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Manually Designed Wi-Fi Cantenna and its Testing in Real-Time Environment

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Abstract—Wi-Fi is a fantastic new gadget, but its reach is only about 50 to 100 meters. Fortunately it is possible to build our own antenna cheaply (less than 10 US dollars) in an hour or two. Now a day, more individuals, businesses and local governments are enjoying wireless internet access proliferating Wi-Fi hotspots, home, office, and public wireless networks. However, Wi-Fi users are rarely completely satisfied with the signal strength offered by the off the shelf Wi-Fi cards, routers, access points and USB adapters. Compounding to the coverage problems, many locate their routers, access points or desktop Wi-Fi cards in a closet, against the wall or under a desk, diminishing signal strength and limiting bandwidth. This research paper includes the steps for the Biquad antenna construction, requirements and software testing of antenna on desktop to check the signal strength at various locations in campus area.

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

I. INTRODUCTION

Wi-Fi signal booster antennas, also called Wi-Fi signal amplifiers are attached to routers or access points to boost the signal. Good quality and powerful Wi-Fi signal amplifiers can increase the signal strength threefold. Bidirectional Wi-Fi signal boosters increase the strength of transmitted, as well as received signals. That is, they work both ways. They boost signal strength by as much as 600%. They can be used as laptop Wi-Fi signal boosters and extend range of Internet access far beyond your home. The need for seamless, uninterrupted and reliable communication is one of the top priorities of every house. The wide access to some really useful information base, for every kind of user makes it extremely important to set up a repeater, which delivers high performance. Repeater is a networking device which, as the name suggests, repeats the signal or increases the reach of the existing wireless network. Very often, it happens that a device has to be connected to an existing wireless network, but it is away in a remote place in the house or a building, where the signal strength is too low or unreachable. A wireless repeater is used in such cases to boost the signal strength or simply repeat the signal so that the said computer comes under the coverage area.

Wireless signals are susceptible to a lot of data loss . When it comes to the wireless signal strength that will be received, the topography of the place where we stay is also a deciding factor. If a large number of trees or buildings come in between laptop and the router we are connecting to, the signal strength will be almost nil. Besides everything, the wireless network cards, that come inbuilt, have very limited power and range. The answer then lies in using a wireless signal booster. A simple solution is getting a wireless card with a higher power or attaching an external USB antenna to the laptop. Wireless signal boosters are simple devices and can simply be plugged into the USB port of your laptop. The taller the antenna of your wireless booster, the better the reception. The working of the wireless booster is pretty simple. It accepts strong signals from the router and amplifies them inside your network, thus increasing the signal strength to a great deal. A wireless signal booster consists of two antennas - the transmitting antenna and the receiving antenna. The receiving antenna is connected to an intermediate amplifier. The other input to the intermediate amplifier is a radio signal source. The intermediate amplifier amplifies the difference between the two signals; the received signal and the radio signal, and passes it over to a low-noise amplifier. This is done to remove any unwanted signals. The low-noise amplifier is connected to the transmitter. The low-noise amplifier further amplifies the received signal and sends it to the wireless card. The wireless signal antennas in the laptops are located internally. Generally, there are two parallel antennas located on the two sides of the LCD screen[14]. The internal location of the wireless antennas causes bad reception of the wireless signals. So, the first problem that a wireless signal booster needs to solve, is to provide an external high gain antenna. This antenna needs to be directed to the access point. The biquad is defined as a high gain antenna with an exceptionally large beam width. The problem faced with high gain antennas are the beam width that the antenna is capable of. For instance a Yagi antenna design with high gain will typically fall into a beam width range of 40 degrees or less. With the case of the biquad you can have an equal amount of gain but with a substantial increase in the beam width. This allows ease of use while setting up the biquad as a directional antenna.

This paper is organized as follows Section II gives a brief methodology to be employed, Section III includes description of Cantenna. Section IV and V includes the design steps. Section VI includes antenna testing.

II. METHODOLOGY

The Aim is to design different Wi-Fi booster antenna and analyze the performance to improve the signal strength for long distance. To overcome drawbacks of existing technology such as :

The High Cost of booster Antennas available in the market. The booster antennas available in market costs very high in dollars and are easily available in foreign countries. This adds to the cost of travelling or shipping the product to the user destination.

The reduced Wi-Fi signal strength for long distance. This aims at increasing the number of access points but in spite of these there are some hot spots or locations where the range is not available because of which we receive weaker signal strength.[14]

For this, the objective is to use home made Wi-Fi booster antenna. Home made antennas solve the purpose of cost, making it cost effective. It provides us with improved signal strength. To achieve this, we need to study the various parameters of booster antenna available in the market, and increase the signal strength thereby improving the performance of our antenna .The Work can be done on Real –Time basis by testing the performance of Booster antenna in the campus at locations where the signal strength is weak.

