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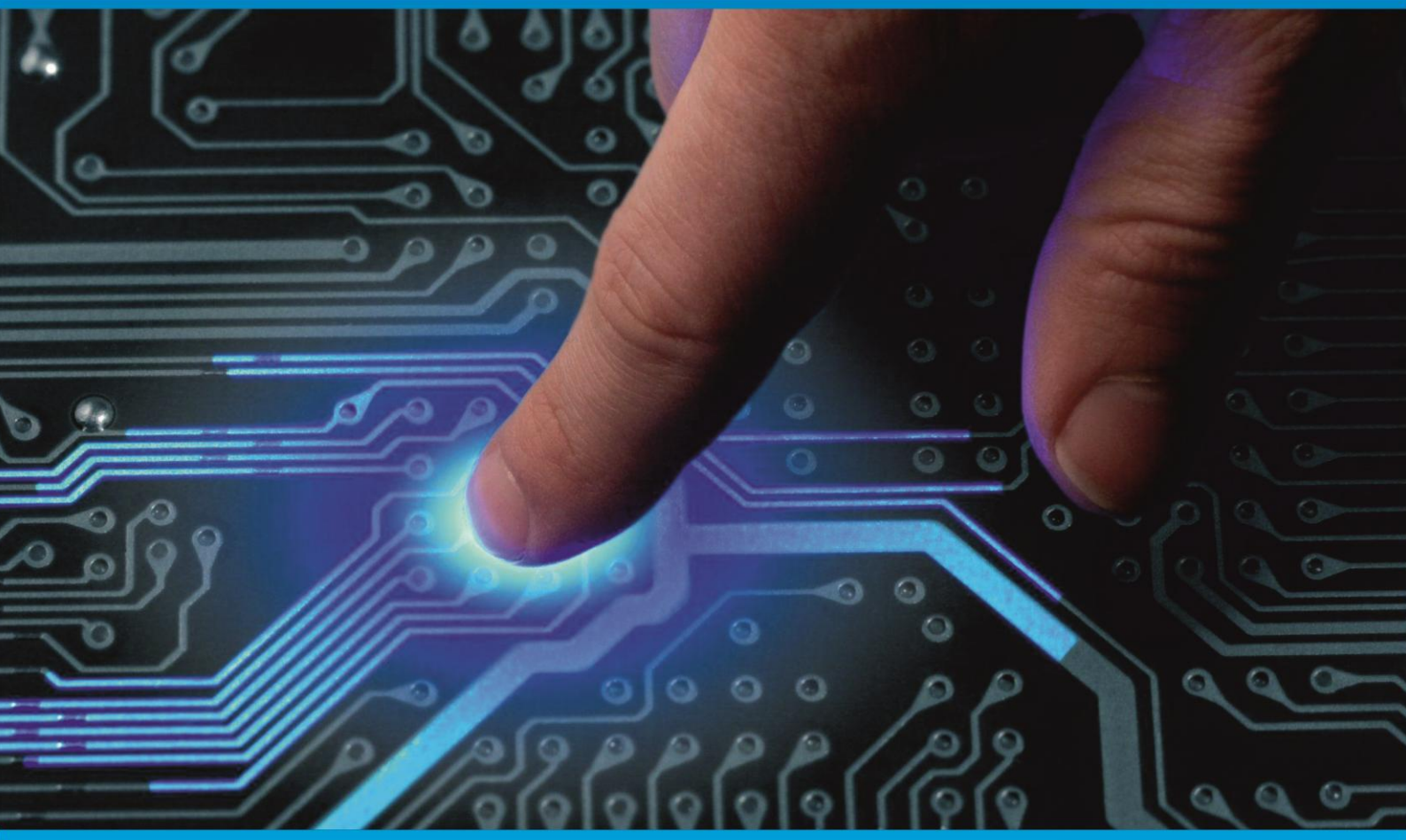

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Review of Microstrip Patch Antenna Array for 5G Mobile Application

Khushbu Pathak[1], Dr. Uday Panwar[2]

Research Scholar, Dept. of ECE., Sagar Institute of Research & Technology, Bhopal, India[1]

