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A Survey on Design and Implementation of MimoAntennas for Wireless Communication

Hanish Chaitanya Bodepudi[1], Arun Raaza[2], V Rajendran[3], V Prabhu[4], M Meena[5]

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Abstract: This multiple-input multiple- output (MIMO) communication has shown to be an effective method for enhancing the performance and capacity of wireless communications systems. The MIMO antenna is highly important in the world of wireless networking today. Over the past 10 years, the field of MIMO antennas has seen a significant amount of study. A new area of connection between vehicles and the infrastructure at the side of the road is called vehicular communication. The opportunity for the distribution of information across real-time communication between vehicles and related infrastructure is being created by advancements in wireless communications. High data rate innovative in-vehicle wireless communications may be achieved with Ultra-Wide Band (UWB) technology. Ultra-wideband (UWB) and multiband antennas are being inflated in analysis due to semiconductor units pursuit of high data speeds. Keyless entry, safety, free of driving, Digital keys, vehicle recovery, andvehicle-to-vehicle communication from a blocked parking space are just a few of the automotive uses for UWB antenna units (Internet of Things). The many uses for multiple-input multiple-output (MIMO)antennas are covered in this survey article. Herethe UWB (Ultra Wide Band) MIMO antennas for automotive communication are discussed and their result analysis is discussed.

***Keywords**: Ultra Wide Band (UWB) and Automotive Applications, Multiple Input and Multiple Output (MIMO).*

1. Introduction

Over the years, rapidly increases the wireless systems. In wireless communication systems, the antenna is essential since it allows the gathering and transmission of electromagnetic (EM)

waves, which carry information. The usage of wireless devices has increased, which has led by the advancements in communication technology. Moreover, for minimization of these wireless devices operating speed as well as higher data rate, there is always an increase in demand. In terms of capacity, there is a limitation in traditional SISO (single input single output). On a daily basis, increased the smart multimedia, high channel band width, improved spectrum performance, and fast data connections which are needed. MIMO techniques are included frequently by infrastructure of modern telecommunications, these consist of wireless local area networks (WLAN) and long-term evolution (LTE). To increase bandwidths capacity andefficiency, multiple elements of antenna are used in modern communication by MIMO technologies, which are utilized most commonly [1].

[1]*Research Scholar, Department of ECE, Vels University, TN, India*
[2]*Director of R&D, Department of ECE, VISTAS, TN, India* [3]*Professor and Director of ECE Department, VISTAS, TN, India*
[4]*Assoc. Professor, Dept of ECE, VelTech MultiTech Dr.Rangarajan Dr. Sakunthala Engg. College, TN, India*
[5]*Associate Professor, Department of ECE, VISTAS, TN, India E-mail: hanishbodepudi@gmail.com*

In order to enhance multiplexing performance, expand channel capacity, and reduce multipath fading, MIMO (multiple input multiple output) antenna systems consider gain and diversity. SIMO is for single input multiple output; MIMO standsfor multiple input multiple output, whereas SISO is for single input single output; and MISO stands for multiple input single output are the four variations of MIMO. Over time, the study has included various inputs and multiple outputs, as a communication purpose it is widely used by leading industries [2].

In next generation mobile/wireless communication systems, a key role wasplayed by MIMO technology by providing high capacity and data rates. A significant attention was gained by MIMO antennas with the increasing demand for high data rates and in millimeter-wave communication, a key technology was considered. To multipath paths fading, resistance, coverage area, and data transmission speed are enhanced the promising features, which are owned by highly recommended MIMOs technology [3].

MIMO (multiple-input multiple-output) uses several antennas rather than a single antenna in the transmitters and receivers. MIMO communication significantly contributes to channel capacity enhancement and ensures improved data throughput. Utilizing a simplified a medium access control (MAC) layer, lowering latency, and demonstrating durability to jamming, and inexpensive low power components are the other benefits of MIMO. In addition, in an efficient way a multiple users can be supported.

For UWB applications, compact antennas are suitable due to its light weight, low cost, and it is simple to fabricate. Ultra- wideband offers significant benefits because of its wide bandwidth, it supports the 3.1 GHz to 10.6 GHz frequency range for short-range wireless communication, both in transmission and reception, there is a less power consumption. Since, in wireless technology, the most important component is antenna, its exponential rate is increasing. With optical characteristics, to design an antenna is a major challenge for these, to dismiss interference it needs in the USB spectrum with present narrowband systems [4].

