SURVEY ON WEARABLE ANTENNA DESIGNS

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***Abstract*— In recent years, wearable antenna design has become the developing research due to its applications in various fields. Recent research about wearable antenna provoked widespread concern for wireless body area network (WBAN) with operating frequency 2.45 GHz (ISM Band) .This paper reviews about the design results of wearable antennas and the further approach model to get the better results.**

***Index Terms* - Wearable antenna, Wireless body Area Network (WBAN).**

I. INTRODUCTION

The wearable technology has been used more in health organizations .WBAN technology has high potential for monitoring and sense to detect the many diseases and allows doctors to prevent the diseases through early detection. The WBAN play a vital role to provide wireless communication not only beneficial to health care but also in multiple applications such as in military tracking and navigation, mobile computing and public safety. The WBAN application mainly focuses in patch antennas due to its light weight, inexpensive and simple in construction. Wearable antennas have to be thin, light weight, low maintenance, robust, inexpensive and easily integrated into RF circuits. A wearable antenna focuses in microstrip patch antennas. Patch antenna have low-profile structure, less fabrication cost; also it supports both linear and circular polarizations. To increase the bandwidth of patch antennas, a thick substrate, resonant slot are cut within the patch with different geometry's and a low dielectric substrate have to be used. The patch antennas have the capable of dual and triple frequency operations. This works intends to present the results based on the designs and other considerations that have to be designed.

II. DESIGN MODELS AND THEIR RESULTS

The following session shows the pictorial representation of the antennas for wearable antenna

2.1 On-Body Textile Antenna

A microstrip on-body antenna with probe-feed excitation is used in [1]. The antenna is fabricated using jean substrate and copper tape as the patch radiating element and ground. The relative permittivity of jean substrate is 1.68, loss tangent is 0.01 and thickness is 1mm. The software used for analysis is HFSS. Patch length=10mm, patch width=20mm, length=45mm, width=35mm.

The results show in [1] is that the antenna is efficient over 200MHZ band from 9.45 to 9.65 GHZ. The gain is 12.8 dB and 13.2 dB with and without phantom respectively. Figure.1 shows the diagrammatic representation of the on body textile antenna.

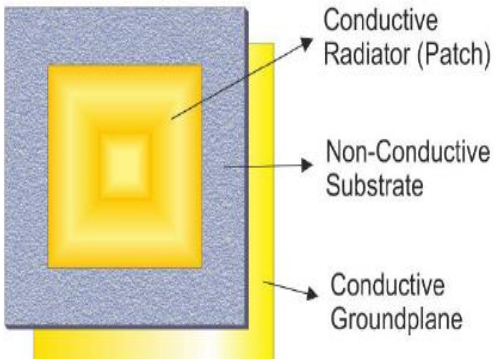

Fig .1 General diagram of on-body textile antenna

2.2 Dual Band Diamond Textile Wearable Antenna

Electro textile diamond shaped dipole antenna was designed in [1] as similar to shown in figure.2. It has dielectric constant of 1.7 and copper foil tape of thickness 0.035mm as conducting element using EM Simulator Computer Simulation Technology (CST).

Three conditions are investigated in [1]: free space (no body phantom), 3mm from the back side of the phantom results in efficiency at 2.45GHZ and in the same position but with the 3mm gap filled by the layer of wash cotton(clothes) (dielectric constant=1.51, loss tangent=0.021) and resonates at 2.45 GHZ and 5.8GHZ.

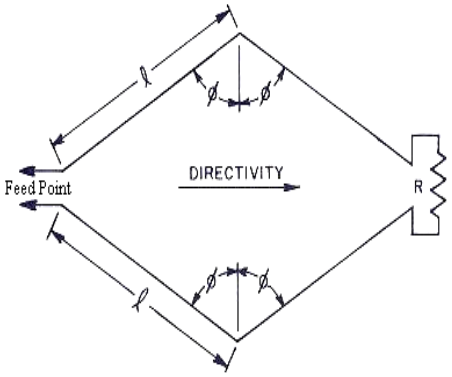

Fig.2 Diamond Shaped Textile Wearable Antenna

2.3 Polygon shaped slotted dual band antenna

A polygon-shaped patch antenna with a ring-shaped slot was proposed in [1]. It operates within two mobile frequency bands, GSM-900 and GSM-1800. Ground and patch is copper. The substrate is jean of thickness 1mm. Dielectric constant is 1.7 and tangent loss is 0.025 .Patch length =120mm, Patch width =120mm, Length =240mm, Width =240mm. The directivity at higher and lower resonant frequencies are 8.1dBi and 7.4dBi respectively. The corresponding radiation (total) efficiencies are 20.5% (16.7%) and 10.3% (4.7%). Figure.3 shows the polygonal shape of antenna.

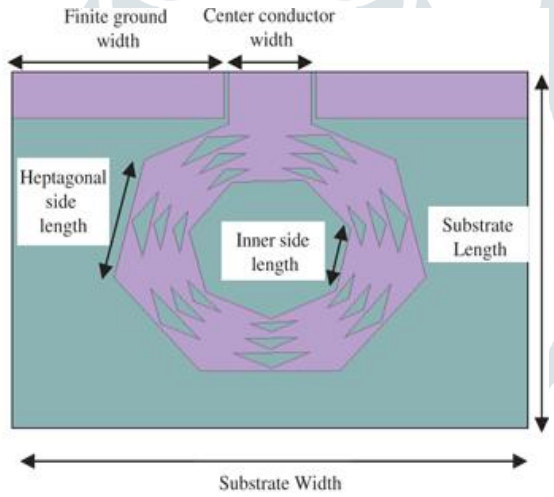

Fig. 3 Heptagonal shaped antenna

2.4 Small planar UWB wearable antenna

The small planar UWB wearable antenna was designed in [1] as similar to Figure.4. It uses the substrate as jean and adhesive copper tape as the patch. Dielectric constant is 1.76 and tangent loss is 0.078 using CST software. A portion of the human arm the appropriate phantom section chosen for the Simulation. The resulting bandwidth achieved from 3 to 4.5 GHz and from 6.5 to 11.5 GHz. The efficiency achieved is higher than 65%.