Associate Professor, Dept. of ECE., Sagar Institute of Research & Technology, Bhopal, India[2]

ABSTRACT: The next generation mobile communication provides various advance application with high quality of services. The research is continuing going on 5G network communications applications. The antenna is key element of any communication devices. The expectation from 5G antenna is to meet the higher speed, low latency and large bandwidth. An antenna array is a set of multiple connected antennas which work together as a single antenna, to transmit or receive radio waves. Microstrip Patch Antenna (MPA) is array design is also very emerging research area for 5th generation communication application. Microstrip patch is very low weight, low profile and result oriented antenna pattern. Previously MIMO pattern was very common geometry for 4G wireless application. An antenna array can achieve higher gain (directivity) that is a narrower beam of radio waves, than could be achieved by a single element. In general, the larger the number of individual antenna elements used, the higher the gain and the narrower the beam In this paper review and challenges of microstrip patch antenna array for future uses under 5G networks. CST microwave studio software are using to design and simulation of microstrip patch antenna array. Key parameters like bandwidth, resonant frequency, return loss, gain can be calculated through CST software.

KEYWORDS: Antenna, array, MIMO, MPA, 5G.

I. INTRODUCTION

The interest for remote versatile correspondences administrations is developing at a touchy rate, with the expectation that correspondence to a cell phone anyplace on the globe consistently will be accessible sooner rather than later. The investigation of microstrip patch antennas has gained extraordinary ground as of late. Contrasted and customary antennas, microstrip patch antennas have more points of interest and better possibilities. They are lighter in weight, low volume, minimal effort, low profile, littler in measurement and simplicity of manufacture and congruity. Additionally, the microstrip patch antennas can give double and roundabout polarizations, double recurrence activity, recurrence dexterity, wide band-width, feedline adaptability, bar filtering omnidirectional designing.

In numerous remote correspondence frameworks it is important to structure antennas with order qualities (high gains) to fulfill the needs of long separation correspondence that may not be attainable by a solitary component antenna. The radiation from the single component is frequently wide in design with huge shaft edges. This isn't useful for point to point interchanges, which requires antennas that are increasingly mandate in nature for example Radar applications. Likewise, a solitary emanating component regularly creates radiation designs with unsuitable bandwidth, effectiveness, and gain parameters. All these and more make the use of a solitary component antenna not recommendable. In this manner, the execution of antennas in array design defeats these downsides.

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Figure 1: Antenna Array under LTE Network

5G is the fifth era of cell versatile correspondences. It succeeds the 4G (LTE/WiMax), 3G (UMTS) and 2G(GSM) structures. 5G execution targets high data rate, lessened inaction, imperativeness saving, cost decline, higher system limit, and colossal contraption organize A fix antenna is made by scratching metal on one side of dielectric substrate where as in actuality side there is relentless metal layer of the substrate which outlines a ground plane [1].

II. RELATED WORK

B. Tütüncü, et al.,[1] In this study, a new microstrip antenna is proposed for 5G mobile communication in IEEE802.11ad standard. Hairpin shaped radiating patch is analyzed on three different substrates; FR4, Rogers R054350B and Arlon AD255C. Directivity and bandwidth analyzes based on permittivity are performed to select the most suitable substrate among these three dielectric layers for 60 GHz operating frequency. Rogers RO4350B has 1.17 dBi higher directivity compared to FR-4 and 0.13 dBi smaller directivity gain compared to Arlon AD255C, but offers 2.4 GHz more bandwidth and more compactness than the others. Finally, the proposed antenna is analyzed on four different thickness of Rogers RO4350B and the best performance is observed at 1.2 mm..

M. Patriotis et al., [2] This work presents a broadband right hand circularly captivated (RHCP) 16-component antenna array working in the recurrence band of 20 - 32 GHz. The array components are shortened patches encouraged utilizing a successive pivot power divider (SRPD). The antenna can be utilized at the same time in the getting mode (Rx) and transmitting mode (Tx) by choosing the implanted reconfigurable channels. A PIN diode reconfigurable bandpass channel (BPF) is utilized at the Tx port so as to choose the band of activity. The antenna array delivers a gain of 12 - 15 dB over its working frequencies and a pivotal proportion under 0.56 dB over its working bands. This reconfigurable antenna array can be utilized for K/Ka-band CubeSat correspondence.

