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Design And Development of Wearable Antenna

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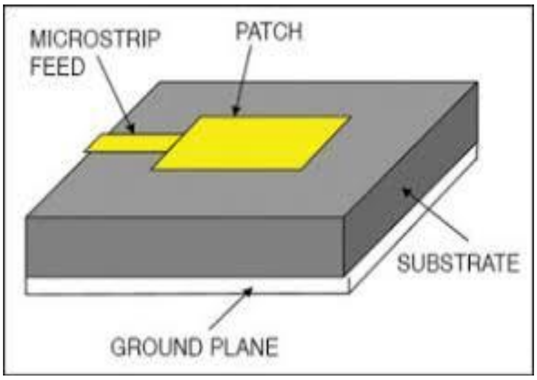
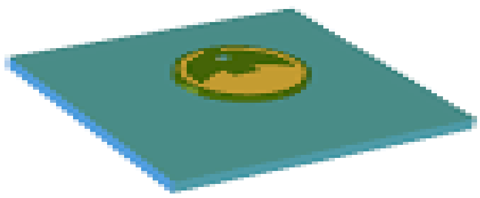
I. INTRODUCTION

Nowdays wearable antennas are used in mostly wireless as well as medical application. In recent years, wearable antennas has a gateway nodes with which it detect medical in Electrocardiogram(ECG),electroencephalo-graphy (EEG) that becomes an important part for healthcare applications.Textile wearable antenna needs to be compact, light weight, almost maintenance-free.

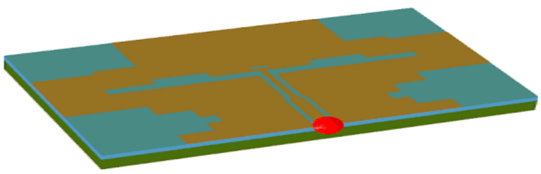
Specifically the WIFI application various types of antenna are used such as dual band button antenna ,array antenna,coplanar patch antenna etc. A **patch antenna** (microstrip rectangular antenna) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The patch antenna consists of a substrate located in between ground plane and patch.



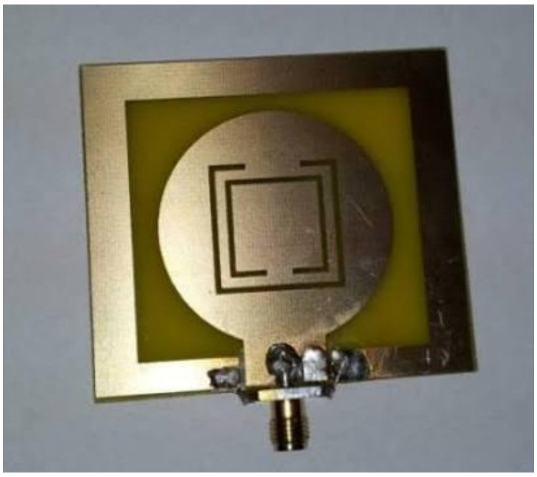
Dual Button Antenna is basically a metallic button shaped with an extra top disc and centred via connector. The antenna is made up of an inner and outer part .The outer part of the antenna is a button shaped top loaded monopole with an empty cylinder inside. The inner and upper part of the antenna is a disc which connects to the lower part through a centred metal via.Honeycomb spacer is used between the two top discs.The first dual band antenna was placed on certain height Velcro substrate and fed by a coaxial feeding connected through the ground plane to the centre of the antenna.Dual band is used in case where the appearance of the button does not gets alter even changing the disc diameters. These antenna does not require a large flat ground plane and the structure is relatively simple to incorporate into clothing by conventional construction methods. Dual-band is reported in button antennas. It is a multilayered structure that requires intricate fabrication. It also creates an omni directional radiation pattern, causing electric and magnetic fields to penetrate into the human body.



UWB Metallic Button Antenna has the wideband characteristics of a standard metallic button antenna can be used to design unobtrusive UWB wearable antennas. A first and basic antenna design can be realized by simply applying a conical shape to part of the middle cylinder and top plate of a metallic button structure. The antenna resembles a conical monopole but still maintains a cylindrical section at the base to enable clothing to be wrapped around it. microstrip feed line on a flexible substrate.

