Virtual MIMO Antenna Design using Microstrip Antenna in Wireless Sensor Network

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Abstract: Those "digital MIMO" techniques are used in wireless sensor networks to make communique extra efficient, and they work much like actual MIMO. Quite a few human beings now use wireless sensor networks that run on battery strength. Because they need to be electricity efficient and last a long term, this means they have to be correct at these things as a way to clear up this, a brand new architectural technique referred to as virtual MIMO become made. To make an power green community, this technique may be very important. It facilitates you figure out how and wherein it have to be used. You may use MIMO generation in a unmarried antenna gadget by taking benefit of the cooperative idea and its energy-saving method with virtual MIMO. This survey paper more often than not talks about the way to try this. To make a wireless sensor community last longer with the least quantity of energy, this suggests how digital MIMO strategies can be used to try this A wi-fi conversation gadget with a couple of in and more than one out antennas, as well as unique S-parameters, are all simulated. Go back Loss in dB is also shown for specific frequencies, like S21, S22, S11, and S12. These frequencies have unique return Loss in dB. A lot of humans now use wi-fi sensor networks that run on battery energy. Because they need to be electricity green and remaining a long time, this means they should be appropriate at these items as a manner to remedy this, a brand new architectural approach referred to as digital MIMO turned into made. To make an energy efficient network, this method may be very vital. It enables you parent out how and in which it need to be used.
Keywords:MIMO (Multiple Input Multiple Output), Single Input Single Output (SISO), Wireless Sensor Network (WSN), Radio Frequency (RF), Microstrip Antenna (MSA).

1. Introduction

It is feasible to make a wi-fi sensor community (WSN) by setting sensors in exclusive elements of the environment. The sensors can then collect statistics about how things are in that region and send it to a primary place. Temperature, sound pollutants, humidity and wind are all things that they could degree [1]. They send sensor data to every other through "wireless advert-hoc networks,"whichare networks that shape on their own. WSNs maintain an eye on such things as temperature, sound, and pressure in the surroundings. Current networks are each amassing statistics and letting people determine what sensors can do. That is why these networks have been made. They can be used for such things as monitoring the battlefield. This thing has "nodes," which can be few or many [2]. There are sensors in every node that hook up with other sensors, and there are sensors in each node that make up every node. Generally, every of those nodes has a radio transmitter and a microcontroller, as well as an digital circuit for connecting to the sensors and an power supply. Those can be batteries or a integrated manner to get electricity from the floor. It's now not yet viable to make sensor nodes that are smaller than a grain of dirt. Sensor node fees also are a little specific from one employer to the subsequent. If the node is complicated, the rate can cross up or down a lot, depending on how a lot money it fees [3]. Having a restrained amount of area and cash makes it hard to get things to paintings. Which means that assets like strength and memory can't be used to get matters to paintings. There are lots of distinctive ways to set up a WSN, from a easy megastar community to a more complicated wi-fi mesh community.

There are loads of people who assume wireless sensor networks are going to be a massive element within the future [4]. Inside the previous couple of years, this field has been getting greater interest from business. A wi-fi sensor community is made of a whole lot of sensor nodes that work together to make sure that the whole thing works. Those sensors are small, so there isn't a lot of energy in them, and it is very difficult to get them lower back up and going for walks once more. One large hassle within the design manner is that wi-fi sensor networks want to use much less energy, so this is a big one. Whilst we cut down on the quantity of energy wireless sensor networks use, we make them final longer [5].

1.1 Multiple Input Multiple Output (MIMO) Antenna

At both the source (transmitter) and the destination (receiver), two antennas each are used. This is called MIMO, which stands for "multiple input, multiple output" (receiver). There are two antennas at each end of the communications circuit that work together to reduce errors, speed up data, and increase radio transmission capacity by allowing data to travel over many signal paths at the same time [6].When radio frequency (RF) systems can handle more information at the same time, MIMO makes connections more stable and less crowded.Figure:1 shows MIMO antenna.