A. M. Yusuf, et al., [3] Unmanned Aeronautical Vehicle (UAV) is one of the stages which can bolster Manufactured Gap Radar (SAR) to distinguish an objective in C and X band. The innovation is generally modest and can be worked in any climate condition. In any case, constrained capacity of UAV for conveying payload drives specialist to construct SAR gadget as little and light as conceivable including the sensor, in this term is the antenna. In this examination, a double band microstrip antenna array 1×8 at C-band (5.8 GHz) and X-band (9.65 GHz) has been planned and fabricated on FR-4 substrate. E-Formed patch has been actualized in this antenna to accomplish double reaction recurrence.

V. Shrivastava, et al., [4] focused on study based various types of microstrip antenna. Return loss, VSWR, bandwidth, resonant frequency and gain is key parameters to judge antenna performance. Good value of return loss is less than -10dB. Considerable range of VSWR is 1-2. CST microwave studio is a advance software to design and simulation of all types of antenna, filter etc.

M. Long, et al., [5] An epic twofold layer scaled down component metasurface is explored to acquire the in-band and out-of-band radar cross-area decrease (RCSR) of a patch antenna. The changed customary square-rings, with focus

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edges twisted internal into empty crosses and eight resistors welt on each side, are embraced to shape the main layer metasurface. It is for the out-of-band episode wave assimilation. The subsequent layer comprises of four Angular polygonal metallic patches and four resistors. Every resistor associates two neighboring Angular patches together.

W. Lin et al., [6] This work displays a reconfigurable opening nourished patch antenna array for ±45° polarizations. Initial, another strategy to understand the reconfigurable ±45° polarizations is proposed. It presents controllable RF turns on a cross-gap to energize a square patch for two symmetrical polarizations. The RF switches are constrained by two arrangements of DC predispositions, which could choose the polarization through the reconfigurable opening. Second, two patch antennas dependent on cross-opening excitation are talked about. The main structure utilizes a split ground plane with four switches, while the other one utilizes an assembled ground plane with eight switches. The two antennas work well as the single component.

A. A. Gheethan, et al., [7] Microfluidic central plane arrays (MFPAs) have been as of late acquainted with actualize conservative high-gain shaft examining antennas without falling back on dynamic RF gadgets. This bar examining strategy depends on a patch antenna component that can be microfluidically repositioned at the central plane of a microwave focal point. The feed organize is deliberately intended to be aloof and suit the position variety in the antenna component. This work, just because, considers the plan subtleties and execution assessment of three distinctive aloof system formats that can conceivably be used to energize MFPAs.

Q. Bai, et al., [8] A roundabout staged array antenna that can produce orbital precise force (OAM) radio shafts in the 10 GHz band is depicted. The antenna comprises of eight inset-bolstered patch components and a microstrip corporate encouraging system. A full-wave electromagnetic test system is utilized to help the antenna structure and hypothetical reenactments are affirmed by estimations.

Table 1: Summary of literature survey

Sr No.	Author Name & Year	Proposed Work	Outcome
1	B. Tütüncü IEEE, 2020	Presents new microstrip antenna is proposed for 5G mobile communication	-15 db return loss, 1.8 GHz Bandwidth
2	M. Patriotis IEEE, 2019	Broadband right hand circularly captivated (RHCP) 16-component antenna array.	Produces a gain of 12 - 15 dB
3	A. M. Yusuf, IEEE, 2018	Dual-band microstrip antenna array 1×8 at C-band (5.8 GHz) and X-band (9.65 GHz) has been designed	Bandwidth in excess of 50 MHz for each band. The gain accomplish 6.39 dBi at C-band and 3.825 dBi at X-band.
4	N. Yan IEEE, 2018	A tale stacked-patch antenna dependent on substrate-integrated.	Achieves a fragmentary bandwidth of 17.5% from 5.2 to 6.2 GHz and gain of 9.7 dBi.
5	M. Long IEEE, 2017	A tale twofold layer scaled down component meta surface.	Achieved from 2.0 to 15.5 GHz.
6	W. Lin IEEE, 2016	A reconfigurable gap sustained patch antenna array for ±45° polarizations.	The estimated 10-dB impedance bandwidth of the array is 9.3%.
7	A. A. Gheethan	The SLL by in excess of 10 dB	Micro fluidic reconfigurable

