Bandwidth Enhancement of Vivaldi Microstrip Antenna for WBAN

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Abstract : Vivaldi antenna with high-frequency selectivity is organized and investigated. This paper gathers the effects of antenna plan parameters on its execution. 3D electromagnetic propagation programming CST was used to reenact various sizes of three significant structure parameters. By looking at a couple of antenna key parametric results including return misfortune (S-parameter), voltage standing wave ratio (VSWR), reference impedance and substrate parameters accept a basic occupation in antenna execution. Results demonstrate that incredible frequency selectivity of the multiband from 4.546GHz to 5.784GHz is recognized, and the antenna shows extraordinary impedance organize, high radiation gain, and heavenly radiation directivity in the multiband. Both the propagation and estimation results are given extraordinary understanding.

***IndexTerms* – Vivaldi, CST, VSWR, S-parameter, FR4, Return loss, 3D**

I. INTRODUCTION

Body area network (BAN), additionally alluded to as a remote body area network (WBAN) or a body sensor network (BSN) or a medicinal body area network (MBAN), is a remote network of wearable figuring gadgets. Boycott gadgets might be installed inside the body, inserts, might be surface-mounted on the body in a fixed position Wearable innovation or might be went with gadgets which people can convey in various positions, in garments pockets, by hand or in different packs. While there is a pattern towards the scaling down of gadgets, specifically, networks comprising of a few scaled down body sensor units (BSUs) together with a solitary body focal unit.

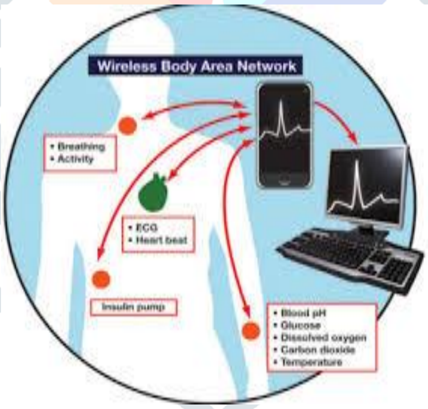

Figure 1: Wireless body area network

Initial applications starting utilizations of BANs are relied upon to show up basically in the human services space, particularly for consistent checking and logging indispensable parameters of patients experiencing incessant infections, for example, diabetes, asthma and heart assaults.

A BAN network set up on a patient can alarm the medical clinic, even before they show some kindness assault, through estimating changes in their fundamental signs.

A BAN network on a diabetic patient could auto infuse insulin through a siphon, when their insulin level decreases.

A. WEARABLE ANTENNA

Recent improvements and innovative progressions in remote correspondence, MicroElectro Mechanical Frameworks (MEMS) innovation and integrated circuits has empowered low-control, astute, scaled down, obtrusive/non-intrusive small scale and nano-innovation sensor hubs strategically put in or around the human body to be utilized in different applications, for example, individual wellbeing checking. This energizing new area of research is called Remote Body Area Networks (WBANs) and use the rising IEEE 802.15.6 and IEEE 802.15.4j gauges, specifically institutionalized for medicinal WBANs. The point of WBANs is to streamline and improve speed, exactness, and unwavering quality of correspondence of sensors/actuators inside, on, and in the quick vicinity of a human body. The immense extent of difficulties related with WBANs has prompted various productions. In this paper, we review the present condition of-craft of WBANs dependent on the most recent norms and distributions. Open issues and difficulties inside every area are likewise investigated as a wellspring of inspiration towards future advancements in WBANs.

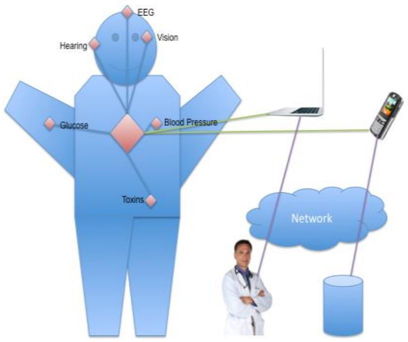

Figure 2: Wearable antenna

Wearable gadgets have amazingly wide application. Before it was familiar with customer grandstand, wearable devices are used as a piece of the military advancement. By then, it has been associated in other field, for instance, gaming, music, preparing, transportation, ineptitudes, health and prosperity. In these fields, the need is to merge the limits expected to a contraption that can be used effectively in step by step lives.

