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COMPACT H-SHAPESLOT ANTENNA FOR UWB APPLICATIONS

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Abstract: In Present days, the essential component of Microstrip patch antenna are widely used for many emerging medical and wireless applications. In this paper, We present a design of h-shape slotted antenna which can be used in microwave, UWB and wireless applications. The proposed design of an antenna is based on h-shape structured slots in order to operate at multiple frequency bands.The proposed antenna with the H-shaped slots is designed on FR4 substrate and is fed through a microstrip line by optimizing the width and the position of the feed along with the width of the partial ground structure. According to -10dB bandwidth criteria, the antenna offers promising performance of UWB design ranging from 3-12 GHz. From the results, it is shown that the maximum Return Loss (RL) occurred at 3.5 GHz, 6.8GHz, 7.8GHz, 8.6 GHz, 10GHz, 11.9 GHz and 13 GHz. For the entire UWB range, the VSWR is < 2 that is one of the desired characteristic of an efficient design with the relative permittivity is 4:4 and the loss tangent of tan is 0:02. The dimensions of the antenna are 35 x 35mm^2.It is also observed that the gain and directivity of proposed design is higher than the conventional patch antenna which makes it more attractive choice for many applications. The proposed design ensures secure and efficient transmission as well as better transmission of input power, i.e. low values of Return Loss.

Keywords: h-shapeslot, Microstrip patch antenna, multi- band

1. Introduction

Microstrip patch antennas posses a number of unique and interesting properties which make them very attractive for many wireless and medical applications. Some of the advantages of microstrip patch antennas are low profile, light weight, compactness, easy to fabricate and to integrate with many modern day mobile devices. As a result of these properties, microstrip patch antennas are very popular for military applications such as aircraft, missile, spacecraft and as well as in commercial applications such as satellite communication, terrestrial mobile communication, digital audio and video broadcast systems and global positioning system (GPS). Another very important and emerging application of microstrip patch antennas is in the health applications. In particular, these antennas are being used in Wireless Body Area Networks (WBAN) and Wireless Sensor Networks (WSN). In the medical scenario, generally patient has to wear a health monitoring device which communicates between other devices in hospitals and medical staff. Microstrip patch antennas being light in weight and easy to integrate, as mentioned before, are the best candidates for the use in such devices. These antennas also widely use onbase station as well as handsets.

Generally a microstrip patch antenna consists of a metal patch on a substrate on a ground plane. However, more advanced microstrip patch antennas generally consist of three layers, a metallic layer with the antenna element pattern, a dielectric substrate and another metallic layer as the ground plane [1]–[3]. These types of antennas are relatively easy to manufacture because of their simple planar configuration and the compact structures. Microstrip patch antennas can take signal feed from various types of feeder lines to produce the desired results for a particular application. Some of the common feeding mechanisms are aperture-coupled, microstrip line feed and coaxial cable feed. Among various types of microstrip patch antennas, rectangular and circular patch antennas are the most common configurations because they are easy to fabricate and simple to analyze.

With the availability of multiple frequency bands for various wireless communication systems, it is required for an antenna to switch between different bands of frequencies without any complicated mechanism. A tunable microstrip patch antenna can provide this facility and can also be tuned at multiple frequency bands while giving high efficiency in terms of energy radiation. A tunable dual frequency patch antenna is also provides an alternative to wideband antennas where large bandwidth is required for operations at two separate transmit- receive bands. The main idea is that when a microstrip patch antenna is loaded with reactive elements, such as slots [4]– [6], stubs or shorting pin [7] it gives tunable or dual frequency antenna characteristics. Recently, dual band antenna is found wide applications in wireless communication. The rapid development and use of Wireless Local Area Network (WLAN) technology demands the antenna having high performance, dual band and good radiation characteristics. A number of microstrip slot antennas for 2.4 GHz operations (WLAN) have been presented in [8]–[15]. However, our proposed design different from the previous work in terms of size and shape (compactness), ease of fabrication (practicality), wide frequency operating range and five different optimized frequency bands. These characteristics make this proposed antenna a suitable candidate particularly for uwb applications.

