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Microstrip Patch Antenna Array for 5G Mobile Communication: A Review

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Abstract : The 4th generation of mobile communication technology standards (4G) is to satisfy people's basic needs. The trend is moving toward the new generation. The 5th generation mobile networks (5G) are developing now a days. The data speed of 5G will be 100 times faster than that of 4G. For high speed communication there is need of advanced microstrip patch antenna. The microstrip antenna has the advantages of low cost, space-saving, and easier manufacturing. This paper is studied about various pre existing designs and performance. MIMO and Array of patch antenna is very common in the field of antenna design and performance analysis area. Array design pattern has own advantages than MIMO patter. In future we will design an advanced microstrip patch antenna array for 5th generation communication applications.

***IndexTerms* –** Microstrip. Antenna, Array, 4G, 5G**.**

I. Introduction

Frequency run 1 (< 6 GHz)- The most extreme channel transfer speed characterized for FR1 is 100 MHz. Note that start with Discharge 10, LTE bolsters 100 MHz bearer accumulation (five x 20 MHz channels.) FR1 underpins a most extreme regulation configuration of 256-QAM while LTE has a greatest of 64-QAM, which means 5G accomplishes critical throughput upgrades in respect to LTE in the sub-6 GHz groups. Anyway LTE-Propelled as of now utilizes 256-QAM, taking out the upside of 5G in FR1.

Frequency extend 2 (24– 86 GHz)- The greatest channel transfer speed characterized for FR2 is 400 MHz, with two-divert accumulation upheld in 3GPP Discharge 15. The greatest phy rate conceivably bolstered by this configuration is around 40 Gbit/s. In Europe, 24.25– 27.5 GHz is the proposed frequencies run. [2]

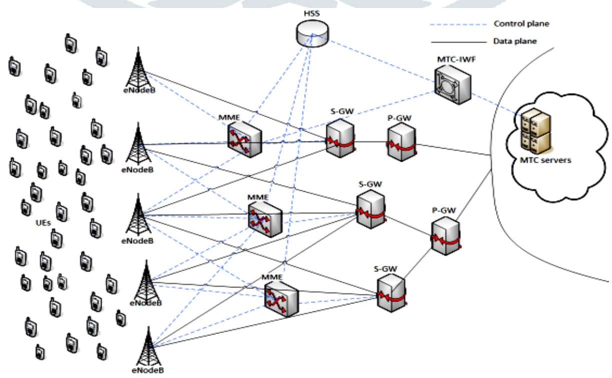

Figure 1: Antenna Array under LTE Network

Monstrous MIMO-Gigantic MIMO (various information and different yield) antennas expand area throughput and limit thickness utilizing huge quantities of antennae and Multi-client MIMO (MU-MIMO). Every antenna is independently controlled and may implant radio handset segments. Nokia guaranteed a five-crease increment in the limit increment for a 64-Tx/64-Rx antenna framework. The expression "gigantic MIMO" was first authored by Nokia Chime Labs scientist Dr. Thomas L. Marzetta in 2010, and has been propelled in 4G systems, for example, Softbank in Japan.

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.

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. BACKGROUND

P. S. Naik et al.,[1] presents a 1×4 microstrip fix exhibit radio wire design as applications at 5G C-band passage. Exhibit utilizes a microstrip recieving wire module at 5G C-Band (3.4-3.8 GHz) with 2 vertical spaces. Minimized size, low profile recieving wire cluster, and essential setup is serious areas of strength for a for execution with 5G passageways. Reproduction and Planning of the proposed opened fix radio wire are done by utilizing a product called High-Recurrence Design Test system (HFSS).

C. Kim et al.,[2] The thin, flexible, fully dense Alumina Ribbon Ceramic (ARC) fabricated by Corning's proprietary process of continuously sintered ceramic (CSC) is used as a substrate for the patch antenna and transmission line for 5G mmWave wireless communication systems. The microstrip line on the 40um thick ARC shows a loss of about 1.6dB/cm at 28GHz. The compact ($0.2\lambda_0 \times 0.2\lambda_0$), low profile and multilayered patch antenna shows a resonant frequency of 29.35GHz with 2.81dBi peak gain, which could be used for 5G mmWave mobile applications.

