A Radiation Pattern Reconfigurable Antenna for WLAN Access

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***Abstract*—This paper presents a new antenna system that reconfigures its radiation pattern through feed rotation. The radiation pattern reconfiguration allows a better Wireless LAN coverage through a personalized command by resorting to an Android phone application and an Arduino microcontroller.**

I. Introduction

Radiation pattern reconfigurable antennas present a suitable solution for communicating over multiple directions while preserving the same frequency band. Wireless communications applications such as cognitive radio, Multiple Input Multiple Output (MIMO) channels, or personal communication devices represent suitable platforms for the implementation of these types of antenna systems.

Reconfiguring the radiation pattern of an antenna structure requires a change in the antenna currents or radiating edges. Thus, an antenna designer must be careful about which reconfiguration technique to use and its integration mechanism into the antenna structure. The reconfiguring components need to have minimal effect onto the antenna's radiation characteristics.

PIN diodes can be incorporated into an antenna structure with the integration of a reflector to constitute a reconfigurable antenna that redirects its radiation pattern over multiple frequency bands in a cognitive radio platform [1]. A reconfigurable feeding network can also be used to feed different antenna structures at different instances insuring radiation pattern reconfigurability and pattern diversity for MIMO applications [2].

In this paper, an antenna system that is composed of two radiating structures is proposed. A feeding network rotates between the two antenna elements to excite each element separately. The rotation of the feed is executed using a stepper motor which is controlled by An Arduino UNO microcontroller. The purpose of a design such as the one presented in this paper is to provide to users the accessibility to efficient WLAN coverage. The antenna proposed herein is planned to be incorporated on a WLAN access point along with the controlling Arduino microcontroller. The user resorts to voice control on an android phone through an application that converts voice commands into strings of characters. The Android application initially connects to a Bluetooth Module (HC-05), which is wired to the Arduino. When a user voices a command, the application uses Android's internal voice recognition to interpret the voice command and send the recognized string of characters to the connected Bluetooth shield. The Bluetooth shield routes the command to the Arduino board which in turns activates the stepper motor and rotates the feeding lines in one direction or the other. Thus it redirects its radiation pattern. It is important to note that while the antenna redirects its radiation beam; its frequency of operation is maintained in the IEEE 802.11a band between 5.1 GHz and 5.4 GHz.

II. Antenna Design and Results

Each radiating structure is a U shaped patch antenna etched on top of a 1.6 mm Rogers Duroid 5880 Substrate with a dielectric constant of 2.2. The two patch antennas form an angle of 120° between each other. A Rotating feed is used to feed each element separately. Once an antenna element is fed, the radiation pattern will be directed outward of the U shaped patch in a 30° tilt angle covering both the 30° radiation direction and its counterpart the 210° as well. The rotation of the feed is executed using a stepper motor that is controlled by an Arduino UNO microcontroller. Fig.1 shows the full antenna system along with its radiation pattern direction and some of its dimensions in mm.

Each U Shaped patch is etched on top of a 65 mm x 56.5 mm substrate. A ground plane covers the bottom layer of the entire antenna system. A rotatable substrate cylinder of radius 17.5

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mm holds two feeding lines of width 2 mm and length 17 mm each. An extension of the feed line stretches over a 1 mm gap between the rotating cylinder and the remainder of the patch to insure constant connection between both sets of feeding lines. The total length of each feeding line is equal to a quarter wavelength at the desired operating frequency which is 5.28 GHz that corresponds to the IEEE 802.11a standard. Fig. 2 shows a comparison between the measured and simulated reflection coefficient of each of the antenna element. The comparison shows good agreement between both data sets.

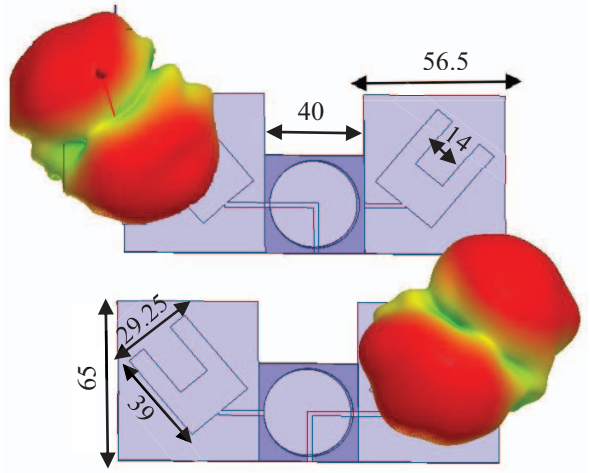

Fig.1 Antenna system with radiation direction for each fed element along with some of its dimensions in mm.