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	IEEE, 2015	comparative with the full corporate feed arrange used in the earlier work	gadgets with higher productivity and force dealing with abilities.
8	Q. Bai IEEE, 2014	The antenna comprises of eight inset-encouraged patch components and a microstrip corporate nourishing network	A full-wave electromagnetic test system is utilized to help the antenna structure and hypothetical reenactments are affirmed by estimations.

III. DESIGN STRATEGY

The literature review knows about various antenna design and results for advance application. The proposed antenna design concepts and application is finalising after the literature review. There is flow chart of case study where all the necessary steps mentioned to meet the desired strategy.

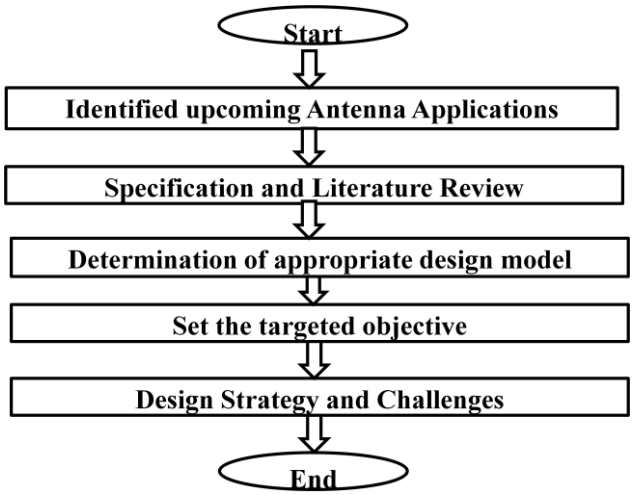

Figure 2: Flow Chart for case study

Firstly, identified the advance or upcoming application like antenna design for 5G communication application, it is identified through previous papers studied. Then find the technical specification. Now find out the appropriate model or design for desired application and outcomes. The next step is to set the target objective of research work. At last focus on the various challenges which occur during research and make the design strategy.

After the selection antenna band and application of design, the next step is to calculate the radiating patch width and length.

Step 1: Calculation of Width (W)

For an efficient radiator, practical width that leads to good radiation efficiencies is:

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Where, μ_0 is the free permeability, ε_0 is the free space permittivity and ε_r is relative permittivity.

Step 2: Calculation of Effective Dielectric Coefficient (ε_{reff}) the effective dielectric constant is

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1 + 12\frac{h}{W}\right]^{1/2}$$

Step 3: Calculation of Effective Length (L_{eff})

The effective length is $L_{eff} = \frac{C}{2f_0\sqrt{\varepsilon_{reff}}}$

Step 4: Calculation of Length Extension (ΔL)

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$$\frac{\Delta L}{h} = 0.412 \frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{rff}-0.258)(\frac{W}{h}+0.8)}$$

Step 5: Calculation of actual Length of Patch (L)

The actual length of radiating patch is obtained by

$$L=L_{eff} - 2\Delta L$$

Step 6: Calculation of Ground Dimensions (Lg, Wg)

Now the use of CST microwave studio software, make the design using calculated dimensions.

IV. PARAMETERS

There are some important parameters which judge the results validity. Some of the followings-

Bandwidth- The bandwidth of an antenna refers to the range of frequencies over which the antenna can operate correctly. The antenna's bandwidth is the number of Hz for which the antenna will exhibit. The bandwidth can be calculated using the difference between upper frequency and lower frequency.

Return loss- return loss is that it is the loss of power in the signal returned / reflected by a discontinuity in a transmission line or optical fibre. This is normally expressed in decibels. In other words if all the power was transferred to the load, then there would be an infinite return loss. The good value of return loss is less than -10dB and it is also know as the S11 parameter.

