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Wearable Antenna For Medical Diagnosis applications

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ABSTRACT:

This composition defines about designing a low profile planar monopole antenna on the substrate which is flexible. Antennas are substantially employed as fundamental factors in wireless communication systems as it's the front- end device of it. It plays vital part for transmitting and entering electromagnetic surge in free space. The ultramodern communication system shows different operations like mobile devices , radar work, biomedical ap plications, etc.It shows that different anten nas are used for different tasks, not only for communication. Although RRSPMA(Rectangular Ring Slotted Planar Monopole Antenna) and CRSPMA(Circular Ring Slotted Planar Monopole Antenna) generally have wideband characteristics on rigid substrates, these conventional designs still have limitations in perfecting the overall antenna performances on flexible substrates. This design focuses on designing a antenna which aims on adding the overall antenna performances.

Keywords: Biomedical Applications, Low profile monopole antenna, Antenna Performances

1. INTRODUCTION:

Antennas have become widely employed in these recent years in variety of biomedical applications in two different ways: either implanted in human bodies or applied to the body's surface, as in the case of biomedical imaging. Antennas are used for biomedical electromagnetic imaging (EMI) in microwave and millimetre-wave (mm-wave) frequencies where imaging systems primarily depend on the antenna-sensor and its operating bandwidth to address the concern in human health without using expensive devices for medical diagnosis. An electrical device known as an antenna transforms electrical power into radio waves and vice versa. When used with a transmitter or receiver, it functions as an interface between electric currents flowing through metal conductors and radiowaves that are travelling over space.

A device that is used to transform an RF signal through conductor into an electromagnetic wave in free space is called as an antenna. Antennas exhibit the reciprocity property, which states that an antenna will retain its properties whether it is transmitting or receiving.

In recent years, wireless body area networks have drawn a lot of interest for a variety of uses, including combat, rescue, and health monitoring. In the WBAN application for health monitoring, wearable antenna is important. Wearable electronics, which comprises of wearable sensors and related circuits, always includes wearable antennas. These antennas send and track bio signals to provide reliable information about an individual's health status.Ultra-Wide Band (UWB), a new technology, offers an alternative strategy to traditional narrow band systems. The field of medicine is one of the most promising applications. Prior to 2001, UWB was primarily used for military purposes; however, starting in 2002, the Federal Communication Commission (FCC) began allowing the use of these bandwidths for commercial purposes. The FCC has set a range of frequencies between 3.1GHz and 10.6GHz for the UWB method.

2. LITERATURE SURVEY

Li and H. Liu," exploration on Performance of Wearable Microstrip Antenna Grounded on Flexible Material," 2021 IEEE 5th Advanced Information Technology, Electronic and robotization Control Conference(IAEAC), 2021,pp. 245- 248, doi10.1109/ IAEAC50856.2021.9391011.

This composition uses the three-dimensional high frequence simulation software HFSS to design a microstrip patch antenna that works at2.45 GHz and is grounded on a polyimide(PI) flexible material. The microstrip line side feed is used to feed it, and the excitation system It's a lumped harborage. Modeling and simulation styles are used to dissect the impact of the flexible antenna on its crucial parameters when it's indirectly fraudulent, and the bending compass is gradationally increased to dissect the changes in antenna performance. The analysis data shows that when the flexible microstrip patch antenna is fraudulent indirectly, its resonance frequence shifts along the high frequence direction, the return loss value is reduced from-18.68 dB to-20.44 dB, and the overall resonance point and return loss value change lower, and as the antenna bending compass increases from 30 mm to 40 mm and 50 mm, the microstrip patch antenna has a detuning effect, and its center frequence is shifted along the low frequence from2.45 GHz to2.455 GHz and2.435 GHz independently. The regularized impedance of the antenna fluctuates, and the antenna gain changes from5.95 dB to5.99 dB and5.78 dB, independently. The overall antenna matching performance is good. In this paper, the exploration on the performance changes of flexible microstrip antennas under bending is of great significance to the operation of microstrip antennas in the field of wearables in the future

Nitika li al., "A New High Gain Omnidi rectional UltraWideband Flexible Micro strip Patch Antenna for Indoor Positioni ng and Tracking Device Applications", 2016 Advances in Electromagnetic Rese arch Symposium (PIERS), 2016, p.