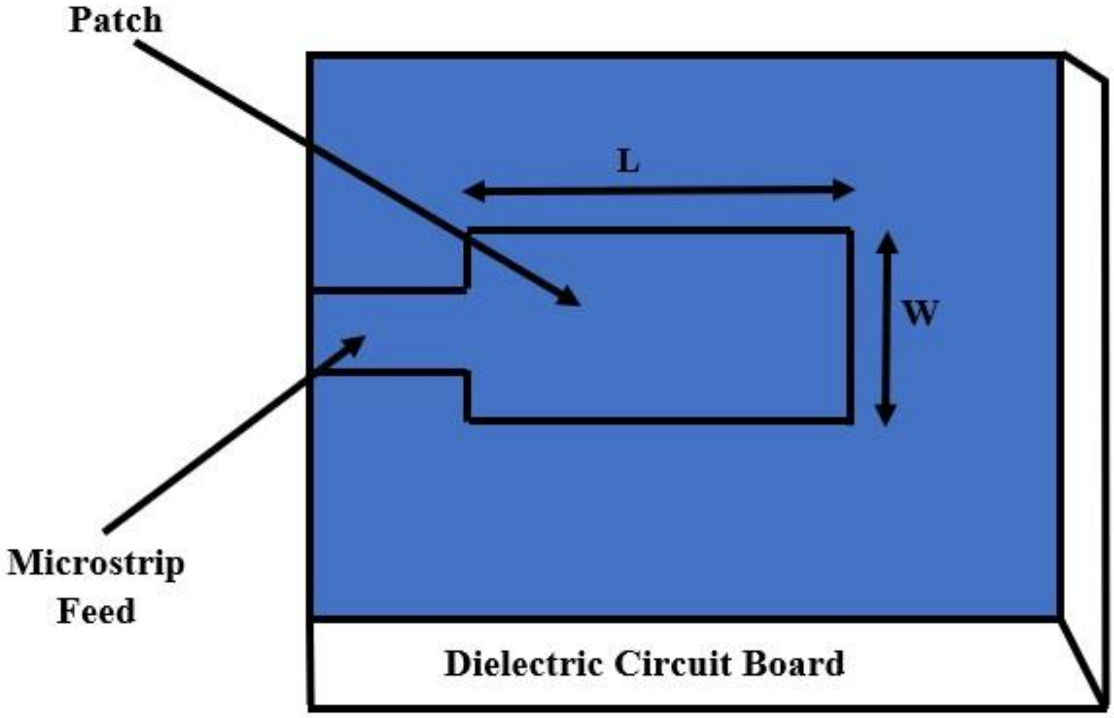

Figure:1 MIMO Antenna [7]

1.2 Microstrip Antenna

The size of the antenna is usually chosen so that the antenna resonates at the operating frequency. This gives the antenna real impedance, which makes the antenna work better. There must be about half a wavelength of dielectric space in order to make rectangular microstrip antennas that can pick up radio waves there must be about half a wavelength of space between the antenna and the ground [8]. One more thing that affects how much impedance there is in the antenna is how wide it is. Because there are open sidewalls, the radiation comes from fringing fields that pass through them and make it happen. However, the structure is mostly a resonant cavity, with only a small amount of radiation coming from the edges of the structure [9]. This means that the frequency range of the radiation isn't the same as the frequency range of the antenna's researchers talked about in the first place. Small bandwidth, on the other hand, is good for a lot of different types of communication. Figure:2 shows microstrip antenna

