Reconfigurable MIMO Antenna System Using Voice Control

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Abstract

Multiple Input Multiple Output (MIMO) antenna has two or more physical antennas in a single kit and is designed to use IEEE802.11n Wi-Fi networks. With the same radio transmission power, data capacity and range are improved as opposed to single antenna. In the work a reconfigurable MIMO antenna network is being introduced. To achieve the MIMO configuration the multiple radiating components of the proposed antenna are located orthogonally. Stepper motor can mechanically alter the feeding network. Using voice recognition software on android devices, the user monitors coverage. Every antenna system operates at a bandwidth of 5.28 GHz and gains of approximately 7.5dB. The radiated field reconfiguration enables the users to interact in different directions. The stepper motor is controlled on personal mobile through a voice recognition program. Such function helps users to modify the communication needs without having to touch the device physically. For boost outdoor coverage along defined directions, the MIMO antenna system can be built into a WLAN access point.

Keywords: *MIMO,Wi-Fi Networks, IEEE 802.11n, Voice Recognition, Reconfigurable antenna*

1. Introduction

Cell phone antennas and other forms of wireless devices link us to anything and everything. With the activities of humanity expanding into space, the need for antennas will rise to an unparalleled extent. Antennas will have the essential connections to everything out there and from there. In everyday life application the personalization of contact needs can be enhanced by adjusting the characteristics of an antenna's radiation pattern. Reconfiguring an antenna structure's radiation pattern involves a modification in the antenna currents or edges that radiate. The topology of antennas allows several radiating elements of the same antenna system to be positioned orthogonally to create a MIMO antenna system.

Costantine et.al [1, 2] Discuss the Reconfigurable Antennas process. Reconfigurable antennas are proposed to cover various wireless services which operate over a broad frequency range. Authors demonstrate the ability to adjust their geometries and behaviors to respond to changes in the circumstances around them and can offer the same multi-antenna throughput. The proposed work is based on "A Radiation Pattern Reconfigurable Antenna for WLAN Access" presentation, Discusses radiation coverage of the antenna over a WLAN link spectrum (5.19-5.4GHz). The coverage of the radiation pattern has been accomplished by two antennas with the same elements positioned orthogonally. Asadallah et.al [3] address the increased coverage of the radiation pattern of the antenna which is the continuation of the work suggested by. The implications of introducing MIMO program for improved coverage of radiation in the WLAN access area were also discussed in literature. Antenna reconfiguration using stepper motor is interfaced via Bluetooth module, and the inputs are also addressed via a voice recognition program in an android-based smartphone. From the online source link [4], the configuration of the micro strip patch antenna in the CST studio suite is referred. Online source

[5] has been used for information on the microcontroller used in hardware implementation, which describes the functions and method of the Arduino UNO microcontroller board.

The suggested antenna system in this paper provides the users with access to effective WLAN coverage. The antenna together with a microcontroller to boost its indoor coverage with the users defined predetermined directions. The feeding network can be mechanically modified by an interfaced stepper motor with an Arduino microcontroller. The user can use the application for voice recognition to reconfigure different antennas via a cell phone that adds more personalization.

The user can use the application for voice recognition to reconfigure different antennas via a cell phone that adds more personalization. The antenna size is small in the form of an array, and the frequency covers up to 5.28GHz and can be used for different WLAN applications. The feed line technique in L-shaped form is used in the antenna array. The antenna being proposed is planned and simulated using software from CST Microwave Studio 2018. The computer simulates the results to get radiation pattern accuracy and high gain.

Reconfigurable antenna system MIMO is implemented using software for the simulation. Through introducing four MIMO antenna arrangement the coverage can be expanded in the proposed network. Each antenna gets the gain of about 7.6 db. Using android based framework, the user can monitor the custom coverage. The layout of the design can increase the area covered. Use a stepper motor the feed to the antenna can be adjusted mechanically. Bluetooth module can communicate with the stepper motor. Further personalisation can be accomplished by changing the path of the feed.

2. Reconfigurable Antenna

2.1 Overview

A reconfigurable antenna is an antenna able to dynamically, in a regulated and reversible manner, change its frequency and radiation properties. To provide a dynamic response, reconfigurable antennas incorporate an internal mechanism such as RF switches or mechanical actuators that allow the RF currents to be intentionally redistributed over the surface of the antenna and result in reversible modifications to its properties.