II. LITERATURE SURVEY

D. Yang, J. Hu and S. Liu [1] In this paper, we propose a position of safety ultra-wideband (UWB) antenna for remote body area networks. The proposed antenna is low-weight and simple to create by printed circuit board fabricating. Streamlined state of the radiation fix and shorted top-stacking patches are acquainted with widen the bandwidth and diminish the profile of the antenna. The stature of the antenna is 0.05λ 0 , where λ 0 is the free-space wavelength at the most reduced working frequency. The mimicked and estimated results demonstrate that an upgraded impedance bandwidth of about 162% in the scope of 2.5 to 24 GHz (S 11 <; - 10 dB) is accomplished. Plus, the impact of the human body to the proposed antenna is insignificant. The time-area conduct of the position of safety UWB antenna is tried, and the outcomes demonstrate an agreeable execution in transmitting and accepting heartbeat signals.

W. Amer, Gui Yun Tian [2] This paper shows a novel antenna structure for ultra wide-band body area network applications. The plan is made out of two Vivaldi shapes set inverse to one another on a similar substrate, which accomplishes consistent impedance coordinating over a wide band and uniform radiation design. To lessen the regressive radiation, two sorts of reflector were utilized: level and bended. Results demonstrate that utilizing a bended reflector improves the radiation design on the majority of the UWB with less impact on the antenna impedance contrasted with the level reflector.

M. Y. ElSalamouny [3] This paper proposes two novel minimized plans of low-profile multi-band microstrip antennas. The first can operate in ISM bands (2.4 GHz and 5.8 GHz), which makes it reasonable for Remote Body Area Network (WBAN) therapeutic applications. Then again, the second structure executes stacking of antenna with the end goal that the subsequent novel plan operates ideally at 3.5GHz and 7.5GHz, which makes it appropriate for Ultra-Wide-Band (UWB) applications. The two antenna plans are minimized in size, that is, the general size of the primary antenna is just 11.54 mm3, though the second is 25.16 mm3. The two antenna plans are reproduced on skin radiation box, so as to permit progressively accurate forecast of the antenna execution when utilized in medicinal implantable gadgets. Aside from the conservative size, both antenna plans produce a base Specific Absorption Rate (SAR) which follows IEEE standard security rules, which is fundamental for shielding patients from electromagnetic harm.

W. Jeong and J. Choi, [4] A position of safety UWB antenna with conelike radiation for on-body interchanges is proposed. The antenna has by and large elements of 64 mm × 64 mm × 6 mm (0.64 λ 0 × 0.64 λ 0 × 0.06 λ 0 at 3 GHz) in the Drive Radio UWB (3.1 GHz - 10.6 GHz) band. The proposed antenna is made out of a mono-cone and a TM41 higher-request mode shorted ring patch. The reenacted outcomes demonstrate that the proposed antenna gets monopole-like radiation exhibitions in the entire working frequency band. The radiation example of the proposed antenna on the apparition is like that in free space so that the on-body WBAN application can be practical.

A. Zaric, J. R. Costa [5] A smaller low-profile (37.6 mm×27 mm×3.1 mm) unidirectional UWB antenna is proposed for remote body area network (WBAN) limitation applications by concentrating on its going presentation and motivation loyalty in time space notwithstanding frequency space attributes. The antenna is invulnerable to direct skin contact, and furthermore demonstrates awesome frequency and time area properties in free space or at any separation to a body: reflection coefficient and radiation design flexibility to body impact; level exchange work adequacy and straight stage over the ideal frequency band from 6 GHz to 9 GHz. Predominant time area execution is demonstrated in recreation and estimations with normal drive devotion of 97% in both free space and when set at 0 mm or 3 mm over the body.

A. Zaric, J. R. Costa [6] A position of safety unidirectional UWB antenna for WBAN (Remote Body Area Networks) Motivation Radio (IR) applications is proposed with practical band from 7 GHz to 10.7 GHz. Recreated reflection coefficient in free space and when 0 mm, 3 mm, or 7 mm over a human body model demonstrate that the body impact is insignificant. Time area investigation of heartbeat loyalty, vital for IR-UWB, indicates normal constancy of 98% in free space and when 3 mm or 0 mm over the body.