The proposed plans of work for booster antennas include:

- To Design different booster antennas and then analyze their performance to increase the signal strength [Manual building and software based testing].
- To Implement Wi-Fi monitoring application.
- Test booster antennas for internet connectivity.

III. CANTENNA

Cantenna devices function by focusing and strengthening the radio wave receiving area of communication devices such as wireless phones, internet, television and radios as opposed to conventional antennas which receive signals over a broader area with minimal strength. When a radio wave enters the opening of the can it bounces off the can walls until it reaches the receiving wire within the can. This receiving wire sends the information to the communication device with minimal static or interference. The area in which the Cantenna can receive the optimum signal is also adjustable, allowing the Cantenna to be used in a variety of locations and environments. A Cantenna consists of a hollow tube (usually a 40oz can) and a coaxial cable, as shown in Figure

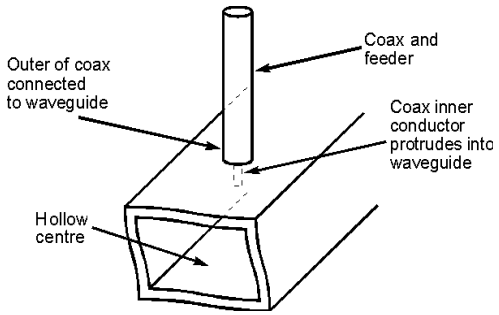


Figure 1: Cantenna Design

This can acts as a microwave waveguide by capturing, confining and propagating the radio frequency signal within its metallic walls. The radio frequency is introduced into the can by a protruding conductor of a coaxial cable. The probe can transmit and receive signals from the waveguide. The frequency that a Cantenna can propagate is a function of the diameter of the tube. Cantenna operate as high pass filters since they can only propagate signal above a certain cut-off frequency. In the case our project, we will be using the common wireless networking (WLAN) standard, IEEE 802.11n-2009 which is transmitted at a frequency of 2.4GHz.

IV. CANTENNA DESIGN

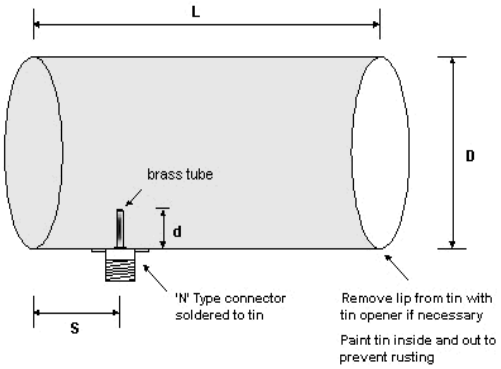
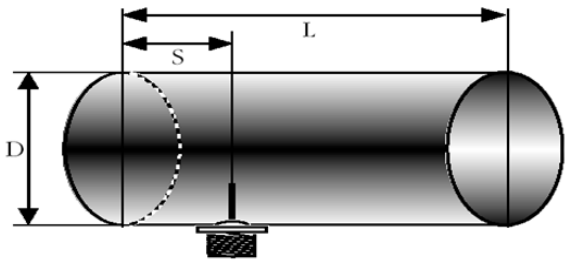


Figure 2: Interior Design for Cantenna

V. DESIGN STEPS FOR CANTENNA

1. Prepare the can: Obtain a clean, empty can (with one end open) of radius of 3.65cm - 4.67cm. It might be necessary to remove the lip at the edge of the can so that it does not interfere with reception. Here: r = 3.65cm

2. Mark the position for drill holes: Use a Cantenna Calculator to calculate the dimensions - there are several available online. Below, is one based in an Excel spreadsheet and another on a do-it-yourself website (Figure 3). Mark the position for the N connector (at ¼ of the waveguide length) with a pencil. Here: ¼ LO = 3.1cm



Frequency	2.4	GHz
D of your can	7.62	cm
Wavelength	12.5	cm
D minimum	7.5	cm
D maximum	9.4	cm
L	34.1	cm (at least)
S	11.4	cm
1/4 WaveLength	3.1	cm

Figure 3: Cantenna Measurements (a)

3. Drilling holes for the N connector and bolts: Using a drill (or a nail in combination with a hammer if an electric drill is not available), drill a hole large enough to insert the N-connector and four holes for the securing bolts.