Fig.1. shows the reconfigurable antenna structure which consists two ports. The change is given to the either of the ports by using RF choke connected to port connector. The connector is given the power through the RF and microwave supply.

Reconfigurable antennas differ from smart antennas because the reconfiguration process resides inside the antenna, rather than in the network creating an external beam. The reconfiguration function of reconfigurable antennas is used in a changing scenario to optimize antenna efficiency, or to meet changing operating requirements.

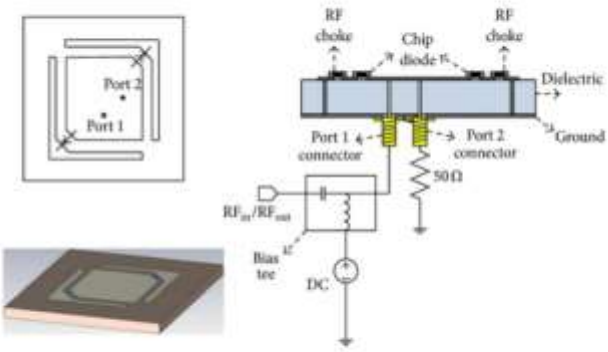

Figure 1. Reconfigurable Antenna

2.2 Reconfigurable Antenna Forms

Reconfigurable antennas may be categorized according to the dynamically modified antenna parameter, usually the operating frequency, radiation pattern, or polarization.

2.3 Reconfiguration Frequenzy

Frequency reconfiguring antennas are capable of dynamically changing operating frequency. These are especially useful in situations where multiple communications systems collide as one single reconfigurable antenna can replace the multiple antennas needed. Using RF-switches, impedance loading or tunable materials, the frequency reconfiguration is usually accomplished through physical or electrical changes to the antenna dimensions.

2.4 Reconfiguration of Radiation Pattern

Configurability of radiation pattern is dependent on deliberate alteration of the radiation pattern spherical distribution. Beam steering is the most extended method which consists of directing the maximum radiation path to optimize the antenna gain in a link with mobile devices. Reconfigurable pattern antennas are typically constructed using movable / rotatable structures or parasite components that are switchable and reactively charged. Due to its small form factor, large beam steering range and wireless applications, meta material-based reconfigurable antennas have gained popularity in the past 10 years.

2.5 Reconfiguration of Polarization

Reconfigurable antennas for polarization are able to switch between various types of polarisation. In portable tools, the ability to switch between horizontal, vertical, and circular polarizations can be used to reduce losses of polarization mismatch. Configurability of polarization can be given by adjusting the balance between the different modes of a multimode structure.

2.6 Compound-Reconfiguration

Compound reconfiguration is the ability to run multiple antenna parameters simultaneously, for example frequency and radiation patterns. Combining frequency agility and beam-scanning to provide enhanced spectral efficiencies is the most common use of the compound reconfiguration. Compound configurability is accomplished by integrating or redesigning the same system of various single-parameter reconfiguration techniques.

3. Proposed MIMO System

The design of proposed MIMO antenna system has been implemented. It is possible to adjust the feed given to the antenna by rotating the L-Shaped feeding network at an angle of 2700, so that the feed can be changed between two orthogonally positioned antennas. The antennas are placed at lambda by 2 length apart (lambda =5.28GHz).

The L-shaped feeding network can be changed using a stepper motor integrated with the antenna. The stepper motor can be controlled using a Arduino microcontroller. A Bluetooth module (HC05) is interfaced with microcontroller. The microcontroller takes the input through a voice recognition application installed in android based mobile phones.

From fig.2, the consumer first determines the antenna radiation pattern coverage region, then the feed can be provided as per the coverage area. These coverage areas can be defined based on the feed given to the antennas.

The following phases are made when different antennas are fed:

Phase A: antenna 1 and antenna 3 are fed.

Phase B: antenna 1 and antenna 4 are fed.

Phase C: antenna 2 and antenna 3 are fed.

Phase D: antenna 2 and antenna 4 are fed.