In this paper, we present also a compact microstrip patch antenna with the emphasis that it can be a candidate for medical applications such as in Wireless Body Area Networks and eHealth systems. The introduction of two rectangular slots in the microstrip patch made the antenna to resonate at multiband frequencies, giving the opportunity to use this antenna for multiple applications. We also present new feeder line technique and corner truncation on the both patch and ground as well. These both techniques has given us outstanding results, presented in Section III.

Related Work: Some of the well known previous works in the field of microstrip patch antennas are described here. Due to the limitation of paper length, we keep this literature review brief here, but interested readers are referred to follow the references given at the end of the paper.

In [8]–[11], the authors presented dual band slot antennas are particularly for WLAN applications. Specifically, in [10], the authors presented dual-band slot antenna consisting of two narrowband linear slots operating at 2.4 GHz and 5.2 GHz.

In [11], the authors presented a dual-band equilateral-triangular slot antenna operating at WLAN frequencies. These previous works that the proposed antennas are capable of operating at two frequencies whereas our proposed antenna design is capable of operating at five different frequencies, providing an opportunity to be a candidate for vast applications. Also we used rectangular slots to obtain multiband frequency operation.

In [16], the authors presented a circular patch antenna for WLAN applications. They used the partial ground plane and quarter wave transformer techniques to achieve impedance matching for the particular application. However, their pro- posed antenna design is optimized only at 5 GHz. We used a corner truncation technique to achieve higher bandwidth and also our proposed antenna design is optimized at five different frequencies to make it more suitable for multiple applications concurrently.

In [17], the authors presented a multiple ring slots ultra wide-band antenna for biomedical applications. They proposed a single element that can further be used within an antenna array to detect breast cancer. Our proposed design is different in geometry and design from this work. In particular, we introduced rectangular slots in the antenna to get resonance at various frequencies. Also, we present new feeder line technique and corner truncation on both patch and ground.

The rest of the paper is organized as follows. Section II presents the geometry and design of the proposed antenna. Section IV presents the results and discussion on the results. Finally, Section IV concludes the paper.

II. Design and Geometry of the Proposed Antenna

In this section we present the detailed design of geometry for the proposed microstrip patch antenna.

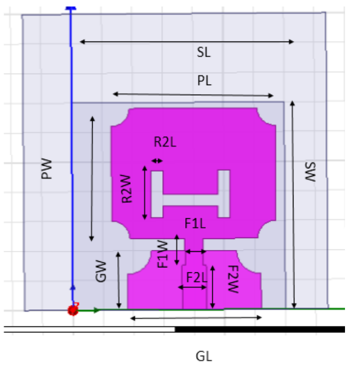

Fig.1. Conceptual diagram of the proposed microstrip patch antenna (top view)

A. Antenna Geometry

The proposed design of the dual rectangular patch antenna is shown in Figure 1. Copper tape of thickness 1mm is used to the patch and ground plane of antenna. Length (SL) and width (SW) of substrate are 35 mm and 35 mm respectively, while the patch length (PL) and patch width (PW) are 22 mm and 27 mm respectively. Different design parameters and their definitions of the proposed antenna are explained in Table I. For the maximum input power trans- mission to the antenna, impedance matching (commonly known as feeder line) of transmission line with the antenna is an important task. In order to achiever this purpose, the proposed antenna is feed with a feeder line that consists of two different dimensions and hence providing 50 Ω impedance matching with the antenna. This make it sure that whatever signal is feed from the source, it is available at the antenna for radiation. It is shown in Figure 1 that a narrow feeder-line directly feeds antenna while a wider feeder-line passes through the ground plane of antenna.

TABLEI
DIMENSIONSOFTHEPROPOSEDANTENNA

Paramet	Dimensions(m
FeederLength1(F1L	4.5
FeederWidth2(F1W	3
FeederLength1(F2L	7.5
FeederWidth2(F2W	4
RectangleWidth(R	8
RectangleLength(R	2
SubstrateLength(S	35
Substratewidth(S	35
GroundLength(GL	10
GroundWidth(GW	22
PatchLength(PL)	22
PatchWidth(PW)	27

