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Simulation and Design of Wearable Antenna for Telemedicine Application

Sonia C. Survase[1], Prof.Vidya V.Deshmukh[2]

PG Student, Dept.of Electronics and Telecommunication, AISSMS C.O.E., Pune University, India[1]

Assistant Professor, Dept. of Electronics, AISSMS C.O.E., Pune University, India[2]

Abstract: Telemedicine is the use of telecommunications technology as a medium to provide live, interactive audiovisual medical services for sites that are at a distance from the provider. Telemedicine and related healthcare technologies aim to provide efficient healthcare remotely. The objective of this paper is to provide a better solution for telemedicine application. Various wireless technologies are used, but wearable antenna is the best solution. In this paper wearable antenna is designed. The design consist of microstrip yagi patch antenna. This antenna is simulated on High frequency structure simulation(HFSS). This simulation gives improved return loss, low front to back ratio.

Keywords: Yagi patch antenna, wearable antenna, data acquisition hardware, gap coupled antenna, Electrotextile antenna, MIMO.

I.INTRODUCTION

Telemedicine means literally medicine at a distance. New technologies in sensing, medical imaging and wireless data communications are allowing telemedicine to provide healthcare at a distance with much lower cost than in the past, enabling the development of new widespread remote medicine initiatives[5].Researches categorize the telemedicine history into three eras[3].The first era can be named as telecommunications era of the 1970s. Applications in this era were dependent on broadcast and television technologies where telemedicine application was not integrated with any other clinical data. The second era of telemedicine, dedicated era, started during the late 1980s as a result of digitalization in telecommunications and it grew during 1990s The transmission of data was supported by various communication mediums ranging from telephone lines to Integrated Service Digital Network (ISDN) lines[6].The high costs attached to the communication mediums that can provide higher bandwidth became an important bottleneck for telemedicine. Dedicated era has turned into an Internet era where more complex networks are supporting the telemedicine. The third era of telemedicine is supported by the technology that is cheaper and accessible to an increasing user population. The enhanced speed and quality offered by Internet or3G mobile telephony is providing new opportunities in telemedicine. Certain recent research projects include the use of satellite-based Telemedicine solutions. Satellite-based telemedicine services are used to solve teleconsultation, tele-education, home care, second opinion and other medical problems[7].

There are many challenges in wireless monitoring of patients, including the coverage, reliability and quality of monitoring. The work done in patient monitoring includes home monitoring wireless telemetry system for EEG epilepsy Bluetooth-based system for digitized ECGs a hospital-wide mobile monitoring system mobile telemedicine and, real-time home monitoring of patients[5]. One of the most difficult challenges in patient monitoring using wireless networks, especially for emergency messages, is the reliability of message delivery[6].Many hospitals and nursing homes are deploying infrastructure-oriented wireless networks, such as wireless LANs, satellites, and cellular and GSM in telemedicine systems range from simple heart rate, blood pressure, body temperature to blood glucose levels and ECG wave forms. To overcome the coverage problems a reliable low profile antenna is required for best performance

The structure of this paper is as follows. In section 2 wireless technology for telemedicine are introduced ,followed by section 3physiological parameter 4 challenges for conventional sensor .In section 5wearable technology is introduced ,section 6 gives conclusion.

II. WIRELESS TECHNOLOGY

Wireless adoption in the healthcare industry is high and is expected to grow even further. The new wireless broadband technologies enabled creation of telemedicine services previously only possible via cable connections. Advanced medical services can be provided to rural areas or areas stricken with disasters otherwise unreachable by cable connections, very quickly and with fraction of the previous cost. Wireless telemedicine is especially suitable for areas lacking proper cable connections or places where installing cable links is difficult, economically unavailable or simply impossible.

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Following table shows overview of different technologies for telemedicine.

