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Flexible Softwear Microstrip Antenna for ISM Band and Bio Medical Application: A Review

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ABSTRACT: Microstrip antenna is an integral part of the most modern equipment with a low profile, low cost antenna for many wireless applications, especially in bio medical applications. Three main categories of flexible antennae are namely wearable antenna, textile antenna and softwear antenna. Softwearmicrostrip antenna plays a major role in biomedical applications, since it is a flexible, a non- invasive, safe, relatively painless, sensing human body parameter, antenna with less radiation, which is suitable for wireless body area network. In this research work Hexagonal structures of softwear microstrip antenna with textile substrates will design, simulate and analyze for various parametric performances. Various experiments will perform to prove that all softwear antennae are flexible and sensing various off body and on body parameters.

KEYWORDS: Microstrip Antenna, Softwear Antenna, Hexagonal structures

I. INTRODUCTION

In the past few years the wearable microstrip antenna has undergone innovatory modernization by generating new ideas to detect various abnormal constraints in and around the human body and have been used to diagnose different kinds of diseases. Existing different methods like Computer Tomography (CT) scans-ray screening, ultrasound imaging scanning, Magnetic Resonant Imaging (MRI) Positron Emission Tomography (PET), are used to identify diseases and injury inside the human body [1]. Whereas X-ray, MRI and Mammogram test are emitting ionizing radiation, microwave signals overcome this radiation as a non-ionizing radiation.

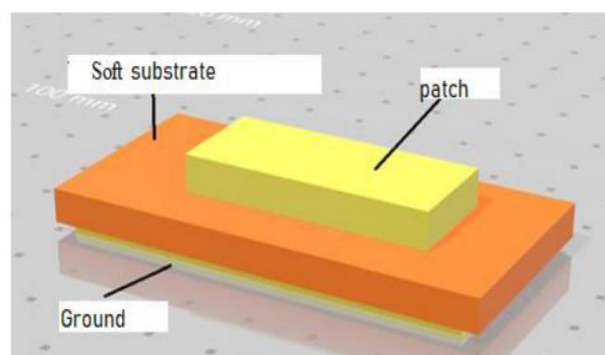


Fig. 1: Flexible softwearmicrostrip antenna

Softwearmicrostrip antenna is used as a non-invasive bio sensor to diagnose the diseases or anomaly in the human body which is focused upon in this thesis. The microstrip patch antenna is an admirable printed resonant antenna for microwave wireless communication. It consists of a radiating patch on one side of a dielectric substrate and the other side a ground plane [2].

Fig. 1 shows the softwearmicrostrip antenna, in general patch is made up of a conducting material such as copper or gold and can acquire any geometrical shape [3]. It supports both linear and circular polarization. The substrate of the microstrip antenna plays an indispensable role in microstrip antenna for its flexible action. Textile substrates can be replaced by other hard substrates. Fringing fields determine how the microstrip antenna radiates the dimensions of the



patch and the fields at the edges of the patch undergo fringing. The fringing effect depends on the width of the patch. The effective dielectric constant is defined as the dielectric constant of the uniform dielectric material.

II. ISM BAND

ISM band refers to parts of the radio spectrum that are internationally reserved for the use of radio frequency (RF) energy intended for scientific, medical and industrial requirements rather than for communications. The 2.54 GHz ISM band is a commonly accepted band for worldwide operations [4]. Cordless phones, microwave ovens, medical diathermy machines, WiFi, Bluetooth, military radars are some of the equipment that make use of this ISM band. These ISM equipment generate electromagnetic interference that disrupt radio communications that make use of the similar frequency. Therefore, this equipment was limited to specific frequency bands.

The U.S. Federal Communications Commission (FCC) liberates the ISM bands for use in mobile communications and wireless LANs. The ISM device applications such as microwave oven operating at 2.45 GHz use microwaves to cook food. In industry the uses areas induction heating, plastic softening, microwave heat treating and plastic welding processes. In medical settings, diathermy machines use radio waves in the ISM bands to apply deep heating in the treatment of killing cancer cells. Hence the Flexible microstrip software antenna uses textile substrates for its flexibility. Different textile substrate wearable antennas working in ISM band have been developed in body area network observation. This influences the human body tissue. The effect of antenna radiation is limited by the specific absorption rate.

The antenna performance changes are observed, when water moisture is absorbed by the software antenna, dielectric constant becomes high and dominates the performance of the antenna by reducing the resonant frequency. When a textile antenna is worn near the human skin, the characteristic of wetness of the fabric changes in performance parameters. Hence the flexible software antenna has to be constructed and to activate properly in the surrounding area of the human body said to be the Body Area Network (BAN). Attention is to be paid to the SAR analysis. When a software antenna is worn on the body, certain important issues are to be considered such as flexibility, working in bending environment, ISM band operation, SAR analysis in the vicinity of the human body.

