Review of different directional MIMO Antenna

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***ABSTRACT*—Majority of cellular radio system operate in urban areas but apparently there isn't a clear line of sight between the transmitting base station and receiving base station mostly due to huge sky scrapers, A multi path propagation technology has however shown to be more effective than the traditional single path propagation technology. An antenna shape also plays an important role in communication, an E-shaped antenna provides a 13% bandwidth boost than a square shaped antenna further bandwidth can be increased by making two slices at the edges to improve the bandwidth to 17%.The multi-input-mutli-output (MIMO) technology is thus proven to be more effective than the tradition single-input-single-output (SISO) antenna.**

***Keywords*—MIMO Antenna, Wireless transmission,WLAN, communication, Bandwidth**

I. INTRODUCTION

In past few years, there has been an extensive boost in wireless data transfer which apparently traditional antennas technologies aren't capable of delivering, due to multipath and co-channel interference. An alternative of using multi-input-multi-output (MIMO) is proven to improve wireless transmission capacity by directing the radiation only to intended area. The MIMO wireless technology is an effective approach in wireless techniques, as bandwidth is becoming an important commodity in today's world techniques are needed to use the available Bandwidth more effectively. We have designed and fabricated Microstrip patch antenna by using MIMO (Multiple Input Multiple Output) technique system, as MIMO offers high data rate for the single user and also reduces fading effect. The frequency range of this Antenna is from 1.8 to 3.0 GHz expected which is very useful in applications such as WIFI, Bluetooth, Wi-MAX etc. The design and simulation of the antenna has been achieved by using 'Computer Simulation Technology (CST) software. As it has high operational frequency range which lies in GHz which makes it compatible for high speed communication application.

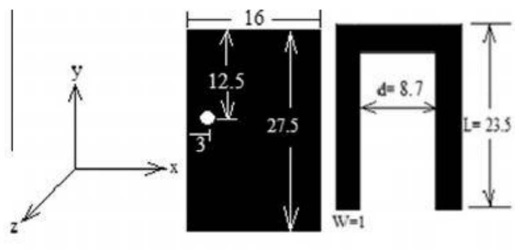
II. PROPOSED TECHNOLOGY

Antennas of different shape provide different bandwidth enhancement and operate at different frequencies while providing various isolation characteristics. Antenna play the most vital role in communication, with recently dramatic growth of data service have increased, the traditional antenna could not be able to keep up with these data requirements so thus an improved technology of antennas techniques is implemented to keep up with data needs, this antenna technology is called MIMO (multi-input-multi-output). In MIMO we use two or more antennas to improve directivity, isolation and mostly bandwidth.

III. LITERATURE REVIEW

A. A Compact 4-Channel Microstrip MIMO Antenna with Reduced Mutual Coupling.

Chandan Kumar Ghosh Worked On A Compact4-Channel Microstrip MIMO Antenna with Reduced Mutual Coupling [1]. A compact four channel (4-Channel) Multiple Input Multiple Output (MIMO) microstrip antenna which is integrated with inverted U-Shaped microstrip resonators and line resonators which are present at the frequency band of 5.25 GHz (WLAN Band). For the reduction in between the nearly spaced elements of antenna Microstrip Resonators are used. For achieving compactness in MIMO structures there must be a small distance kept in between the adjacent patch elements and the distance is 0.5 ƛ. With the used of the resonators of electrical length 2*ƛg (where ƛg = guided wavelength) In between the antenna elements which will leads to suppress the mutual coupling by 44 dB at the resonance frequency between the horizontal antenna elements. To suppress the mutual coupling in between the vertical elements of antenna higher than 36 dB, a line resonator of optimized length 22.1 mm (0.8*ƛg) is introduced at the resonance frequency. To keep the mutual coupling minimum, the parameters and distance between two arms of inverted U-shaped resonators are optimized. The antenna designed with a compact structure have the peak gain of 10.54 dBi and bandwidth of 250 Mhz. The mutual coupling in between the horizontal antenna elements is reduced by more than 44 dB and in between the vertical antenna elements by more than 35 dB is achieved with electrical length of 2*ƛg and line resonator of length 0.8*ƛg.