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. Solder the wire onto the connector. After cooling, bolt the N connector into the can (to reduce obstructions, keep the bolts inside the can and the nuts on the outside).

5.Connect to WLAN: Connect the Cantenna to the computer's wireless card using a pig-tail cable. Note: One of end of the cable will have the matching N male connector, the other will connect to the wireless card.

6. Find the best reception: Cantenna are linearly polarized. Rotate the Cantenna until the strongest signal is achieved. Use Kismet (Linux-compatible) to determine the strength of the wireless signal.

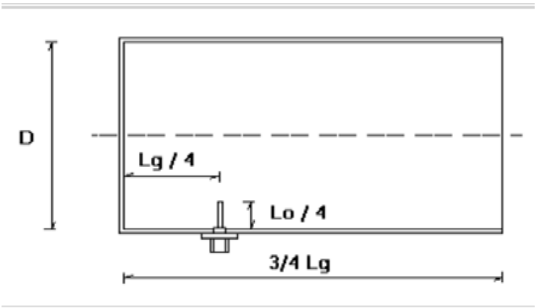


Figure 3: Cantenna Measurements (b)

VI. ANTENNA TESTING

The Antenna testing is basically done on a desktop computer in college lab . The requirements for testing are :

1. Wi-Fi access point
2. Antenna
3. LAN card
4. Wireless software for wireless connectivity

The LAN card is fitted in the CPU and then an antenna is attached to it .The wireless software installation was done for enabling the wireless connectivity. I had developed a software coding through which we can measure the strength of signal in percentage which shows the accuracy in how much signal strength exactly we are getting. This idea came to my mind because our campus is WI-FI campus and there are around 86 access points all over the campus , but still the signal strength in some locations are still weak and due to which the speed is less. I had developed an Cantenna and tested in our

campus at locations where the signal strength was found low and the results we observed was more than originally we had with dipole antenna that was being used as a booster .

The below result shows Cantenna results which were taken in our campus area where the signal strength was found to be 70% initially and testing with the Cantenna gave the height of almost 20% (Figure 4***)*** at the same location with the same network as we were connected to.

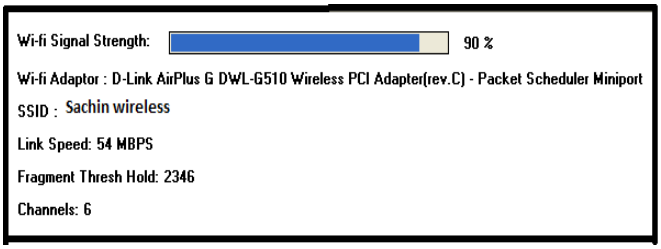


Figure 4: Cantenna Testing

Bandwidth Monitoring module (Figure 5) is basically deal with monitoring network traffic. Traffic in the sense whenever data is transferred over network cable it get measured. Different application gets data or sends data over network. Data has some size. This is size can be considered as bandwidth. This module of project keeps watch on data transfer and measures it and monitors it. This module also shows sent and received data size. Logic behind that is will read LAN adaptor information continuously. First get the object of LAN card controller class. Then read different data from its object. Whenever data get transferred data member of this object get changed. And project will show this changed value in loop. It won't required any special programming logic. It need only reading data in loop.

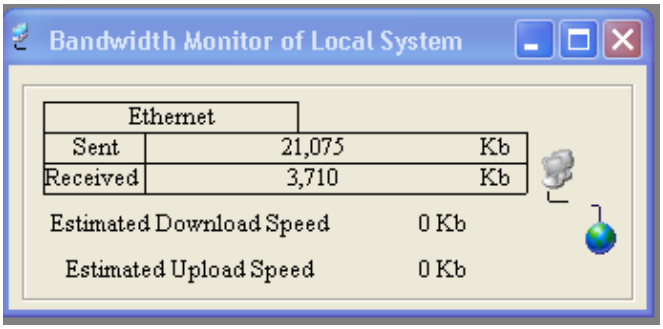


Figure 5: Bandwidth Monitor

The Internet Ping command (Figure 6) bounces a small packet off a domain or IP address to test network communications, and then tells how long the packet took to make the round trip. The Ping command is one of the most commonly used utilities on the Internet by both people and automated programs for conducting the most basic network test.

