"ENHANCING THE COVERAGE AREA OF WI-FI ACCESS POINT USING CANTENNA"

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Abstract– **In general, access points (IEEE 802.11) consist of traditional Omni-directional antenna which supports 8 to 10 users and function within the range up to 100 meters within the campus. The coverage area depends upon the environment where the access point is being placed. The main aim of this project is to increase the coverage area of an access point by replacing the traditional antenna with Cantenna. A Cantenna is a homemade directional circular waveguide antenna, made out of an open ended metal can. Cantennas are typically used to increase the range of Wi-Fi.**

Keywords— Wi-Fi, Routers, Access point, signal strength, booster antenna, Cantenna.

I. INTRODUCTION:

Wi-Fi signal antennas are also called Wi-Fi signal amplifiers. They are connected to access points or Wi-Fi adapter to boost the signal. Best quality and powerful Wi-Fi signal amplifiers can further increase the signal strength greatly. Bidirectional Wi-Fi signal antennas are also available. They will increase the signal strength for both transmitter and receiver. They can increase the signal strength extended to 600%. They can be connected to laptop, to boost the signal quality and extend the internet access better to homes. The users are in the need for perfectly consistent, hindered and responsible communication. The wide access is really useful information base, for all kind of users is an important phenomenon, there is need to set up a repeater, which produces high performance. Repeater is a device that receives a digital signal on an electromagnetic or optical transmission medium and regenerates the signal along the next medium. In remote areas or in some places there may found many obstacles, where the signal strength is poor or unreachable. Wireless signals are prone to loss of data frequently. The reception of signal strength depends upon the topography of the place, where we stay will be a deciding factor. The signal strength will be zero or nil if a large number of trees or buildings come in between laptop and the router. In spite of this, the wireless network card are available inbuilt, but they have only limited power and range. A solution for this is, using a wireless card with a high power or attaching an external USB antenna to the laptop. Wireless signal boosters device transmitter. The low-noise amplifier is used to amplify the received signal and it is send to the wireless card. Laptops locate the wireless signal antennas internally. On the two sides of the LCD screen of laptop, there available two parallel antenna. The internal location of the wireless antennas causes bad reception. So, the problem in wireless signal booster needs to solve, by providing an external high gain antenna. Directional antennas are preferable. The biquad is a high gain antenna with a large beam width. The beam width is the major problem facing by the high gain antennas that the antenna is capable of .With biquad, the equal amount of gain is produced; in addition the beam width is increased. This allows ease of use while setting up the biquad antenna.

This paper is organized as follows Section II gives a brief methodology to be employed, Section III includes description of Cantenna theory and design steps of Cantenna. Section IV includes working of the Cantenna and section V includes the testing methodology and simulation results of Cantenna. Section VI includes conclusion and future works are drawn in the last section

II. EXISTING SYSTEM

We are here to design a Wi-Fi access point with antenna preceding Omni-directional antenna to achieve received signal strength index for long distances. The drawbacks of existing technology are:

The declination in Wi-Fi signal strength for long distance. Increasing in number of access points increase signal strength, but some hot spots are available where the range is very weak.

For this, the objective of our project is to use homemade Wi-Fi antenna. Homemade antennas are cost effective with increased signal strength. To achieve this, we need to study about the various parameters of antennas to increase the signal strength for long distances. The Work should be done on Real –Time basis by analyzing the performance of antenna in the campus at locations where the signal strength is very weak such as in rural areas. The proposed plans of work for antennas include:

- To Design Cantenna and then analyze their performance to increase the signal strength [Manual designing and software based testing].

- To analyze and test Cantenna for internet connection

II. DESIGN METHODOLOGY ANDTHEORY OF CANTENNA

The main function of Cantenna is to focus on the signal strength of receiving radio waves from the communication devices such as internet, ad hoc and mobile networks, and wireless cards and so on. This is so effective when compared to conventional antennas which receives signal from broader area with minimal strength. When the waves entered into the tin can, it bounces off the walls until it reaches the radiating element. The radiating element sends the information to communication with minimum amount of interference. The receiving signal of Cantenna can be adjustable and so it can be used in various environments.