(a) (b)

Fig.1.Schematic diagrams of (a) patch antenna (b) Resonator of electrical length 2ƛg

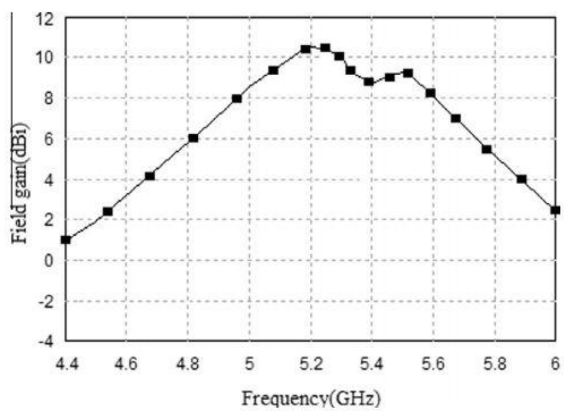


Fig.2. Plot of Total field gain v/s frequency of the proposed antenna designed system

B. A 2x2 MIMO Patch Antenna forMulti-Band Applications.

Islam Md Rafiqul et el worked-on A 2x2 MIMO Patch Antenna for Multi-Band Applications [2]. By using groups of rings, A Multiple Input Multiple Output (2x2 MIMO) patch antenna is designed for Multiband applications. The modification is proposed in order to increase the resonant frequencies and reduce the mutual coupling. By using Computer Simulation Technology (CST) software, 2x2 MIMO patch antenna is designed and with such small geometrical dimensions, these proposed antenna designed is applicable for distinct applications such as LTE (1.8 GHz), Wi-Fi (2.4 GHz) and Wi-Max(3.5 GHz,5.2 GHz and 5.5 GHz). The multiple transmitters and multiple receivers are used in MIMO (Multiple Input Multiple Output) which provides the higher data rate which is required for services. The drawbacks encountered with Single Input Single Output (SISO) such as Multipath Fading and Low Data Rate Capacity are overcome by Multiple Input Multiple Output (MIMO) antenna system. MIMO antennas are capable to gain high speed data rate for uplink channels as well as for downlink channels which will eliminate the multipath fading and even it achieve the higher channels capacity without assigning more bandwidth. In 2x2 multiband MIMO microstrip antenna, the mutual coupling is reduced and also the bandwidth and efficiency is enhanced by arranging the rings and mid-slot in antenna. In addition with this more resonant frequency have been obtained by using four or multiple groups of rings positioned around the stepped around at four corners to enhance more bandwidth and efficiency also.

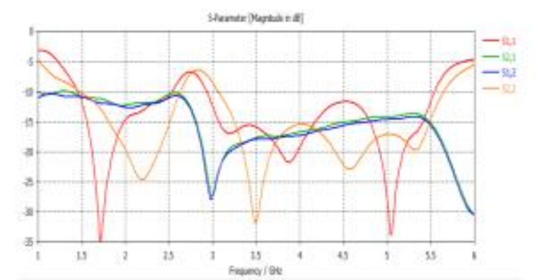
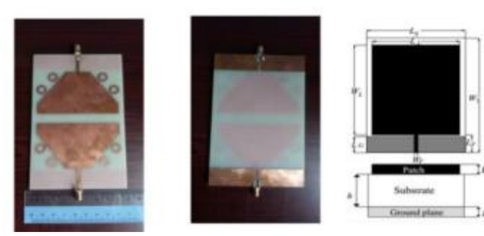


Fig.3.Simulated response of return loss and coupling coefficients for the proposed 2x2 MIMO antenna system.



(a) (b) (c)

Fig.4. Fabricated pictures of 2x2 MIMO antenna system (a) Front view (b) Top view (c) Side view

C. Design of an inverted U-Shaped MIMO patch antenna for dual band patch antenna.

T. Mohan Krishna et el worked-on design of an inverted U-shaped MIMO patch antenna for dual band patch antenna [3]. In this paper the author observed the dual band frequency of 2.8GHz and 6.4GHz. The author achieved a good return loss (loss in backward direction) and isolation characteristics by using a co-axial feeding technique which is printed on a dielectric FR-4 substrate. The dual band frequency of this antenna made it useful in applications such as WLAN and satellite. We observed that at 2.8GHz the radiation pattern was a circle with the dominant side of circle facing towards the direction of the radiating antenna and at 6.44GHz the radiation pattern was more like a maple leaf shape with dominating towards the direction of antenna. the author in this paper strived on achieving a simple microstrip antenna that provided dual band frequencies 2.8GHz and 6.44GHz.