In vehicles, to guarantee safe driving, ensure communication with other automobiles, and assure trouble-free driving, these became increasingly popular due to high speed mobile communication. Therefore, in connected automobiles, wireless communication technology is expanding rapidly. Devices of transceiving must have affordable antennas, low profile, and multi-band, number of wireless standards in order to handle the growth. Internet of Things (IoT) has utilized increasingly by the automotive industry, this has completely changed the way that people interact with vehicles. Device's networking was referred by the IoT such as sensors, gateways, actuators and electrical components. Driver management that supports vehicle-to- everything (V2X), vehicle-to-vehicle (V2V), and vehicle-to-infrastructure (V2I), and Intelligent Transport System (ITS) communication made the use of IoT necessary for automotive services like parking, lane-changing, steering, advanced driver assistance system (ADAS), time/route/fleet, and braking. Vehicles and intelligent/smart transportation systems are connected through the V2X IoT network [5].

IoT powers semi-autonomous vehicles development, collisions can be avoided, thus driver workload can be reduced, and itis capable of making real time decisions. In smart vehicles, these recent developments offer a more secure driving and comfortable environment to the passengers and drivers. In the recent past, a tremendous research interest has received by the automotive communication. With an entertainment services and information plurality, automobiles are equipped in present day. The aim of these services is to improve the experience of travel of both the passengers and the driver. As the number of services increases, so does the necessity for an antenna. Furthermore, due to the environmental change, the automotive scenario is complex and hence, channel conditions are changed. A real challenge is to establish a reliable communication link and the issue of paramount importance was addressed [6]. Automobiles presentlyutilize two different types of technology to handle problems: multiple-input multiple- output (MIMO) and ultra-wideband (UWB) communications. The multipath fading problem is solved by using multiple-input multiple-output (MIMO) technology and the broader bandwidth of UWB system was utilized efficiently [7].

Ultra-wideband (UWB) diversity antennas and multiple-input multiple-output (MIMO) technologies improve IoT applications' communication reliability. Due of its prospective uses, UWB communication has attracted significant attention in recent years, outperforming narrowband technology in terms of research, it has advantages. From low data rate, the narrowband systems suffer and to receiver and transmitter locations, it is highly sensitive. A high data rate was likely provided by the UWB technology. In many applications, the UWB technology was adopted such as emergency services and roadside assistance, tracking with high spatial resolution, in-car sensor network communication, high-speed mobile communications, RADAR, and automotive localization. However, from multi-path fading, the UWB systems suffer. Thus, in the automobiles, with MIMO technology the UWB systems are integrated to achieve high data rate, alleviate multipath fading, and link quality and to ensure channel capacity [8].

In a variety of applications, ultra-wideband (UWB) is used widely, including in automotives. The information is spread through the bandwidth which is greater than 500 MHz that was characterized by UWB systems. On the other hand, to receive and transmit information signals, multiple antennas are used by the MIMO communication. In a rich scattering environment, the UWB integration with MIMO reaps most of its benefits [9].

In this work, a survey on design and implementation of MIMO antennas for wireless communication is presented. The section II describes the literature survey on various applications of MIMO Antenna. The section III describes the UWB MIMO antenna for Automotive communication techniques. The section IV presents the UWB MIMO antennas for different applications. The section V presents conclusion.

2. Literature Survey

Different applications of MIMO Antennas are described here which are as follows:

Shoaib N., Khattak R. Y., Shoaib S., Chen X., Shoaib I., and Perwaiz A.et. al., [10] MIMO Antennas for Smart 5G Devices is described. For upcoming 5G devices, including smart watches and dongles, the 8x8 MIMO antenna design was first presented in this paper. Each 3x4 mm^2 MIMO configuration antenna was produced on the substrate top layer as a rotating H-shaped patch.

The Rogers RT- 5880 board, measuring 31.2x31:2x1.57 mm^3, 2.2 is its dielectric constant. There are eight MIMO antennas on the substrate's top layer, whereas the ground plane makes up the lowest layer. For efficiency and gain enhancement, designed an electromagnetic bandgap-based structure which is known as ground plane. The MIMO antennas good performance was substantiated by the measurement and simulation results, for compact 5G devices that making them suitable. But the reduction of the substrate size and improvement is needed in terms of fabrication.

