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Antenna Design using Slot and Array Technique for WiMAX & WLAN

Arti[1], Dr. Sunil Kumar[2]

[1]M.Tech (ECE), Sri Sai University Palampur, Himachal Pradesh, India

[2]Professor & Dean (ECE), Sri Sai University Palampur, Himachal Pradesh, India

Abstract – A *dual-band antenna by use 2 x 2 patch array with L-slot is presented for simultaneously worldwide interoperability for Microwave Access (WiMAX) and wireless local area network (WLAN) application. A hypothetical overview on microstrip patch radio wire is introduced. After investigation of different examination papers it reasoned that lower gain and low power handling limit can be overcome through an exhibit setup and opened patch. A few attributes of sustaining method and different reception apparatus parameters are talked about. Specific microstrip patch reception apparatus can be intended for every application and distinctive benefits are contrasted and ordinary microwave antenna or receiving wire. The proposed approach to maximizing the efficiency by L-Shaped slot loaded microstrip patch antenna for wireless communication applications. Main purpose of this is to analysis the radiation pattern of L shaped slot microstrip 2×2 patch antenna and 4×4 microstrip patch antenna for dielectric substrates and comparison on the basis of gain and efficiency.*

***Key Words*:** Wireless Communication, Antenna, Microstrip Patch Antenna, Two Array Antenna, MATLAB.

1. INTRODUCTION

The exchange of the data between two or more focuses which are not specifically associated is essentially called Wireless communication or correspondence. The expression "Wireless or Remote" came into open use to allude to a radio recipient or handset (can be utilized both as transmitter and collector) building up its utilization in remote correspondence, for example, in cell system and remote broadband web. It is likewise used to allude to an operation that is executed without utilization of wires. It envelops different sorts of settled, versatile and convenient two way radios, cell phones. Different illustrations are satellite TV, remote PC mice, consoles and headsets, telecast TV [1]. Remote operation grants administrations, for example, long range correspondences, that are unimaginable or unreasonable to actualize with the utilization of wires. The most widely recognized utilization of remote systems is to interface the portable workstation/versatile information correspondence clients who head out from area to area. Another essential use is for portable systems that associate through recieving wires, by means of satellite interchanges.

2. MICROSTRIP ANTENNA

Microstrip antenna is one of the most popular types of printed antenna. It assumes an extremely critical part in this day and age of remote correspondence frameworks. Microstrip radio wires are exceptionally basic in development utilizing a traditional microstrip manufacture procedure. Microstrip patch radio wire comprises of an emanating patch on one side of a dielectric substrate (FR4) that has a ground plane (Cu) on the other side as appeared in Figure 1.

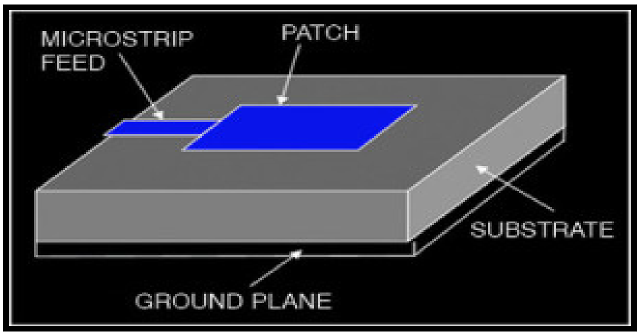

Figure 1: Physical Geometry of Microstrip Antenna.

The patch is for the most part comprised of a directing material, for example, copper or gold and can take any conceivable shape like rectangular, roundabout, triangular, and circular or some other normal shape. The transmitting patch and the food lines are generally photograph carved on the dielectric substrate.

Microstrip patch recieving wires emanate fundamentally as a result of the bordering fields between the patch edge and the ground plane. For good reception apparatus execution, a thick dielectric substrate having a low dielectric steady (<6) is alluring since it gives higher effectiveness, bigger data transmission and better radiation. Nonetheless, such a setup prompts a bigger radio wire size. Keeping in mind the end goal to plan a conservative microstrip patch radio wire, a substrate with a higher dielectric steady (<12) must be utilized, which results in lower proficiency and smaller transfer speed. Thus a trade off must be come to between reception apparatus measurements and recieving wire execution. Excitation manages the electromagnetic vitality source to the patch, creating negative charges around the food point and positive charges on the other part of the patch. This distinction in charges makes electric fields in the reception apparatus that are in charge of radiations from the patch radio wire. Three sorts of electromagnetic waves are emanated. The initial segment is transmitted into space, which is "valuable" radiation. The second part is diffracted waves, which are reflected once more into space between the patch and the ground plane, adding to the genuine force transmission. The last part of the wave stays caught in the dielectric substrate because of aggregate reflection at the air-dielectric detachment surface. The waves caught in the substrate are by and large undesirable**.**

