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Design & Simulation of SWB Antenna For Air Bone Radar System

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Abstract:-
A low profile novel compact microstrip antenna is presented for super-wideband (SWB) applications.The proposed antenna is used to air bone radar system. The proposed antenna consists of a octagonal radiating patch and a partial ground plane. The substrate of the proposed antenna is made of Dacron fabric with permittivity 3. The ground plane is slotted with author name initials. Super wide bandwidth is achieved by optimizing the geometry, introducing a square slot in the partial ground plane and introducing novel slot pattern on the radiating patch of the antenna. This novel slot represents the "wireless antenna" icon which gives range of an antenna. The dimension of the proposed antenna substrate is 40×34×1.7 mm^3 and the bandwidth 10.969 GHz starting from 38.965 GHz to 49.9333 GHz for return loss less than -10 dB. The gain variation is from 3.2 dB to 11.2147 dB and average total efficiency more than 83%. Maximum power of 19.39mW may be set as input to the proposed antenna in order to guarantee compliance with the IEEE C95.1-1999 safetystandard.The proposed antenna design details and simulated results are presentedbyHFSS.

Keywords:HFSS, SWB, Air Bone Radar System, Return Loss, Gain

INTRODUCTION

SWB is a radio technology, used for short-rangecommunication. It occupies a bandwidth of at least 25% of thecenter frequency or more than 1.5 GHz unlike the narrowerfrequency band of the conventional systems. SWB signal usesOrthogonal Frequency Division Multiplexing (OFDM) as themodulation technique to occupy the wide frequency band. Thecommercial use of frequency bands from 3.1 to 14.6 GHz for SWB systems was approved by the Federal Communications Commission (FCC) in 2002 [2]. SWB offers extremely lowradiated power in low/medium data-rate applications based onnarrow pulses, thus being very attractive for air bone radar system.

Numerous papers have been published about the design,fabrication and applications of radar antennas and systems.

Previously reported works are based on single frequency band radar antennas [3] and later dual frequency band radar antennas [4]. In the recent researches, Wideband, UWB and SWB technology is one of the most fascinating choices for WBANapplications. Many of SWB antennas using rigid substratematerial [5-6], large in size and small bandwidth [7-10][12-13]have been reported. However, it is quite difficult to obtainlarge bandwidth with compact size and a very low thickness in case of air bone antenna system . In this paper, a novel and compact design of SWB antenna is proposed for WBANapplications by merging the SWB technology with radar technology.

This paper is motivated from the above reported papersand presents a novel design of a wearable Octagonal SWBtextile antenna. Novelty of this work is the slotted area ofhexagonal patch that represents the "wireless antenna" iconwhich is unique and also compact in size. The bandwidth ofthe proposed antenna operates in the wide range, achieving theSWB system requirements.

The rest of the paper is organized as follows. Section II outlines the complete design of SWB patch antenna. Measured and simulated results of the proposed antenna are discussed in Section III& IV. The conclusions are given in Section VI.

Octagonal patch Antenna Design

An Dacron substrate with 4.4 and thickness 1.7 mm was used in this design. The dimensions of the patch antenna were chosen in such way that when octagon radiate energy.

A patch of area 30 ×30 mm was selected. Such a patch resonatedat 42.04 GHz in normal operating mode. To reduce theresonant frequency of the patch antenna, zero iteration wasetched out from its radiating patch at its center. After that it is compare with second iteration which was etched out from its radiating patch as in star form.

In the design of the zero iterationpatch, the dimension of the star lengthwas varied and the antenna was tuned to resonate at 42.04 GHz using the commercial software HFSS. The final design obtainedis shown in Fig. 1. The length of each side was 11.078 mm.The feedline width was 13.49 mm, which givesa characteristic impedance of 50 Ω. The top view of octagonal patch antenna is as shown in the fig 1.

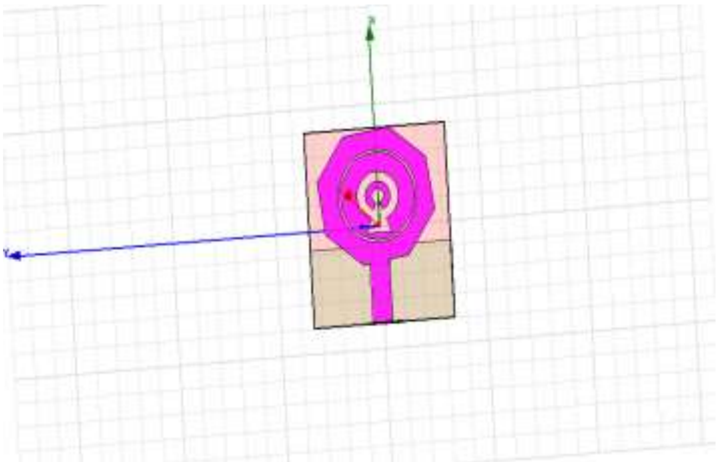

Fig 1. Top View of Octagonal Patch Antenna

The proposed antenna is compare with ground slotted patch antenna as shown in fig 2.Dimension of ground is 16 × 34 mm. A square notch is cut into the ground surface. This notch enhances the gain & minimizes the return loss.