T.V.Padmavathy, Yadhamuri Vinitha Reddy, Neelapareddy D.S.Bhargava, Vuppalapati Hema, Kavitha, et. al., [11]for mobile communication, MIMO antennas simulation and design was presented. proposed. The antennaconstruction that was positioned at the FR_4 substrate has a loss tangent value of

0.001 and is made up of four symmetric F- shaped components with a dielectric constant of 4.4. 122 x 147 x 0.8 mm3 are the overall measurements of the proposed structure, with a 1.6 mm substrate thickness. Performing in the LTE band 42 frequency range of 3.4–3.6 GHz, the designed antenna features a 125MHz impedance bandwidth. The antenna's design and specifications Standing Wave Ratio of Voltage, Directivity, and Gain, Efficiency, and Return Loss are analyzed using CST 3D simulation software. In the desired frequency range, a better antenna performance was shown by the simulated results.

Shanmuganathan Shanmathi, Gulam Nabi Alsath M., Palaniswamy Sandeep Kumar, and Kanagasabai, Malathi et. al., [12] For mobile communication, the presentation included a novel low-profile 5G MIMO antenna. A unique low-profile 5G MIMO antenna arrangement has been presented for automotive communication to show thesafety band (ITS-5.9 GHz) and the 5G NR-n2 channel (1.9 GHz) on dual-band frequencies. Obtaining the lowestresonance frequency while maintaining a size that is comparable to the suggested antenna, determining its operating wavelength is a difficult problem. Towards improving the electrical length inside the dimension, dual-band resonance is achieved by adding slots to a modified square patch antenna. Therefore, resonant modified-W and loop U slots for 5.9 GHz and 1.9 GHz ring and loop slots comprise the design. In GSM applications for vehicle safety communication, a better performance and relatively higher gain were provided by a MIMO and modified square single element antenna.

Hsiao B. -R., Chen Y. -A. and Liao W. -J.et. al.,[13] The LTE MIMO antennas on different sized tablet computers are discussed, offering extensive band coverage. With comprehensive coverage a two-antenna system on 690 to 960 MHz and LTE bands on 1710 to 2690 MHz is proposed for uses on different sizes tablets. To reduce coupling two different antennas configuration are employed. The main antenna is based on an inverted-F structure. To enhance performance of bandwidth, Lumped element loadings are used. To minimize the footprint of antenna, a capacitive coupling element was adopted by the auxiliary antenna and to the ground, clearance distance will be reduces. Issues of implementation such as design transportability across platforms, antenna diversity gain, and fabrication difficulty are looked into. Moderate efficiency was shown by the measured results and in LTE bands, good characteristics of isolation with acceptable return loss. With measured effective diversity gain the performance of its superior diversity is validated, for LTE MIMO uses it confirms that the proposed design is suitable.

Choukiker Y. K., Sharma S. K. and Behera S. K. et. al.,[14] A hybrid fractal form antenna was introduced for portable mobile devices, using MIMO implementation to handle multiband wireless communications. A planar monopole antenna with a hybrid fractal structure is offered for use in handheld mobile devices multiple-input multiple- output (MIMO) applications, covering various wireless communication bands. The structure that was suggested combines Minkowski island curve with fractals of the Koch curve. Measuring impedance matching, the fractional bandwidth (dB) between 1.65 GHz and 1.9 GHz, and between 2.68 GHz and 6.25 GHz, for band

2. An satisfactory agreement was established between the parameter performance of the simulated and measured antennas. These attributes proved that the suggested antenna is a desirable option for handheld mobile devices.

P. Kumar et al. [15] A new DGS-equipped six-port small UWB MIMO antenna design has been demonstrated for enhanced isolation. In this research, a six- port ultra wideband (UWB) antenna with a new decoupling structure was printed with a low profile and examined for improving port-to-port isolation. In the proposed design, with defective ground structures a six symmetrical pyramidal from UWB antennas interspersed, it was served as a unique decoupling structure with parasitic components. On the ground plane, the modified rectangular stubs and grounded branches generate open and close channels of current distribution, that causing uniform flow of current to be distributed and neutralized the coupling effect. By antenna design, with a pea gain of 8.3 dB, the radiation properties at 7.5 GHz are considered acceptable. Further, to the diversity metrics and time domain characteristics, the projected design is also exposed. Correspondingly, the values of fidelity factors and group delay among different ports are more than 0.92 and less than 1.5ns. The suggested antenna is a strong contender for UWB communicationsystems, and all performance metrics are acceptable.