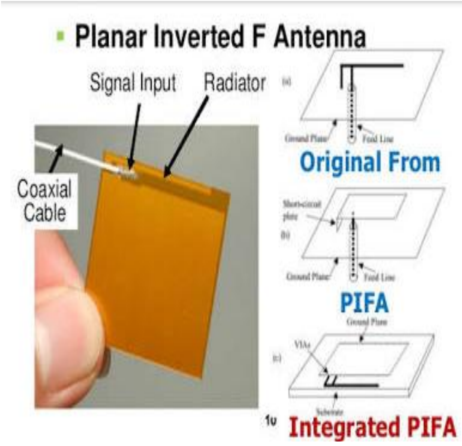


A **Circular polarized** of **coplanar waveguide (CPW) fed antenna** of wide impedance and axial ratio bandwidths that are essential to body-worn textile antenna applications as it has higher tolerance to different conditions on a human body. Also it only consists of a single layer of metal. Therefore, a cost effective and high performance body-worn textile antenna can be designed based on a wide-slot antenna topology. However, due to the missing ground plane, the influence of human body to the antenna near field has to be carefully simulated . The antenna structure has to be simple and robust enough for bending on a human arm and the antenna is able to operate at various distances from a human body.

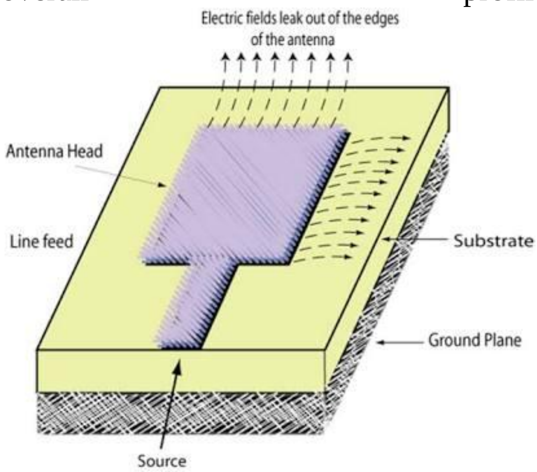


Planar antenna structures are generally favored in wearable applications since they can easily be integrated in clothing. Inspired by the simple buildup of printed microstrip antennas, we adapted this technology to textiles. Therefore, we needed an electrically conductive fabric for the ground planes as well as for the antenna patches. we required a fabric substratewith constant thickness and stable permittivity. An accurate determination of the electrical parameters for the fabrics (dielectric substrate and conductive textile) is crucial for correct antenna simulations and agreement with measurements.

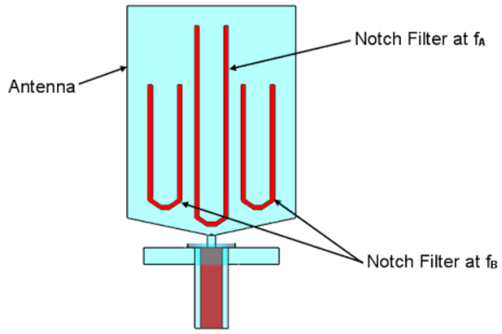
PIFA (planar inverted F antenna) operating in the ISM band (2.40–2.48 GHz) was proposed for on-body communications. In the antenna design, we adopted two shorting structures (shorting pin and shorting plate) and a folded ground plane the antenna is low profile and compact in size.



Microstrip patch antennas and cavity-backed slot antennas are suitable for off-body communications due to their broadside radiation patterns, but they exhibit a narrow bandwidth and ground plane size dependent front-to-back (FB) ratios. Substrate-integrated waveguides can reduce the profile of slot antennas, but they still retain a large lateral size. isotropic AMC ground planes were utilized to provide a high degree of isolation between the antenna and human tissue while maintaining a reasonably small overall profile.