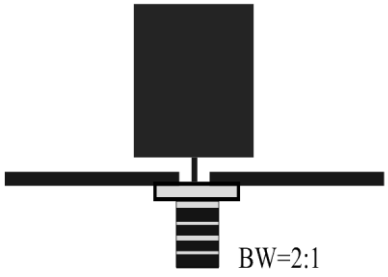

Fig.4 General Structure of Small Planar UWB Wearable Antenna

2.4 Compact UWB wearable antenna

The combination of slot and truncation techniques is proposed in [1] so that the impedance bandwidth is improved. Figure.5 shows the compact UWB wearable antenna. With jean substrate, copper adhesive tape acts as ground, dielectric constant is 1.76 and tangent loss is 0.078. The bandwidth covers up to 86.48% and the gain is 2.74dB at 3GHZ, 4.17dB and 4.07dB at 7GHZ and 9GHZ respectively.

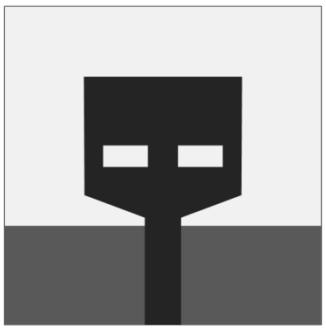

Fig.5 compact UWB wearable antenna

2.5 Notch loaded U shaped textile antenna

The notch loaded U shaped micro strip patch antenna is proposed in [2] as similar to Figure.6. The substrate is jean and ground is copper tape. The simulation tool is IE3D. The thickness of jean substrate is 1mm and the dielectric constant of jean substrate is 1.7 and tangent loss is 0.025.

The obtained bandwidth in [4] is 42.2% (2.19GHZ-3.356GHZ).Return loss is -21.15dB and gain is 4.72 and directivity is 4.92dBi. Antenna efficiency is 95.6% and radiation efficiency is 96.3% and resonates at 2.442GHZ.The feed used is micro strip line feed.

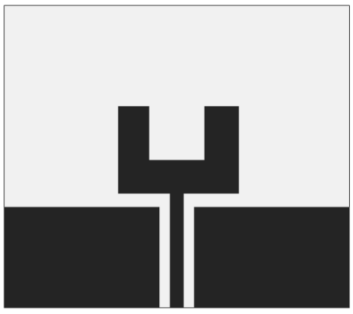

Fig .6 U shaped antenna

2.6 Wearable antenna for skin cancer detection

Star shaped ring (SSR) wearable antenna is designed in [3] and it operating in X-band (8-12GHZ). HFSS simulation tool is used in [1] for the same shape of the antenna as similar to Figure.7. The thickness is 1.57mm. The antenna size is 4.8×3.8cm. The resonant frequency is 11.7GHZ with bandwidth and gain is 1.34GHZ and 10.9dBi respectively.

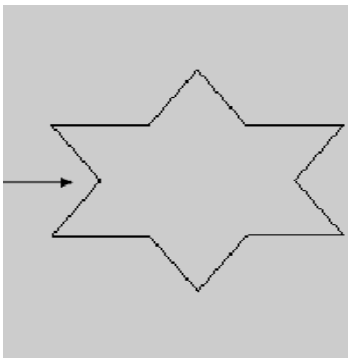

Fig. 7 Star shaped antenna

Table.1 Comparison of the various shapes of Wearable Antennas

Parameters	Substrate	Ground	Software	Gain	Return loss
On body textile antenna	Jean	Copper tape	HFSS	12.8db And 13.2db	0.01
Dual band Diamond Textile Wearable antenna	Electro textile	Copper foil tape	CST	16 db	0.021
Polygon Shaped Slotted Dual Band antenna	Jean	copper	CST	8.1db and 7.4db	0.025
Small planar UWB wearable antenna	Jean	Adhesive Copper tape	CST	10db	0.078
Compact UWB wearable antenna	Jean	Adhesive Copper tape	HFSS	2.74db	0.078
Notch loaded U shaped textile antenna	Jean	Copper tape	IE3D	4.72db	0.025
Wearable antenna for skin cancer	RT/ Duroid 5880	Human body	HFSS	10.9db	0.0009

Table.1 shows the various wearable antenna parameters like material, Gain, Return Loss and software used.

III. DESIGN ANALYSIS AND THE FUTURE WORK

From the survey result, most of the design model used jean substrate. The jean has very low dielectric constant 1.68 so it reduces the surface wave losses and increases the bandwidth of the antenna. For simple construction micro strip patch antenna is used for design.

In proposed design, clover slot antenna structure with the dimensions of 14 ×12 ×0.8 mm^3 will be used. It uses jean as the substrate and thickness of 1mm operates at 2.5 GHz. The Patch used is copper and the human body acts as ground. The micro strip line feed is used to get the better gain and bandwidth and improved radiation efficiency. ADS 2011 and CST 2014 simulators will be used to analyze the parameters and various parameters like return loss, gain, directivity, radiation pattern and bending effects will be discussed.

IV. CONCLUSION

Our study examines the design aspects of various wearable antenna designs and its performance. The antenna is the key element in the design of body centric wireless communication. Wearable antennas are more promising and boast a great future alongside the development of the rapidly growing wireless communication technology.

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