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A Novel Copper Tape Wideband Wearable Antenna for Wban Application

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ABSTRACT- The compact antenna for on-body applications is designed for covering ISM frequency bands. The antenna covering ISM frequency bands in range of 2.45 and 5.8 GHz. The circular structure with triangular slots is responsible for obtaining the dual band applications. The antenna designed on flexible polyimide substrate having dielectric constant of 3.5 with loss tangent of 0.008. The bending analysis of the antenna is performed to analyze the flexible nature. The proposed antenna covering the frequency range 2.3-3.5 GHz and 5.1-6.8 GHz with fractional bandwidth of 41% and 28%. The antenna provides the stable dipole and omni directional patterns. The measured antenna provides the peak gain of 2.3 dBi at 2.5GHz and 4.7 dBi at 5.8 GHz radiation efficiency of 78% at 2.5 GHz and 84% at 5.8 GHz. To validate the antenna performance antenna undergone for the comparison of simulated and measured results by placing antenna on human body.

KEYWORDS- SAR, On-body applications, Circular Ring

I. INTRODUCTION

In the recent years most of the microwave antennas for bio-medical application is focused on developing hyperthermia and physical parameter monitoring [1]. Antennas placed at inside/outside of the human body are used to evaluate the temperature of cancer cells. For this purpose, low profile antennas with monopole or dipole with co-axial feed are used for internal uses. The implanted antennas will act as sensors and communicate with external devices for transferring physiological parameters for analysis [2-3]. These antennas must be small and should have tolerance towards the biocompatibility tissues. Designing of such kind of antennas that operate in tissues is a challenging task. The main parameters to be considered are low power requirements, high tissue conductivity, impedance matching, antenna size and bio compatibility plays a vital role [4-5]. So, while simulation dielectric constants and geometry of tissues needed to be considered. The antenna design for this implantable application, it needed to cover ISM band application frequencies.

A. Antennas Types

There are extensive varieties of antennas according to their geometries which have been developed in the years. In late 1880s Heinrich Hertz work provides experimental proof of Maxwell's theory of electromagnetic waves and presented several basic antenna types that are still in use today for various uses such as telecommunication, satellite communication, broadcasting, radar, two- way radio and other applications. At present antennas are vitally used in wireless communications. Generally, there are two types of antennas (a) conventional antennas (b) non-conventional antennas. Other than PCB antennas are conventional antennas. Different types of antennas are shown in Figure 1.

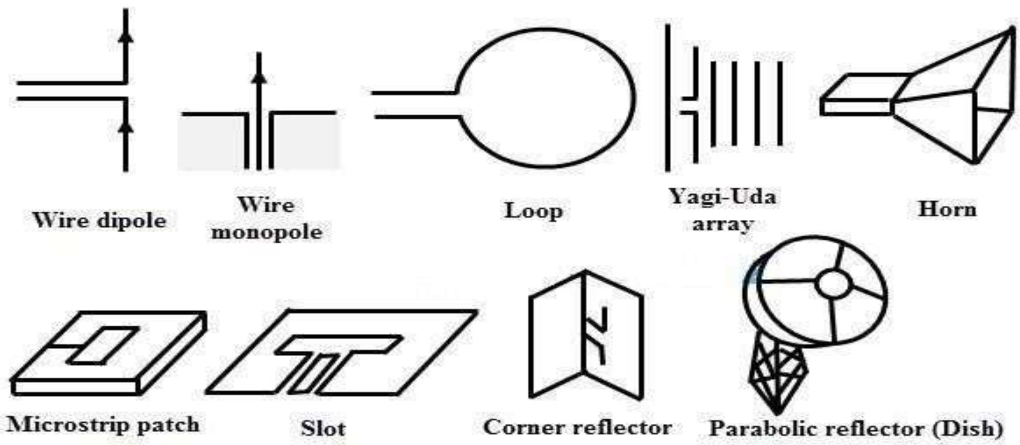

Figure 1: Block digram basic anteena structure

II. LITERATURE SURVEY

Future electronic systems are described as being an essential component of our everyday apparel that offers the wearer such sophisticated personal helpers. By examining the potential for creating wearable UWB antenna where textile materials are utilised for both the substrate and the conducting elements of the planned antenna, this work aims to take steps closer to true wearability. A nonconducting fabric has been employed as the antenna base material, while two different types of conducting materials have been used for the conducting sections. The proposed design was given with a [1] set of comparison findings that were examined. More information was provided on the impacts on the return loss for each constructed antenna prototype in bent and totally wet situations.A hybrid coupler is a classic microwave circuit component that can be used to split an incident signal. These hybrids are sometimes referred to as magic-tees. They are used in a myriad of micro wave circuits such as antenna feed networks,[3] phase shifters, balanced mixers, and push-pull amplifiers. However, transmission line parasitic can significantly degrade performance in practice, especially as the frequency increased. It should be noted that although the design details are not reported, UWB hybrid couplers are commercially available up to 40 GHz [5-12]