A. A. Surve and D. Niture et. al., [16] talks about the UWB MIMO Microstrip Antenna's design and implementation for 5G's sub-6GHz transmission. This study presents the development of a 4-element MIMO antenna capable of covering the whole 3.1 - 10.6 GHz UWB spectrum. To design the structure, we used a 3D electromagnetic high frequency program called ANSYS HFSS. We have computed the diversity measurements of performance, such as channel capacity loss (CCL), diversity gain (DG), and envelope correlation coefficient (ECC), in this UWB frequency range, and the results are much better than the appropriate limitations. Following antenna manufacturing, we used a vector network analyzer (VNA) to assess parameters and confirm performance. It is discovered that there is agreement between the measured and simulated performance characteristics.

3. Uwb Mimo Antennas for Automotive Communication

Modern automobiles integrate wireless communication applications whereantenna position and size matter, such asdedicated short range communications (DSRC), Wi-MAX, WLAN IEEE 802.11a/b/g/n, and GSM are worldwidenetworks fo mobile communication. Vehicle communication antennas need to be small, omnidirectional, and have aslittle impact on the ground as possible. Inan effort to enhance road safety, traffic-free movement, dependability, and efficiency, the automotive industry hasdemonstrated heightened interest in a number of electronic integration issues,consisting of vehicle-to-everythingcommunication-based remote keyless entry, reduced cable lengths, above-groundantennae, and passenger safety. In order toincrease the communication system'sconnection dependability, new automobiles could use MIMO/diversity technology with large data rates. This section describes various works on UWBMIMO antenna for automotive application.

Palaniswamy Sandeep Kumar, Sachin Kumar, Lulu Wang, Kanagasabai Malathi, Nabi Mohammed Gulam Alsath, Rama Rao Thipparaju, and Kannappan Lekha, et. al., [17] An antenna with quad ports for multiservice diversity was described for use in automobile applications. This work presents the performance of a quad- element multiple-input multiple-output (MIMO) antenna operating in ultra wideband (UWB). MIMO antenna consists of four orthogonally organized microstrip line fed hexagonal monopole radiators and a modified ground plane. To get additional resonances at 2.45 GHz and 1.5 GHZ, G- shaped and the radiator also has e-shaped stubs added to it. Antenna dependability in the vehicle context is examined, accounting for housing effects. The housing effects demonstrated the consistent functioning of the antenna whena large mental object is present. This antenna's performance in terms of diversityis assessed and designed. According to the data, the DG is higher than 9 dB, the ECC is less than 0.4, the TARC is more than -10dB, and the CCL is less than 0.4 bits/s/Hz. Numerous automotive applications, including intelligent transport system (ITS), the presented MIMO antenna showspotential for vehicle-to-everything (V2X), vehicle-to-vehicle (V2V), vehicle-to- infrastructure (V2I), and RFID-basedelectronic toll collection.

D. Potti et al., [18] offers a novel UWB antenna that is optically transparent for automotive MIMO communications. Aunique optically transparent multiple-input-multiple-output (MIMO) antennawas developed in this study for automobileapplications.

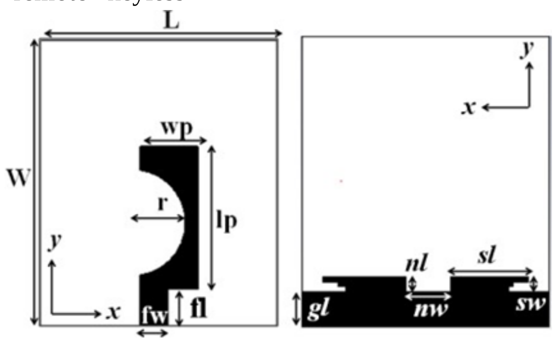
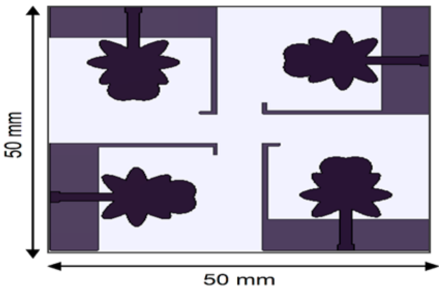


Fig 1 shows the proposed transparent monopole antenna from the front (a) and rear (b). The dimensions are as follows: g = 5mm, gl = 3.5 mm, nw = 4.3 mm, nl = 1.5 mm,sl = 7.6 mm, sw = 1.5 mm, wp = 2.8 mm, lp = 5.6 mm, r = 5.4 mm, fw = 5.9 mm, fl = 3.75 mm, and g = 5 mm.