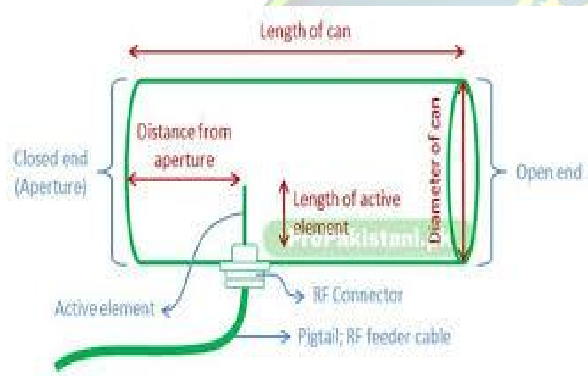


Fig.1 Methodology of Cantenna

This acts as a micro waveguide in cylindrical form by capturing, confining and propagating the radio waves within the iron (metallic) walls. The radio wave frequency is introduced into the CAN by a protruding negative conductor of co-axial cable. This probe will transmit the signals from the waveguide. The frequency of the Cantenna that can propagate into the waveguide will be based on the diameter of the tube. In our project, we are using an access point (WLAN) standard, IEEE 802.11n which transmits signals certainly above 2.4 GHz frequency.

DESIGN CALCULATION FOR CANTENNA:

Step 1: To find the length of the primary radiator:

The active element is nothing but the monopole antenna. The monopole antenna will act as a band pass filter, so we have to choose the Centre frequency for primary antenna, between 2400MHz to 2500MHz.

To find λ,

We choose f = 2450MHz

We know, $\lambda = \frac{c}{f}$[1]

Where c is the velocity of light, c=3 $\times 10^8$m/s

r is the diameter of the cylindrical waveguide

so, $\lambda = \frac{3 \times 10^8 m/s}{2450\ MHz}$ = 122mm

We know that the length of the monopole antenna is $\frac{\lambda}{4}$.

Length=$\frac{122\ mm}{4}$=30.5 mm

Step 2: To find the Diameter of Can:

Cantenna is based on the theory of circular waveguide .choosing the frequency is the most important part of design. As the Wi-Fi networking equipment operates at a range of frequencies from 2.412 GHz to 2.462 GHz. Ideally, the TE11 cut-off frequency should be lower than 2.412 GHz and the TM01 cut-off frequency should be higher than 2.462 GHz

For a circular waveguide,

$$\lambda = \frac{2\pi r}{k}[m] \qquad [2]$$

Where k is the Eigen value of circular waveguide for a given mode.

Here TE11 mode exists, thus the value of K= 1.84, and we will be choosing the higher cut-off frequency as, f= 2.412MHz for r_{min}, because cantenna works as high pass filter.

Now we have to find both the minimum and maximum diameter.

Solving for r_{min}:

$$\text{We know } \lambda = \frac{c}{f}, \frac{c}{f} = \frac{2\pi r}{k}$$

From this the value of r_{min} is,$r_{min} = \frac{ck}{2\pi f}$[3]

Substitute the required values in equation [3],

$$\text{We get,} r_{min} = \frac{1.84 \times 3 \times 10^8}{2 \times 3.14 \times 2412 \times 10^6}$$

$$r_{min=36.44\ mm}$$

Thus ,$D_{min} = 72.88mm$

Similarly for solving r_{max}:

For maximum radius we have to choose the lower cut-off frequency as, f = 2.462 MHz here TM01 will acts, so the value of k = 2.4

Sub these values in $r_{max} = \frac{ck}{2\pi f}$

Substitute these values in $r_{max} = \frac{2.4 \times 3 \times 10^8}{2 \times 3.14 \times 2.462 \times 10^6}$

r_{max} =46.52 mm

D_{max} =93.04 mm, approximated to D_{max}=90mm

Thus the diameter of the aluminum CAN, should be between D = 70mm to D = 90mm.

Maximum the diameter of can, maximum will be signal strength and the increase in coverage area.