A. Qayyum et al.,[3] A dual-band high-performance circular patch microstrip antenna for future 5th generation (5G) of mobile communication is proposed. The designed antenna has a ring-shaped Defected Ground Structure (DGS) in the ground plane. The proposed antenna operates at 28GHz (27.68GHz - 28.55GHz, 3.10%), which is a proposed frequency for 5G. A ring-shaped Defected Ground Structure is suitably inserted in the ground plane resulting in an additional frequency band at 38GHz (37.13GHz - 38.20GHz, 2.81%). The gain of the antenna at 28GHz is 6.87dBi and 4.17dBi at 38GHz. The size of the proposed antenna is 7.23mm x 7.23mm. The introduction of Defected Ground Structure also improved the antenna performance. Furthermore, different parameters of the proposed antenna are varied, studied and discussed in detail to observe its effects on the antenna performance.

M. Nurrachman et al.,[4] presents a microstrip antenna with rectangular MIMO array 1×2 and tapered peripheral slits method. This antenna proposed to be operated in 28 GHz for 5G wireless communication. It has small design and a tapered peripheral slit method will be added to reduce the size of the microstrip antenna and other miniaturization techniques to obtain a compact antenna dimension. Using this design our antenna was compact just only 16mm × 14mm in dimension. Furthermore our frequency band was 28 GHz, with frequency center 27.8 GHz (simulation) and 27.44 GHz (measurement), for bandwidth 5.68 GHz (simulation) and 1.57 GHz (measurement), for S11 parameter -32.89 dB (simulation) and -21.14 dB (measurement).

A. M. Tota Khel et al.,[5] presents a four-element multiple-input multiple-output (MIMO) antenna with slotted ground plane and patch for 5G millimeter waves communication systems. It is designed using Computer Simulation Technology (CST) software on Rogers RT/Duriod 5880 with a thickness and dielectric constant of 0.787mm and 2.2, respectively. The inset feeding technique is applied to obtain the matching impedance of 50Ω. The overall size of the antenna is $48 \times 12 \times 0.787mm^3$, and the dimensions of the slots on the ground plane and patch are determined through applying the empirical Hill Climbing algorithm to achieve an enhanced bandwidth and gain. It resonates at 26.455GHz with a reflection coefficient of -65.09dB and provides a huge bandwidth of 4.468GHz in the range of 23.37GHz - 27.838GHz at $S_{11} \leq -10dB$. It also achieves a mutual coupling of less than -32dB without utilizing a decoupling structure or extra spacing. In addition, other MIMO antenna parameters such as Envelope Correlation Coefficient (ECC), Diversity-Gain (DG), and Channel Capacity Loss (CCL) are evaluated which satisfy 5G systems requirements.

I. Ahmad et al.,[6] presents a rectangular shape low profile, High gain and high efficiency patch antenna with rectangular slot is presented for 30 GHz 5G wireless communication. In fact 5G wireless communication systems requires a compact size, low profile and simple design structure to make sure the reliability, mobility and high efficiency. The proposed antenna is designed on a compact Rogers Substrate Rt-5880 with overall dimensions of $4.8 \times 5 \times 0.50$ mm^3 with relative permittivity εr of 2.2 and loss tangent δ value, 0.0009. the proposed design provides a very high gain of 10 dBi at resonance frequency of 30 GHz which is one of the distinct features of the proposed Antenna The Impedance bandwidth of the proposed design ranges from 29.5-30.5 GHz which is sufficient enough spectrum for smooth flawless communication. For achieving very high gain and efficiency no any complex performance improvement techniques has been utilized like Split Ring Resonator (CRR),Electromagnetic bandgap as well as extra metamaterial involvement which itself demands some extra challenges. The antenna is more than 98% efficient. The proposed antenna is designed and optimized using commercial 3D full-wave software, viz HFSS 2018 The simulated results qualify the required standard criteria for the value of reflection coefficient |SII|≤-10dB. the of radiation pattern is directional. All these attractive Performance parameters specify the proposed design as a potential candidate for 5G wireless Communication.

S. Costanzo et al.,[7] A dual-band dual-linear polarization reflectarray configuration is developed for future 5G cellular applications. A single layer unit cell including two pairs of miniaturized fractal patches is designed to operate at two distinct frequencies within the Ka-band (27/32 GHz), in a dual-polarization mode. An in-depth analysis of the unit cell behavior is carried out, to demonstrate the total independence between the designed frequency bands and polarizations. The proposed configuration offers a very simply and thin structure, small unit cell sizes, and low losses, while leading to an independent optimization of the phase at each frequency and polarization. A dual-band/dual-polarized reflectarray prototype is designed and tested, thus demonstrating the unit cell flexibility to offer arbitrary beam directions/shapes at each frequency, for both polarizations.