VSWR- VSWR stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by Γ, then the VSWR is defined by the following formula:

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

Resonant Frequency- A radio antenna is a form of tuned circuit consisting of inductance and capacitance, and as a result it has a resonant frequency. This is the frequency where the capacitive and inductive reactance cancels each other out.

Antenna Gain- Antenna gain and effective radiated power. The term antenna gain defines the degree to which an antenna concentrates radiated power in a given direction, or absorbs incident power from that direction, compared with a reference antenna.

V. MICROSTRIP ANTENNA ARRAY CHALLENGES

An overview on microstip reception apparatus is done at first to assess the development of the exploration action on the point along the most recent 40 years. The early long periods of the microstrip innovation and particularly of microstrip antennas are examined in detail. The quick advancement of the innovative work exercises that occurred over the most recent 30 years is depicted with regards to the related advances and zones of utilization. At long last, the current circumstance of the microstip antenna field and patterns of conceivable future development are inspected.

Table 2: Conventional Antenna Dimensions

Parameters	Description	Size
L	Length of substrate	40mm
W	Width of substrate	40mm
Lf	Length of feed line	10mm
Wf	Width of feed line	3mm

In Regardless, inherently MPA have flimsy information move limit so to update transmission limit various techniques are secured. Today Specific contraptions support a couple of utilizations which require higher information transmission, for instance, mobile phones these days are getting progressively slim and increasingly splendid yet various application maintained by them require higher exchange speed, so microstrip antenna used for playing out this errand should give increasingly broad transmission limit and their size should be moderate with the objective that it should include less space while keeping the range of device as meager as could be normal considering the present situation.

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The varying assortment gathering mechanical assembly is arranged by following spatial, point and polarization good assortment thoughts. The better than average assortment antenna contain exuding patch, substrate and ground. The best transport, radiating patch involve 4 gathering contraption segments which are spatially disengaged with a detachment of under 2.5mm and each antenna segments has an edge balance of 90 degree with both even and vertical polarization with the base conductor, defected ground structure(DGS) which has perfect electric property.

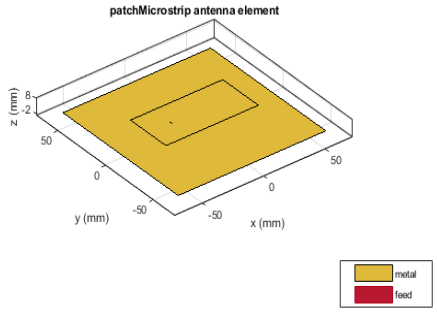

Figure 3: Element of microstirp antenna

The inside layer is the FR_4 substrate which is made with the dielectric steady of 4.6, incident deviation of 0.01 and thickness of 1.6mm. The made arranged assortment antenna works at 5.263GHz with the appearance loss of about 20dB with the information move limit of 2GHz and separation and decoupling of 15dB. The recreated gain and tolerable assortment at center repeat are 0.532dBi and 5.793dBi. The voltage standing wave ratio(VSWR) is 1:1.21 at 5.2GHz repeat. The radiation plan with respect to E and H field are destitute down using the diversion gadget. The gathering mechanical assembly is suitable for remote advantageous contraptions supporting WLAN with insignificant size of 30×28×1.6mm. The fundamental region includes a short introduction about the WLAN measures and average assortment thoughts are given with the composing survey. The subsequent portion involve plot strategy of the different assortment antenna starting from single segment arrangement is explained and the eventual outcomes of the better than average assortment gathering mechanical assembly are discussed.

VI. CONCLUSION AND FUTURE WORK

Theoretical study on microstrip patch antenna has done in this paper. While laying out the antenna the things which we have to consider is substrate which we will use, empowering create, dielectric reliable of the substrate and its height and width. Therefore it is clear from literature review; antenna array is emerging design for advance communication due to its higher bandwidth and good gain. So it is believed that, this little size antenna will continue profiting for future years in 5G communication. Next optimize the antenna array dimension and implement using CST software.

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