III. LITERATURE REVIEW

Sivabalan et al. [1], presented four purely textile patch antenna for bluetooth in wearable computing applications using the frequency range around 2.4GHz. For conducting textile patch, three materials were used instead of copper; they are silver plated knitted fabric, and nickel plated fabric, and nickel-silver knitted fabric. For textile substrate, woollen felt with a thickness of 3.5mm and microstrip feed line was used instead of co-axial feed for fabrication ease.

Ashyap et al. [2], proposed two types of ultra-wide band antennae suitable for WBAN applications. A UWB annular slot antenna and a coplanar waveguide fed printed UWB disc monopole were designed and simulated. In this work the transmitting antenna was mounted on the surface of the human body and the receiving antenna was kept in free space with a distance. Adhesives were used and they penetrated on the surface of the conductive plane.

Li et al. [3], investigated the feasibility of the usage of textile materials in the antenna design devoted to 2.45 GHz frequency range. EM field simulator was used to design the patch antenna fabricated from non-conductive and conductive textile materials. The transmission features of the transmitter and the receiver antenna pairs showed circular polarization of the E-textile antenna.

Z. Hamouda et al. [4], designed and fabricated four antennas with different textile materials to achieve good gain, high efficiency and confirmed that the microstrip antenna was appropriate for wearable application. Impedance and radiation characteristics were determined experimentally. Different polarizations and improved bandwidth were also proved for wearable characteristics. Finally, for human body interface bending and flexible parameters were achieved in the fabricated antennae.

An ultra-wideband antenna made fully with textile material was introduced by **S. M. Saeed et al. [5]**, who developed a flexible antenna for health care monitoring. Conducting thread material was used. Telecommunication systems and



wearable products were integrated within the garments. By the proper choice of design and fabric material used, this antenna was flexible and this garment attached antenna was very demanding when it was treated as a daily garment. Manufacturing of this textile antenna has critical steps to achieve good performance. For good repeatability process superior manufacturing scheme should be employed.

K. Agarwal et al. [6], introduced a novel folded UWB antenna for WBAN applications, which could decrease the backward radiation and closeness effects of human bodies. This antenna had a bevel edge feed structure to achieve broadband impedance matching and a metal plate as a major radiator. The folded structure expanded the lower frequency band and provided additional resonant frequency. Ground plane prevented the closeness effects of the human body. Simulated SAR values were lower when compared with disc planar monopole antenna which proposes for WBAN application.

S. Bhattacharjee et al. [7], reviewed textile antennae and showed that several properties of the material changed the behaviour of the wearable antenna such as thickness of the substrate, permittivity. Investigation focussed on the analysis of the dielectric properties of normal fabrics. When an exchange of water molecules, takes place in textile material, it influences their electromagnetic properties. To minimise the unwanted effects in the behaviour of the antenna, the textile fabrics properties such as porous, compressibility and anisotropic are taken into consideration.

V. Kumar et al. [8], proposed an antenna for healthcare provisions around the clock with compact size. Short circuit pin method was introduced in the antenna design, different insert positions, varying number of the pins and by reducing the width and length of the antenna the resonant frequency and return loss changes were observed. Due to the usage of conducting thread material it was flexible and washable. Property results in terms of return loss, bandwidth, and current distribution were validated.

IV. SOFTWARE ANTENNA CRITICAL DESIGN ISSUE

Software antennae are flexible and form fascinating substrates and can be integrated into clothes. Generally low dielectric constant improves the bandwidth of the antenna and decreases the surface wave losses. Stretching and compression of the fabric has a strong influence on the EM characteristics of the antenna.

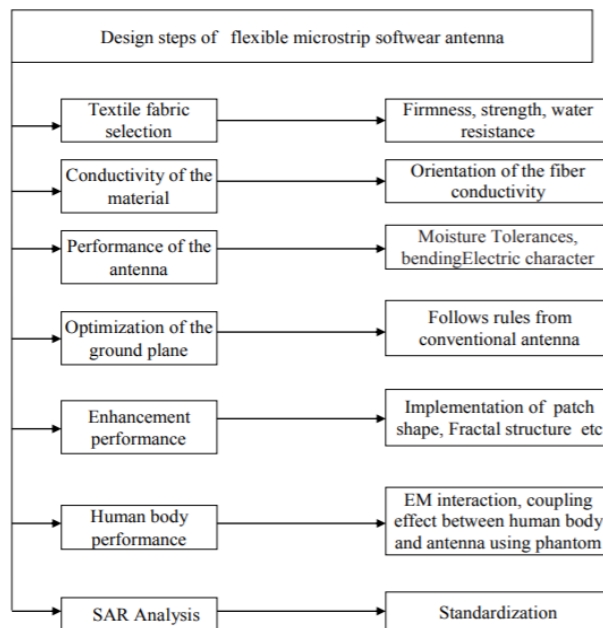


Fig. 2: Software antenna design process

Variations in the resonant length of the antenna detune its frequency band. Similarly the variation in the width of the substrate changes the impedance bandwidth and the resonant frequency which can be characterized by measuring S11



of the antenna using a Network analyzer. Textile materials are suitable for patch antenna substrates, operating in (WLAN) suitable for bio medical applications, which involve linear polarization.