Two semicircular slot-loaded monopoles are made up of MIMO antennas with a staircase ground construction. It has dimensions of 29 x 50 mm^2 and is produced on a glass substrate. Four Ω/sq and ten Ω/sq, respectively, are the sheet resistances, ITO and fluorine-dopedindium tin oxide (FTO/ITO) made up the conductive layers on top and bottom of the substrate. The manufactured antenna may be mounted on the car's glass surface since it has an optical transmittance of more than 72%. The presented antenna has suitable impedance matching between 2.4 and 11 GHz, based on the measured data, it is appropriate for use in ultra-wideband (UWB) automotive applications with a maximum realized gain of 2 dBi and isolation of over 20 dB. Without the addition of any decoupling structures, the separation between the antennas is higher than 20 dB. It has a great chance of becoming the UWB MIMO antenna due to its ECC value of less than 0.04 and diversity gain of greater than 9.8 dBi. The observed and simulated results agree rather well with one another. At 7 GHz, the expected peak radiation efficiency is 60%, while the measured peak real gain is 2 dBi, it features an omni-directional radiation pattern.

Manoharan Sangeetha, Palaniswamy Sandeep Kumar, Sachin Kumar, and Sriram Arumugam, et. al., [19] An analysis of a small's functionality and design, for usage in automobile communications, a four-element UWB MIMO antenna was shown. The planar ultra-wideband (UWB) multiple input- multiple output (MIMO) antenna analysis and design for contemporary automotive communication systems was provided in this study. This figure represents a quad- port UWB multiple-input multiple-output (MIMO) antenna.



Modified elliptical radiators were used to

generate the proposed unit cell antenna configuration. It measures 22 x 22 x 0.76 mm3 and is mounted on a Rogers RO3003 substrate. 3.14 GHz to 12.24 GHz is its impedance bandwidth (S11 <-10 dB). Respectively, the unit cell prototype's peak gain and efficiency are 81% and 5.1 dB. An antenna design for a 50x50x0.76 mm^3 MIMO was subsequently created using a unit cell, this four components in a single plane that are orthogonal to one another. There was more than 20 dB of measured isolation between the antenna components. The detected MIMO antennas envelope correlation coefficient (ECC) was less than 0.004, overall active reflection coefficient (TARC) was less than <-10 dB, diversity gain (DG) was better than 9.67 dB, and mean effective gain (MEG) ratio was larger than > 0.99. In the presence of a conducting body, the suggested MIMO antenna and unit cell characteristics were examined to confirm the consistency of antenna performance for hosing effects. In addition, using a virtual model of car, the antennas radiation characteristics were analyzed when mounted on a vehicle. The proposed MIMO array of quad-element UWB has good performance, is compact, and for automotive applications it is well suited, which are shown by the results.

Kannappan Lekha, Malathi Kanagasabai,Sandeep Kumar Palaniswamy, and Sachin Kumar et.al., [20] for Vehicular Applications, a CPW-Fed semitransparent antenna was inspired by a car logo design which was described. In this investigation, a four-port, semitransparent multiple-input multiple-output (MIMO) antenna was built for automotive application. The prototype antenna for windshield applications ismade of clear soda lime glass, in contrast, this copper metal used to make the radiator is nontransparent. As the 'NISSAN automobile-like" logo, the MIMO antennas unit cell radiator is similar. The figure 3 shows the layout of presented antenna. There is a bandwidth of 3.4 to 11 GHz and -10 dB impedance to the

proposed MIMO antenna. In the MIMOsetup, there is a 6 mm gap between each unit. To offer dual (vertical and horizontal) polarization, the elements of antenna are oriented perpendicularly, which aids in providing signal reception in all direction and better isolation.

