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Review of Broadband Microstrip Patch Antenna

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***Abstract** – Microstrip Patch Antenna (MPA) has several advantages over conventional microwave antenna and therefore are widely used in many practical applications. Microstrip Patch Antenna is generally used in modern communication devices. Study of past few year shows that, most of work on MPA is focused on designing compact sized Microstrip Antenna. As per Microstrip Patch Antenna offer low profile, low cost and low volume. But inherently MPA have narrow Bandwidth so to enhance bandwidth various techniques are engaged. This review paper shows some certain critical issues like enhanced bandwidth and gain through different techniques. I will be enhance results using different techniques like using slots in patch ,by changing height, dielectric constant and feed point.*

***Keywords**:* Compact size, Bandwidth, Patch Impedance, Coaxial-feed. Artificial Ground (AG) Structure, Microstrip Line Feed

I. Introduction

The Microstrip patch antennas are well known for their performance and their robust design, fabrication and their extent usage. The advantages of this Microstrip patch antenna are to overcome their de-merits such as easy to design, light weight etc., the applications are in the various fields such as in the medical applications, satellites and of course even in the military systems just like in the rockets, aircrafts missiles etc. the usage of the Microstrip antennas are spreading widely in all the fields and areas and now they are booming in the commercial aspects due to their low cost of the substrate material and the fabrication.. In this paper review on various techniques like changing feed point, height and slot loading on microstrip antenna are presented. Microstrip antennas operate at their fundamental TM01 mode, which gives a broadside beam. Microstrip antenna operating at the higher order TM02 mode has dual symmetric radiation beams, with each beam directed at respectively. It is well known that the major drawback of a microstrip antenna is its narrow bandwidth. One of the popular techniques for broadening the patch antenna bandwidth is to incorporate a U-slot on its surface as proposed.

II. Review & Survey

II.1. Enhanced Bandwidth Using U-slot on Rectangular patch

In [1], we studied about, a U-slot microstrip antenna operating at the TM02 mode to attain dual radiation beams with wideband performance. The U-slot inclusion on the patch's surface introduces a symmetry which affects the radiation characteristics such as pattern symmetry, pattern stability and the direction of the beams. The proposed antenna geometry consist a coaxial-feed rectangular patch is printed over a Rogers RT\Duroid substrate of thickness h=3.175 mm and permittivity ε_r =2.2. A U-slot is cut on the patch's surface, which is mounted over the substrate of size Lg×Wg = 67×74 mm. The other side of the substrate is coated with metal, which is the ground plane of the antenna. Parameters L and Ls are responsible for the patch and U-slot electric lengths, whereas W changes the patch impedance. The antenna operating frequency range is 5.18–5.8 GHz with VSWR less than 2, which corresponds to 11.8% impedance bandwidth. It exhibits

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two radiation beams, directed at 35 and with 7.92 dBi and 5.94 dBi realized gain, respectively at 5.5 GHz.

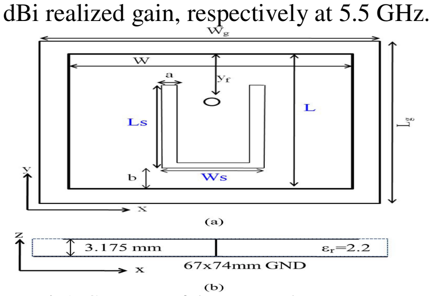

Fig1. Geometry of the proposed antenna

DIMENSIONS OF PROPOSED U-SLOT MICROSTRIP ANTENNA

Parameter	L	W	Ls	Ws	a	b	y_f
Units (mm)	34	27	28.25	12	2	2	5.5

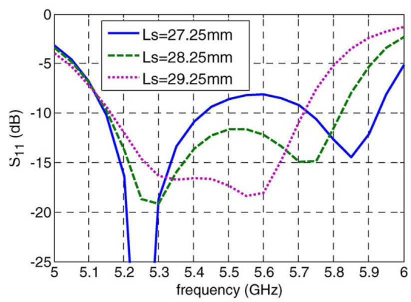

Fig.2 Measured return loss of the proposed U-slot antenna

II.2. Enhance Bandwidth by changing the size and shape of ground plane

In [2], A high gain wideband U-shaped patch antenna with two equal arms on poly tetra fluoro ethylene (PTFE) substrate is proposed. An inverted U-shaped slot is introduced on the circular patch. In this communication the effect of size and shape of the ground plane on impedance bandwidth is studied. Maximum impedance bandwidth of 86.79% (4.5–11.4 GHz) is obtained with circular shaped ground plane with diameter 36 mm. The highest gain achieved is 4.1 dBi. The simulated results are confirmed experimentally. The proposed antenna is simple in structure compared to the regular stacked or coplanar parasitic patch antennas. It is highly suitable for wireless communications.