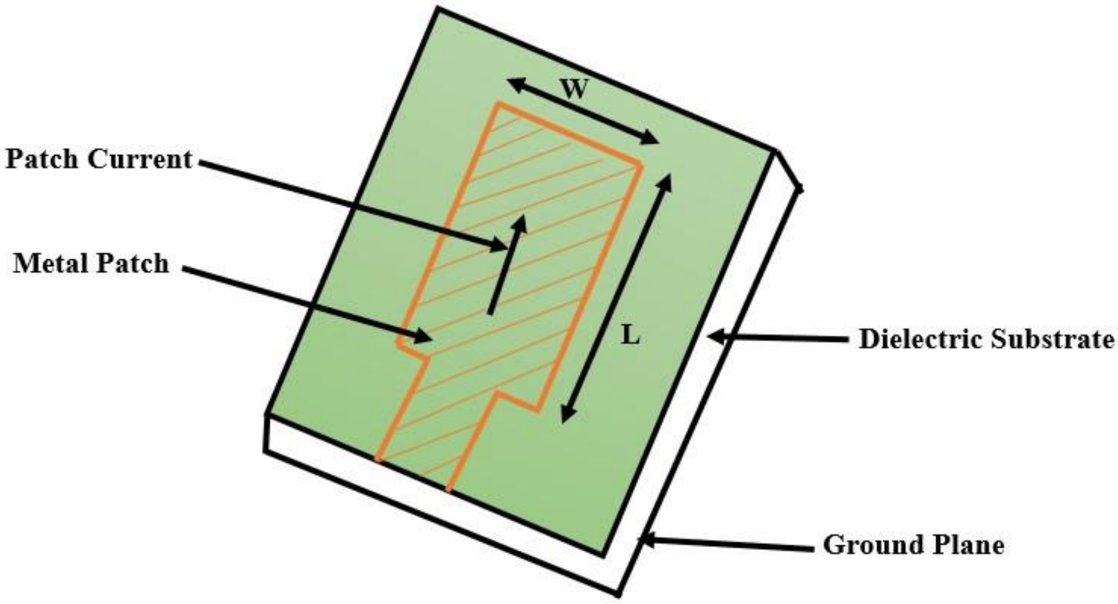

Figure:2 Microstrip Antenna [10]

2. Literature Review

Chan Hwang, et al. [11] A new printed diversity monopole antenna is shown that can be used for WiFi and WiMAX, among other things. In this antenna, there are two crescent-shaped radiators that are both placed symmetrically with respect to a ground plane that has been broken. In order to make sure that the antenna has good impedance matching and low coupling, a neutralisation line is put between them. This shows that the proposed antenna is a good choice for multiple-input multiple-output portable or mobile devices because of these things.

Jobs, Magnus, et al. [12] A lot of attention is paid to antenna design, adaptive antenna control, and how antennas can make small wireless nodes work better by adding more antennas. In order for wireless nodes to be able to compete on the market, they need to be small and have good performance. The main part of this thesis talks about how to do this through techniques. In a wireless node, the use of discrete phase sweep diversity has been tried and found to be a big help. An echo chamber and an office were both used to test how well a discrete phase sweep diversity system worked.

Xu, Lei, et al. [13] For Space Wireless Sensor Networks, we take a look at the working frequency and wireless transmission technology, as well as antenna design and anti-jamming technology, to come up with a set of complete and feasible secure communication solutions. These solutions are both safe and secure (SWSN). There is a way to make sure that high-speed nodes can talk to each other safely and quickly. All kinds of information will be exchanged automatically, in accordance with the rules of the message format that you're going to use.

Shigeo Kawasaki et al. [14]There is a new, small MIMO antenna system that can be used in many different ways. It has a UWB sensor antenna and can be used in many different ways. For cognitive radio applications, the model that was made can be used as a whole antenna platform for all of them. Different ways are used to change the antenna system so it can work with different types of wireless systems. Multi-band reconfigurable MIMO antennas and a UWB sensor antenna for cognitive radio applications make up the whole system shown in a very small package.

Wang, Ren, et al. [15] People have thought of making a small antenna that can be turned so that it can point in four different directions. This is how the antenna works: It has a main radiator and four other parts that are printed on a dielectric surface. Because diodes that are soldered to the parasitic elements can be turned on and off, the antenna can make four directional waves and one omnidirectional wave. A lot of the main beam directions of all four modes are almost in line with each other. This mode is called "omnidirectional," and it uses four directional beams to cover a wide area in this mode.

Sharawi, Mohammad S. et al. [16] During the last six years or so, there has been a big rise in the number of scientific articles and conference papers that talk about possible solutions for antenna systems that have more than one input and one output (MIMO). Recently, a lot of the most important conferences on antennas and how they work have talked a lot about MIMO antennas and how they can be used. There are a lot of wireless devices and gadgets that use these antenna systems now, and this trend is going to keep going because 4G and 5G wireless standards use a lot of MIMO technology, which is why these antenna systems are so important.