Table1. Different wireless technologies for telemedicine

Type	Sub-type	Frequency band	Data transfer rate
GSM	GSM-900	900MHZ	9.6-43.3 kbps
	GSM-1800	1800MHZ	9.6-43.3 kbps
	GSM-1900	1900MHZ	9.6-43.3 kbps
GPRS	GPRS	900/1800/1900MHZ	171.2kbps
Wireless LAN	IEEE 802.11a	5GHz	20Mbps
	IEEE 802.11b	2.4GHz	11Mbps
	Hiperlan1	5GHz	20Mbps
	Hiperlan2	5GHz	54Mbps
	Bluetooth	2.4GHz	723.2Mbps
Satellite	ICO	C,S band	2.4kbps
	Globalstar	L,S,C band	7.2kbps
	Iridium	L,Ka band	2.4kbps
	Cyberstar	Ku,Ka band	400kbps-30Mbps
	Celestri	Ka band and 40-50GHz	155Mbps
	Teledesic	Ka band	16kbps-64Mbps
	Skybridge	Ku band	16kbps-2Mbps

III.PHYSIOLOGICAL PARAMETER

The physiological parameters that are monitored are Electrocardiogram (ECG), heart rate derived from ECG signals by determining the R-R intervals, blood pressure, body temperature, Galvanic Skin Response (GSR), Oxygen saturation in blood (SaO2), respiratory rate, Electromyogram (EMG), Electroencephalogram (EEG) and three axis movement of the subject measured using an accelerometer[12].

IV.CHALLANGES

The conventional physiological monitoring system used in hospitals cannot be used for wearable physiological monitoring applications due to the following reasons .

• The conventional physiological monitoring systems are bulky to be used for wearable monitoring.

• The gels used in the electrodes dry out when used over a period of time, which lead to increase in the contact resistance and thereby degrading the signal quality.

• The gels used in the electrodes cause irritations and rashes when used for longer durations.

.•The sensors used in conventional monitoring systems are bulky and are not comfortable to wear for longer durations[3].

To overcome the above problems associated with the conventional physiological monitoring there is a need to develop sensors for wearable monitoring and integrate them into the fabric of wearer and continuously monitor the physiological parameters.

V.WEARABLE TECHNOLOGY

A. Wearable monitoring system

Wearable physiological monitoring system

consists of an array of sensors embedded into the fabric of the wearer to continuously monitor the physiological parameters and transmit wireless to a remote monitoring station. In the conventional wearable physiological monitoring system, the sensors are integrated at specific locations on the vest and are interconnected to the wearable data acquisition hardware by wires woven into the fabric.

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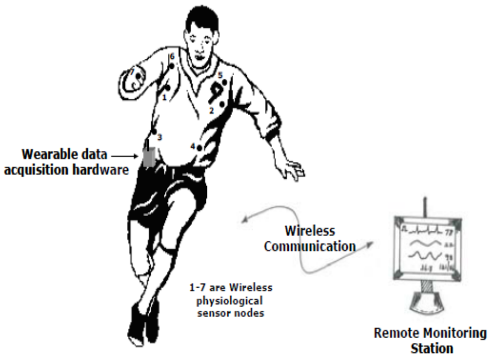

Fig1.Overall architecture of the wireless sensor network based wearable physiological monitoring system.

The drawback in sensor system is that the cables woven in the fabric pickup noise such as power line interference and signals from nearby radiating sources and thereby corrupting the physiological signals. Also repositioning the sensors in the fabric is difficult once integrated[8].Number of sensors integrated into the fabric form a network (Personal Area Network) and interacts with the human system to acquire and transmit the physiological data to a wearable data acquisition system.

B.Wearable antennas

The health parameters that may be transmitted wirelessly to remote stations (off body mode) in telemedicine systems.In addition to off body applications, on body mode is also necessary for communication between sensors devices located on or within the patient's body[6].Therefore a reliable low profile antenna is required for best performance. Various types and design approaches of wearable antennas are being proposed including: Electro-textile, microstrip patches , buttons antennas, wearable MIMO systems, or hybrid systems based on one or more of such designs .wearable antennas are required to be small size, lightweight, but robust at the same time[1]. They also have to be comfortable and conformal to the body shape, yet they must maintain high performance in terms of reliability and efficiency. Electro textile based antennas seem to be a low profile low profile solution for wearable application; however, they are more prone to discontinuities in substrate material, fluids absorption, bending, twisting, and compression . Furthermore, microstrip button antennas offer favorable characteristics such as lower profile construction, low cost, ease of fabrication, capability of integration with clothing.