III. PROBLEM FORMULATION

From the above literature review it can concluded that the main issue with the Vivaldi microstrip patch antenna is Narrow bandwidth, lower gain (6 dB), large ohmic loss in the feed structure of array, polarization purity is difficult to achieve, lower power handling capability etc. in the light of literature study it can formulate a problem of lower bandwidth and low return loss is the main disadvantages. No efficient antenna design for wearable antenna over body area network applications.

Table 1: Summery of reviews

Author Name	Year of Publication	Frequency Range	Objective
D. Yang	Dec 2017	2.5 to 24 GHz	low-weight and easy to produce by printed circuit board manufacturing
W. Amer	Nov 2017	2 GHz to 5 GHz	Novel antenna design for ultra wide-band body area network applications.
M. Y.	July 2018	2.4 GHz to 5.8 GHz	Novel compact designs of low-profile multi-band microstrip antennas
ElSalamouny	Nov 2017	3.1 GHz - 10.6 GHz	Monopole-like radiation performances
Zaric Y. Dong	Nov 2015	3.1 GHz to 12 GHz.	Novel folded ultrawideband antenna for Wireless Body Area Network

IV PROPOSED DESIGN

In figure 3, showing top view of proposed Vivaldi microstrip patch antenna, one side of a dielectric substrate acts as a radiating patch and other side of substrate acts as ground plane. Top view of a rectangular patch antenna with coaxial feed has. Patch and ground plane together creates fringing fields and this field is responsible for creating the radiation from the antenna.

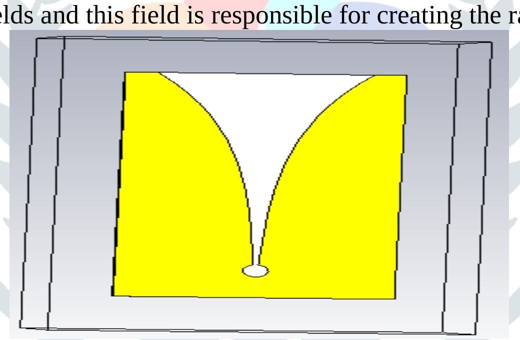

Figure 3: Top view of proposed vivaldi antenna

The design of a vivaldi microstrip antenna which has a wide bandwidth with directional radiation pattern works on 3.1 to 10.7 GHz and using cheaper substrate. Substrates used for vivaldi microstrip antenna vivaldi is FR4 with a dielectric constant of 4.3 and a thickness of 1.6 mm. Based on the simulation results we obtained that the antenna design has frequency range 3.1-10.7 GHz for return loss less than -10 dB with a directional radiation pattern. This antenna gain is 4.8 to 8 dBi with the largest dimension is 50 mm x 40 mm.

V. SIMULATION RESULT

In order to realize multiband antenna, a wide variety of antenna types, which uses different multiband techniques, is used. The most widely used technique for obtaining multiband antenna system is the usage of multiple resonant structures. The multiple resonant structure method is also often used in body area network communication systems .

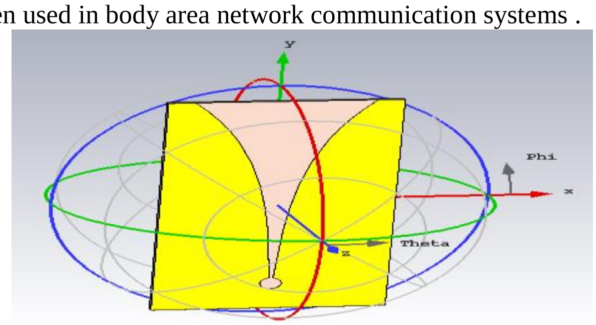

Figure 4: Simulation and fields of proposed antenna

Figure 4, showing simulated proposed antenna in CST microwave studio, it is a specialized tool for the fast and accurate 3D EM simulation of high frequency problems. Along with a broad application range in different field.

A. S11 PARAMETER AND RETURN LOSS

Return loss is the difference, in dB, between forward and reflected power measured at any given point in an RF system and, like SWR, does not vary with the power level at which it is measured. Figure 5, shows the Return Loss (S_{11}) parameters for the proposed antenna, which represents the multiband bands of frequency for which the antenna designed is optimized i.e. frequencies ranging from 4 GHz to 7 GHz with S_{11} value beyond -10 dB and the range of frequencies as per the results shows that it has a good bandwidth as compared to other microstrip antenna. The obtained value of S_{11} for 4.546GHz is -36.37 db and 5.784GHz is -34.45db. Here 4.546GHz and 5.784GHz is resonant frequency, where antenna efficiency is higher. Values -36.37 db and -34.45db are return loss receptively, it is greater than -10db, so it's good value of return loss.