But flexible antenna makes it difficult to the design process. So, it is a challenging one to design a flexible textile antenna which has a stable electrical characteristic. The needs of the softwear antenna are application specific and some of the common requirements for bio medical applications are ISM band operation, reduced SAR, inexpensive, lightweight, low profile, low maintenance, flexibility, robust etc. Important design features include material property based on antenna performance, ground plane size influence, textile material selection, material conductivity effects, enhancement in the characteristic performance, effect of wearable performance and human body positioning of the antenna and SAR analysis. Performance of the microstrip patch antenna in free space is contrasted from the performance near to human body.

Water absorption and the effect of environmental conditions will affect the performance of the antenna. Accordingly the antenna material selection is a trade-off between mechanical and electrical properties. Temperature variations and moisture may reduce the operational life time, which gives rise to supplementary material requirements such as water resistance. Fiber material, Fabric structure characteristics etc. Some of the design challenges include from material and from human body. Performance of the antenna changes due to wetness, which reduces resonant frequency when it has proximity to skin.

V. METHODOLOGY

The word tumor refers to mass of tissue formed by the accretion of abnormal cells. There are two types of tumor, namely benign and malignant. Benign tumor is harmless, whereas malignant tumor is cancerous tumor. All tumors are not malignant and 80 percent of tumors are biopsied and confirmed as benign. Most of the women have benign tumor. But formation and location of new tumor is considered as cancer tumor by doctors. Biopsy process is an invasive one which is a painful screening test. Depending on the stage tumor sizes starts from a pea size to several mm; larger size of tumor is very rare. Researchers have found that a tumor begins to grow around ten years before the detection.

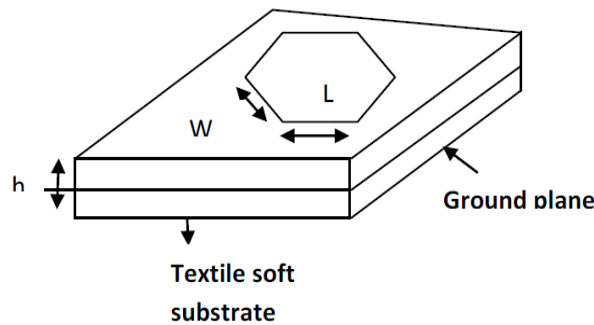


Fig. 3: Flexible hexagonal jean softwear antenna

The work flow for the breast tumor detection. Hexagonal jean softwear antenna was designed, compared and analysed using slotted and without slot patch, because of reduced SAR, without slot in patch is chosen, then it is positioned on breast model, performance analyses of antenna with and without breast tumor were noted.

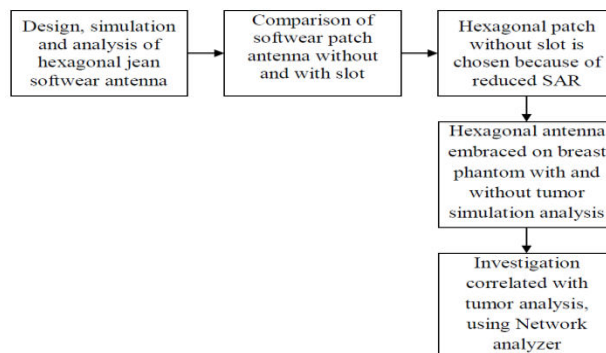


Fig. 4: Block diagram of hexagonal softwear antenna for breast tumor detection



VI. CONCLUSION

Various types of flexible textile softwearmicrostrip antenna were introduced and tested. To prove the flexibility the fabricated antennae were measured and experimental analyses were made using different PVC pipes with various diameters and different resonant frequencies. It was also noted that as diameter increased, a frequency shift working in ISM band was achieved. This showed all the proposed textile antennae were working in bending environments suitable for biomedical wireless body area network applications. When a patient is to be continuously monitored around the clock this softwear antenna is an optional one. This flexible softwear patch antenna is enhanced for an early detection of pleural effusion that leads to congestive heart failure. Various inferences were observed in simulation by using dielectric constants related to lungs and heart. Investigation was related to normal and abnormal body temperatures and the responses in the antenna were noted. The next application introduced the softwear antenna as a noninvasive bio sensor, with different textile substrates and patch shapes for the detection of tumor and tumor size in breast phantom.

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