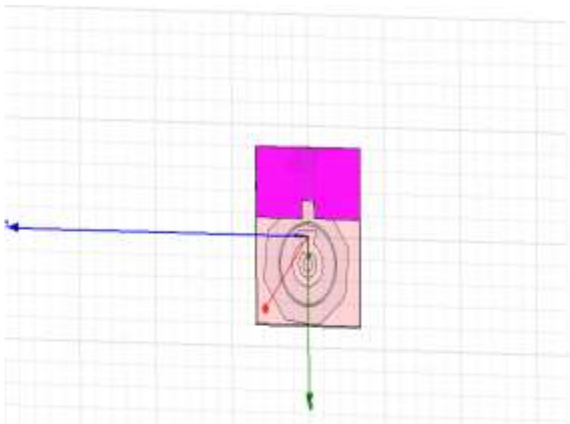

Fig 2. Bottom View of Octagonal Patch Antenna

Return Loss is important parameter for an antenna design. The ideal return loss is assumed to be -10db. Return loss should be minimum. The antenna is simulated in HFSS tool and return loss is measure. In case of octagonal patch antenna return loss is -15.0988 db. The return loss of octagonal patch is given by fig 3. This graphs shows that impedance matching of port to the antenna

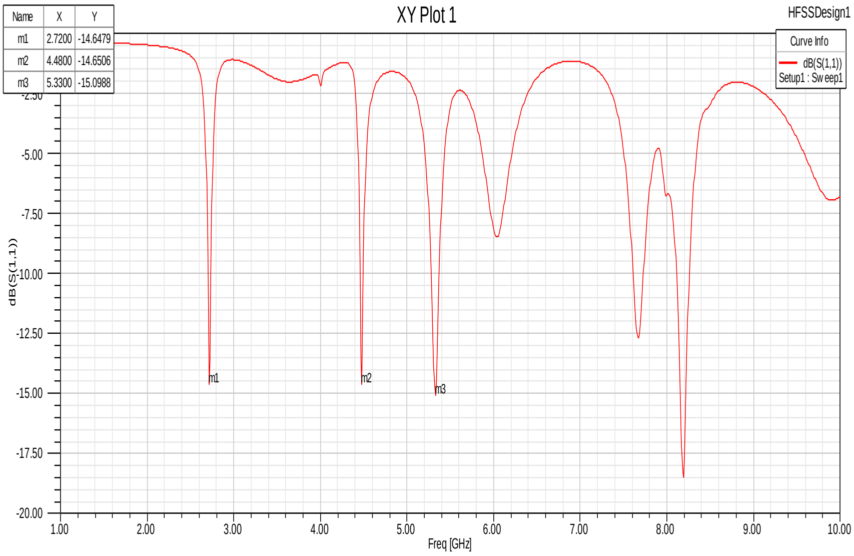

Fig 3. Return Loss of Octagonal Patch Antenna

The current distribution gives an idea to distribute a charge to the whole surface. The distributed current is gives in ampere per meter. In case of zero iteration current distribution is given as $3.1871 \times e^{+001}$ ampere per m^2.Current distribution of Octagonal patch is shown in fig 4.

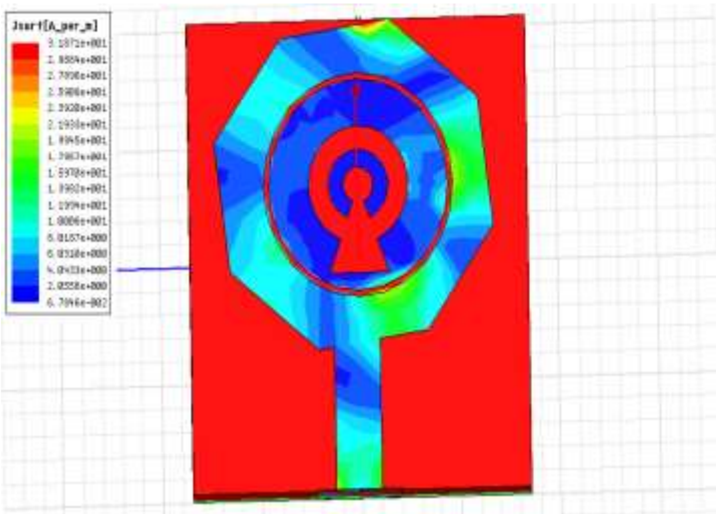

Fig 4. Current Distribution of Octagonal Patch Antenna

Gain is also an important parameter to design an antenna. The Gain enhanced by drawing different slots. Radiation pattern of gain given in fig 5. Gain of zeroth iteration antenna is 1.2841db