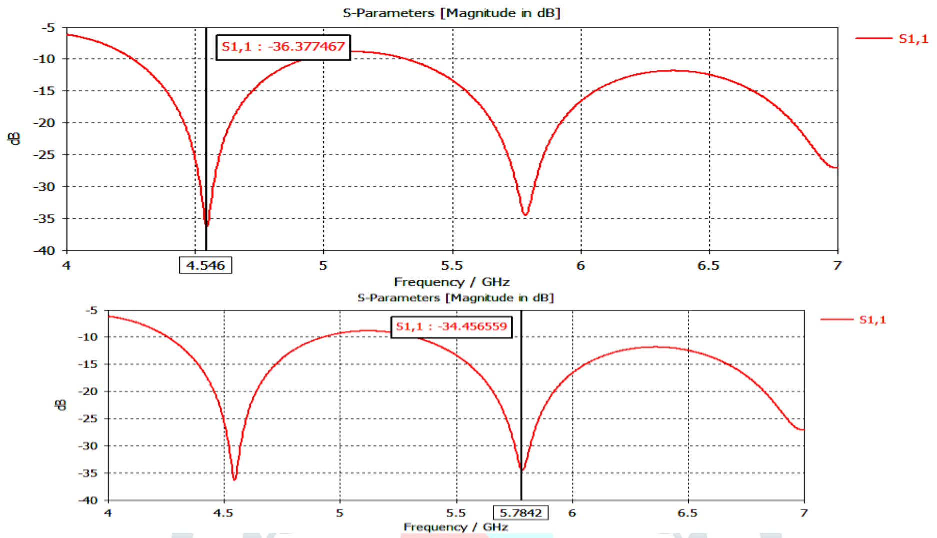

Figure 5: S parameter and Return loss

B. BANDWIDTH

Bandwidth, for a system, could be the range of frequencies over which the system produces a specified level of performance. A less strict and more practically useful definition will refer to the frequencies beyond which Performance is degraded. The bandwidth of an antenna is defined as "the range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard." For broadband antennas, the bandwidth is usually expressed as the ratio of the upper-to-lower frequencies of acceptable operation.

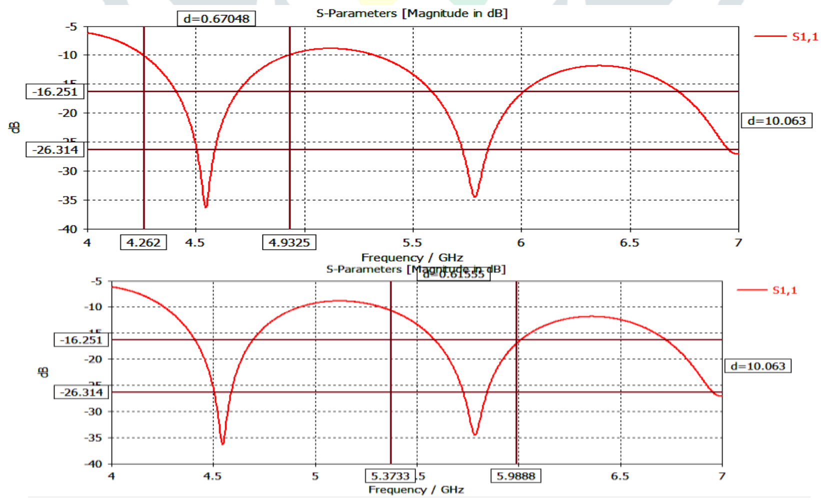

Figure 6: Bandwidth calculation

For broadband antennas, the bandwidth is expressed as a percentage of the frequency difference (upper minus lower) over the center frequency of the bandwidth.

The bandwidth of proposed antenna is 670.48 MHz, (4.262GHz-4.9325GHz), for first band and 615.55 MHz, (5.9888GHz-5.3733GHz), for second band

C. VOLTAGE STANDING WAVE RATIO (VSWR)

VSWR (Voltage Standing Wave Ratio), is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load (for example, from a power amplifier through a transmission line, to an antenna). In an ideal system, 100% of the energy is transmitted.

