Antenna Radiation Signal Measurement System using Raspberry-Pi

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Abstract: - Wireless communication is being used extensively and has attracted the attention of many researchers throughout the world. A major component in all wireless systems is the antenna. Antenna is essential in every connected modern society. It is mandatory to measure the parameters of any newly designed antenna before being used for anticipated applications. Conventionally, the characterization of antenna's radiation pattern requires complex lab facilities and instruments such as antenna test chambers, network analyzers or field strength meters. These methods are very expensive. The low Field Programmable Gate Array (FPGA) based system for the measurement of the antenna radiation patterns used is not system friendly, since it is basically developed using FPGA hardware and hence not used. To overcome this problem, innovative learning is required. A portable, user-friendly measurement system that can perform the antenna parameters measurement easily is presented. Once the antenna is validated through the agreement of measured parameters data matching with simulated parameters data, then that antenna can be employed in the probable application.

Key-Words: - Antenna Under Test, Voltage Standing Wave Ratio, Raspberry-Pi, Pi camera, Hybrid 200-2220, Character recognition algorithm.

1 Introduction

An antenna plays a vital role in a communication system. It is used in both the transmission and reception of radio frequency signals. In fact, an antenna is a structure that can radiate electromagnetic (EM) waves or receive them. Basically, an antenna is generally a metallic object often a wire or collection of wires, used to convert high frequency current into electromagnetic waves and vice versa. Thus, a transmitting antenna converts electrical energy into electro- magnetic waves, whereas a receiving antenna converts electromagnetic waves into electrical energy. Apart from their different functions, transmitting and receiving antennas behave identically. transmitting and receiving antennas behave identically i.e., their behavior is reciprocal. When a transmitting antenna is held vertically, the electromagnetic waves produced are polarized vertically. When the same antenna is held horizontal the EM waves produced are polarized horizontally. Radiation is the term used to represent the emission or reception of wave front at the antenna, specifying its strength [1.2]. The sketch drawn to represent the radiation of an antenna is its radiation pattern. It is used to understand the function and directivity of an antenna. It represents the energy radiated by the antenna and is a representation of the distribution of radiated energy into space, as a function of direction. Hence it is the major property of an antenna. Therefore, it is important to analyze the radiation pattern of an antenna to characterize it.

2 Methodology

To draw the radiation pattern of the antenna under test (AUT) that's needs to be rotated from 0º to 360º in steps. At each step the received signal from the transmitting antenna needs to be captured, processed, and stored. We use a stepper motor to automate this process of rotating the receiving antenna instead of manually rotating it to gain high accuracy in the steps. Raspberry Pi is used to provide control to the stepper motor and to process the images captured by Pi camera.

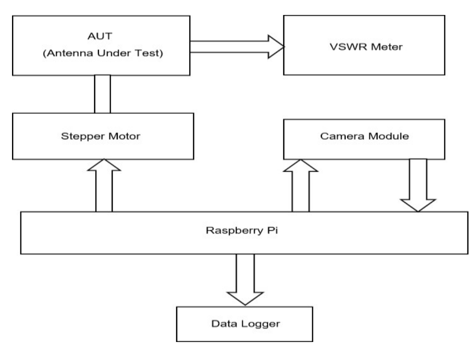


Figure 1: Block diagram of the proposed system.

Once we have the signals received at their corresponding angle the radiation pattern can be drawn.

Figure 1 shows the block diagram of the proposed System. The transmitting antenna and the receiving antenna (AUT) are kept at a distance greater than the far field distance. The AUT is mounted on the stepper motor. using the stepper motor driven by the

Raspberry Pi. The received signal at the receiving antenna is given to the VSWR meter which gives the received power in dB. At each step of the stepper motor rotation, the camera captures the power reading from the VSWR meter. The received power is detected and recognized using the image captured and the data is stored in a data logger which consists of the angle and the corresponding power of the received signal. This procedure is repeated for every step until the motor completes 360º rotation. The stored data can then be used to draw the radiation pattern of the antenna.