proposed Designs of a polygon shape microstrip antenna for increasing number of side lengths are studied. A detailed analysis is presented for the

variations observed in the first and second order mode resonance frequencies in a polygon shape patch, from triangle to square to pentagon, ending up in a circle. In the Radiating patch can take an arbitrary shape, but from the fabrication and mathematical modelling point of view , regular shape and their Variations are preferred [1-3].In addition, slots also modify the surface current distributions at higher order patch mode to give broadside radiation pattern the wideband response is the result of coupling between the fundamental and modified higher order orthogonal resonant modes of the patch. Across the BW, with the same polarization of the radiated field. In future work the work continuous with machine learning and deep learning algorithms [13-17]

The basic structure of antenna comprises of circular monopole with CPW feeding technique. The antenna is designed on flexible polyimide substrate with dielectric constant of 3.5 and loss tangent of 0.02. The antenna has the dimensions of 40 x 30 x 0.1 mm3. The circular patch is designed with the radius of 12.5 mm and top corner is truncated with rectangular slot of 2 x 22 mm2. Further the antenna is inserted slotted section to circular patch. At the middle of the circular patch, slot with the line of 2 mm is inserted. The antenna is fed by 50-ohm microstrip line with CPW feeding. The ground structure consists of two rectangular elements on the either side of the feed line. The antenna having the feed line of Lf xwf with the gap of ‘g’ in between the feed and ground. Figure 2 shows the gain with respect to radiation efficiency.

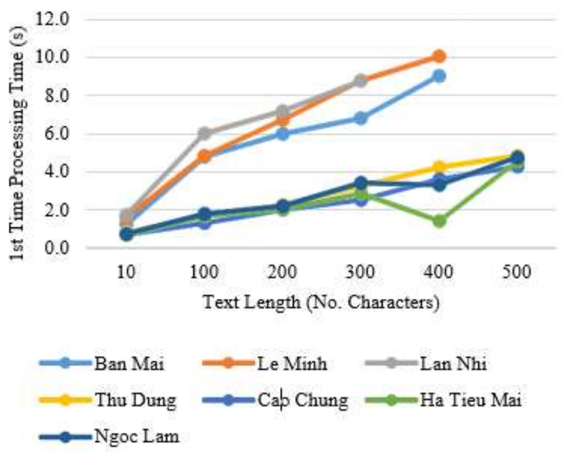

Figure 2: Reflectiin coefficient of antenna of different materials

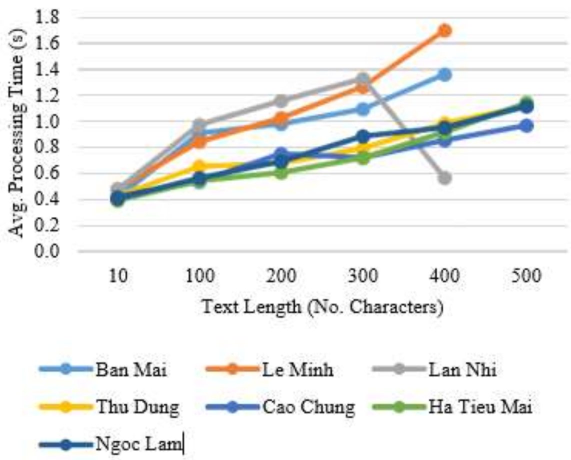

Figure 3: Simulated and measured peak gain of antenna

The designed antenna covers the frequency of 2.25-3.1 GHz with operating bandwidth of 0.8 GHz and provides the impedance bandwidth of 32% and till third step antenna operates in the single operating frequency. In final step antenna provides dual band operating characteristics and first operating frequency ranges from 2.3-3.5 GHz with bandwidth1.2 GHz and provides the impedance bandwidth 41% covers LTE2300,WLAN,WiMAX and ISM bands(2.45-2.48 GHz) and second operating band covers the frequency in the range of 5.1-6.8 GHz with bandwidth of 1.7 GHz and provides the impedance bandwidth of 28% and covers application like ISM (5.725-5.825 GHz).