The motivation behind this work is to evaluate the performance of microstrip patch antennas with different substrate and ground shapes (symbol, rectangular, square, elliptical and hexagonal) using the data transfer switch for UWB wireless applications. In this paper, a new omnidirectional UWB flexible microstrip patch antenna operating at frequencies above 8.2 GHz is proposed for indoor and monitoring devices such as radio frequency identification (RFID). The substrate used in the proposed antenna is flexible FR-4 with a dielectric constant of 4.4 and a thickness of 1.Made 5mm. The main purpose of using FR-4 flexible material is to make the antenna resistant to materials such as bending and bending. The antenna has a rectangular circuit, the microstrip feeder is mounted on the top of the substrate to feed the power to break, and the ground plane is on the underside of the substrate. In the manufacture of antennas, 17 µm thick copper material is used in the manufacture of power lines, microstrip supply lines and many earth surfaces. The performance of high demand UWB switch can microstrip patch antenna was evaluated according to the effect of image difference on return loss (dB), impedance bandwidth (GHz), gain (dB), directivity (dBi) and VSWR. and antenna impedance.It has been shown that the performance of the desired antenna depends on the ground and ground conditions. The antenna was designed and simulated using CST Microwave Studio 2014. The reported antenna was originally built and tested using an E5071C network analyzer and an anechoic chamber. It has been shown that the experimental results are in good agreement with the simulation results.

J. Kurian, U. Rajan M.N. and S. K. Sukumaran, "Flexible microstrip patch antenna using rubber substrate for WBAN applications," 2014 International Conference on Contemporary Computing and Informatics (IC3I), 2014, pp. 983-986, doi: 10.1109/IC3I.2014.7019760.

This article presents a rubber-based flexible microstrip patch antenna. Flexible antennas are widely accepted in the current environment and these antennas play an important role in wireless physical network (WBAN). This article describes the main ways of using natural rubber as materials for the antenna field and natural rubber in combination with materials. The rubber material is the reason for antenna flexibility.The antenna operates in the ISM band (2.4GHz–2.5GHz). The ISM band is a candidate band used for WBAN operation.

G.J. Hayes,J. So,A. Qusba,M.D. Dickey andG. Lazzi," Flexible Liquid Metal Alloy (EGaIn) Microstrip Patch Antennas," in IEEE deals on Antennas and Propagation,vol. 60,no. 5,pp. 2151-2156, May 2012, doi10.1109/TAP.2012.2189698.

This article describes a revolutionary microstrip patch antenna using a new multilayer structure consisting of a liquid metal (eutectic gallium indium) encapsulated in an elastomer. The combination of liquid and elastomeric substrates makes the antenna flexible and durable enough for antenna applications. Injection of metals into microfluidic channels provides a simple way to analyze the shape of the liquid fixed by the thin oxide coating formed on their surface. This approach has proven to be sufficient to create single-layer antenna geometries such as dipoles. Many fluid antennas, especially those with large planar areas, must consider additional design to meet the metal's requirements.

Here, a multilayer patch antenna is created using specially designed serpentine channels. Because these take advantage of the characteristic rheological properties of liquid metal alloys. The simplicity of the resulting antenna is demonstrated and it is shown that the antenna is free of any features through simulations and measurements in the stationary and bent states.

3. EXISTING SYSTEM

Substrate: The substrate material used in the flexible antenna must have minimal dielectric loss, low relative permittivity, low coefficient of thermal expansion, and high thermal conductivity. There are three types of substrates that have often appeared in the fabrication of the flexible antennas: thin glass, metal foils, and a plastic or polymer substrate. Although thin glass is bendable, its intrinsic fragility limits its usability. Metal foils can withstand high temperatures and provide inorganic materials deposited on them, but the surface roughness and high cost of the materials limit their use. Plastic or polymeric materials are the best candidates for flexible antenna applications, which include: (1) thermoplastic semi-crystalline polymers: polyethylene terephthalate (PET) and polyethylene naphthalate (PEN), (2) thermoplastic non-crystalline polymers: polycarbonate (PC) and polyethersulfone (PES) and (3) high glass transition temperature, Tg materials: polyimide (PI). They have been popular and attractive in recent years for their flexible electronics robustness, flexibility, wettability and extensibility.