Step 3: To find the length of the CAN:

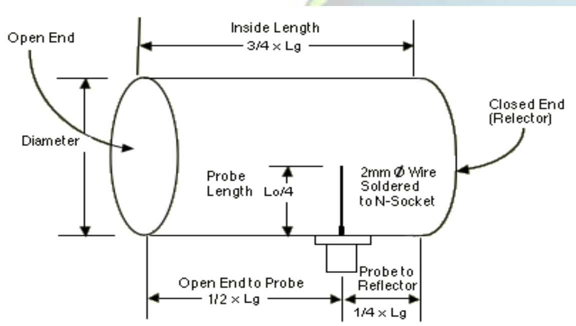


Fig.2 Functional Dimensions of Cantenna

From the theory of circular waveguide, the length is defined as

$$\left(\frac{1}{L_0}\right)^2 = \left(\frac{1}{L_c}\right)^2 + \left(\frac{1}{L_g}\right)^2 [4]$$

Where L_0 is the wavelength of the Wi-Fi signal in open air, which is also known as central wavelength of given bandwidth .

Lo = cf = 122.45 mm, which is already found

L_c is the wavelength of the lower cut-off frequency for a given diameter . L_g is the length of the can .

$$r = \frac{ck}{2\pi f}, \text{ Where r= 45 mm, k= 1.84}$$

$$\lambda = \frac{c}{f}, \text{ where } \frac{c}{f} = \frac{2\pi r}{k}$$

$$L_c = \frac{c}{f}, L_c = \frac{2 \times 3.14 \times 45}{1.84} = 153.58\text{mm}$$

Sub the values of Lo and L_c ,

$$\left(\frac{1}{122.45}\right)^2 = \left(\frac{1}{153.58}\right)^2 + \left(\frac{1}{L_g}\right)^2$$

$$\left(\frac{1}{122.45}\right)^2 - \left(\frac{1}{153.58}\right)^2 = \left(\frac{1}{L_g}\right)^2$$

Lg = 202.9 mm

Step 4: To find position of primary antenna:

The position of the primary antenna should be quarter wavelength, (i.e.) $\frac{Lg}{4}$

Thus it is 50.72, which is approximated as 51 mm

Requirements of Cantenna:

The required parts and construction steps are described below:

- Aluminum CAN (Ideal dimensions are calculated as above)
- RF connector (type: N-Female)
- Active element; Short piece of high gauge (thick) copper wire.
- N-female connector to connect antenna to RF source.

Design steps of Cantenna:

1. Prepare the CAN : Obtain a clean, empty can (with one end open) of diameter of 72.3mm-92.3mm. It might be necessary to remove the lip at the edge of the can so that it does not interfere with reception. Here D=90mm

2*. Mark the position for drill holes:* Drill a hole in the tin can at a distance of 51 mm from the ground-base. The copper pipe has to be fit in that hole which can be done by reamer to enlarge the hole.

3. Drilling holes for the N connector and bolts: With the use of electric drill, make a hole which is large enough to insert the N-female connector into the tin can.

*4. Soldering the N connector and copper wire :*Cut the copper wire such that in total, the length of the connector and the wire is ¼ LO = 3.1cm (i.e.) 30.5 mm. Use the soldering wire to solder the active element within the connector.

5. Connect to WLAN: Connect the Cantenna to the computer's wireless card using a pig-tail cable. We need a co-axial cable with N connector female at one end and

SMA female at another that is inserted through the hole in the exact position of tin can from the rear and bolted.

6. Find the best reception: Cantenna are linear polarization antennas. Rotate the Cantenna until the strongest signal is achieved. Use Wireless Mon (Wireless Monitoring) to determine the strength of the wireless signal.