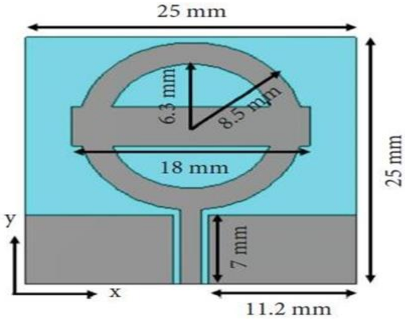


Fig. 3: Layout of Proposed Antenna

Without the use of any decoupling structure, there is more than 15 dB of separation between the resonating parts. Examined the diversity antenna to have a greater understanding of the MIMO antenna's performance. Less than -10 dB is the total active resistance coefficient (TARC) and less than 0.07 bits/s/Hz is the channel capacity loss (CCL), respectively, however, the diversity gain (DG) exceeds

9.98 dB and the envelope correlationcoefficient (ECC) is less than 0.01. 52.26% of transparency was provided by the quad-port MIMO antenna across the whole region. The suggested antenna may be appropriate for vehicular communications applications in automobiles, the automatic vehicle identifier (AVI), and intelligent transportation systems (ITS). In the future, as ground planes and radiators with transparent tin film, on completely transparent substrate the antenna could be developed.

4. Results Discussion

In this section, different UWB MIMO antennas are examined and tabulated for use in various applications:

Citation	Proposed Method	Description	Results
Lekha Kannappan et.al., [21]	Intelligent Vehicle Internet of Things Communications: Thirty-two-port MIMO/diversity antenna design and measurement usingthe radiator-ground isomorphic inverse method	This paper suggests a massive hex-polarized MIMO antenna with 32 portsand can function atultra-wideband (UWB), GPS, and Wi-Fi frequencies.	Using far-field measurements, the computed envelope correlation coefficient (ECC) forthe MIMO antennaassembly is less than 0.1. A less than -10dB total active reflectance coefficient (TARC)and a less than 1 dBmean effective gaindifferential (MEG) are found.
P. Kumar et. al.,[22]	Quad-Element Super-Wideband MIMO antenna design and internet of things applicationwas implemented	Coplanar waveguide (CPW) feed lines with tapered ends supply power to the four identical sickle- shaped resonating components of the proposed antenna. Rotational symmetry determines the arrangement of the antenna components, in order to provide maximal port isolation, are mutually orthogonal to one another.	Arranging the antenna componentsin an orthogonal andanti-parallel orientation results inmore isolation and polarization selection. Thesuggested design'scoplanar shape is beneficial as it makesit easy to integratethe MIMO antennainto Internet ofThings modules.

S. Lemey et al., [23]	Triple Symmetric Rotationally Extremely Short-Range MIMO Transmission Using SIW Antenna Array	This high-performance, cavity-backed, three-element substrate integrated waveguide(SIW) slot antenna array's goal is to establish a stable, high-speed, a 3 × 3 multiple-input multiple-output (MIMO) wireless	The antenna array ensures a minimum isolation between antenna components of a minimum bandwidth of 1.078 GHz and 30 dB throughout the whole [5.15 - 5.85] GHz range. Measurements demonstrate that integration into a
		communication connection with a very short-range MUplaced on a desk. Inthe 5.15–5.85 GHz range, it functions.	worktop is possible with just a negligible impact on mutual coupling and return loss.
Thennarasi Govindanet. al., [24]	Smart fabric communications using UWB MIMO antenna architecture	This research offers an ultrawide band (UWB) high-performing flexible MIMO antenna for applications using smart clothes. 2.9–12 GHz is the frequency range covered by the MIMO antenna and is made up of four radiators that are octagonal in form and have severalslots loaded into them.	The MIMO antenna'sSAR study reveals acceptable values that are noticeably less than 1.6 W/Kg, qualifying the suggested antenna foruse in patient monitoring applications.
I. K. Sokhi et.al.,[25]	UWB-MIMO antenna architecture for wireless applications	Seven squares made up the design, with the ground plane partially completed in the central square. The second prototypea small multiple- input multiple-output(MIMO) antenna with dimensions of36 x 40 mm ^{2}.	There is a reciprocal loss of less than -15 dB between the portscoupling. According to UWB-MIMO simulation results, the frequency range in which the antennaoperates is 3.1–10.6 GHz.