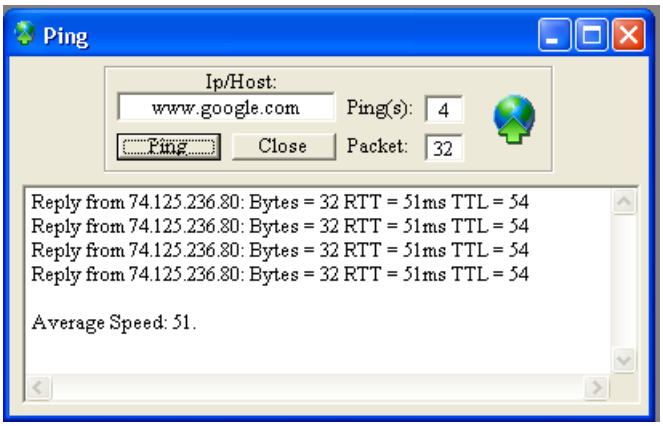


Figure 6:Ping

The trace route command (Figure 7***)*** traces the network path of Internet routers that packets take as they are forwarded from your computer to a destination address. The "length" of the network connection is indicated by the number of Internet routers in the trace route path. Trace routes can be useful to diagnose slow network connections. For example, if you can usually reach an Internet site but it is slow today, then a trace route to that site should show you one or more hops with either long times or marked with "*" indicating the time was really long.

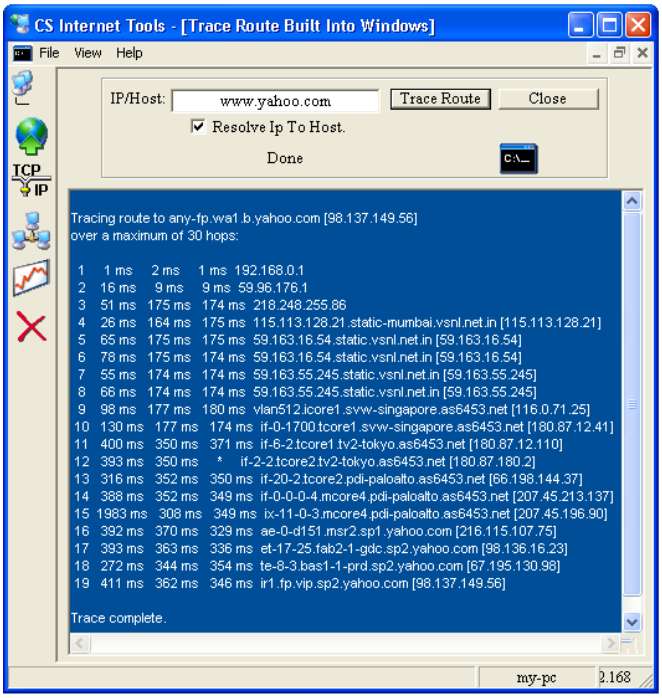


Figure 7: Trace Route

VII. CONCLUSION

Wireless networks are clear benefits (mobility, flexibility, ease of installation, low maintenance cost, and scalability) but also has some disadvantages (use demanding equipments for operating parameters such as humidity , temperature etc). Smart Antennas can be used to achieve different benefits[14]. The most important is higher network capacity. It provides better range or coverage by focusing the energy sent out into the cell, multi-path rejection by minimizing fading and other undesirable effects of multi-path propagation. Smart antennas are a solution to capacity and interference Problems. Good quality and powerful Wi-Fi signal amplifiers can increase the signal strength threefold. Bidirectional Wi-Fi signal boosters increase the strength of transmitted, as well as received signals. That is, they work both ways. They boost signal strength by as much as 600%. Thus the Wi-Fi booster antenna is used in improving the signal strength by considering the above mentioned points. It is basically effective in locations where there is coverage problem in case of mobile or when the signal strength becomes less as the distance increases . Thus we conclude that , on testing the antenna the signal strength reduces with the increase in the distance between the antenna and the Wi-Fi access point.

VIII. FUTURE WORK

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 include the manual designing of other booster antennas such as parabolic antenna booster and cantenna and testing their performance in real environment. Testing comparison with antenna and manual build booster antenna . The performance of the antenna could be better tested on laptops , 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.

IX. APPLICATION

- Hot spots similar to those serviced by today's Wi-Fi systems (airports, hotel lobbies, etc.)
- Academic campuses, in various self-contained areas (quads, auditoriums, cafeterias, etc.)
- Stadiums and arenas, again, which offer self-contained environments.
- Malls and shopping areas, favored by large numbers of younger, Internet-savvy users.
- Mass transportation (trains, etc.) with users looking for interaction and entertainment.
- Enclosed parks and recreation areas.
- Residential homes, supplanting DSL/Cable services

The WI-FI Antenna booster gives increased signal strength at locations where the signal strength goes low as the distance increases. It also provides us with a cost-effective product as compared to the boosters available at the market. So this approach is more suitable for the small-scale use .

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