Fig.3 Cantenna

IV.WORKING PRINCIPLE OF CANTENNA

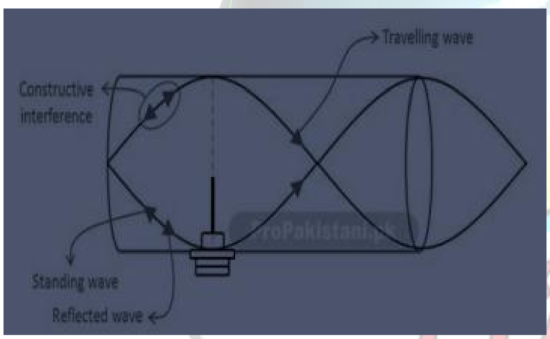


Fig.4 Working of Cantenna

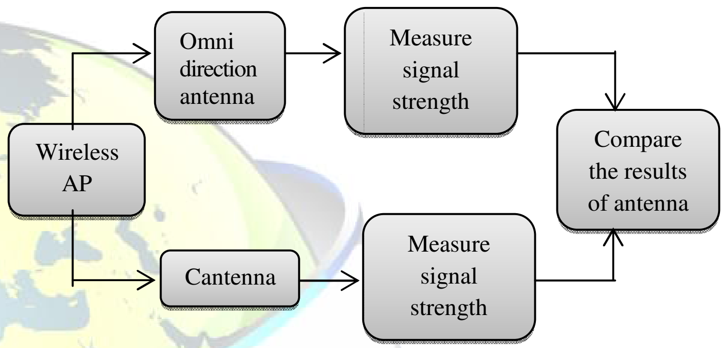
In the above figure, the probe radiates the electromagnetic waves spreading away from the source. The waves radiated towards the bottom of the can are reflected back. Because of the careful placement of the probe, the reflected wave superimposes the wave which naturally gets radiated towards the open end of the can, combining the radiated power in one direction.

V.CANTENNA TESTING AND SIMULATION RESULTS

The prototype of Cantenna that has been designed offers a coverage area up to 300 meters. The antenna performance is tested with the help of wireless monitoring tool software which we have used in our project work is pass mark wireless monitoring tool version 4. Christo Ananth et al.[5] discussed about E-plane and H-plane patterns which forms the basis of Microwave Engineering principles.

Analysis of Cantenna:

Initially a Wi-Fi hotspot is created by installing our access point to an internet connection. The antenna is connected to the access point. This access point acts as a base station. The antenna which is deployed to the access point starts wirelessly transmit the signal, when our Wi-Fi enabled device (laptop) encounters the hotspot the device will connect to the specified network wirelessly. With the help of pass mark wireless monitoring tool installed in our laptop we check the signal strength.



Wireless monitoring tool overview:

Wireless Monitoring is a software tool that allows users to monitor the status of wireless Wi-Fi adapter(s) and gather information about nearby wireless access point and hot stops in real time. Wireless Monitoring can log the information it collects it into a file, while also providing complete graphing of signal level and real time applications in IP and 802.11 Wi-Fi methods.

- Freely available and easily downloaded from internet.
- Reliable to windows XP and windows 7.
- It provides very brief wireless LAN information by displaying various parameters.

Simulation Results:

The status column represents the status of the providers (at the hall which installed the wireless LAN), the SSID column represents the status of sender, for example **eme hotspot** zone and tot hotspot, while the sending signal of the researchers in the column SSID is XXX and the channel column is for fix the channel of signal and of researchers SSID namely XXX is channel 11. The security column is used for telling the status to the receiver (the receiver is the computer that receives the data), if the picture shows the locked up key, it means that the receiver cannot use the service but if the unlocked up key shown, that is the opposite meaning (in the case of using the service, the user must know the password of the provider). The column RSSI is for representing the status of the signal (represent in the form of the bar graph and the circle graph). The column rates supported is the wireless data transmission rate per channel in mb/s (of the researches, it is 54 mb/s). Column MAC address depends on the position of the wireless access point (of the researches, it is namely network). Column infrastructure is the wireless LAN services.