The wearable antenna for telemedicine has proven to be better option for patient monitoring. Such antenna with specified parameter as can be simulated on antenna software such as CADFEKO, HFSS, CST Microwave studio , and then fabricated. Depending on the comparative study of result the antenna can be fabricated for optimum result.In this paper wearable yagi antenna for two different design is designed

VI.CIRCULAR YAGI PATCH ANTENNA

A. Design model

First proposed design for wearable antenna is circular yagi patch antenna.In this design the shape of substrate is circular. Following fig 3.Shows the design model for circular patch yagi antenna.

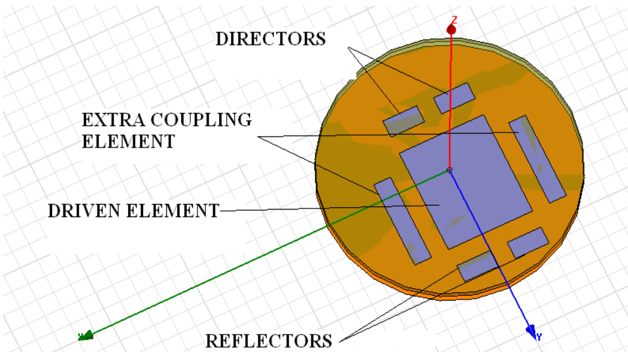

Fig3 .Proposed yagi microstrip antenna

B.Antenna parameters

Following table gives the specification for antenna parameter

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Table 2 Antenna parameter specifications

Sr.no	Parameter	Value
1	Operating freq	2.45GHz
2	Dielectric const	4.4
3	Substrate thickness	0.85mm
4	Substrate radius	36mm
5	Ground radius	36mm
6	Ground thickness	0.5mm
7	Driven element dimension	30mmX25mm
8	Director dimension	10mm X 5mm
9	Reflector dimension	10mmX5mm
10	Extra coupling ele. Dime.	25mmX5mm

C.RESULTS

The prosposed antenna on HFSS have given the results as follows

1. S11 return loss

Fig 4 shows the S11 plot for the proposed antenna which indicates that the antenna gives improved result as compared to previous one.It gives -24dB return loss.

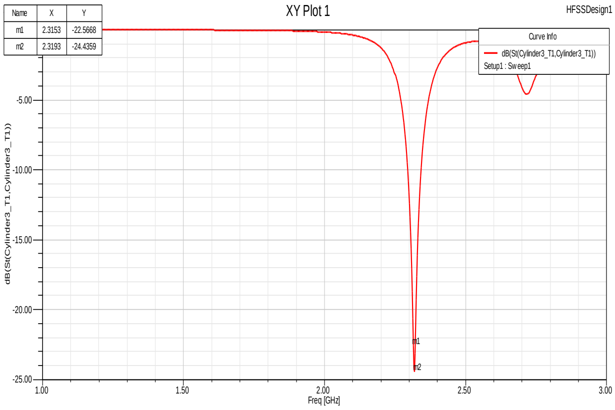

Fig 4 VSWR plot

2. Gain

Fig 5 gives the antenna gain 2 dB which is less and that should be improved.

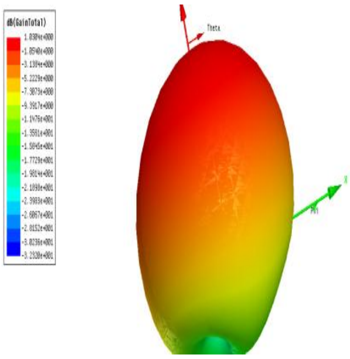

Fig.5.Gain

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3.Radiation pattern

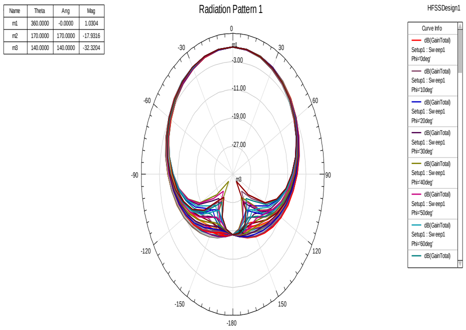

Fig.6 Radiation pattern

From the plot of radition pattern it is proven that as we get main lobe larger than back lobe ,the front radiation are larger and low F/B ratio.