3. LITERATURE REVIEW

According to J. P. Saini proposed conservative microstrip patch recieving wire at working recurrence of 2.5 GHz. The emanating component of the proposed reception apparatus comprises of Swastika image patch utilizing dielectric substrate 4.2, misfortune digression 0.0012 and having the same substrate stature 1.6 mm. The reception apparatus size is exceptionally conservative (28.8 mm × 37.2 mm × 1.6 mm) and spreads 1.696 GHz to 2.646 GHz and can be utilized for GSM and WLAN applications. Utilizing IE3D programming bundle of Zealand, the composed radio wire is reenacted. The PC recreation results demonstrate that the radio wire can understand wideband attributes having great impedance data transmission of 43.758% (VSWR ≤ 2) for all thunderous frequencies. Our point is to decrease the span of the reception apparatus and also build the impedance data transfer capacity [1]. According to Nasimudin et al. proposed round symmetric opened microstrip patch recieving wire with smaller size. This radio wire was gotten by cutting shapes in corner to corner headings of microstrip patch recieving wire. . A deliberate 3 dB pivotal proportion (AR) transfer speed of around 0.7% (6.0 MHz) with 2.0% (18.0 MHz) impedance transmission capacity was accomplished. The deliberate boresight addition was more than 3.3 dBi over the working band was gotten. Diverse shapes for the spaces are concentrated on and thought about, in light of the settled general volume of the recieving wire for circularly enraptured askew symmetric opened microstrip-patch radio wires. This radio wire was intended to have reduced size of little measurements [2]. According to Joshi et al. exhibited a rectangular opened microstrip patch reception apparatus with somewhat stacked metamaterial various split ring resonator (MSRR) ground plane. The MSRR stacking lessens the shared coupling keeping in mind the end goal to acquire better coordinating at the full frequencies [3].

According to Lee at al. demonstrated the essential geometry of a microstrip patch radio wire (MPA) comprising of a metallic patch imprinted on a grounded substrate. Three generally utilized encouraging techniques are coaxial food, strip line food, and gap coupled food. In this we additionally talked about the focal points and weaknesses offered by patch recieving wire that is low profile, likeness to a formed surface, simplicity of creation, and similarity with incorporated circuit innovation, however the fundamental geometry experiences thin transmission bandwidth [4]. According to Motin et al. outline the viable state of a patch radio wire with lower return misfortunes, better pick up and execution for X-band (2 GHz to12 GHz), Ku-band (12 GHz to 18 GHz) and K-band (18 GHz to 26 GHz) applications. Endeavors have been made to enhance the radio wire execution by expanding the quantity of spaces, by utilizing openings as a part of various position in patch and by utilizing exhibit methods [5].

4. ANTENNA PARAMETER

To describe the performance of an antenna, definition of various antenna parameters is necessary. Some of the parameters are interrelated.

4.1 GAIN

Gain is a parameter which is firmly identified with the directivity of the recieving wire. We realize that the directivity is how much a radio wire moves vitality in one bearing in inclination to radiation in different headings. Thus, if the reception apparatus is 100% effective, then the directivity would be equivalent to the recieving wire pick up and the radio wire would be an isotropic radiator. Since all radio wires will transmit more in some course than in others, along these lines the

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increase is the measure of force that can be accomplished in one bearing to the detriment of the force lost in the others [3]. It is given as:

$$Gain = 4\pi \frac{Radiation\ Efficiency}{Total\ Input\ (Accepted)\ Power}$$

4.2 VSWR

For a radio (transmitter or receiver) to convey energy to a recieving wire, the impedance of the radio and transmission line must be very much coordinated to the reception apparatus' impedance. The parameter VSWR is a measure that numerically portrays how well the recieving wire is impedance coordinated to the radio or transmission line it is associated with. VSWR remains for Voltage Standing Wave Ratio, and is additionally alluded to as Standing Wave Ratio (SWR). VSWR is an element of the reflection coefficient, which depicts the force reflected from the reception apparatus. If the reflection coefficient is given by Γ, then the

VSWR is resolved from the voltage measured along a transmission line prompting a radio wire. The forward (or episode) signal from the source blends with the opposite (or reflected) signal from the reception apparatus to bring about a voltage standing wave design on the transmission line. VSWR is the proportion of the crest abundancy of a standing wave to the base sufficiency of a standing wave. VSWR is defined by the following formula:

$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

When all is said in done, if the VSWR is under 2 the recieving wire match is viewed as great and little would be picked up by impedance coordinating.

