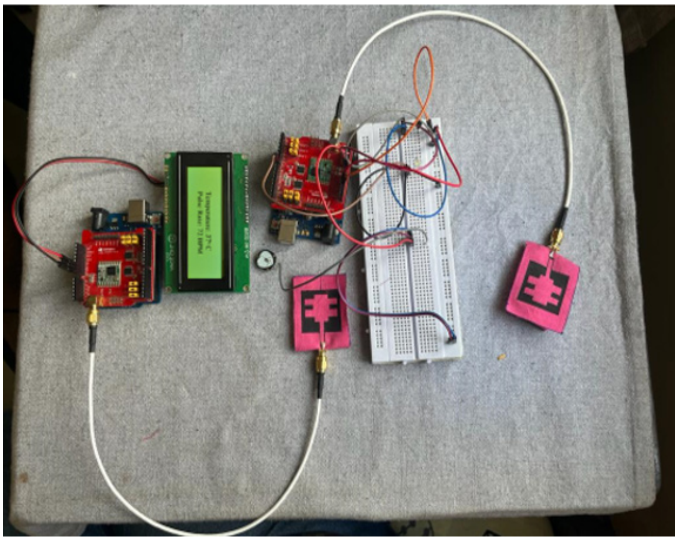

Figure 13: Implementation of the system

After all the hardware connection, the syatem is as shown in Figure 13. The LCD display shows the sensed value by the temperature and pulse sensor. The temperature displayed is in Celcuis and pulse rate is bpm. On the transmitter, the sensor values are radiated with lora shield which is mountd on arduino. The sma connector of the lora shield is connected to the textile antenna with the help of coaxial cable. On the receiver, the lcd display displays the final output the same way the sensed value were transmitted. The lora shield receives the sensor output via textile antenna which is sent to arduino uno. It then sends it to the LCD display for monitoring.

6. CONCLUSION AND FUTURE WORK

This prototype helps to monitor health of person in Wi-Fi range. Removed the requirement of an individual who keeps monitoring the body temperature using a temperature gun during this hard time and risking their health. It can be very useful to monitor the health in places like offices, airports, schools, colleges, hospitals etc.The incorporation of various technologies under one roof has given path to achieve goals in such an efficient manner in the past. These technologies bring about successful implementation of various components such as lora shield, temperature sensor, pulse sensor, Arduino UNO, wearable antenna. The two sensors collect the respective information and feed it to the micro-controller, the control unit of micro controller processes the information and feed it to the lora which is mounted on the Arduino UNO which is attached to the textile antenna for transmission. The antenna then transmits the information which is received by the receiver module. The arduino uno then processes the data and sends it to the lcd display for displaying the result.

In future, a machine learning algorithm will be incorporated which can detect the distance between the individuals in an area along with body temperature and pulse rate. Also to incoperate another feature which can detect blood oxygen level of a person.

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