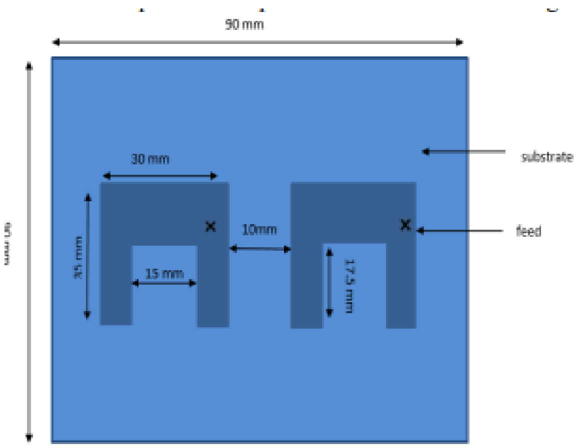


Fig.5.Inverted U-shaped MIMO patch Antenna

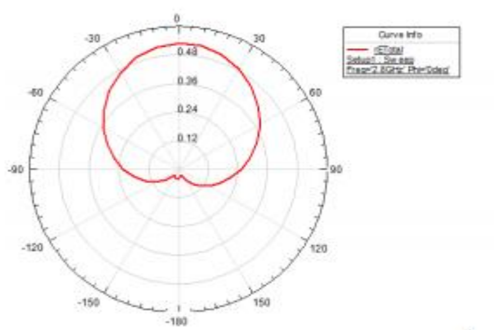


Fig.6.Radiation pattern of proposed antenna system at 2.8 GHz for Φ=0°

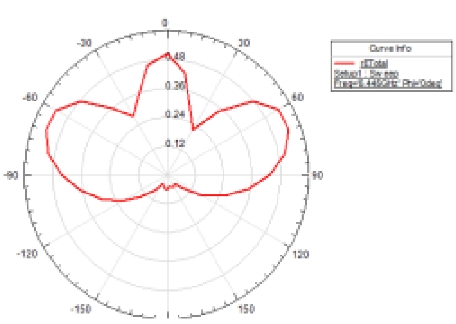


Fig.7.Radiation pattern of proposed antenna system at 6.44 GHz for Φ=0°

D. Analyzed & designed E-shaped patch antenna in x band.

Alka Verma analyzed & designed E-shaped patch antenna in x band [4]. In this paper the author had successfully implemented an E-shaped in x-band (7.0 GHz to 11.2 GHz). The author observed that by using an E shaped antenna made a 13% bandwidth boost rather than a rectangular antenna that gave 3.6% bandwidth boost. The author designed the antenna in IE3D software and E-shape itself provides a electrical length better than rectangular shape. The input feed point of the antenna is middle arm of the E-shape antenna which equally distributes the input feed through upper arm and lower arm. For designing of the antenna the author cut two parallel slots on a rectangular microstrip antenna and antenna uses a substrate 0.1575 cm RT-DUROID with dielectric constant of 2.2 and tangent loss of 0.0004. The author concluded by using an E shape microstrip antenna due to its shape proved better bandwidth boost than a rectangular microstrip antenna.

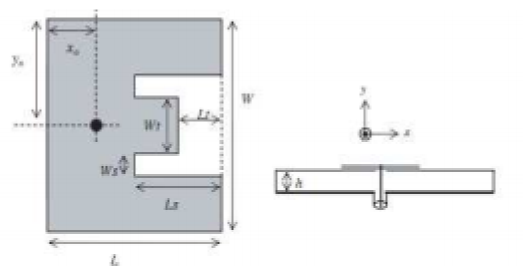


Fig.8.E shaped patch antenna

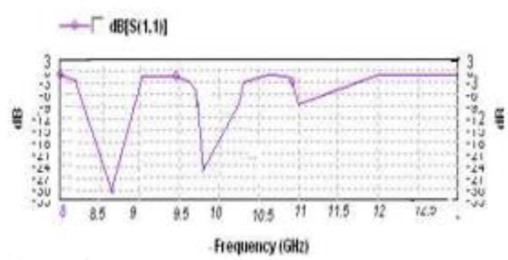


Fig.9.Return loss of E shaped patch antenna

E. A Modified E-shaped patch antenna, which can be used for Multiple Input Multiple output (MIMO) systems.

Dr. L. Pratap Reddy et el worked on A Modified E-shaped microstrip patch antenna, which is used for different multiband applications and multiband systems [5]. The authors described the modification that can be made to improve the bandwidth, these modifications were done by making two square slices at the two ends of the E shape microstrip antenna. The two slices provided a bandwidth boost of 17%

and improved electrical length. This modification also improved directivity, bandwidth and return loss characteristics than the non-modified E shape antenna. The proposed antenna works best for WiMAX application since it is resonated at dual frequency band of 5.36 GHz and 5.89 GHz for VSWR ≤ 2. The author designed the antenna using EM simulator which works on the principle of FITT.