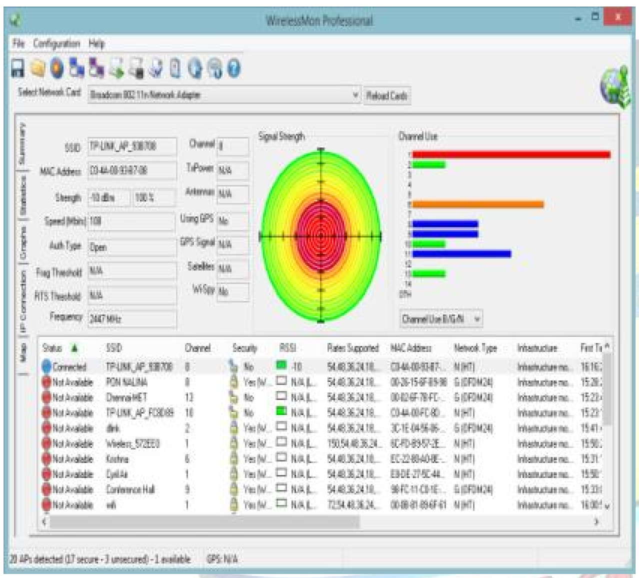


Fig.5 Wireless Monitoring Tool 1

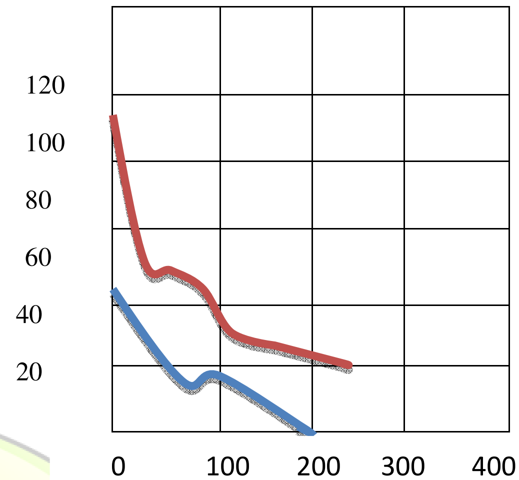
The RSSI (Research Signal Strength Indicator) column indicates the signal strength for various antennas are measured at different coverage locations.

By comparing the results we analyzed that

- Gain of Omni directional is around 0 to 6dbm with coverage area up to 100m.
- Gain of Cantenna is about 15 to 20 dBm with increased coverage area of 200-300m.

Comparison of Cantenna with Omni-directional Antenna:

Signal Strength:



Gain:

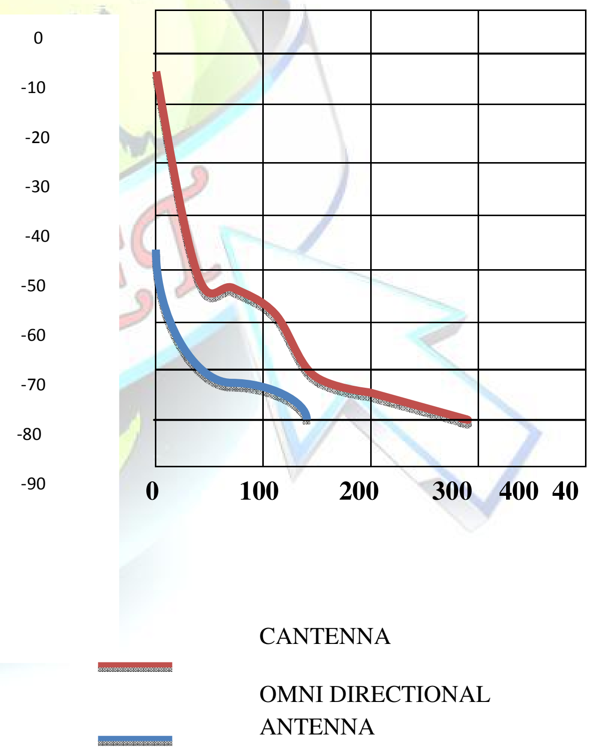


Table 1.Comparison between Omni directional antenna and Cantenna

Distance	Omni directional antenna		Cantenna	
	Gain in dB	Signal strength in %	Gain in dB	Signal strength in %
0	29	76%	19	86%
25	32	65%	22	75%
50	74	41%	64	64%
75	77	26%	67	57%
100	85	18%	75	44%
125	88	15%	78	38%
150	95	3%	84	26%
200	N/A	N/A	88	15%
250	N/A	N/A	90	10%
300	N/A	N/A	91	5%

VI .CONCLUSION

A Cantenna for Wi-Fi is proposed prototype of the proposed antenna has been designed, fabricated and tested. The Cantenna is probably the best overall because of its low cost, simplicity, ease of use and 14dbm gain properties. This antenna would be easily mounted on the dash board or in the windows of a vehicle. Radar can be used here to protect the antenna from Environmental Hazards, but it should be made from certain materials that do not affect antenna performance. Also it may be possible to use the same antenna for any 2.4GHz Link Application like ISM BAND, WLAN and Bluetooth interception.

VII. FUTURE SCOPE

It includes designing of manually build booster antenna by following the above mentioned steps and testing the performance in the real environment where the signal strength is low .Testing of the antenna on the desktop as well as laptop. Future work also includes the manual construction of other booster antennas such as parabolic antenna booster and antenna and testing their performance in real environment like hotspot location. Testing comparison with antenna and manual construction of booster antenna includes the performance of the antenna could be better tested on laptop , where the signal strength could be easily observed going high or less as the distance increases . The testing of antenna outside the campus area also adds to the obstruction of the signal by walls or trees.

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