Galajda, Pavol, et al. [17] A new field of study and engineering called underwater wireless communication is becoming more important. The acoustic channel used to send underwater data from the transmitter to the receiver had a lot of problems, such as slow data transmission, a set bandwidth, a different transmission delay, and more. This is what the channel was used for. To make things worse, this caused multipath fading and the Doppler effect to happen. In the water, there is a network of wireless sensor nodes that pick up acoustic waves. They talk to each other through an acoustic link that goes from one node to the next.

Janhunen, Janne, et al. [18] The number of IoT (Internet of Things) devices is expected to rise dramatically over the next few years. People are paying a lot of attention to how these devices are made and how they work, as well as how they affect the environment and the economy, as well. There are ways to deal with both of these issues at the same time. One way is to use energy-neutral systems, which get their energy from the environment. Wireless power transfer (WPT) is the main problem with this system, which is that it doesn't work very well. In this paper, we build and study a system that is only powered by WPT over a radio frequency (RF) channel.

G. Goswami. et al. [19] The cognitive radio (CR) gives people new ways to use frequencies that aren't being used. This is called spectrum sharing. Using software-defined radio to solve the problem of channel congestion in cognitive radio networks is a good way to deal with it (CRN). Using a software-defined radio (SDR), users can change the frequencies and transmission properties between a licenced primary user (PU) and an unlicensed secondary user (SU). This is done by manipulating a wide range of frequencies (SU). For extra-large band scanning, this is a must because a common radiating antenna makes this possible. New, small antenna: This paper proposes a new antenna that can sense a wide range of frequencies in order to take advantage of empty channels in a wireless cognitive radio sensor network. It's small and easy to use (WCRSN).

Malarvizhi Subramani et al. [20] In this case, the CR radio and UWB Multiple Input Multiple Output (MIMO) systems work together to send short-range HD video and CR wireless sensor networks (CR-WSN). People who want to make this kind of integrated antenna system want to get around the problems of an antenna system that can change the frequency of UWB and Narrow Band (NB) radio waves. The CR antenna and the UWB MIMO antenna system are both part of the whole system, so they work together.

3. Applications of Wireless Sensor Network

There are groups of sensor nodes that communicate wirelessly to get information about the environment around them [21]. Wireless sensor networks (WSNs) are groups of nodes that communicate with each other. They have low power and are spread out in an ad hoc way. The fact that WSNs have become very popular doesn't mean they are safe. They have limited memory, computing power, battery life, and bandwidth, which makes it hard to keep them safe. If you want to keep your information private, you could be the target of a wide range of attacks [22].

Area monitoring -Use WSNs all the time to keep an eye on something. It is called area monitoring when the WSN is spread out over a certain area that needs to be watched for something. In the military, sensors are used to see if an enemy is near [23]. The geo-fencing of gas or oil pipelines is an example of this.

Health care monitoring -The sensors can be implanted, worn, or integrated into the environment. It is possible to put medical devices inside of the body. It can be on the surface of a person's body, and it can also be near the person who is using it. These systems use sensors that are found in the environment.

Threat detection - WATS is supposed to be able to find a nuclear "briefcase bomb" that goes off on the ground when it does. If WATS was built, it would have wireless gamma and neutron detectors that talk to each other through a network of wires [24]. Sensors pick up data that goes through "data fusion." This is the most important part of the system.

4. Multiple Input Multiple Output Antenna for Wireless Communication System

"MIMO" used to be a term in wireless that meant using multiple antennas at both the sender and receiver. This is no longer the case, though [25]. Multipath propagation makes it possible to send and receive multiple data signals at the same time over the same radio channel at the same time. This is called "MIMO." When orthogonal frequency division multiplexing is used to encode each channel, the storage capacity goes up. "Multipath" may be interesting, but this "multipath" is not the reason. MIMO is very different from smart antenna techniques like beamforming and diversity, which are used to improve the performance of a single data signal [26]. MIMO is not the same as smart antenna techniques like beamforming and diversity.

Lots of people think that the term MIMO comes from research papers written in the 70's about digital transmission systems that had multiple channels and cross talk between wire pairs in a cable bundle [27]. The math used to deal with mutual interference helped make MIMO possible. Even though these aren't examples of using multipath propagation to send multiple information streams, the math used to deal with mutual interference helped make it possible [28].