5. TWO ARRAY ANTENNA

Suppose two antenna elements to make an array as in Figure 2 above. The two elements are fed with current *l1* and *l2*.

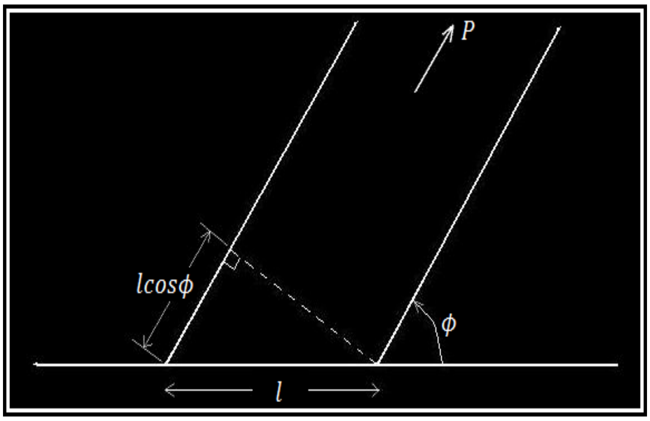

Figure 2: Two Element Array.

l1 and *l2* are equal in magnitude but out of phase:

$$l1 = l1\angle\alpha$$

The point of observation is in the far field, the path length difference is $lcos\alpha$, where l the distance between the two elements is. As it is defined in [1, 9, and 13], the radiation of element 1 at *P* will lead the radiation of element 2 with angle ψ where:

$$\psi = \beta l cos\varphi + \propto$$

β= phase constant of the transmitted wave.

The total field at P is

$$E = E_1[1 + exp(j\psi)]$$

Where E_1 is the field at *P* due to element 1.

The magnitude of the field at P is:

$$|E_\varphi| = 2E_1 cos\left(\frac{1}{2}\psi\right)$$

$$= 2E_1 cos\frac{1}{2}(\beta l cos\varphi + \propto)$$

$$= 2E_1 cos\left(\frac{\pi l}{\lambda}cos\varphi + \frac{\alpha}{2}\right)$$

From above equation we can see that for a given phase difference and a given distance we can change the radiation pattern by changing $\left(\frac{l}{\lambda}\right)$.

6. LINEAR ARRAY

We have studied a simple array consist of two elements, now if we put more elements in the line of our two elements array, we build a linear array, Figure 3.

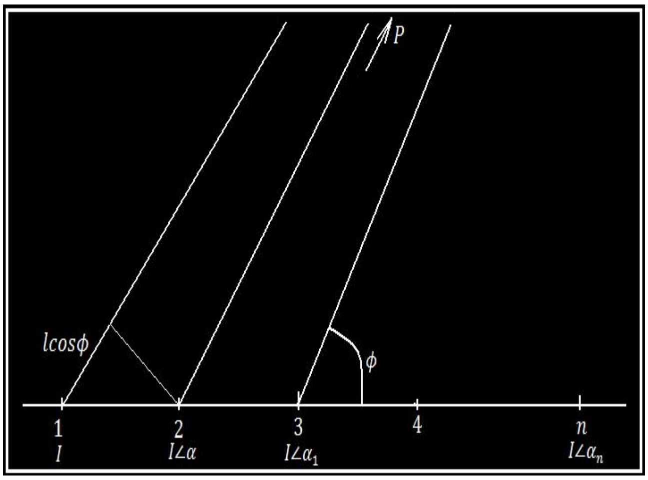

Figure 3: Uniform Linear Array of n Elements.

Now consider Figure 3 of a simple linear array with equal separation between elements l and equal current in magnitude and equal difference in phase I.

$$I, I\angle\alpha, I\angle\alpha_1, I\angle\alpha_2, \ldots, I\angle\alpha_n$$

Field at point P is:

$$E = E_0 \left| \frac{\sin\frac{n\psi}{2}}{\sin\frac{\psi}{2}} \right|$$

Where ψ=βlcosφ+α

The quantity $\left| \frac{\sin\frac{n\psi}{2}}{\sin\frac{\psi}{2}} \right|$ is known as the array factor and it determines the shape of the radiation pattern. The equation has a maximum when *ψ=0 so βlcosφ=-α*. We can now place the maximum as we wish by choosing α correctly [12]. The phase of each element in this array can be controlled by phase shifter, and the amplitude of the elements is adjusted by an amplifier or attenuator.

6. EXPERIMENTAL RESULTS AND ANALYSIS

In designing the L-Shaped slot microstrip patch antenna many parameters are important. Dielectric substrate is the main parameter in design purpose.