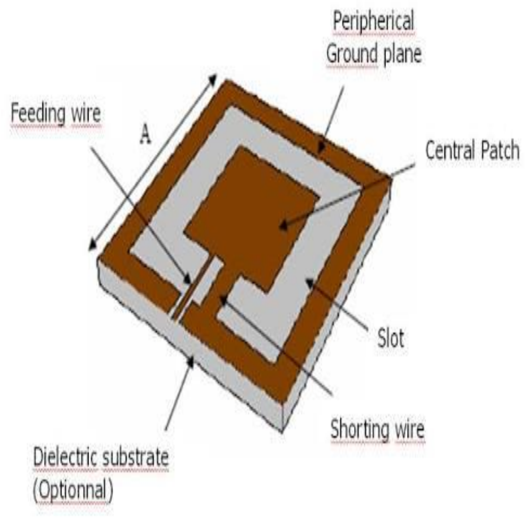


Planar UWB monopole antenna with wide bandwidth together with the specified stop band is design.The antenna consists of a rectangular radiating patch one side and solid ground up to the half length of the antenna. The band notch operations are achieved by etching two C-shaped slot in the rectangular metal radiating patch. Combination of each notch element on the UWB antenna is aimed for providing dual band rejection function.



Haigh-Farr Button antennas utilize proven materials and methods of construction, providing a solid package that requires only one "D" hole in the vehicle for mounting. Superb protection is obtained through the use of a high-impact, high-temperature radome, with excellent properties for environments containing moisture and contaminants.

A **Coplanar patch antenna**, giving a much wider operating bandwidth and more flexible band spacing than is possible from a dual-band microstrip patch antenna while maintaining the front to back ratio. These antennas are to be placed against the body and hence it is desirable to reduce the backward scattered radiation as much as possible. The antenna has been integrated with a dual-band EBG material to act as a high-impedance surface (HIS) to reduce back radiation and make the antenna tolerant to positioning on the body. The performance of the coplanar antenna and the dual-band EBG are presented and compared with a dual-band microstrip patch antenna. The antennas are conformal and manufactured from flexible materials that are readily hidden or sewn into items of clothing.



Literature Survey

Tero Uusitupa and Takahiro Aoyagi, presented FDTD simulations were carried out with a human body model to study on-body communication channel dynamics and to analysis channels for various movements and polarization schemes at 2.45 GHz . Results were obtained for 3 movements, for 6 TX-RX links and for 9 different polarization schemes regarding the orientations of the small TX and RX dipoles.

Ivo Loche , Tunde Kirstein, andGerhard Troster, ,designed a four purely textile patch antennas for Bluetooth applications in wearable computing using the frequency range around 2.4 GHz and the antennas can withstand clothing bends down to a radius of 37.5mm. The conductive textiles possess a sheet resistance of less than 1 ohm and bending causes a impact on the characteristic of linearly and circularly polarized antenna, though, circularly polarized antennas lose their CP property at the specified center frequency (2.4 GHz).

S. Sankaralingam and Bhaskar Gupta , proposed a measure of dielectric constant of fabric substrate materials used for the development of wearable antennas (also called textile antennas). The microstrip antenna is a suitable for wearable applications, as it can be built using fabric substrate materials and antenna measures a gain of 9.61 dBi at its design frequency.

Gareth A. Conway and William G. Scanlon,presented the antennas for over-body-surface communication at 2.45 GHz and the performance of a compact higher mode microstrip patch antenna (HMMPA) with a profile as low as $\lambda/20$. The 5- and 10-mm-high HMMPA prototypes had an impedance bandwidth of 6.7% and 8.6%, respectively, sufficient for the operating requirements of the 2.45-GHz and maximum gain in the direction tangential to the body surface, thus maximize the creeping, surface wave propagating mode.

Yuehui Ouyang and William J. Chappell, designed a high Frequency Properties of electro-textiles for wearable antenna applications and efficiency of the fully fabric patch antenna is high as 78% due to the use of low loss electrotextiles and eight layers of 100% polyester fabrics were stacked to form an insulation layer of about 4 mm. The dielectric constant of the polyester fabric is 1.9 and loss tangent is 0.0045and the ground plane is 115 mm by 73 mm and the size of the patch is 48.5 mm by 28 mm.

