Design Team
Corey Davis
Jarret Lavallee

Our plan was to create a design that allows us to fabricate a device which enables us to access wireless internet remotely over the distance of a few miles by implementing a cost effective design, whereby we take our existing capabilities of receiving wireless transmissions and make it more efficient.

How WiFi Works

The radios that are used for WiFi communication are similar to those of cell phones, radio's and tv's. Wireless adapters transmit frequencies of 2.4 GHz or 5 GHz. These higher frequencies are necessary because they allow much more data to be transmitted. The most common types of this networking standard are 802.11g and 802.11b.

How Radio Waves are Transmitted and Received

Radio waves are transmitted by means of oscillating electromagnetic fields which pass through space. These waves are picked up and received by antennas in some type of receiver. The distance these radio waves can travel depends on the strength of the transmitter. The same goes for WiFi.

"Many different types of antennas are used in satellite communication. The two most commonly used are narrow beam antennas and reflector antennas. There are also two different types of designs. The Cassegrain design incorporates a convex subreflector and a hyperboloidal surface, whereas the Gregorian's design utilizes concave design with a ellipsodial surface." (Dr. Robert A. Nelson)

According to Dr. Robert A. Nelson, the antenna's fundamental characteristics are its gain and half power beamwidth. "The gain is measured by how much of the input power is concentrated in any given direction. The half power beamwidth is the angular seperation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value."

Dr. Nelson states that "The gain of an antenna is determined by the intended area of coverage. The gain at a given wavelength is achieved by appropriately choosing the size of the antenna. The gain may also be expressed in terms of the half power beamwidth."

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Antenna Research

Through understanding other designs can we expand upon them and create a system that goes beyond the limits of the past. There are many different forms wireless antennas that have been implemented. All have their advantages and disadvantages, but only a few will suit our needs. We wanted to make an antenna that is cost effective and simplistic. A well designed antenna that is inexpensive and easy to make is perfect. A few different antennas that we found are in this category. There were three categories that we looked at; Directional and Omni-Directional.

Omni-Directional antennas are fit for our purpose, they are normally cheap and they has a significant gain. They are antennas in which have a significant gain, but in multiple directions, like an radio antenna on a car. These antennas are they normal type that come on wireless receivers. They can range from low gain up to around 15 dBi, a considerable gain. The problem with these antennas are that they do not focus the waves, so they do not get as much gain as with directional antennas, but they do on the other hand, receive from normally 360 degrees, rather than 90 degrees. The design and implementation of these are normally inexpensive, consisting of some coax cable and PVC piping. The difficulty comes in implementing the design. The coax cable is cut into pieces about ¼ of the wavelength alternating from side to side from a fixed center line. to accomplish this, the pieced have to be stripped and soldered in a precise fashion. This usually requires the use of a jig, a template, to get the pieces in line. the whole process is not complicated if one has the ability to solder and some wood to make a jig up. Home made omni-directional antennas get normally around 4 to 8 dB gain, but are small and easily stored.

Conversely Directional antennas and normally bigger and get more gain. They are able to send and receive a signal over a long distance, for they focus the waves. The gain for these can be up to around 30 dB, but that is not even close to the limit. There have been records of a wireless connection over 125 miles using 10 and 12 foot satellite dishes. Directional antennas are bigger and less dynamic than omni-directional antennas, but have larger gain. There are many different types of directional antennas. Many different types are sold commercially, and can also be home made. These include; Cantennas, biquad, double biquad, SatCap, Antcap, Panel, and more. Cantennas are simplistic in design and implementation. Cantennas are based off of a pringles can design. They use a simple N-connector at a focus point within the can to receive wireless signal. They receive about 12 to 15 dB gain and are inexpensive and simple to make. Biquad and Double Biquad antennas are similar in design. A biquad antenna consists of copper cable fashioned in a bow tie shape with a rear reflector plate of PC board. A double biquad is the same, but in a double bow tie shape. These antennas normally get around a 11dB gain. SatCap is an extension of AntCap with normally an extra gain of 1dB. AntCap antennas are have around 12 to 14 dB gain. The AntCap is essentially a biquad antenna with an enclosure, for external mounting, giving it a small gain. Panel antennas are also similar in design, they have a gain of about 15 to 20 dB. Most all directional antennas are based upon the same design, a reflector focuses the waves onto a receiver. They have great gain increases. These all can be mounted on a satellite dish to focus more waves and get a much higher gain, reaching upwards of 25 to 30 dB. A gain of what we are aiming for.

Conclusion

A directional antenna mounted on a satellite dish seems to be the best solution to our scenario. Satellite dishes are cheap and easy to come by with the popularity of satellite television. Satellite television dishes offer high gain with easy modification. This will be the central frame for our design. The design will consist of a satellite dish with a directional antenna mounted at the focus point. The directional antenna will be based off an N-connector. The N-connector makes a great base, for it makes for easy mounting to an antenna jack through a pigtail. The pigtail will connect to a wireless card. The antenna will not be amplified. Amplifiers for antennas extend the receiving and transmitting power, but are dangerous because they emit more waves. Since the waves are similar to waves emitted by microwaves, we though it best to not emit them with more power. To keep it safe and along our original guidelines, we eliminated the option of omni-directional antennas, for the soldering and preciseness its far out of the reach of being easily assembled. This left us with directional antennas, which was the best option. They are more expensive than omni-directional, but they have a better gain and are simpler to build, so they seem like the better option. The plan is to mount a directional antenna onto a satellite dish to get the maximum gain with the most ease and least cost. Which leads to the question of which antenna to build.

A cantenna is easy and cheap to build with a considerable amount of gain. There are many designs of cantennas, because there are many different types of cans out there. The ones with that are longer and have around a 8mm diameter work better for receiving waves, but when mounted on a satellite dish, a wider and shorter can works better. A coffee cantenna mounted on a dish can give gain around 22 dB. The can is easy to get and the overall construction of the cantenna is simple. it requires some measurements of the can and some math to find the place to mount the N-connector. Overall it would be a simple procedure with little technical skills. It is relatively inexpensive and effective with good gain. This does seem like the most cost effective and simplistic design. On the other hand a biquad antenna has a better gain and does not require much more technical knowledge. The biquad and double biquad antennas require more parts, and are more fragile. A biquad antenna mounted on a dish can give around 24dB gain. The question is if the 2dB of gain is worth the fragility and more complicated construction. The cantenna is cheaper, easier, more durable and more cost-effective. It seems like the better choice, but there is where the AntCap comes in. The AntCap is an alternative to the biquad antenna. The AntCap is a more durable version of the biquad. it is a bit more expensive, but it is made to withstand being outside, which makes it more favorable in this situation. Higher gain with more durability, but a higher cost and even more technical requirements and tools. This goes for the same as with the SatCap, which is a more durable version of the AntCap. Our best option is the cantenna. It is the cheapest, most cost-effective design with the least amount of technical requirements.

Our next task was to figure out what can to use. There are many cans out there and determining which can is best for our situation was a difficult task. Through more research and considerations we decided that a Maxwell House Coffee can is the best for our given situation. It is readily available, the contents are not too expensive, also the shape gives the best results. The N-Connector will be mounted 2 inches from the back with a 1.25 inch piece of copper soldered onto it. the N-connector will connect to a coax cable which will be connected to a pigtail. The pigtail will connect to the wireless card. In effect completing out overall antenna design.

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