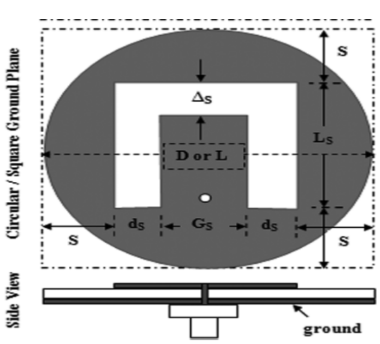

Fig 3. Geometry of the proposed antenna with circular ground plane

DIMENSIONS OF PROPOSED MICROSTRIP ANTENNA

	ANTENNA - A	ANTENNA - B	ANTENNA - C	ANTENNA - D
GROUND PLANE	CIRCULAR	CIRCULAR	CIRCULAR	CIRCULAR
D or L	32	36	40	36
S	6	8	10	8
L_P	20	20	20	20
d_P	5	5	5	7
G_P	10	10	10	6
Δ_P	3	3	3	3
L_S	20	20	20	20
d_S	5	5	5	7
G_S	10	10	10	6
Δ_S	5	5	5	3

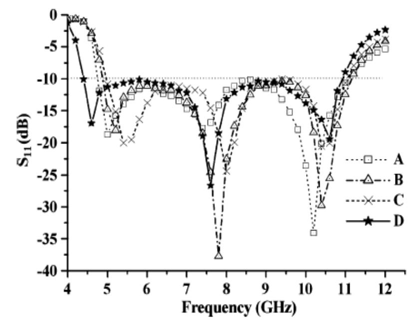

Fig.4 Measured return loss of the proposed antenna

Impedance bandwidth for antenna “A”, “B”, and “C” are 81.01% (4.7–11.1 GHz), 77.5% (4.9–11.1 GHz) and 76.72% (4.9–11 GHz) respectively. All these antennas show three resonant frequencies which are merged to form a wide band. U shaped patch is responsible for second resonance where as first and third resonances are due to coupling of inverted U shaped slot with the patch. The result shows that impedance bandwidth is varying inversely with size of the ground plane.

II.3. Bandwidth Enhancement of a Printed Slot Antenna with a pair of Parasitic Patch

In [3] A printed microstrip-line-fed slot antenna with a pair of parasitic patches for bandwidth enhancement is proposed. By using the parasitic patches along the microstrip feed line, an additional resonance is excited, and a good performance of bandwidth enhancement can be obtained. The proposed antenna is designed and manufactured successfully. The measurement shows a good agreement with the simulation. From the measured results, the enhanced impedance bandwidth, defined by voltage standing wave ratio (VSWR) less than 2, is about 136% ranging from 2.1 to 11.1 GHz. In addition, stable and nearly omnidirectional far-field radiation patterns are observed over the entire operating band. The proposed antenna is fabricated on an FR4 substrate with the thickness of 1.6 mm, relative permittivity of 4.4, and overall size of 37 mm × 37 mm. It has a simple configuration, consisting of a printed wide slot, a coupled patch embedded in the center of the slot, and a pair of parasitic patches along the microstrip feed line.

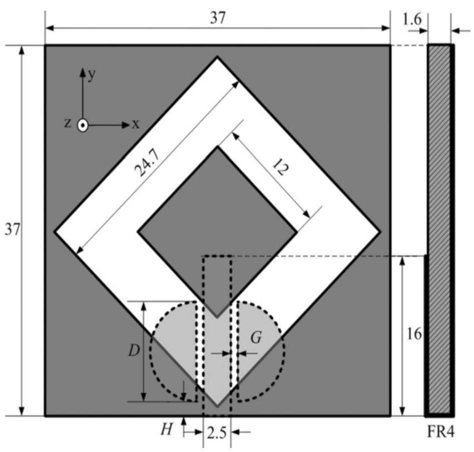

Fig.5. configuration of the proposed antenna

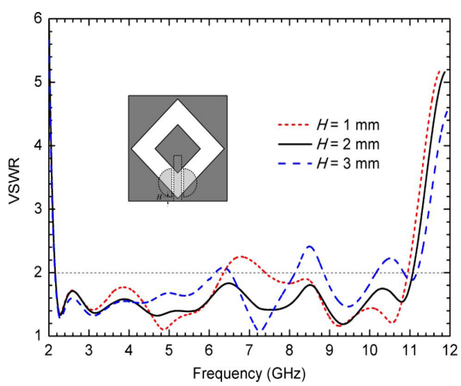

Fig.6. simulated and measured VSWR of the proposed antenna

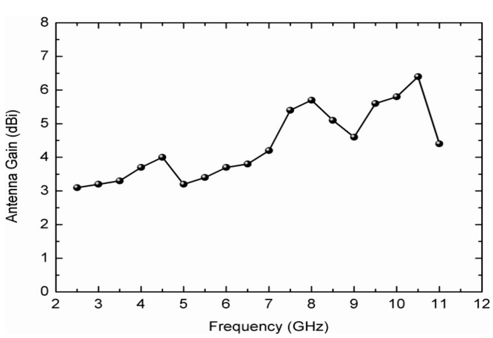

Fig.7. measured antenna gain of proposed antenna

II.4. Microstrip Patch Antenna using Artificial Ground Structure With Rectangular Unit Cells