K. G.S et al.,[8] Three essential data models are observed for mobile terminal data usage and hence three conformal elements are presented with shared ground for least physical footprint with reduced SAR. First, a strongly resonant inset fed microstrip patch antenna with 90° bend is investigated which offers an impedance bandwidth of 2 GHz centered at 28 GHz and a forward gain of 9 dBi for an effective radiating volume of $0.082\lambda_0{}^3$. The second element is a conformal tapered slot antenna optimized for the corner bend which resonates at 28 GHz with a gain of 7 dBi. The third element is a conformal tapered slot antenna loaded with a parasitic ellipse with a gain of 9 dBi and aperture efficiency of upto 80%. All the three elements are integrated with a common ground for pattern diversity.

T. S. S. Apoorva et al.,[9] presents, design work of dual band millimeter wave (mmWave) frequency antenna for 5G wireless technology is presented. The microstrip low profile patch antenna radiates at center frequency of 27.5GHz and 35.7GHz with respective gain of 6.267dB and 8.391dB. The antenna has larger bandwidth of 3.3GHz in the lower band and 3.5GHz at the higher band. The overall dimension of the patch is 12.5 x 10.1mm ^{2} . Additional patches are included and structural modification is performed in the basic design to improve the overall performance. The relative permittivity of dielectric is 2.2 and substrate is RT Duroid 5880 with a thickness of 0.87mm. Simulation is performed using applied wave research (AWR) design environment.

Z. Shuai et al.,[10] Body-centric wireless communication has become an important part of the fifth-generation communication systems. Many modern applications such as, telemedicine, health monitoring and personal entertainment is adding to its popularity. In this work, a wearable finger ring antenna array radiating at 28GHz has been proposed for the 5G/mmWave communication system. The antenna is composed of a microstrip patch array, which is mounted to a Teflon ring base, to make it wearable. CST Microwave Studio has been used to model, simulate and optimize the antenna. The simulated results illustrate that the proposed design provides a good return loss at the desired frequency with a peak gain of 5.14dB. Good performance in terms of bandwidth and radiation characteristics, along with a miniaturized form factor makes it a suitable candidate as a wearable antenna to communicate at the mmWave frequency spectrum.

C. Şeker et al.,[11] presents a compact microstrip monopole antenna, for fifth generation (5G), can operating in millimeter wave (mmWave) communication. It is consisted of RO4003 with thickness of 0.203 mm and it was designed as planar-fed single-band by placing quarter circular slots on rectangular patch, as a simple and compact structure. Thus, the proposed antenna was simulated in the Ansys HFSS module and various antenna parameters such as radiation performance and ante006Ena gain were obtained in a single frequency range. The return-loss bandwidth was measured as 2.49 GHz centering at 26 GHz, covering the required bandwidth of 5G standard, as a reference of -10 dB.

Z. Lodro et al.,[12] This work presents mmWave compact microstrip patch antenna array design for 5G wireless communication. First of all, antenna element with form factor of 18.4×13.0×0.787 mm ^{3} is designed by using CST MWS. The designed antenna element resonates at resonating frequency of 10 GHz with minimum return loss of -30 dB. In this element the peak realized gain of 5 dBi, total efficiency 62% and acceptable VSWR<; 2 is observed. After that 1×4 antenna array is designed which has maximum bandwidth of 500 MHz and peak realized gain of 11 dBi. The designed antenna array efficiency, gain and equivalent circuit modelling is also presented and discussed. Overall, the designed inset fed microstrip patch antenna array can be integrated to 5G wireless communication devices.

B. T. Mohamed et al.,[13] presents, a new patch antenna array containing 16-elements, Parallel-series Feed operated at millimeter waves, for 5G mobile wireless applications have been designed and realized. The proposed antenna contains 16-elements excited by one port, through a Y-Junction power divider. The array has a bandwidth of 27.5 to 28. 35GHz and a high gain of 17.5dBi.

Y. Luo et al.,[14] present design employing a patch structure with the shorting pin to particularly generate extra zero modes. By taking advantages of the 2 nd zero-mode with the TM_{01} mode, we can obtain a wide bandwidth covering 23.5~28 GHz, a large-angle beam scanning with ±60°, as well as keep the substrate as low profile as 0.508 mm. Thanks to the zero-mode induced patch-type design, it is compatible to multi-layer configuration possessing the extensibility and flexibility for further module design. We experimentally valid the design of a 4 × 2 array with multi-layer configuration in a cell phone environment. Good RF performances with ±60° scanning in the wide bandwidth indicate this proposed design can be an appropriate candidate for 5G mobile terminals.

III. 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.

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.

The varying assortment gathering mechanical assembly is arranged by following spatial, point and polarization good assortment thoughts. The better than average assortment antenna contains 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.

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.

IV. CONCLUSION

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.

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