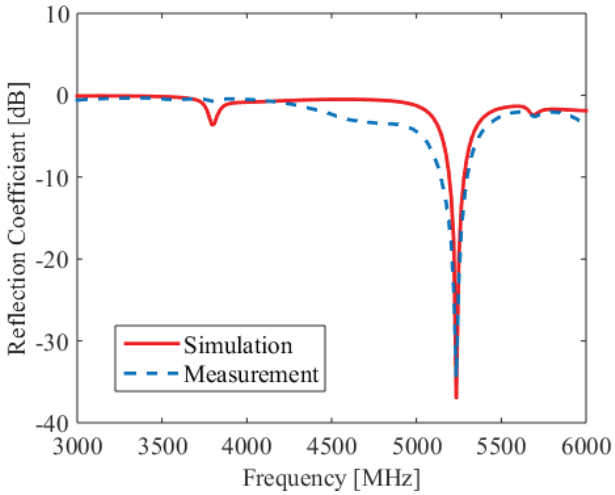

Fig.2 Comparison between the measured and simulated reflection coefficient of the antenna system.

III. Antenna Control and Automation

The control of the antenna system is designed to be personalized and user friendly. The rotation of the stepper motor is controlled by an Arduino UNO microcontroller [3] that is incorporated with the antenna on a WLAN access point. The Arduino board used is the Arduino Mega 2560. A Bluetooth module (HC-05) is wired to the Arduino board. The goal of the Bluetooth module is to insure connection with an android phone. A voice recognition application known as AMR voice is installed on the user's android phone. The AMR voice application can be found on the Google play store and can be easily installed on any android phone. The voice recognition accuracy is improved with a software "Add-On" known as bitvoicer [4] that is installed on the Arduino board. The antenna system is designed to operate in different modes. The user specifies the desired mode of operation by activating the application on the android phone and voicing the command word that is specific to the desired mode of operation. Once the application receives the command it converts it into strings of characters that are then relayed through the Bluetooth connection to the Arduino Microcontroller. The Arduino controller analyzes the character strings and orders the stepper motor to rotate to a pre-specified angle that corresponds to feeding one antenna element. Once the radiating antenna is fed, radiation is that specific direction is achieved. Fig. 3 shows the Arduino board connected to the Bluetooth shield and the stepper motor.

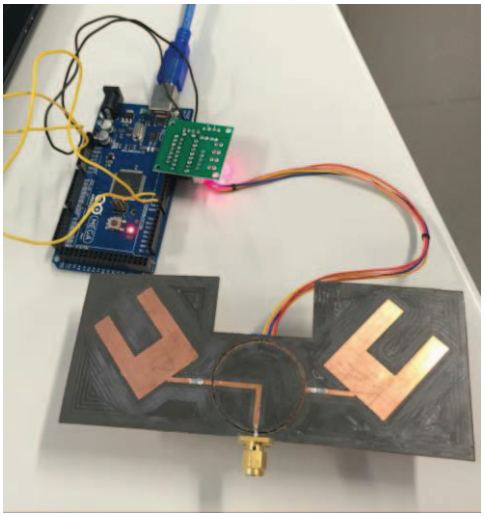

Fig.3 Adruino UNO board's connection to the stepper motor on the bottom layer of the antenna system.

IV. Conclusion

In this paper we present a new reconfigurable antenna system that relies on a rotating feed structure to redistribute its radiation pattern. The antenna system is designed to be integrated into a WLAN access point. It is controlled through voice command on an android phone that is then connected via Bluetooth to an Arduino board that orders a stepper motor to rotate the antenna feeding network. Such antenna allows the user a personalized control of WLAN coverage and optimizes its connectivity.

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