The principle of Quarter-Wave Transformer and described in Section II-B. The dimensions of these two feeder-lines are shown in Table I.The resonance of the antenna at multiple frequencies in the Transverse Electromagnetic Modes (TEM) depends not only on geometry and material of the antenna (μr , r) but also on the feed current. Corner truncation and slotting techniques were used to divert the patch current for better bandwidth and gain values[8].H-shaped slots of same size are situated at suitable distance from each other to disturb the current path which results in resonance at higher frequency and greater gain. The simulations were carried out using HFSS which is a commercially available electromagnetic simulation software. The operating bands are at central frequencies of 3.5 GHz, 6.4 GHz, 7.8 GHz , 8.6 GHz ,10GHz ,11.1 GHz and 11.9 GHz respectively. The final simulated return loss ouput characteristics are shown in Figure 5. The novel part of the proposed antenna design is the combine use of partial ground plane and quarter wave transformer with the slotted transmission line. The length and width of the ground plan are 10 mm and 22 mm respectively. Partial ground technique is used to increase the bandwidth of the proposed antenna whereas the quarter wave transformer is used for impedance matching between the connector and actual antenna [16].

B. Quarter-Wave Transformer

When the impedance of a load is same as the characteristic impedance of the transmission line i.e, there is no reflected wave and all the input power is dissipated at the load. There are many ways to achieve this impedance matching. One of them is a presented technique called Quarter-Wave Transformer. A Quarter Wave Transformer (QWT), similar to low fre- quency transformers, changes the impedance of the load to another value so that matching is possible. A quarter wave transformer uses a section of the line of characteristic impedance ZT of ($\frac{\lambda}{4}$) long [3]. To have a matching condition, we want Zin = Zo .

As we know that the input impedance of QWT can be

calculated as The feeder lines work Zin = ZT

Further, if $Z_o = Z_{in}$, then Equation (1) implies that Z 2 =

Zo ZL ⇒ ZT = $\sqrt{}$Zo ZL .

III. Results and discussion

In this section we present the numerical results of the proposed microstrip patch antenna. we used hfss software to simulate our proposed antenna.

A. Effect of H Shape

The simulation was carried out with varying h shaped slot of the each rectangle size from 8 mm to 11 mm with 1 mm distance variation. The purpose of this process was only to check the behavior of return loss on various values of r and the result is shows in Figure 3. The distance between the slots affect the return loss due to the current distribution on the patch. The compromised value of 9 mm with good return loss is selected. As the each rectangle size slots is increased from 8 mm to 11 mm, the radiations interfere constructively and return loss increases.

B. Effect of Corner Truncation

Corner truncation technique is used to shift the frequency at higher values [17]. A graphical explanation of this phenomena is shown in Figure 3. Single corner truncation shifted the frequency to lower band with increase in return loss. So one by one corner truncation process was carried out to observe the behavior of return loss. Return loss improvement was observed after the truncation of all four corners of the patch and shown in Figure 3. The change in the behavior of return loss is due to the current distribution on the patch surface.

C. Input Power Loss

The proposed antenna was simulated and analyzed using HFSS between the frequencies 3-12 GHz. The return loss of the rectangular slots multiband patch antenna is shown in Figure 4. It is obvious that the return loss is lower than -10 dB at 3.5GHz, 6.4 GHz, 7.8 GHz, 8.6 GHz ,10 GHz, 11.1 GHz and 11.9GHz operating frequency bands. The -10 dB return loss shows how much matching offers by presenting patch antenna for different bands of frequency. The results are much satisfied for the application like in Biomedical Imaging, Wireless Communication, Ground Penetrating Radar system (GPR) and Wireless Sensor Networks (WSN). For microwave imaging, a good matching antenna is an ultimate goal