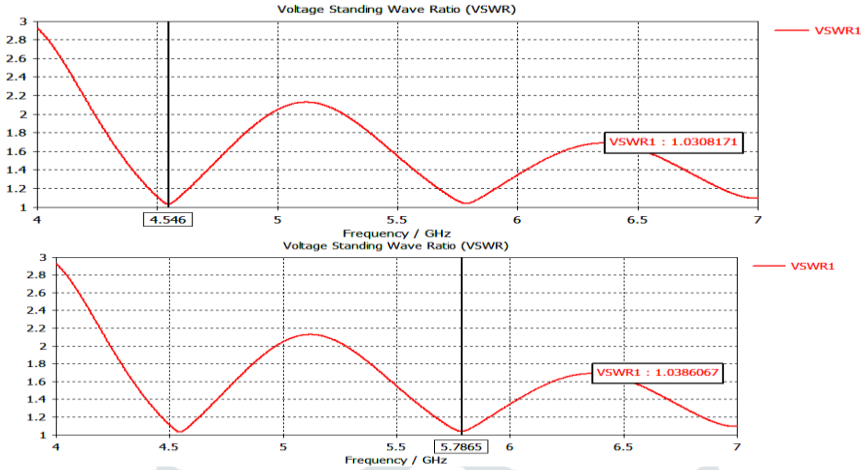

Figure 7: Voltage Standing Wave Ratios

VSWR must lie in the range of 1-2, which has been achieved for the frequencies 4.915GHz and 6.018GHz. The value for VSWR is 1.030 and 1.038 respectively.

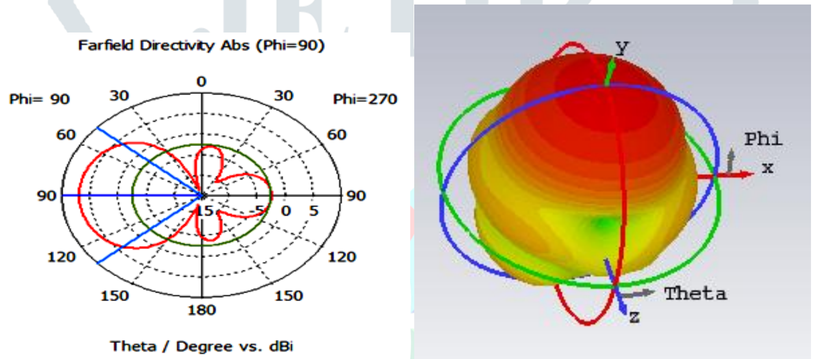

Figure 8: Radiation pattern

Table 1I: Result summary of proposed Antenna

Sr. No.	Parameter	Value (Band-I)	Value (Band-II)
1	S11& Return Loss	-36.37 db	-34.45db
2	Band Width	670.48 MHz	615.55 MHz
3	VSWR	1.030	1.038
4	Resonant Frequency	4.546GHz	5.784GHz
5	Z parameter	49.79 ohm	48.95ohm

Table III. Comparison of proposed design result with previous design result.

Parameter	Previous work	Proposed Work
Design shape	Vivaldi	Vivaldi
Bandwidth	180 MHz	670 MHz
Return Loss	-29db and -27.5db	-36.37 db and -34.45db

Resonant Frequency	4.35 GHz and 6.59GHz	4.5GHz 5.7GHz
VSWR	>1	1.009

VI CONCLUSION

Wireless Body Area Network (WBAN) is one of developed technology that supports telemedical services. So far, the antenna's performance is mainly affected by a human body when it is applied near to the human body. In the paper, the new types of proposed antenna (Vivaldi microstrip patch antenna), which are more appropriate for body area network applications.

A double band, rectangular microstrip patch antenna is designed and simulated using CST simulation software. The simulation results are presented and discussed. Structure of proposed antenna is simple and compact in size of approx $40 \times 40 \times 1.6\, mm^3$. the compact size of designed antenna makes it easy to be incorporated in small devices. Results show that the frequency bandwidth covers WBAN (4-7) GHz, at centre frequencies 4.915 GHz and 6.018GHz respectively for VSWR less than 2, and S11 less than -10 dB. The final results satisfy all the parameters of an efficient antenna. The designed antenna works efficiently under all conditions with low return loss and proper impedance matching.

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