SDMA is a way to communicate with people who are in different places near the same base station at the same time. It has antennas that are directional or smart [29]. In this case, the base station has "a lot of receiving antennas," and there are "a lot of people who are far away."

5. Multiple Input Multiple Output Antenna Functions for Wireless Sensor Network

People who use MIMO can break it down into three main groups: pre-coding, spatial multiplexing or SM, and diversity coding [30-32].

Precoding -One signal is sent out by each transmit antenna with different phase and gain weightings, so that the signal power at the receiver is at its highest point. This is how it works: When it comes to cell networks, beams aren't the best way to think about them. Cellular networks are made up of many different paths. It can't keep the signal level high at every antenna at the same time when the receiver has a lot of them. Many times, it's good to pre-code with multiple streams in mind.

Spatial multiplexing -To separate these streams into (almost) parallel channels at the receiver, there must be a big enough difference in how these signals look in space. The receiver must be able to figure out what it is. Spatial multiplexing is a very good way to add more channels at a better signal-to-noise ratio by adding more channels (SNR).

Diversity Coding -It is used when the transmitter doesn't know which channel it is on. It is different from spatial multiplexing when only one stream is sent. Use space-time coding to make the signal more clear. Almost all of the transmit antennas have orthogonal coding that is full or almost full for each of them. There are many antennas that send and receive signals, and each one fades at its own rate. This makes the signal more stable. It doesn't work this way because there is no way to know which channels are being used.

6. Enhancing the network bandwidth in mines

Positioning an antenna near the ceiling's centre or on one of the side walls may increase excitation power by using the total coupling efficiency of antenna-radiated power. Both close and distant field areas may be improved by optimising the antenna's polarisation and position. In order to validate the grid-based test system, systematic measurements were made in an underground coal mine tunnel. Experimentation and the underlying assumptions are in great accord. Additionally, EM interference caused by mine infrastructure was measured and compared to the signal received by antennas in different places. Some cables, such as power and communication, may be overlooked in the study because of their long-term, stable demands.

7. Applications of Multiple Output Multiple Input Antenna

Base stations in the 3rd Generation can use space-time transmission diversity schemes with beamforming to send more data at the same time (CDMA and UMTS). Fourth Generation (4G) LTE and LTE Advanced are very advanced air interfaces that use MIMO a lot. These air interfaces are very high-tech [33]. A lot of attention is paid to single-link MIMO with Spatial Multiplexing and space-time coding in LTE, but multi-user MIMO is added in LTE-Advanced, which makes it even more complicated. A lot of people use spatial multiplexing to make the receivers more difficult to use, so they usually use Orthogonal frequency-division multiplexing (OFDM) or Orthogonal Frequency Division Multiple Access (OFDMA) modulation instead. MIMO wireless architectures and processing techniques can be used to solve problems with sensing, and they can help. The study of this is done in the field of radar known as MIMO radar. It is possible to use MIMO technology in systems that don't communicate with each other by wireless means [34].

7.1 Significance of MIMO for users

It was added to Release 8 of the Mobile Broadband Standard by the 3rd Generation Partnership Project, which is also called the 3GPP. There has never been a time when MIMO has been used in this way [35]. If you want to connect to Wi-Fi networks and cell phones, this is what you need. You can also use it for things like law enforcement, broadcast TV production, and the government. If you want to communicate with a lot of data, you might use MIMO. This is because it's very important not to have microwave or RF systems interfere with these kinds of communications, which are very important.

7.2 LTE applications of MIMO

Most people use MIMO, which is a type of wireless that works well. In the development of LTE and wireless broadband technology, it played a big role. Speeds go up with LTE because it uses MIMO and orthogonal frequency-division multiplexing to send and receive data faster. In LTE, MIMO makes it easier for data to be sent more reliably and faster than before [36]. In order to send it, it splits the data up into several different streams. Sending information through the air to someone who already knows about it is called transmission. This helps the receiver figure out the best way to get a signal, so it can get the best signal.

7.3 MIMO and 5G massive systems

There are a lot of new ways to use MIMO, and the wireless industry is always trying to fit more antennas, networks, and devices into the same space, which makes MIMO better and better over time. There are a lot of examples of this, but one of the most well-known is the use of the 5G network [37]. Use a lot of small antennas to give more bandwidth to users than 3G and 4G cell phones. They can also have a lot more users on each antenna. You can't use 4G MIMO, which uses a frequency division duplex (FDD) system to support multiple devices. This is not the same thing. Instead, 5G massive MIMO has a different setup called time division duplex.