Top and bottom layers: Heinrich Hertz demonstrated the microstrip antenna in 1886. Microstrip antennas are also called "printed antennas". In recent days, Microstrip antennas find application in various wireless standards. The microstrip antenna consists of three layers. The bottom layer is the ground plane and the top layer is a patch with a dielectric substrate placed between these layers. The range of dielectric constants of the substrate used in the design is 2.2 < < 12. Copper is mostly used as the radiating material for the patch and ground plane.

Patch Shape: Commonly available patch antenna shapes are square, rectangular, circular, dipole, triangular, circular ring and elliptical with square and rectangular shapes.

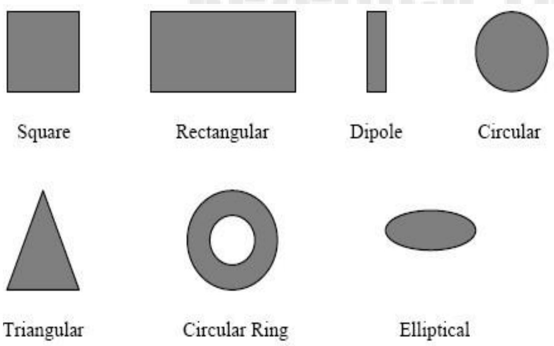

Fig: Shapes of Microstrip Patch Antenna

Feeding Techniques: Excitation of the radiating element is a fundamental and important factor that requires careful consideration when designing the most suitable antenna for a particular application. A wide variety of feed mechanisms are available not only for coupling energy to individual elements, but also for controlled distribution of energy to linear or planning array elements.

The power element can either be flush with the radiating elements or it can be located in a separate layer of the transmission line. Therefore, a brief overview of only four of the most popular microstrip antenna powering techniques is presented. These are:

- Microstrip line
- Co-axial Probe
- Aperture coupling
- Proximity coupling.

4. PROPOSED ANTENNA

The main objective of our project is to design a miniaturized flexible microstrip antenna that can be used for 5GHz application and observe the effect of various antenna parameters such as return loss (dB), gain (dBi), directivity (dBi) and bandwidth and verify the overall performance of the antenna . Microstrip line feeds were used to drive the proposed flexible Microstrip patch antenna.

ANTENNA DESIGN:

The geometry of the proposed antenna is shown in the figure below. The overall size of the antenna is 12x13mm. The antenna consists of 3 layers named ground, substrate and patch. The patch and ground are made of copper and the substrate is made of FR4 material with a dielectric value of 4.3. The thickness of the substrate is 1.6 mm and the thickness of the patch and grind is 0.035 mm.

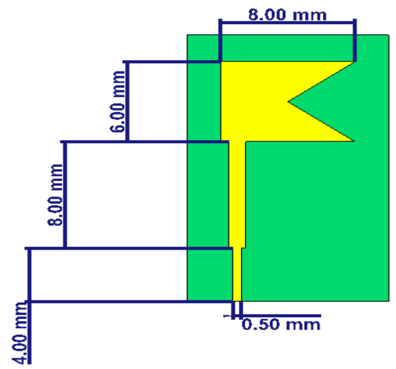

Fig:Proposed antenna design Front view

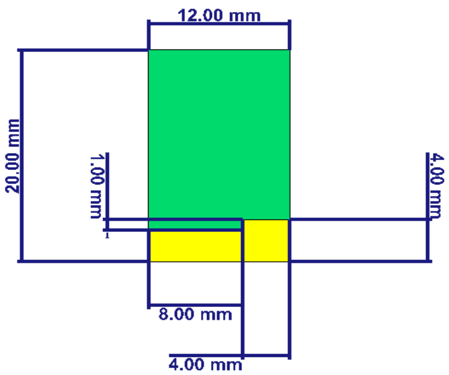

Fig:Proposed antenna design Back view

EXPERIMENTAL SET UP:

The figure shown below shows the simulation setup where the antenna is designed and a port is connected to the feed to energize the antenna so that the antenna starts radiating. The antenna parameters like reflection coefficient, Bandwidth, VSWR, Gain, Directivity and radiation pattern where analysed.