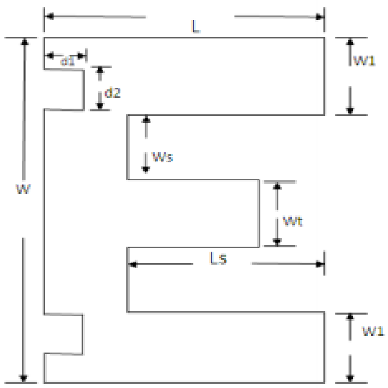


Fig.10. Modified E-shaped patch antenna

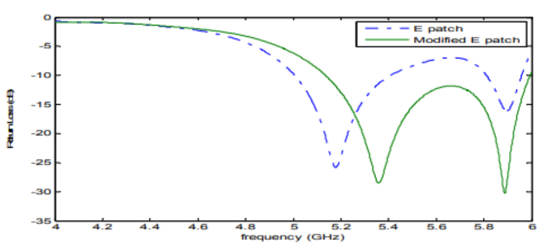


Fig.11.Comparison of return loss between the normal E shaped patch and modified E shaped patch antenna

F. *A Compact Dual Band MIMO Antenna with Improved Isolation for WI-MAX and WLAN Applications.*

Pratima C. Nirmal et el worked on A Compact Dual Band MIMO Antenna with Improved Isolation for WI-MAX and WLAN Applications [6]. The authors used two f shaped antennas to successfully provide dual band frequencies to be used in applications such as WiMAX and WLAN. The design consists of two counter facing f shaped antenna which are closely spaced together. The two f shaped monopoles are spaced at 10mm away. Each f shaped monopole operates at dual band frequencies of 3.5GHz and 5.8GHz bands. The overall dimension of this antenna is 30 x 26mm as described by the authors. The radiation pattern was observed to be stable with correlation coefficient < 0.03, diversity gain > 9.8d. The authors concluded that this antenna technique of using two f shaped antenna was suitable for MIMO applications. The authors concluded proposed dual band MIMO antenna was simple to construct and design and provided a better isolation and reduced mutual coupling using elliptical slot and rectangular parasitic strip.

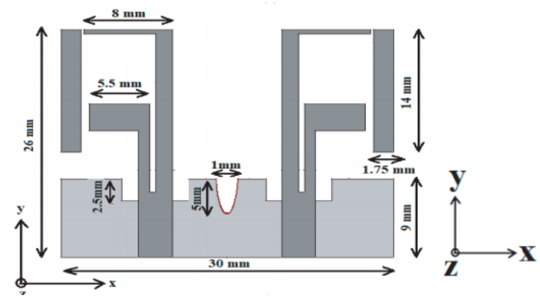


Fig.12.Proposed MIMO structure

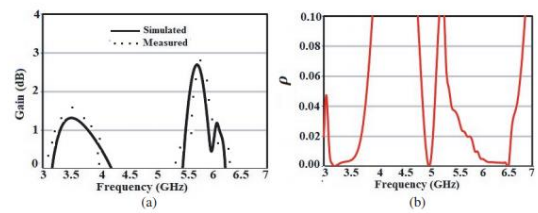


Fig.13.(a) Gain and (b) correlation coefficient of the proposed structure

G. *Dual Polarized Triple Band Hybrid MIMO Cylindrical Dielectric Resonator Antenna for LTE2500/WLAN/ WiMAX Applications.*

Anand Sharma et el worked onDual Polarized Triple Band Hybrid MIMO Cylindrical Dielectric Resonator Antenna for LTE2500/WLAN/ WiMAX Applications [7]. The authors used inverted L shaped strips and metallic strips were used to separate the ground planes. By doing this the authors achieved an enhancement is isolation. The L shaped strips on the ground planes generated a frequency band of 2.7GHz. The Metallic strip on the ground plane are used as they acts as an electromagnetic (EM) reflector for enhancing the isolation between the two antennas. The proposed antenna operates at tri frequency bands which are in ranges of 2.24–2.38 GHz, 2.5–3.26 GHz, and 4.88–7.0 GHz with the fractional bandwidths of 6.06%, 26.4%, and 35.7% respectively. For the multiband applications such as LTE, WI-MAX and WLAN, the proposed antenna designed is used. The proposed MIMO antenna system is analyzed by using Ansoft HFSS EM simulation software and the achieved results were compared with CST-MSW simulation software.