8. Microstrip Antenna

An antenna called a microstrip antenna is usually made on a printed circuit board by using photolithography techniques to print an antenna that is small enough to be seen but not so small that it can't be seen by the naked eye. PCBs (printed circuit boards) have a layer of metal foil in different shapes on the surface of them. This layer is called a "pattern antenna." Metal foil is used to make a ground plane [38]. If you buy a lot of microstrip antennas, they usually have a lot of patches in a 2-D pattern. In most cases, a transmission line made of foil microstrip transmission lines is used to send or receive radio waves. An antenna sends radio frequency current between its antenna and the ground plane, which makes it possible for you to listen to radio waves. They have become very popular in the last few decades because they are very thin and flat. Printed circuit techniques can be used to make them for things like consumer goods, planes, and missiles, and they can be used to make them as well. They can also be made with active devices, such as microwave integrated circuits, to make active antennas that are more powerful [39].

This is the most common type of microstrip antenna. If you look at the antenna, the name is a patch antenna. In addition, it is possible to make antennas that use patches to make up the parts of a group of antennas. This is how a patch antenna is made: The antenna elements are etched into the surface of a metal trace that is attached to an insulating dielectric substrate, like a printed circuit board. This is how a patch antenna is made: To make a ground plane, a metal layer is then glued to the other side of the substrate. Some common shapes of microstrip antennas are square and rectangular, but they can also be made into any shape that you want. If you build a patch antenna, some of them don't use a dielectric base. In place of that, they are made of a metal patch on top of a ground plane with dielectric spacers in between. Less durable: It has a wider range of frequencies but isn't as strong. If you want to put these antennas on the outside of planes and spaceships, they have a very low profile and are very durable. They can also be shaped to fit the curving skin of a vehicle.

8.1 Advantages

They are easy to make and design because they have a two-dimensional shape that is simple to make and design. To understand why they are used at high frequencies, you need to know how long the antenna is at its resonant frequency. This is why they are used at UHF and above. When you use lithography, you can print a lot of different patches on one piece of paper at once. As many patches as possible can make you more money than if you only had one patch.

8.2 Rectangular Patch, Specifications and Other Types

An antenna made of air has a length that is about one-half of a wave in the air. With a dielectric as its base, the antenna's length gets shorter when it has a higher relative dielectric constant than it did when it was not filled with anything. To explain why, think about the "fringing fields" that surround your radio. These fields make the antenna's electrical length a little longer. An early model of the microstrip antenna is a piece of microstrip transmission line with equal loads on both ends. This shows how radiation is lost when it comes from both ends. The dielectric loading of a microstrip antenna has an effect on both its radiation pattern and its impedance range, so it's important to pay attention to what you do. two things happen when a substrate has a high dielectric constant, and both of them happen at the same time. The range of impedance gets smaller. These slots make up an array and have the best directivity when the antenna is made of air. Directivity goes down when this dielectric is replaced with a dielectric substrate that has a higher relative permittivity than the old one.Figure:3 shows MSA design.

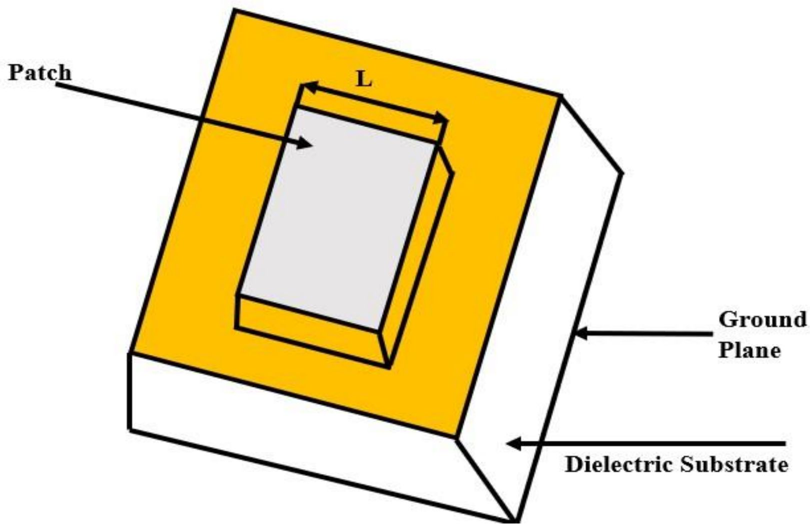

Figure:3Microstrip Antenna Design and Performance [40]