The measured peak gain of 2.3 dBi is observed at 2.5 GHz and 4.7 dBi at 5.8 GHz when antenna is in standalone condition. Similarly, the antenna radiation efficiency of the antenna is observed in standalone condition with simulated radiation efficiency of 82% is observed at 2.5 GHz. The far field radiation patterns of antenna when antenna is placed on the top of the human ear is observed in the Figure 3. At the 2.5 GHz in YZ-plane omnidirectional radiation patterns and in XY and XZ- planes dipole type of far field radiation patterns is observed

III. PROPOSED METHOD

A. Design Methodology of Antenna

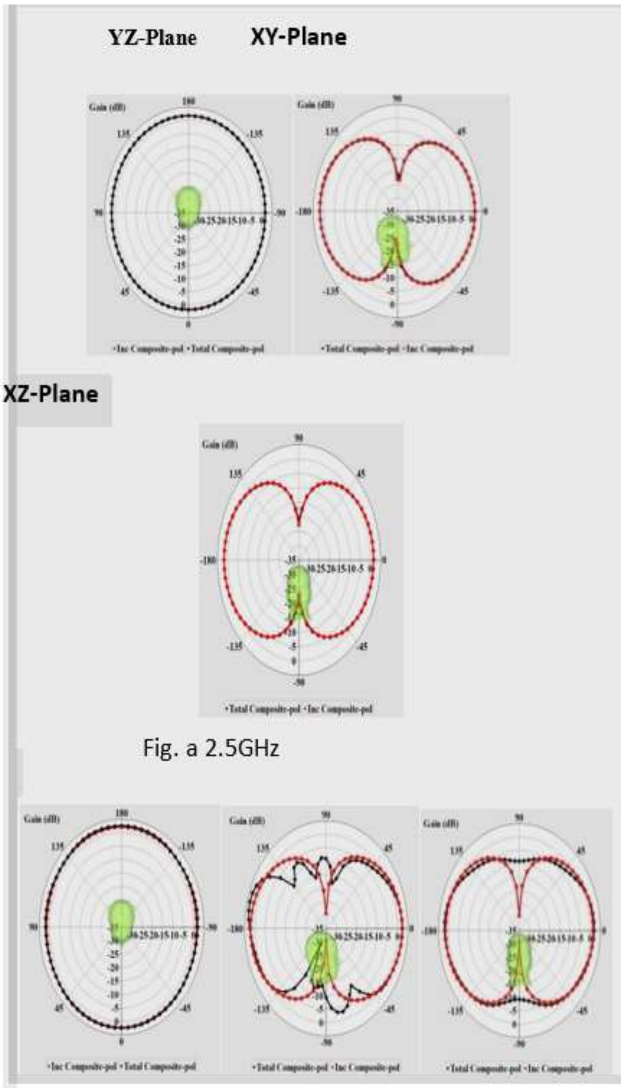

Figure 4: Far field radiation characteristics of antenna on human head at 2.5 GHz and 5.8

IV. CONCLUSION

The dual band antenna to cover ISM frequencies for wearable applications is done in this article. The antenna having the compact dimensions of 40 x 30 x 0.1 mm3. The on-body analysis of antenna is carried out using CST microwave studio. The 3D gain of the antenna is observed at operating frequency. The maxium gain of 7.24 dBi is observed when the antenna is placed on the top of the head. The antenna undergone with SAR analysis and obtained lower values of 0.157 W/Kg when the antenna is placed on the ear of human head. The antenna covering covers LTE2300, WLAN, WiMAX, and ISM bands (2.45- 2.48 GHz) (5.725-5.825 GHz).

REFERENCES

[1] M. A. R. Osman, M. K. A. Rahim, N. A. Samsuri, M. K. Elbasheer, and M. E. Ali, "Textile UWB antenna bending and wet performances," International Journal of Antennas and Propagation, vol. 2012, Article ID 251682,

[2] M. El Gharbi, R. Fernánde z-García, S. Ahyoud, and I. Gil, "A review of flexible wearable antenna sensors: design, fabrication methods, and applications," Materials, vol. 13, no. 17, pp. 1–18, 2020.

[3] R. Joshi, E. F. N. M. Hussin, P. J. Soh et al., "Dual-band, dual-sense textile antenna with AMC backing for localization using GPS and WBAN/WLAN," IEEE Access, vol. 8, pp. 89468– 89478, 2020.