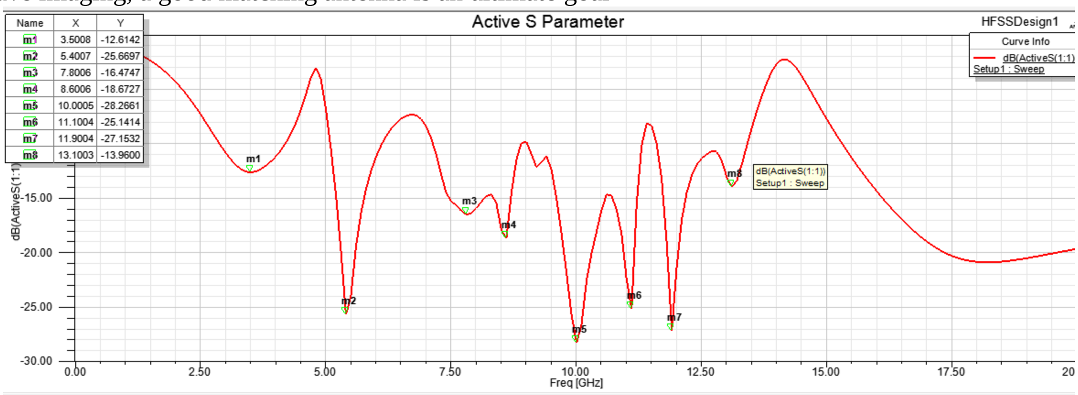

Fig.3. EffectofcornertruncationonReturnLossoftheproposedantenna design

D. Antenna Gain

The gain of an antenna is closely linked with the surface or volume of the antenna. As a general rule, larger surface area results in higher antenna gain. The proposed antenna has small area covered at both patch and ground, but produces high gain. This high gain is achieved because of the corner truncation feeder line techniques used in the proposed patch antenna. Figure 4 shows the behavior of gain in dB as a function of φ measured in degrees. From the obtained results, it is clear that the gain of the proposed antenna is 9 dB at frequencies ranges are 3.5 GHz, 6.8GHz, 7.8GHz, 8.6 GHz, 10GHz, 11.9 GHz and 13 GHz.

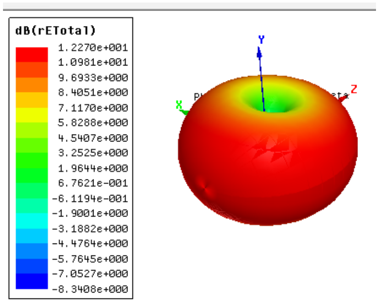

Fig.4. gainoftheproposedantennadesign

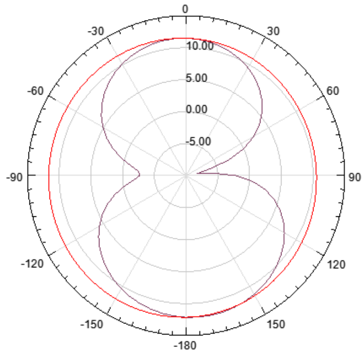

Fig.5. Radiation pattern

E. Voltage Standing Wave Ratio (VSWR)

VSWR is an important parameter to measure the power transmission efficiency of an antenna. VSWR reflects the mismatch between the transmission line and the antenna. If we represent the reflection coefficient by Γ, then VSWR can