In [4], a broadband circularly polarized patch antenna using an artificial ground (AG) structure with rectangular unit cells as a reflector is proposed. The AG structure changes the reflection phase. A rectangular AG structure with rectangular unit cells is used for a microstrip patch antenna to generate circularly polarized waves from the patch antennas in accordance with the polarization state of the incident wave. By properly combining the transmitted wave from the antenna and the reflected wave from the AG structure, broadband circular polarization can be obtained. The AG structure and the antenna are simulated using a full-wave solver and the results show a 10 dB return loss bandwidth of 48.6% and a 3 dB axial ratio and bandwidth of 20.4%.

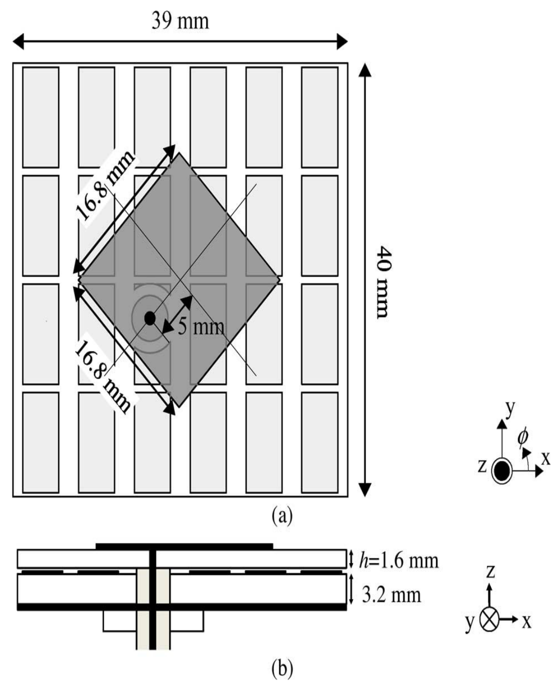

Fig.8. Geomety of Proposed Antenna

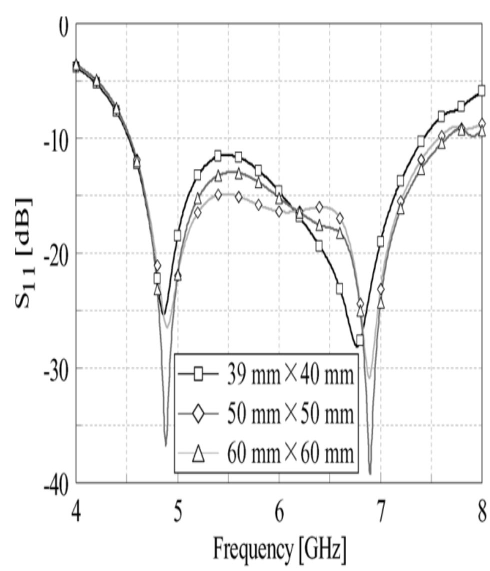

Fig.9. Simulated and measured return loss of proposed antenna

III. Literature Survey

An intense survey has been carried out for analysing the radiation characteristics of different microstrip patch antennas. It is presented in tabular form.

TABLE I
Literature Survey

NAME OF THE JOURNAL	REF[1]	REF[2]	REF[3]	REF[4]
DIELECTRIC SUB.	RT-DUROID	POLY TETRA FLUORO ETHYLENE (PTFE)	FR4	RT-DUROID 5880
FREQUENCY	5.5 GHZ	2.31 TO 2.56 GHZ	10.5 GHZ	6GHZ
EFFICIENCY	95%	-------------	-------------	82%
FEEDING METHOD	COAXIAL TRANSMISSION LINE	COAXIAL PROBE FEED	MICROSTRIP LINE FEED	COAXIAL FEED
GAIN	7.92 dBi	4.1 dBi	6.4 dBi	3 dBi
BANDWIDTH	5.18 TO 5.8 GHZ (11.8%)	4.5 TO 11.4 GHZ 86.79%	2.1 TO 11.1 GHZ (136%)	48.6%

IV. Conclusion

From this review, it is understood that many efforts are going on to overcome some of the limitations of Microstrip patch antenna characteristics. This review work is done on some certain critical issues like bandwidth enhancement through different techniques. Nevertheless, as regards this issue, useful solutions are still few in number and the solutions often suffer from other problems like distortion of radiation patterns, complexity of structure, reduction of gain etc. Hence, the further research is seriously needed in these areas.

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Author’s Profile

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