These phases comprises of major and minor coverage in a particular zone of WLAN region. The zones will have major coverage and minor coverage according to the strength of the feed given. All the zones have major coverage and minor radiation coverage. These coverage zones specify the desired area to be covered. This is explained in the table shown.

ZON E 1 **Major coverage** phase A, phase B **Secondary coverage** phase C	**ZON E 2** **Major coverage** phase C, phase D **Secondary coverage** phase B
ZON E 3 **Major coverage** phase A, phase C **Secondary coverage** phase D	**ZON E 4** **Major coverage** phase B, phase D **Secondary coverage** phase A

Figure2. Zones of Coverage of Radiation Pattern of Antenna

When the coverage area is selected, the feeds according to the zones are fed by using L-shaped feeding network. The Arduino voice application receives voice as commands and converts it into string characters which can be accepted by Arduino microcontroller. Such string characters are provided to the stepper motor as inputs using a Bluetooth module that is ordered to rotate the feeding network in L-shapes. Fig.3. represents the Flow diagram of the proposed MIMO antenna system is represented as follows.

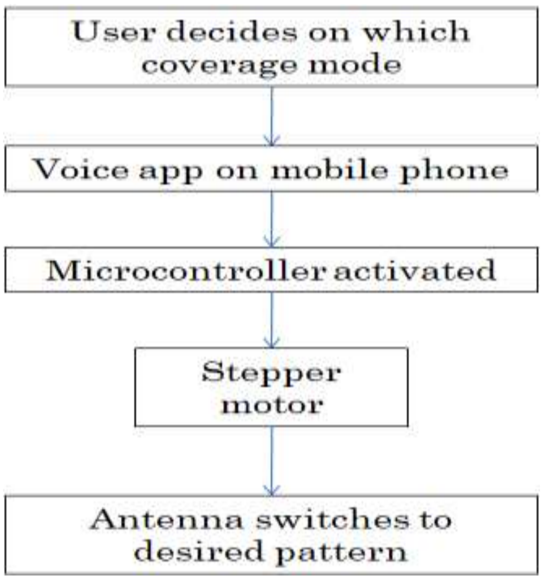

Figure 3. Flow Diagram of The Proposed Antenna System

4. Simulation Using CST Studio Suite Software

4.1 Computer Simulation Technology

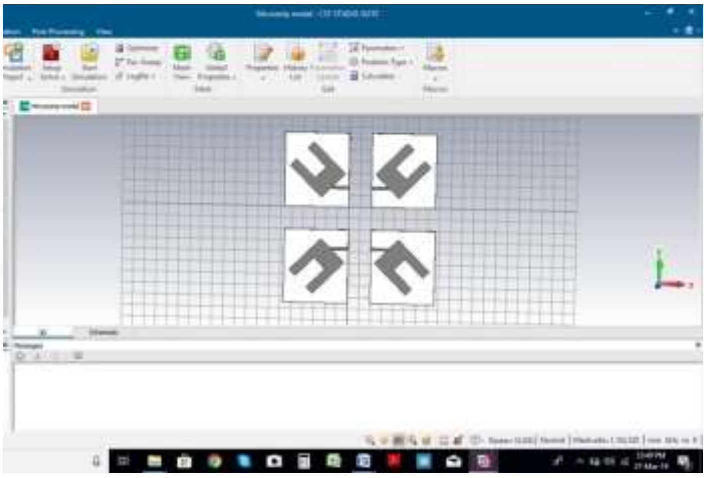

Figure 4. Designed MIMO Antenna System

5. Feeding Technique

A variety of methods can be used to fire micro strip patch antenna. Such strategies can be divided into two contacting and non-contacting groups. Use a connecting factor like microstrip thread, the RF power is directly fed into the radiating patch in the contacting process. Electromagnetic field coupling is performed in the non-contacting region to transfer power between the microstrip line and the tracking pad.

These antennas are primarily fed using following simple methods

- Probe Coupling Method
- Micro strip Line Feeding Method
- Aperture Coupled Microstrip Feed Method
- Proximity Coupling Method
- L-shaped feeding technique

5.1 L-Shaped Feeding Network

This L-Shaped feeding system can be incorporated at the middle of the whole antenna system between two antennas. It is shown in fig.5. The feed can be changed between the antennas by rotating the feeding L-section 2700 apart. This rotating part will have a radius of 17.5mm.