$VSWR= 1+ \Gamma/1-T$

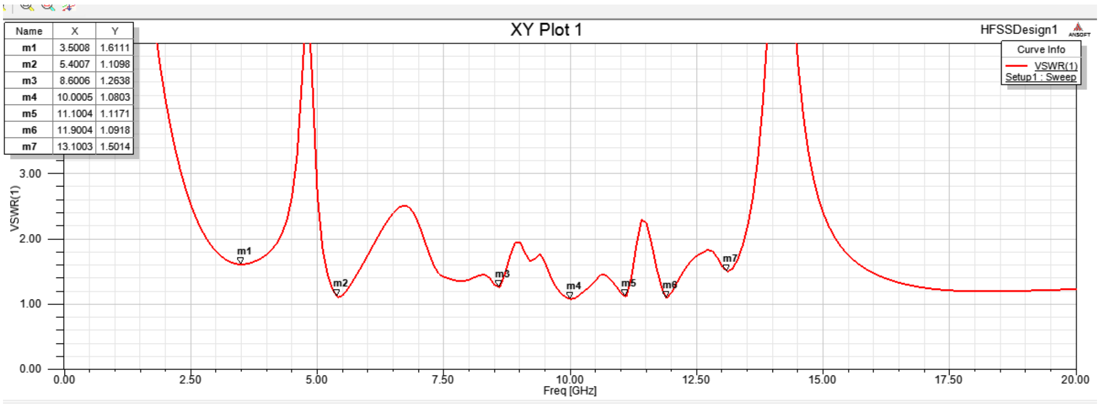

Fig.6. VSWRoftheproposedantennadesign

The minimum value of VSWR is 1.0 which is an ideal value and it means that no power is reflected back from the antenna and all supplied power is transmitted through the antenna. Obviously achieving the ideal value in practical systems is not possible. However, in the antenna design, lower value of VSWR indicates better antenna design. Figure 6 shows the VSWR performance of the proposed antenna at various operating frequencies. In general, there are fluctuations in VSWR of the proposed antenna, but at frequencies of interest, the VSWR is close to unity which shows that the proposed antenna is optimized at these frequencies. The VSWR result also satisfies the data obtained by return loss shown in Figure 4 where it is evident that as the return loss decays at specific frequencies, VSWR of the proposed antenna goes close to unity as well. We can also study the matching results from VSWR of the proposed antenna, which shows a good matching (with the transmission line) patch antenna. Such type of antenna is a beneficial and useful in various wireless communication systems, UWB applications.

IV. CONCLUSIONS

A multiband rectangular patch antenna is designed and fabricated to analyze the performance for multiband UWB applications and wireless applications (i.e)WiMax and WLAN applications . The design consists of H-shape slot on patch with corner truncation on the patch and ground surfaces as well. Hence, these techniques make an antenna convenient for Multiband operations. Different resonant frequencies are achieved through proposed antenna design. The resonant frequencies occurred in the range of 3 - 12 GHz. Also, the VSWR of proposed antenna is < 2with high gain (9 db). The presented antenna is easy to manufacture and cost effective.

V. REFERENCES

[1]. C. A. Balanis, "Modern Antenna Handbook," 1st Edition, Wiley- Interscience, 2008.

[2]. C. A. Balanis, "Antenna Theory: Analysis and Design," 3rd Edition, Wiley-Interscience, 2005.

[3]. D. M. Pozar, and D. H. Schaubert, "Microstrip Antennas: The Analysis and Design of Microstrip Antenna Arrays," Wiley-IEEE Press, 1995.

[4]. D. D Krishna, M Gopikrishna, C. K. Aanandan, P. Mohanan and K. Vasudevan, "Compact dualband slot loaded circular microstrip antenna with a superstrate," Progress in Electromagnetic Research, vol. 83, pp.245-255, 2008.

[5]. A. A. Eldek, A. Z. Elsherbeni and C. E. Smith, "Square slot antenna for the dual and wideband wireless communications system," Journal of Electromagnetic Waves and Applications, vol. 19, pp.1571-1581, 2005

[6]. A . Mishra, P. Singh, N. P. Yadav, J. A. Ansari and B. R. Vishvakarama, "Compact shorted patch microstrip patch antenna for dualbandoper- ation," Progress in Electromagnetic Research C, vol. 9, pp. 171-182, August 2009.

[7]. A. E. Daniel and G. Kumar, "Tunable dual and triple frequency stub- loaded rectangular microstrip antennas," IEEE AP-S Int. Symp. Dig. New port Beach, CA, pp. 2140-2143, June 1995.

[8]. E. Wang, J. Zheng, Y. Liu, "A novel dualband patch antenna for WLAN communications," Progress in Electromagnetic Research C, vol.6 pp.93-102, 2009.

[9]. C. J. Wang, and S. W. Chang, "Studies on dualband multi slots antenna," Progress in Electromagnetic Research C , Vol.83, pp.293-306, 2009.

[10]. C. M. Su, H. T. Chen, F.S Chang and K. L Wong, "Dualband slot antenna for 2.4/5.2 GHz WLAN operation," Microwave and Optical Technology Latters, vol. 35, pp.306-308, October 2002.

[11]. J. W. Wu, "2.4/5- GHz dualband triangular slot antenna with compact operation," Microwave and Optical Technology Letters, vol. 45,pp. 81-84, February 2005.

[12]. C. W. Liu, "Broadband dual frequency cross shaped CPW-fed monopole antenna for WLAN operation," Microwave and Optical Technology Latter, vol. 46, pp. 353-355, June 2005

[13]. C. Y. Pan, C. H. Huang, and, T.S. Horng, "A novel printed G-shaped monopole antenna for dualband WLAN applications," Antennas an d Propagation Society International Symposium, vol.3, pp.3099-3102, June 2004.

[14]. Y. L. Kuo, and K .L. Wong, "Printed double–T monopole antenna for2.4/5.2 GHz dualband WLAN operations," IEE Transactions Antennas and Propagation, vol. 51, pp. 2187- 2192, September 2003.