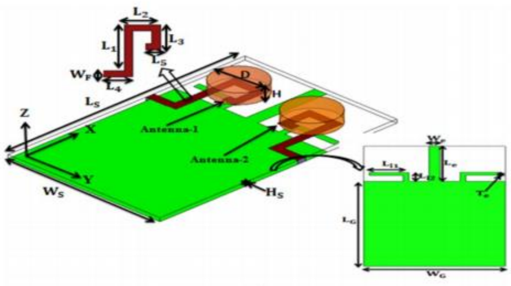


Fig.14. Schematic diagram

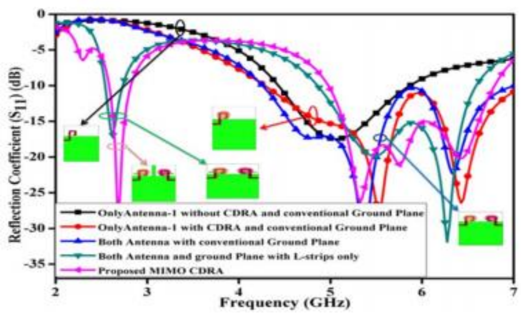


Fig.15. Effect of various resonating structures used in proposed MIMO antenna on reflection coefficient

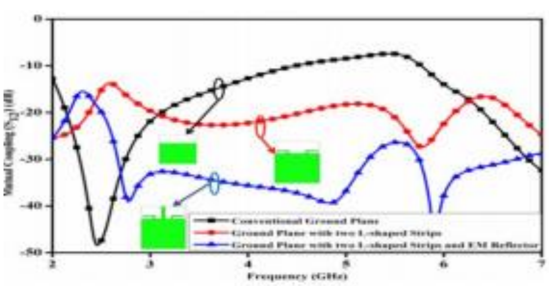


Fig.14.Variation of coupling between antenna-1 and antenna-2 with different modification in ground plane.

H. Designing of a Dual-band MIMO Antenna for 5G Smartphone Application.

Weijun Zhang et el worked on Designing of a Dual-band MIMO Antenna for 5G Smartphone Application [8]. The authors used four antennas to successfully implement MIMO antenna technology. The four-antenna operated in ranges of 3.3GHz - 3.6GHz and 4.8GHz -5GHz. The antenna proposed by the authors are perpendicular (90 degree) to system circuit board. The simulations results concluded that the reflection coefficient is <-6dB and isolation >12dB. These antenna designed consist of a four bent lines which are printed on the inner surface and outer surface of the smartphones. The system circuit board was chosen to have dimensions of 130mm x 74mm, an FR4 substrate which is 0.8mm thick of relative permittivity 4.4 is used. The simulation was done on ANSYS HFSS and it was observed that the reflection coefficient of four antennas <6dB. The authors conclude that the proposed antenna designed provides high isolation with the small size antenna which is ideal for today's ultra-thin smartphones communication.

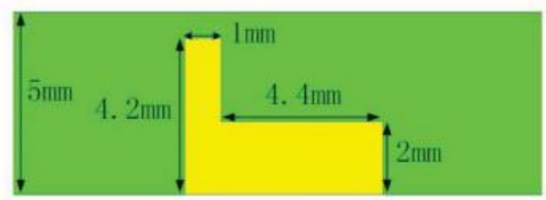


Fig.16.Antenna element model rear view

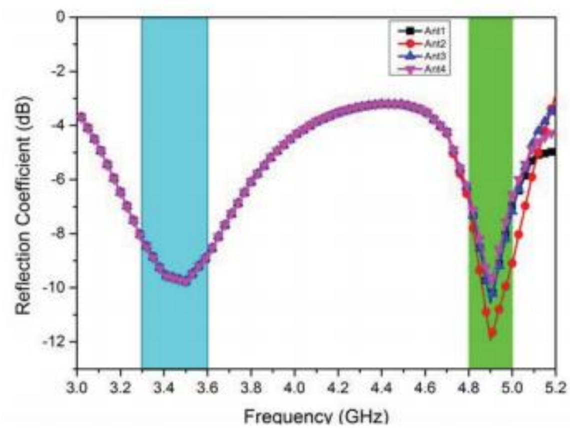


Fig.17. Simulated Reflection Coefficient.