[4] M. M. Ur Rashid, A. Rahman, L. C. Paul, and A. K. Sarkar, "Performance evaluation of a wearable 2.45 GHz planar printed meandering monopole textile antenna on flexible substrates," in Proceedings of the 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology, pp. 2–7, Dhaka, Bangladesh, May 2019

[5] M. Alibakhshikenari, "A comprehensive survey of "metamaterial transmission-line based antennas: design, challenges, and applications," IEEE Access, vol. 8, pp. 144778–144808, 2020.

[6] J. P. Xu, L. J. Xu, L. Ge, Z. Duan, and Y. M. Tang, "Flexible wearable antenna based on MIMO technology," in Proceedings of the 2019 IEEE MTT-S International Wireless Symposium, pp. 13–15, Guangzhou, China, May 2019.

[7] R. Sanchez-Montero, P. L. Lopez-Espi, C. Alen-Cordero, and J. A. Martinez-Rojas, "Bend and moisture effects on the performance of a U-shaped slotted wearable antenna for off-body communications in an industrial scientific medical (ISM) 2.4 GHz band," Sensors, vol. 19, no. 8, 2019.

[8] .J. Zhang, S. Yan, X. Hu, and G. A. E. Vandenbosch, "Reduction of mutual coupling for wearable antennas," in Proceedings of the 13th European Conference on Antennas and Propagation, EuCAP, Krakow, Poland, April 2019.

[9] H. L. Kao and C. H. Chuang, "Bending effects on a fabric-based antenna for wearable applications," in Proceedings of the 70th Electronic Components and Technology Conference, Orlando, FL, USA, June 2020

[10] I. Adam, H. A. Rahim, M. N. M. Yasin, and M. N. M. Nasrol, "Mutual coupling suppression in wearable MIMO antenna for on/off-body WBAN applications," Journal of Physics: Conference Series, vol. 1755, no. 1, Article ID 12011, 2021

[11] E. A. Mohammad, H. A. Rahim, P. J. Soh, M. F. Jamlos, M. Abdulmalek, and Y. S. Lee, "Dual-band circularly polarized textile antenna with split-ring slot for off-body 4G LTE and WLAN applications," Applied Physics A, vol. 124, no. 8, 2018.

[12] H. A. Rahim, M. Abdulmalek, P. J. Soh, K. A. Rani, N. Hisham, and G. A. Vandenbosch, "Subject-specific effect of metallic body accessories on path loss of dynamic on-body propagation channels," Scientific Reports, vol. 6, Article ID 29818, 2016

[13] D. Pifa, J. Wang, L. Zhao, G. Chen, Y. Wang, and W. Yu, "Ground plane effects on SAR for

[14] human head model exposed to a dual-band PIFA," in Proceedings of the IEEE MTT-S 2015

[15] S. Patibandla, M. Archana, and R. C. Tanguturi, "Object Tracking using Multi Adaptive Feature Extraction Technique," International Journal of Engineering Trends and Technology, vol. 70, no. 6, pp. 279–286, Jun. 2022, doi: 10.14445/22315381/ijett-v70i6p229.

[16] G. Sadineni, A. M, and R. C. Tanguturi, "Optimized Detector Generation Procedure for Wireless Sensor Networks based Intrusion Detection System," International Journal of Engineering Trends and Technology, vol. 70, no. 6, pp. 63–72, Jun. 2022, doi: 10.14445/22315381/ijett-v70i6p208.

[17] S. Patibandla, Dr. M. Archana, and Dr. R. C. Tanguturi, "DATA AGGREGATION BASED HYBRID DEEP LEARNING TECHNIQUE FOR IDENTIFYING THE UNCERTAINTIES AND ACCURATE OBJECT DETECTION," Indian Journal of Computer Science and Engineering, vol. 13, no. 3, pp. 697–708, Jun. 2022, doi: 10.21817/indjcse/2022/v13i3/221303049.

[18] Dr. S. R. Anand, Dr. R. C. Tanguturi, and S. D S, "Blockchain Based Packet Delivery Mechanism for WSN," International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 2, pp. 1112–1117, Jul. 2019, doi: 10.35940/ijrte.b1627.078219.

[19] M. V. Bharathi, R. C. Tanguturi, C. Jayakumar, and K. Selvamani, "Node capture attack in Wireless Sensor Network: A survey," 2012 IEEE International Conference on Computational Intelligence and Computing Research, Dec. 2012, doi: 10.1109/iccic.2012.6510237.