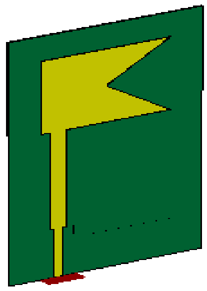

Fig: Simulation setup in CST Studio

Reflection Coefficient (S11): The S11 for the proposed antenna is illustrated in below figure. The proposed antenna has a resonant frequency at F= 4.23 GHz. The proposed antenna produces a bandwidth from 4.04GHz to 4.44 GHz. The return loss obtained for the resonant frequency is around -28.66 dB.

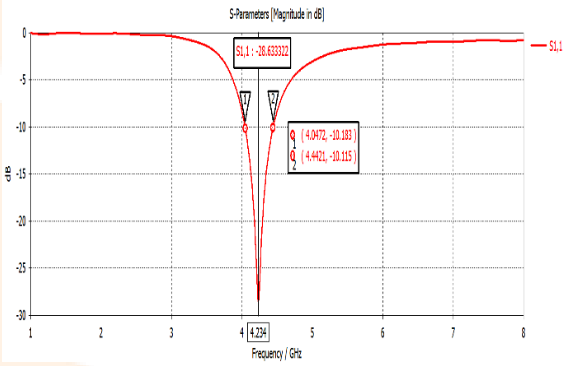

Fig: S11 for proposed antenna

VOLTAGE STANDING WAVE RATIO (VSWR):

Voltage standing wave ratio (VSWR) is a measure of how efficiently RF energy is transferred from the power source through the transmission line to the scale (for illustration, from the power amplifier through the transmission line to the antenna). In an ideal system, 100 energy is transferred. VSWR is always a real and positive number for antennas. The lower the VSWR, the better the antenna is matched to the transmission line and the more power is delivered to the antenna.The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal. Antennas must constantly meet the bandwidth requirement, which is given by the VSWR value. To illustrate, an antenna may claim to operate in the 100-200 MHz range with a VSWR.

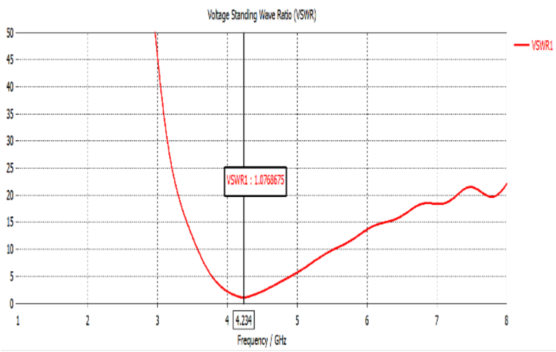

Fig: VSWR for proposed antenna

GAIN OF PROPOSED ANTENNA DESIGN:

The obtained gain for the proposed antenna design is around 1.75 dBi. A 3D view of the antenna gain is shown in the figure. The gain is calculated for a resonant frequency of f=5.09 GHz.

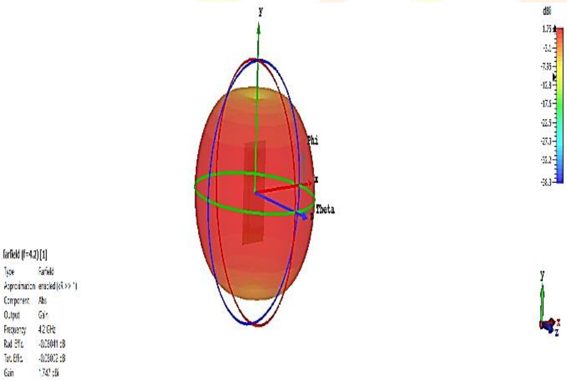

Fig: Obtained Gain for proposed antenna

DIRECTIVITY OF PROPOSED ANTENNA DESIGN:

The directivity for the proposed antenna design obtained is around 3.185 dBi. A 3D view of the directivity of the antenna is shown in the figure. The directivity is calculated for the resonance frequency f=5.09 GHz.