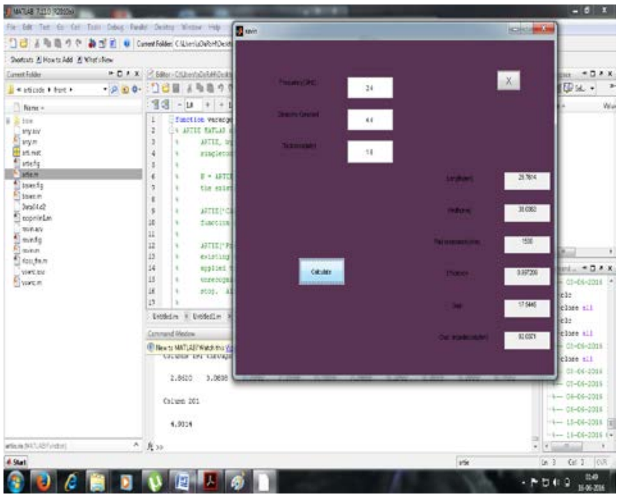

Figure 3: Front End of Simulation.

Main purpose of this is to analysis the radiation pattern of L shaped slot microstrip patch antenna for dielectric substrates and comparison of these results. Matlab is the basic tool for design purpose. Figure 4 show the front end of simulation for WLAN. Figure 5 show the radiation pattern of proposed design for Phi=0, 45, 90 degree at 2.4 MHz frequency.

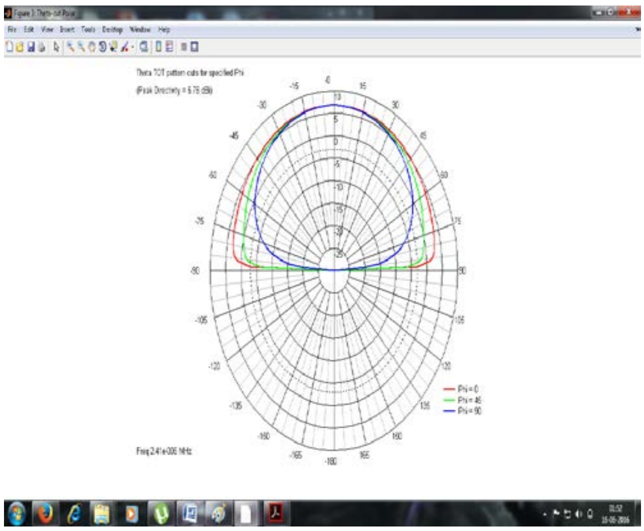

Figure 5: Smith Chart of L-Shaped Slot Microstrip Patch Antenna.

Figure 6 show the VSWR plot of L-Shaped Slot Microstrip Patch Antenna.

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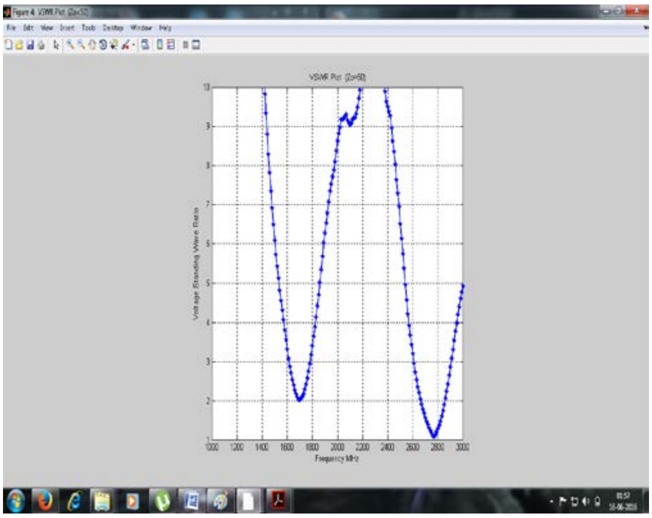

Figure 6: VSWR plot of L-Shaped Slot Microstrip Patch Antenna.

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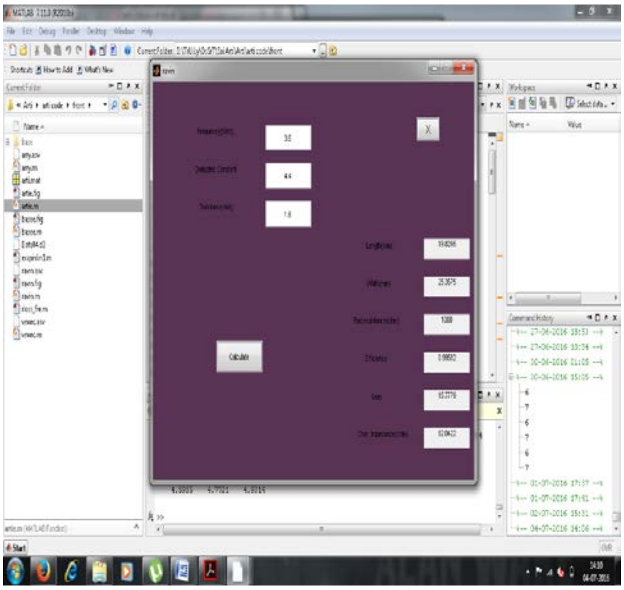

Figure 7: Front End of Simulation.