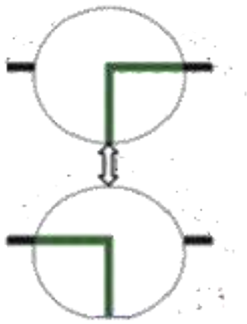

Figure 5. L Shaped Feeding Network

6. Simulation Results and Discussions

6.1 Radiation Pattern

A radiation pattern describes the intensity variation that an antenna radiates as a function of the direction away from the antenna, or it is simply a plot that helps us to envision where the antenna transmits or receives power. Such power variance is observed in the far field of the antenna, as a function of the angle of arrival.

6.2 Three Dimensional Radiation Pattern

The 3D plots are useful to visualize which ways the antenna radiates. A typical antenna that is installed into a WLAN access point gives a directive gain of < 5dB. The proposed antenna will generate a gain of approximately 7.6 dB which is much greater than the standard antennas used in the WLAN access point.

Figures 6.1 represent the 3-dimensional radiation pattern for each antenna of the proposed MIMO network.

- Fig 6.1a shows the 3-D radiation pattern when antenna 1 is fed.
- Fig 6.1b shows the 3-D radiation pattern when antenna 2 is fed.
- Fig 6.1c shows the 3-D radiation pattern when antenna 3 is fed.
- Fig 6.1d shows the 3-D radiation pattern when antenna 4 is fed.
- Fig 6.1e shows the scale of dB values of the antenna's gain pattern.

The value obtained differs from 7.6 dB with a minimum value change of about 0.6 dB. All the antenna in the system experiences the same gain pattern characteristics. Each antenna experiences an almost 7.6 dB directive gain which is higher than previous works. From the gain pattern analysis, we can note that the orthogonally arranged antennas should have a pattern of gain which is perpendicular to one another.

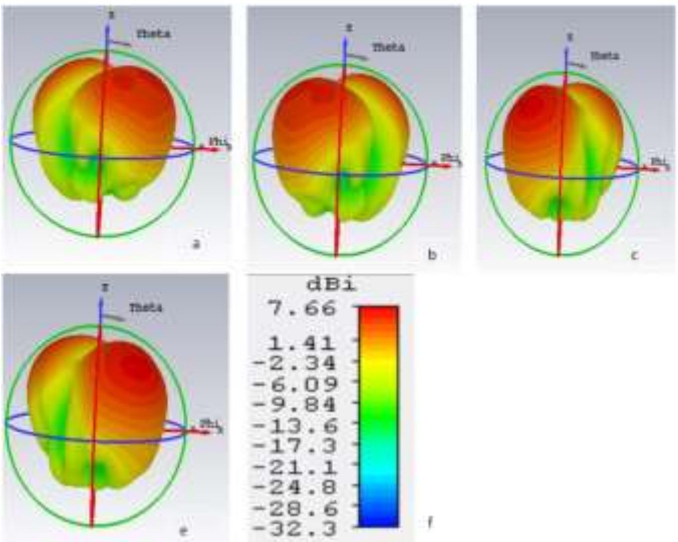

Figure 6. Dimensional Radiation Pattern of the MIMO Antenna

6.3 Two Dimensional Radiation Pattern

The radiation patterns are plotted in 2-dimension to make representation of radiation patterns simpler. Through the 3 dimensional plane the patterns are given as 'slices.' The pattern of radiation is azimuth plane which represents the radiation pattern plot for a fixed polar angle. A process is 'isotropic' if the distribution of radiation in both directions is similar. In reality, antennas with isotropic radiation patterns do not exist, but are often discussed as a way of comparison with the actual antennas. For each feature in the MIMO antenna system at 5.28 GHz, the simulated radiation patterns along the elevation plane (phi=900), described in polar form for the proposed antenna topology, are shown.

- Fig 7 a represents the 2-D radiation pattern while feeding antenna 1
- Fig 7 b represents the 2-D radiation pattern while feeding antenna 2.
- Fig 7 c represents the 2-D radiation pattern while feeding antenna 3.
- Fig 7 d represents the 2-D radiation pattern while feeding antenna 4.