Irshad Khan M et.al., [26]	Engineering and Study of a Modern UWB-MIMO Antenna with Optimal Isolation	The ultrawide band(UWB) applications suggested by this study need for a compact, high isolation and more bandwidth are provided by this semicircle-shaped MIMO antenna design.	The suggested antenna measures 18x36x1.6 mm^3 in its entirety. Within the frequency range of 3-40 GHz, the suggested antenna's |S11| and voltage standing wave ratio (VSWR) are less than −10 dB and 2, respectively. There are several MIMO- UWB wireless applications that can benefit from the recommended
			antenna.
Dhuddu Haripriya et.al., [27]	Using Roger material, a two- element WLANUWB-Mimo antenna with single band- notched behavior and excellent isolation	Ultra-wide band (UWB) applications are advised to utilize a highly isolated MIMO antenna. Two rectangular monopole antennas positioned next to one another on the proposed MIMO antenna structure is built on the same substrate.	The designedMIMO-UWB antenna improves isolation to provide ahigh signal strength through strong impedance matching between measured and simulated results.
hea Nath, PramodSingh et. al., [28]	MIMO Antenna Design and Analysisfor UWB Applications	The total dimensions of this UWB MIMO antenna set are 32x32x1.6 cum. 2.3 to 10.07 GHz is the frequency range of operation for this two-port MIMO antenna. Reducing the degree of isolation among the antenna components, a defective ground structure (DGS) is suggested.	An improved level of isolation between the antenna ports can result in a -29dB mutual coupling.

Narges Malekpour et.al., [29]	Creating a Compact,Highly Isolated MIMO Antenna for UWB Applications	Antennas with MIMO have been proposed for UWB communication. Impedance matchingand isolation betweenthe UWB MIMO antenna's two identical monopole antenna componentsare enhanced by thecomb-line pattern onits ground plane.Examined have beenthe envelopecorrelation coefficient, radiationpattern, efficiency,peak gain, mutual coupling, and reflection coefficient	The 26 × 31 mm2 suggested antenna is small in size. The suggested for UWB MIMO systems, UWB MIMO antennas are a serious contender, according to all of the measured and computed results.
		in connection to simulation and measurement analysis.	
Santanu Mondal et.al., [30]	Ultra-Wideband Applications usingMIMO Antenna Architecture	SPEMAs, or shortedplanar elliptical metalantennas, are designed for use inultra-wideband (UWB) settings. TheMIMO antenna's Eand H planes showthe radiation patterns and absolute peak gain.	In the UWB band, the suggested MIMO antenna has a low mutual coupling (< −13 dB), a low correlation coefficient ((<0.02),and a low reflectioncoefficient (<−10dB).

Table 1: Research UWB MIMO antennas

5. Conclusion

It is necessary to have fast data rates, great reliability, and outstanding transmission connection quality of communication systems due to the overuse of digital platforms and the fast growth of their user base in the wireless domain. More and more high-speed communication systems nowadays use MIMO antennas, and the development of modern wireless technology has been greatly supported. This paper presents the Design and implementation of MIMO Antennas for wireless communication. It has been demonstrated that MIMO communication is a useful technique for enhancing the performance and capacity of wireless communication systems. With the advantages of UWB MIMO techniques, automotive applications of an additional freedom degree can be achieved. A brief description of MIMO antennas, different design approaches, applications of MIMO antenna and UWN MIMO methodologies are discussed to analyze the automotive techniques performance. UWB MIMO antenna systems are extremely valuable for both current and prospective Auto-motive Communication. In future we will try to improve the performance of UWB MIMO antennas for automotive communication.

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Hanish chaitanya BodepudiAssistant professor

Research scholar Department of ECEVISTAS

hanishbodepudi@gmail.com

Dr. Arun Raaza Director R&D of ECEDept. VISTAS

TamilNadu, India director.card@velsuniv.ac.in

Dr. V Rajendran

Prof. and Director of ECEDept. VISTAS

TamilNadu, India. director.ece@velsuniv.ac.in

Dr. V Prabhu

Assoc. Prof and HeadVelTech MultiTech

Dr. Rangarajan Dr.SakunthalaEngineering College,

Chennai-600062.

prabhuv@veltechmultitech.org

Dr. M Meena, Associate. ProfessorDepartment of ECE

VISTAS, TamilNadu, Indiameena.se@velsuniv.ac.in