Chia-Hsien Lin, Kazuyuki Saito, Masaharu Takahashi, and Koichi Ito,proposed a compact planar inverted-F antenna for 2.45 GHz on-body communications. The impedance of the proposed antenna close to the phantom at 2.45 GHz is 5.9+j13.2

ohm and measured bandwidth is 120MHz and gain is -0.6 dBi, which appears at 48 .

Branimir Ivsic, Davor Bonefacic, and Juraj Bartolic, presented a embroidered textile antennas for wearable applications and full-textile prototype of a PIFA is designed and to operate properly in the ISM 2.4 band. The measured gain of the considered textile antenna is reduced by around 2 dB in free space compared to the metallic prototype, which is due to the lower conductivity of the conductive threads.

Esther Florence Sundarsingh, Sangeetha Velan, Malathi Kanagasabai, Aswathy K. Sarma,Chinnambeti Raviteja, and M. Gulam Nabi Alsath,designed a polygon-shaped slotted dual-band antenna and a wearable dual-band patch antenna for operating in the GSM-900 and 1800 bands. Specific absorption rate (SAR) values ranging between 0.00039–0.0035 W/Kg and the directivity values at higher and lower resonant frequencies are 8.1 and 7.4 dBi. The corresponding radiation (total) efficiencies are 20.5% (16.7%) and 10.3% (4.7%) and 7.04% frequency detuning is observed.

A. K. Gautam Indu and Binod Kr Kanaujia,proposed adual band-notched rectangular monopole antenna for ultra wideband applications and each notch element on the UWB antenna is aimed for providing dual band rejection function at WLAN 2 (5.15–5.825 GHz) and ITU 8 GHz (8.025–8.4 GHz). dual band-notch monopole antenna offers a very wide bandwidth with two notched bands from 5.2 to 5.96 GHz and 7.84 to 8.4 GHz. The prototype with overall size of 26 ×3× 32× 3 ×762 mm achieves good impedance matching, over an entire operating bandwidth of 2.8–12.16 GHz

Nasser Ojaroudi ,presented a microstrip monopole antenna with dual band-stop function for ultra wideband applications . The proposed antenna offers very wide bandwidth from 2.65 to 15.1 GHz with two notched bands covering all the 5.2/5.8 GHz WLAN, 3.5/5.5 GHz WiMAX, and 4 GHz C bands. Fabricated antenna has the frequency band of 2.65 to over 15 GHz with two rejection bands around 3.3–4.2 and 5.1–6.2 GHz to block any interference form C/WLAN/WiMAX wireless system.

B. Sanz-Izquierdo, J.C. Batchelor and M. Sobhy ,designed a UWB wearable button antenna and the antenna resulted is a rigid wearable antenna structure which is able to operate within the 3.1 GHz to 10.6 GHz bandwidth required for UWB communication systems. The gain was between 2.8dBi and 4dBi within in the matched frequency bands.

Benito Sanz-Izquierdo, Fengxi Huang, John C. Batchelor and Mohammed I. Sobhy,
a study of single and dual band wearable metallic button antennas for personal area networks (PANs) and a dual band design that also covers the HiperLAN/2 band. No external matching circuits are required when the antenna is fed with a 50 Ω coaxial line.

S.SarojaMeenakshi, J.K.Vidhyalakshmi, N.Kumutha,B.Manimegalai ,proposed a wearable button antenna for body area network application and development of circular patch is built on multilayer substrate havingFR4 and Velcro material and it resonates at 2.45GHz and 5GHz. A return loss of -30dB and -16.2dB is observed at 2.45GHz and 5GHz .

DESIGN PROCEDURE and Result Discussion

Investigation work has been done to investigate radiation capability of button size antenna spiral arm used as the top conducting layer. The purpose antenna structure is design to used as fabricated antenna

To improve the design parameters such as stable gain and size reduction in fabric antenna, investigation has done on various works of last decade and a novel technique has proposed.