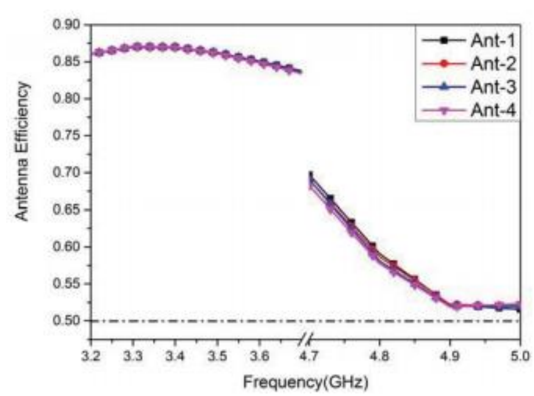


Fig.18. Simulated Antenna Efficiency

IV. CONCLUSION

Microstrip antennas become rapidly growing as they are light weight, small size and also easy for manufacturing. But there is one limitation of narrow bandwidth and to overcome this limitation E-Shaped microstrip patch antenna is used which increases the bandwidth by 13% as compared to the normal shape microstrip patch antennas. With the used of microstrip patch antennas, the mutual coupling between horizontal antenna element is reduced by 44 dB and mutual coupling in between vertical antenna element is reduced by 33 dB. Thus, proposed system is used to improve mutual coupling. With the small dimensions the microstrip antenna is useful for various applications such as LTE (1.8 GHz), Wi-Fi (2.4 GHz) and Wi-Max (3.5 GHz, 5.2 GHz and 5.5 GHz). We observed from various simulated results that a significant bandwidth, better coverage, higher impedance and sufficient gain was provided by using MIMO antenna techniques which made it significant for high speed data applications used in today's world.

V. REFERENCES

[1] Chandan Kumar Ghosh,"A compact 4-channel microstrip MIMO antenna with reduced mutual coupling", Int. J. Electron. Commun. (AEÜ) 70 (2016) 873–879.

[2] Islam Md Rafiqul, Waheeb S. A.*, Sarah Rafiq, M. S. Yasmin and M. H. Habaeb," A 2X2 MIMO Patch Antenna for Multi-Band Applications", Indonesian Journal of Electrical Engineering and Informatics (IJEEI) Vol. 5, No. 4, December 2017, pp. 383~389 ISSN: 2089-3272, DOI: 10.11591/ijeei.v5i4.374.

[3] T.Mohan Krishna, K.Kranth Kiran, K.Prasanth, B.Shivaji Reddy, A.Tathababu," Design of an Inverted U-Shaped MIMO Patch Antenna for Dual Band Applications", INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING Vol. 3, Issue 3, March 2015.

[4] Alka Verma," ANALYSIS AND DESIGN OF E SHAPED PATCH ANTENNA IN X BAND", International Journal of Advanced Engineering Technology E-ISSN 0976-3945.

[5] K. Jagadeesh Babu,Dr.K.Sri Rama Krishna,Dr.L.Pratap Reddy," A MODIFIED E SHAPED PATCH ANTENNA FOR MIMO SYSTEMS", International Journal on Computer Science and Engineering (IJCSE),Vol. 02, No. 07, 2010, 2427-2430.

[6] Pratima C. Nirmal, Anil Nandgaonkar, Sanjay Nalbalwar, and Rajiv K. Gupta," A Compact Dual Band MIMO Antenna with Improved Isolation for WI-MAX and WLAN Applications", Progress In Electromagnetics Research M, Vol. 68, 69–77, 2018.

[7] Alishir Moradikordalivand, Tharek Abd Rahman, Chee Yen Leow and Sepideh Ebrahimi," Dual-polarized MIMO antenna system for WiFi and LTE wireless access point applications", INTERNATIONAL JOURNAL OF COMMUNICATION SYSTEMS Int. J. Commun. Syst. (2014) Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/dac.2898.

[8] Weijun Zhang, Zibin Weng, Lei Wang," Design of a Dual-band MIMO Antenna for 5G Smartphone Application",978-1-5386-1851-6/18/$31.00 2018 IEEE.