Main purpose of this is to analysis the radiation pattern of L shaped slot microstrip patch antenna for dielectric substrates and comparison of these results. Matlab is the basic tool for design purpose. Figure 7show the front end of simulation for WiMAX. Figure 8 show the radiation pattern of proposed design for Phi=0, 45, 90 degree at 3.6 MHz frequency.

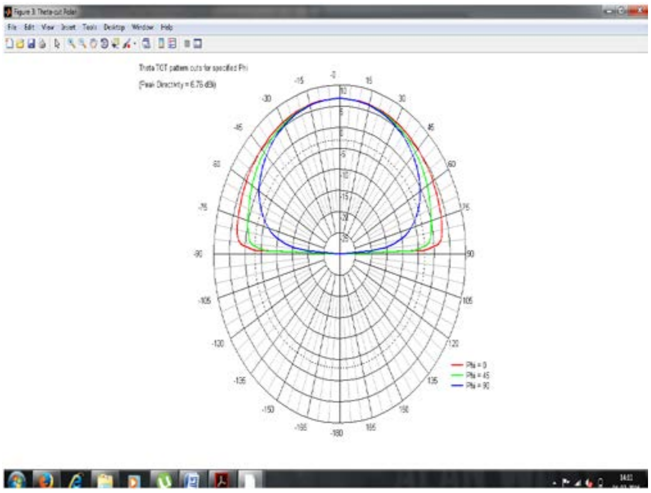

Figure 8: Smith Chart of L-Shaped Slot Microstrip Patch Antenna.

Figure 9 show the VSWR plot of L-Shaped Slot Microstrip Patch Antenna.

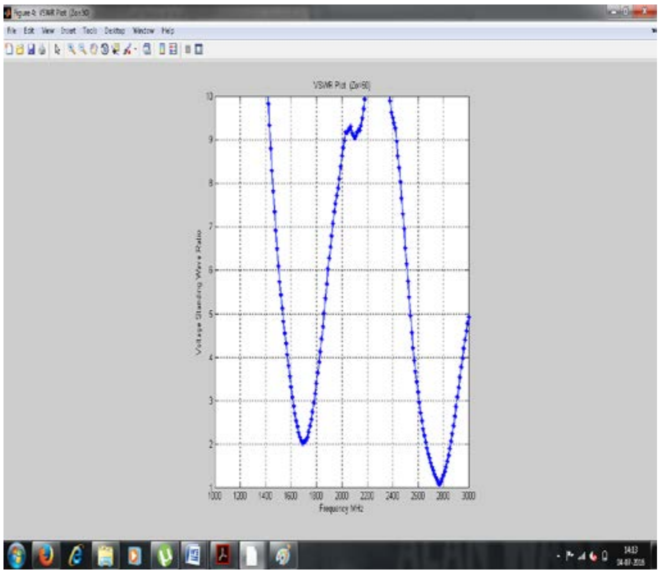

Figure 9: VSWR plot of L-Shaped Slot Microstrip Patch Antenna.

7. CONCLUSION

The proposed approach to maximizing the efficiency by L-Shaped slot loaded microstrip patch antenna for wireless communication applications.

Main purpose of this is to analysis the radiation pattern of L shaped slot microstrip 2×2 patch antenna and 4×4 microstrip patch antenna for dielectric substrates and comparison on the basis of gain and efficiency which is shown in Table 1.

Table 1: Comparative Analysis with Previous One.

WLAN		
Parameters	**Previous Work**	**Proposed Work**
Gain	7.56 dB	17.55 dB
Efficiency	99 %	99.72 %
WiMAX		
Parameters	**Previous Work**	**Proposed Work**
Gain	2.45 dB	15.77 dB
Efficiency	99 %	99.72 %

Extensive results justify that the proposed algorithm has higher efficiency and gain either by introducing slot loaded and array technique in microstrip patch antenna, surface current and radiation pattern can be improved. Future study can be investigating design of a microstrip patch antenna array operating at UHF frequency which provides better results

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