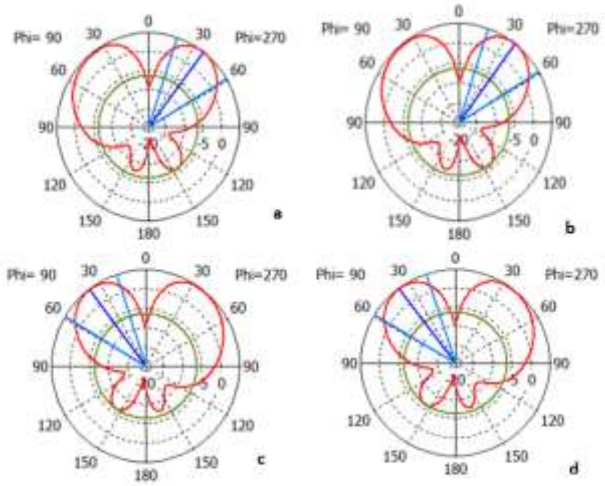

Figure 7. Dimensional Radiation Pattern of the Antenna

6.4 S Parameter

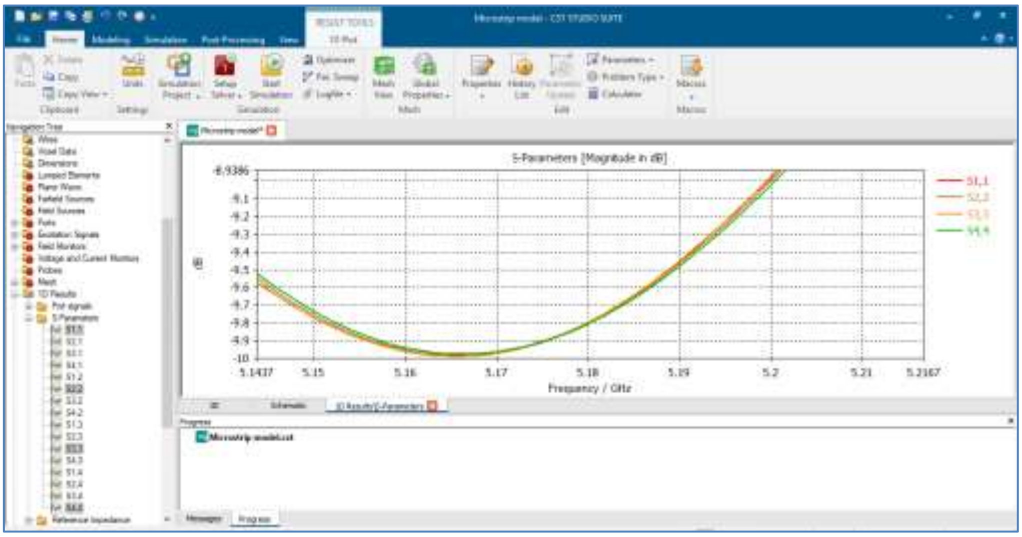

Figure 8 S-Parameter

The most widely cited antennal parameter is S11. It measures how much power the antenna reflects, and is also known as the co-efficient of reflection. S-Parameters are often used in radio frequency (RF) and microwave frequency operating networks where the quantification of signal strength and energy factors is simpler than currents and voltages.

In addition to the characteristic impedance or device impedance, S-parameters vary with the measurement frequency, so frequency must be determined for any defined S-parameter measurements. The S Parameter values of the proposed antenna are represented in the above figure. It gives a peak value of about -10dB. Fig 8 displays the values of the S parameters for each MIMO antenna system antenna. Every antenna in the system experiences same value for gain pattern, radiation pattern, and reflection co-efficient values

7. Conclusion

In the proposed work, a user's ability to redirect beam from a MIMO antenna system which relies on a rotating feeding structure that redistributes the antenna's radiation pattern characteristics. At 5.28 GHz the antenna operates with a gain of around 7.6dB. Using Bluetooth via a microcontroller interface, the more personalization of WLAN coverage can be reconfigured via the voice commands via android application in android mobile phone.

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