2.1 Working

Raspberry Pi looks after the processing and control tasks. It controls the rotation of the stepper motor. It controls the Pi Camera which is used to capture images of the power reading on the VSWR meter. It receives the image from the Pi Camera and passes it through the optical character recognition algorithm which detects and recognizes the target text which is the power reading in dB and stores it in a dictionary. The power requirements of the raspberry pi are 5V, 2A. The Raspberry Pi camera It is specifically suited for use with a Raspberry Pi. It captures the image of the power reading displayed on the VSWR meter after every 9º rotation of the stepper motor. The captured image is received by the Raspberry Pi which is then processed to get the received power value. The HY200-2220 stepper motor is used to rotate the AUT, and it is to be rotated for every 9º and then stopped to capture the image of the power reading. The step angle of this stepper motor is 1.8º. Since 1.8 times 5 is 9, the stepper motor must complete 5 steps of 1.8º each and then click the image and process it to find the corresponding received power at that angle. The received signal at the receiving antenna is given to the VSWR meter. The VSWR meter takes the received signal as input and computes the received power in dB. This received power is displayed on the dot matrix display of the VSWR meter which is captured using the Raspberry Pi Camera Module. The AUT is the antenna whose radiation pattern is to be determined. It is also the receiving antenna. It is mounted on the stepper motor, hence rotates as the stepper motor rotates. The received signal at the receiving antenna is given to the VSWR meter. The data logger is used to store the received power values at different angles. A dictionary which is a key-value pair is used to store the data extracted. The keys represent the angles, and the values represent the received power values at corresponding angles. The data is stored in a text file and updated to google sheets. This data can be used to draw the radiation pattern of the AUT.

2.1.1 Sub-subsection

When including a sub-subsection you must use, for its heading, small letters, 11pt, left justified, bold, Times New Roman as here.

3 Results and Discussion

The figure 2 shows the working of the proposed system.

Figure 2: Working model and its overall setup.

Figure 3: Images clicked by Pi Camera

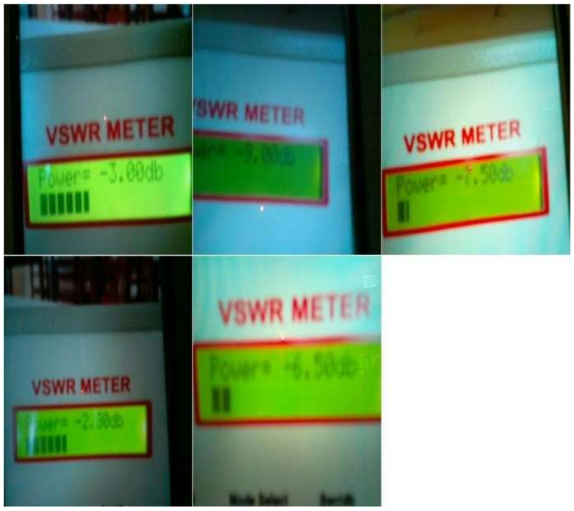
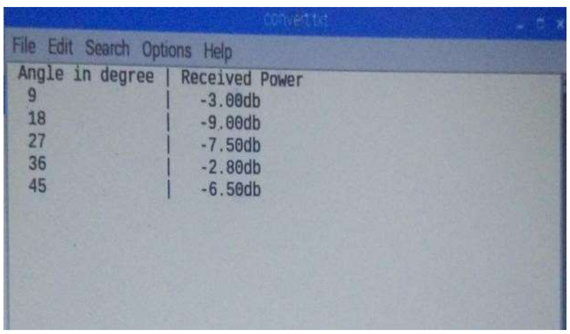
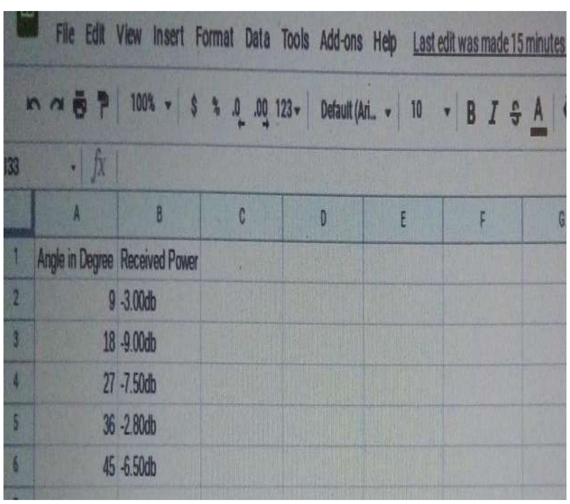


Figure 4: Images clicked by the Raspberry Pi Camera.



Angle in degree	Received Power
9	-3.00db
18	-9.00db
27	-7.50db
36	-2.80db
45	-6.50db

Figure 5: Results stored in a text file.



	A	B
1	Angle in Degree	Received Power
2	9	-3.00db
3	18	-9.00db
4	27	-7.50db
5	36	-2.80db
6	45	-6.50db

Figure 6: Results stored in google sheet.

4 Conclusion

The radiation pattern characterizes an antenna; hence it is necessary to design a system that gives the received power which can be further used to draw the radiation pattern. A simple and automatic system to measure the received power simple and automatic system to measure the received power of an antenna is designed. The system automates the process of rotating the antenna by using a stepper motor. It also automates the process of noting down the VSWR meter readings thus saving time and eliminating any human intervention. The Raspberry Pi camera does not provide clear images hence a better camera module could be used. This system is limited to low weight antennas as the motor cannot drive heavy loads. The set up would give more accurate results if it's conducted in an anechoic chamber as there would be no reflected signals and noise.

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