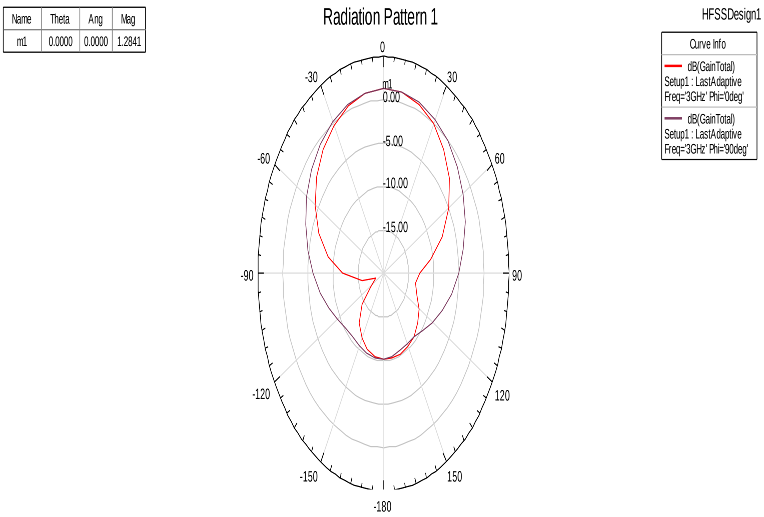

Fig 5. Radiation Pattern of Gain of Octagonal Patch Antenna

Octagonal patch Antenna with ground slot Design

The author's name initial slotted antenna is compare with simple octagonal patch antenna as shown in fig 6. Same shape as previous antenna is designed. Two slots also designed to with ground area having dimension 4 ×4 mm. The name initial are A and S respectively

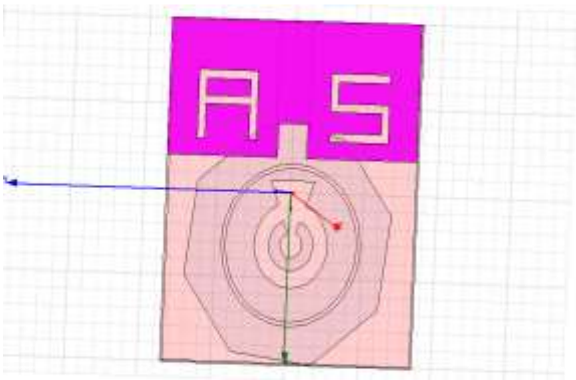

Fig 6.Top View of Octagonal Patch Antenna with Ground Slot.

In case of slotted antenna, return loss is -32.711 db. The return loss of slotted antennais given by fig 7. This graphs shows that return loss becomes more negative as compared to simple octagonal antenna.

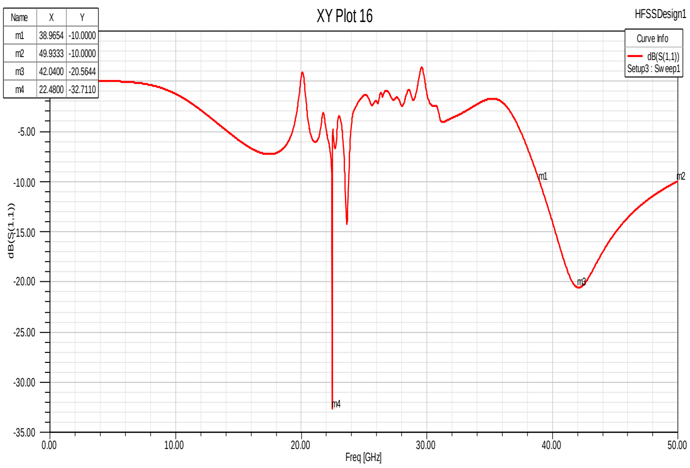

Fig 7. Return Loss of Octagonal Patch Antenna with Ground SlotAntenna

The currentdistribution is improved in slotted antenna. The distributed current is gives in ampere per meter. In case of slottedantenna current distribution is given as $3.2844e^{+001}$ampere per m^2 and $3.187e^{+001}$ampere per m^2respectively.Current distribution on patch and slotted ground is shown in fig 8 and fig 9 respectively.