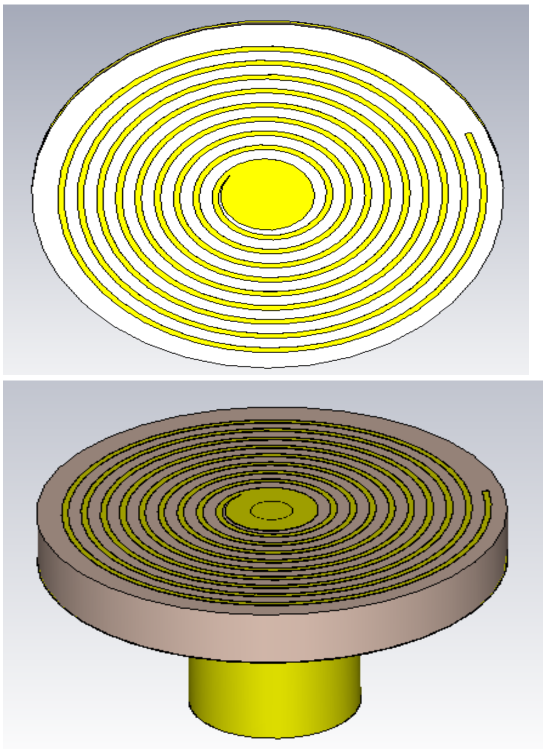
Proposed work has considered evaluating the conventional fabric antenna, and its modified versions for improving stability in gain and reduction in physical size.

The conventional fabric antenna Fig. 1(a) designed and optimized for the Wi-Fi 2.4 GHz with the referred parameters [3].

The resonant frequency and the VSWR are tuned by varying the length of the spherical design and the distance between them respectively.

The antenna printed on FR4 substrate with a dielectric constant of 4.4 and thickness of 1.6mm with loss tangent of 0.025. In this design substrate is benign used as cycle FR-4.

The spherical patch is 5 mm in radius, and ground plane fully covered. To compensate for the shift in frequency due to change spherical arm and to maintain the return loss, the optimized distance between spherical arms is 1 mm the ground plane values 10mm.



Fig[1]

The radius of the circular spiral patch is optimized from 15 to 10 mm and the corresponding bandwidth shifts from 2.9 to 2.4. So the lateral size is also reduced.

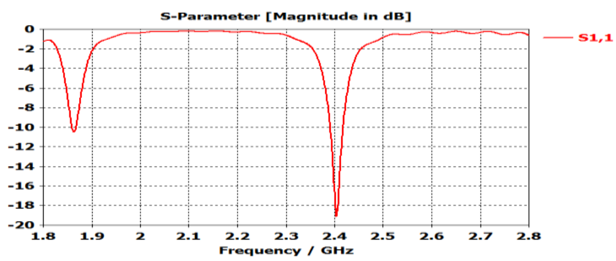


Fig [2]

Fig [2] Input and output waves are defined here, output wave are travelling inside

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antenna in time scale, power are behaving according the propagation.