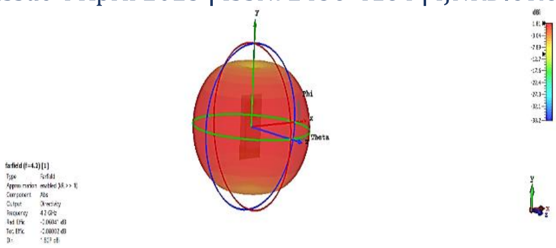

Fig: Obtained Directivity for proposed antenna

RADIATION PATTERN OF PROPOSED ANTENNA:

The power output from the antenna is represented by the radiation pattern of the antenna. The electrical model is a graphical representation of the distribution of electrical energy as a function of its transmission in space. The field model is designed as a function of electric and magnetic fields. They are arranged on a logarithmic scale. Electric current is plotted as a function of the square of the electric current and the magnetic magnitude. They are plotted logarithmically or generally on a dB scale. The main part of the radiation covering a large area is the main lobe or main lobe. This is where you have the greatest power right now. The orientation of this lobe represents the integrity of the antenna. Other parts of the model where radiation is diffused out are called side lobes or small lobes. This is where power is wasted.

H-PLANE RADIATION PATTERN OF PROPOSED ANTENNA DESIGN:

The H-plane radiation pattern is generated by selecting (phi=90) and the corresponding graph is shown in figure. In this radiation pattern the shape is in donut shape and the main lobe is directed towards 164^0 at frequency f=5.09Ghz.

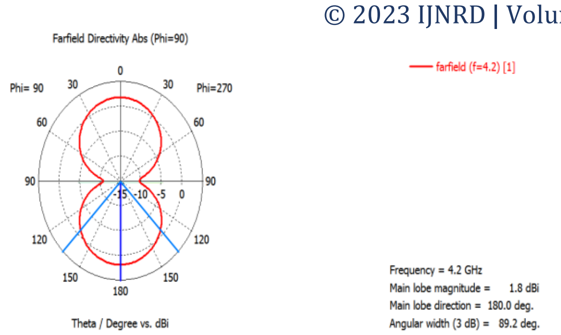

Fig: H-plane radiation pattern of Proposed Antenna

E-PLANE RADIATION PATTERN OF PROPOSED ANTENNA DESIGN:

The E-plane radiation pattern is generated by selecting (phi=0) and the corresponding graph is shown in figure. In this radiation pattern the shape is in donut shape and the main lobe is directed towards 180^0 at frequency f=5.09Ghz.

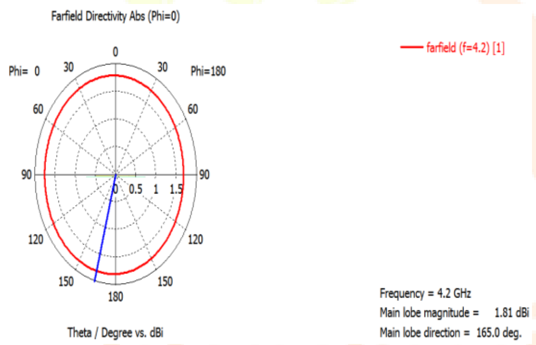

Fig: E-plane radiation pattern of Proposed Antenna

CONCLUSION

A miniaturized flexile microstrip patch antenna was designed and simulated in CST studio software tool. The designed antenna is 12x13mm dimension . Hence the designed antenna is very compact in size.The designed antenna abled to resonate at 4.23 GHz frequency and produce a gain and directivity of 1.74 and 3.18 dBi respectively. The performance of the antenna is obtained by introducing partial ground and triangular slot made on the patch. The ability to provide better gain is reduced because of the introduction of partial ground . Since a full ground will act as reflector, the return loss value obtained for the resonant frequency of 4.23 GHz is -28.66 dB. The antenna can be used for various biomedical applications like wearable health monitoring devices.

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