VII.RECTANGULAR PATCH ANTENNA

First proposed design for wearable antenna is circular yagi patch antenna.In this design the shape of substrate is circular. Following fig 3. Shows the design model for circular patch yagi antenna

A. Design model

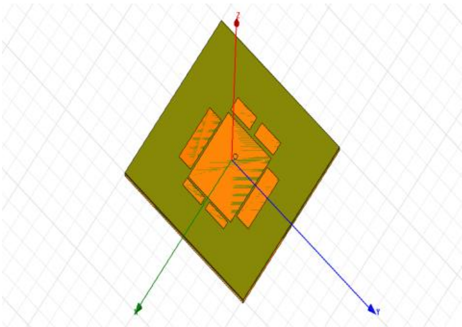

Fig7 Rectangular yagi patch antenna

B.S11 parameter

Fig 8shows the S11 plot for the proposed antenna. This plot indicates that the antenna gives improved result as compared to previous one.It gives -24dB return loss.

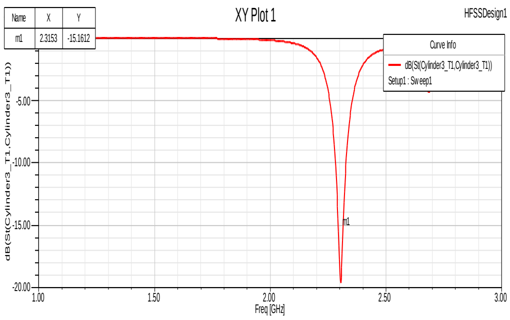

Fig.8 S11 plot

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C.Radiation pattern

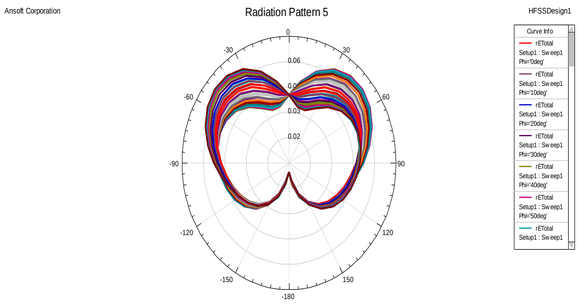

Fig 9 Radiation pattern

Fig.9 shows the plot of radiation pattern.In rectangular patch antenna we get side lobe radiation dominating

D.Gain

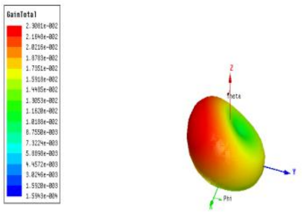

Fig 10. Gain

Fig 10 gives the antenna gain 7.8dB which is good

VIII. COMPARISON BETWEEN CIRCULAR AND RECTANGULAR DESIGN OF YAGI PATCH ANTENNA

Following table2 gives comparison of results of Rectangular and Circular patch antenna

Table2 Comparison of circular and Rectangular patch antenna

Sr. No.	Parameter	Circular yagi patch antenna	Rectangular yagi patch antenna
1	Gain	2 dB	7.8dB
2	S11	-24dB	-15dB
3	VSWR	1.1	1.1

From simulation result of circular and rectangular yagi patch antenna it is clear that the performance parameter changes as change in geometry.

IX.COMPARISON OF SIMULATION ON DIFFERENT SOFTWARE

Following table gives comparison of result on different software

Table 3 Comparison of simulation on different software

Sr. No.	Parameter	CST	HFSS	CADFEKO
1	Gain	6dB	9dB	8dB
2	S11	-24dB	-19dB	20dB
3	VSWR	1.1	1.1	1.1

From above table it is clear that performance of antenna parameter vary with simulation software .HFSS gives the improved results.

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X.CONCLUSION

In previous work same antenna was designed in CST MICROWAVE studio software but the result were not satisfactory. Same design in HFSS gives improved result. With this design we get improved result of return loss ,F/B ratio, but gain result is not satisfactory. Gain can be improved by changing some dimension.

For telemedicine wearable antenna is the best solution previous work has done with CST software , but this antenna is proposed with HFSS software which has given the improved result and lower F/B ratio. Dielectric constant used for this antenna is FR4 epoxy which is easily available in market. By changing the shape, dimension the simulation will be performed and the result will be taken and with best result antenna will be fabricated.

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