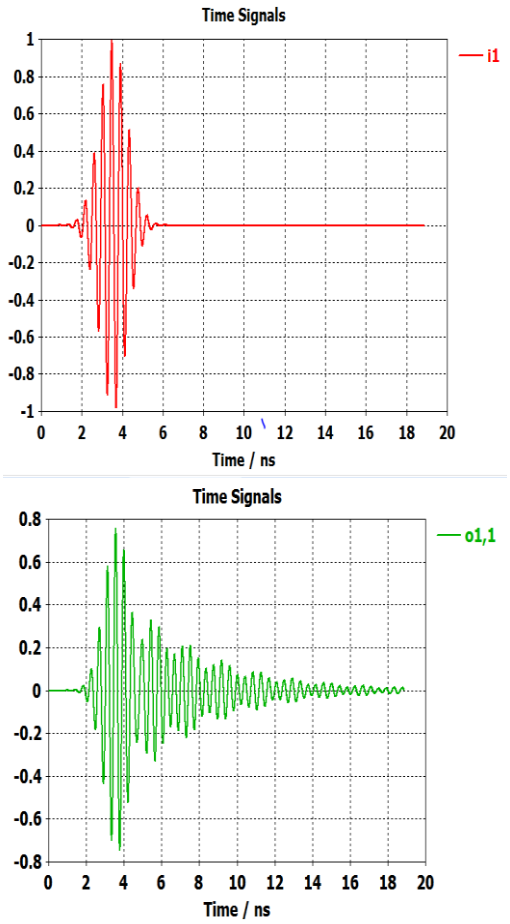

Fig [3]

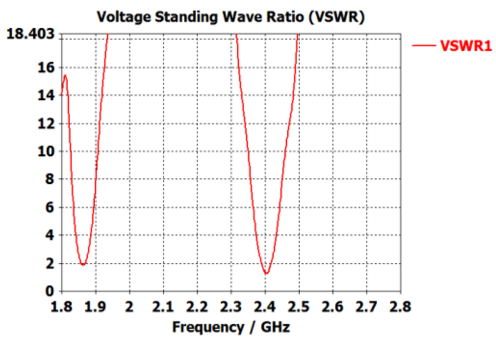

Fig [4]

Antennas is screened based on VSWR also specifications. The antenna is measured with a network analyzer, and the VSWR as a function of frequency is recorded. VSWR is identified as the 2.4 GHz. It below the 2 DB attenuation also and it identified as 1.6 DB.

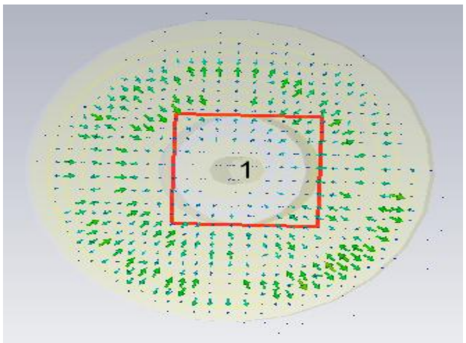

Fig [5]

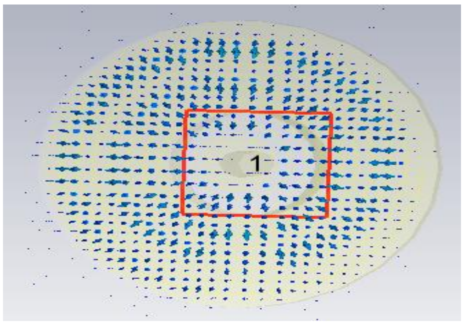

Fig [6]

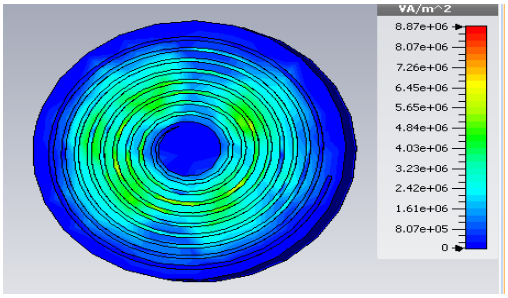

Fig [7]

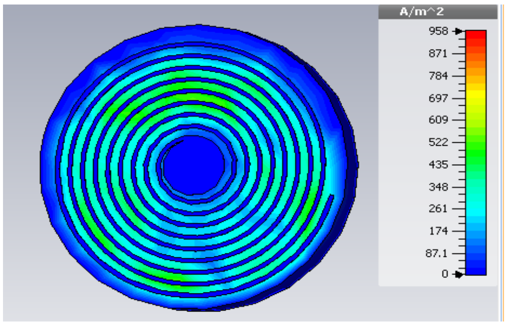

Fig [8]

Fig [5] – Fig [8] representing the distribution of electric field and magnetic field. Electric field and magnetic field distribution representing by VA/m^2 and magnetic field are representing in A/m^2. Field are distributed uniformly to perform equally distributed in all direction.

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