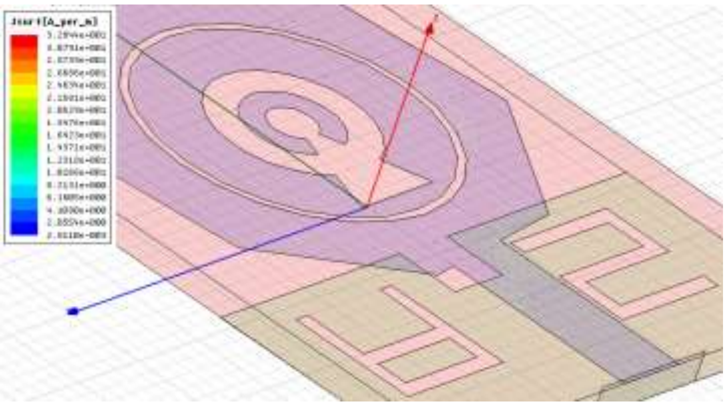

Fig 8. Current Distribution of Octagonal Patch Antenna with Ground Slot Antenna on Patch

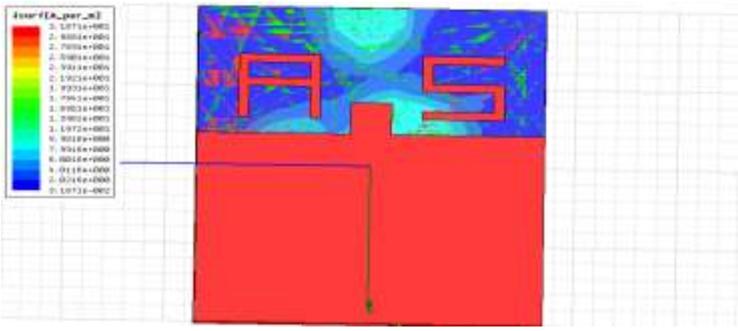

Fig 9. Current Distribution of Octagonal Patch Antenna with Ground SlotAntenna on ground**.**

Gain is improved with designing name initial slots. Radiation pattern of gain given in fig 10.Gain of slotted antenna is 11.2147 db.

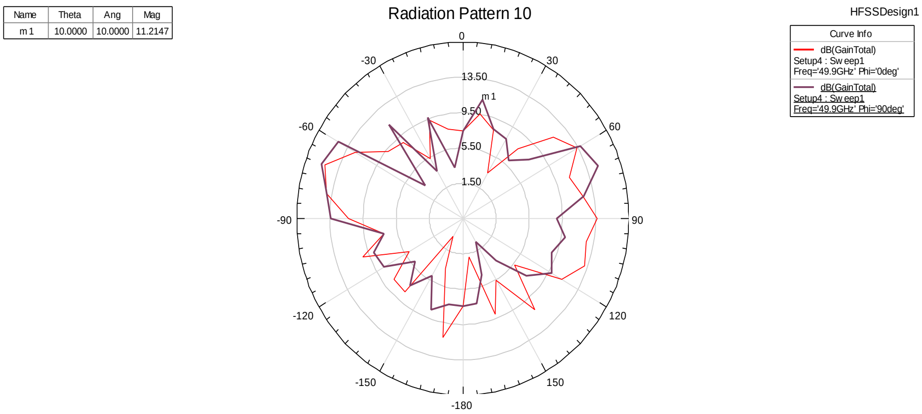

Fig 9. Radiation Pattern of Gain of First Iteration Antenna

Comparative Analysis

In this section, comparative of two configurations is shown in tabular form. Return loss and bandwidth is compared in table 1.

Table 1. Comparative analysis of different iteration of Antenna

Sr. No	Parameter	Simple octagonal Patch Antenna	Simple octagonal Patch Antenna with initial slots
1.	F_L	14.9	13.05
2.	F_H	19.67	23.52
3.	F_0	17.45	17.45
4.	% B.W	27.33	60
5.	Return Loss	-15.0988	-32.711
6.	Gain	1.2841	11.2147

Conclusion

After Simulation, it is found that Octagonal patchantenna has low return loss with high gain andbandwidth. Simulated return loss is -32.711 with gain 11.2147 db and bandwidth 60% is obtained from slotted patch antenna. This range of frequency is used in air bone radar system.

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