9. Simulated Results and Discussion

The term "antenna techniques" refers to the process that antennas go through to make sure they meet or define the criteria. Here, we talk about all of the antenna parameters, which are called S-Parameters and Return Loss. These are called S-Parameters and Return Loss.

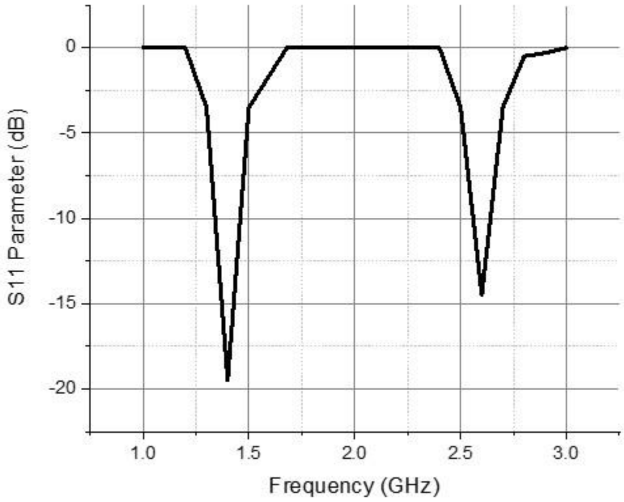

Figure: 4Plotted Frequency Response of the MIMO Antenna S_{11} Parameter

It will show the frequency response of the MIMO antenna in figure: 4, figure: 5, figure: 6, figure: 7, and figure: 8. The return loss will be shown in figure: 8. S-Parameter measurements are made to find out how much of the prototype is lost and how isolated it is. Because of its MIMO antennas, the S-Parameter can measure the power of the antenna. The lower return loss means that the prototype is more efficient. The resonant frequency of the prototype is calculated at the place where the return loss is the lowest.

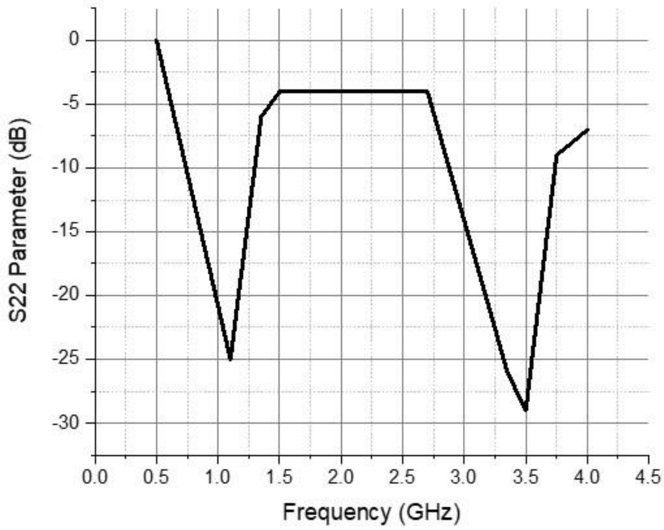

Figure: 5Plotted Frequency Response of the MIMO Antenna S_{22} Parameter

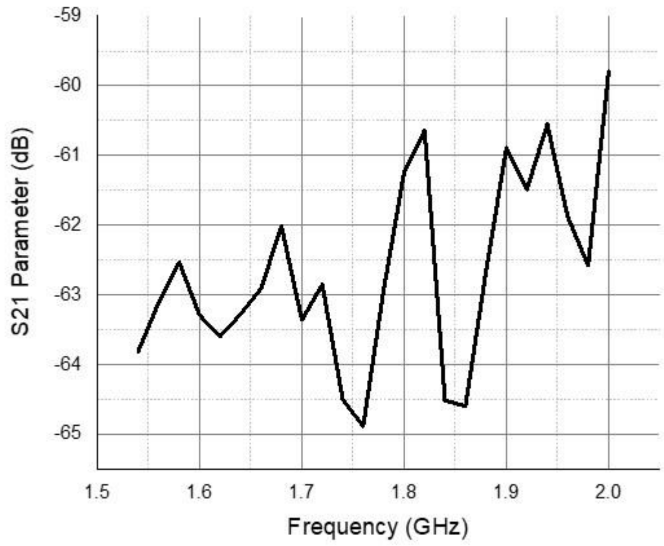

Figure: 6Plotted frequency response of the MIMO Antenna S_{21} parameter

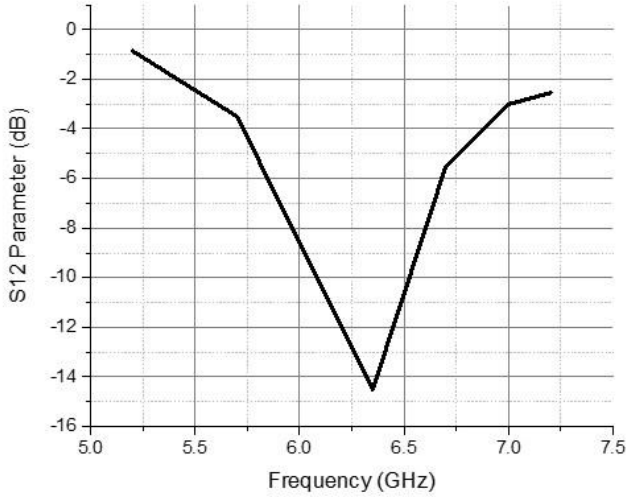

Figure: 7Plotted frequency response of the MIMO Antenna S_{12} parameter

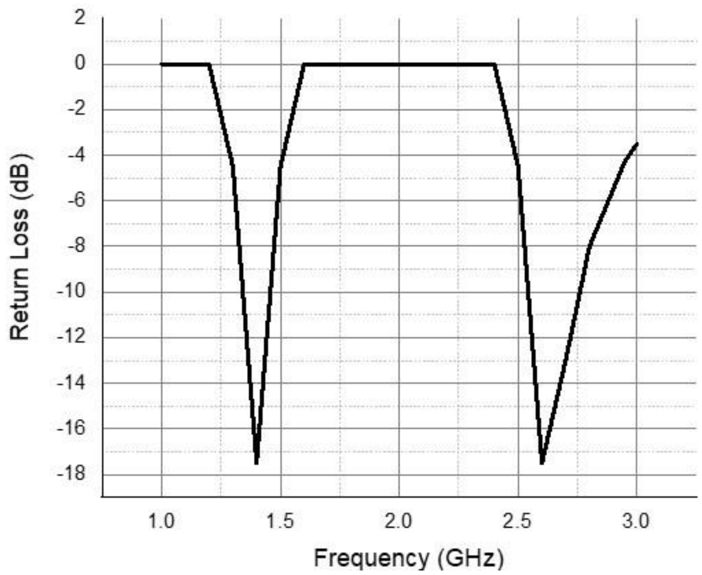

Figure: 8Plotted Frequency Response of the MIMO Antenna Return Loss Parameter

10. Conclusion

These "virtual MIMO" techniques are used in wireless sensor networks to make communication more efficient, and they work just like real MIMO. We look into virtual MIMO at both fixed and variable prices. This is what we do. When we used virtual MIMO, we came up with a way to use less energy and save money. Data were measured in an underground mining mine tunnel to verify the wire test system's results. Coal mines could use this deployment approach because the theoretical and experimental values results were in good accord, proving its efficacy.Wireless sensor networks are becoming more and more popular because they can sense, compute, and send. Isn't that why it has a lot of little sensor nodes that run on small batteries? It takes less energy to send the same number of bits with the efficient modulation schemes and transmission schemes. To learn about MIMO and its energy model, read this paper. You will learn how different MIMO schemes use energy, and how MIMO schemes are different. If you want to save energy, there are many different ways. The method of multiple input multiple output saves the most energy.

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