Powering the Past; Energizing the Future

"Wireless Electricity"

New Mexico

Supercomputing Challenge

Final Report

April 3, 2013

Team 106

School of Dreams Academy

Team Members

Emma Clary-Gelinas

Kaleb Brown

Jose Montoya

Teacher

Jerry Esquivel

Executive Summary

Think about how much you use electricity in your daily lifer? The possibility of have wireless electricity once seemed farfetched and like something out of a Sci-Fi story, but now is a real possibility. In fact it is already present on the market in forms of chargeable pads and electric tooth brushes. This is just the beginning though, a group formed at MIT has begun research on wireless transmission and has had success. Before we know it we will be powering our homes wirelessly.

The benefits of wireless power aret not just to reduce clutter or wires in our homes and towns. It can do so much more than that. If wireless power was widely available people with medical devices such as electric hearts and diabetes monitors could be charged with having to carry around battery packs and chargers. Electric cars would be powered at all times, and we would never have problems with phones or computers loosing charge. In the military devices would be powered with the transmitter, this would make travel much simpler and lighter. We could take wireless power to third –world countries; bring them to a new age. These are just some of many amazing things we could do with wire-less power.

As a team we decided to being to research into this new idea. We have spent the last six months research, testing and exploring in the field of electric transmission. All our group has gained a understanding of how electricity works and how close we are to having wireless power. We have created a model of a town power wirelessly and we hope to continue working on this model and this project. Our goal is to aid the research in wireless power through creating simulations in real-world scenarios of wireless transfer of electricity.

Contents

1. Introduction

1.1.History

Electricity has always run our world, even before human's harness the power, lighting strikes would light up the sky in a thunderous display of their awesome power and potential. Records show that humans have been harnessing the power of electricity since around 600 BC suing simple techniques to create static electricity. Since them our ways of harness electricity and what we do with have dramatically changed. Electricity has shaped our world and brought it where we are today. It is the bases of what our society and even our world has to run on and without we would be at a loss.

Generally when we thing of electricity we think of thousands of wires connecting us but what if those wires we not necessary anymore. What it we could simple power something by sending out a cloud of electricity, wireless electricity- this is our future. As we move into this new electrical age one name from past stands out, Nikola Tesla.

Prior to the sixteen hundreds there really where no advancements in electricity, for us now it is hard to think about a world not run electrically but back then it was a very real thing. For the following three hundred years many people with many ideas experimented with electricity, all based on similar ideas. However Tesla decided to break down the wall of traditional thoughts of electricity, although considered eccentric at the time he has brought about great changes in the world that continue to improve electric technology today. Although before there time Tesla theories were ingenious, transferring power from one point to another without wires, have now become real.

1.2. Real-world Significance

Currently wireless electric transmission has become a very real possibility, in fact research groups have already been developed at top schools such MIT. Look at electric toothbrushes or charging pads these are examples of wireless power distribution that already present in today's market..

Although there are not serious and directly noticed problems without current form of electrical distribution, it is in what we don't currently have that the problems arise. With wireless electricity the problems that could be fixed are immense, it could fix problems as simple as clearing the clutter or wireless from homes and office to as important as keeping artificial hearts and other medical devices running.

Wires can be faulty at general times and also run the risk of being purposely damaged, while black outs are not good in general a loss of power to hospitals and emergency places can be fatal. If there was a method to keep the supply of power more reliable, wouldn't you take it? Although wireless electricity is still being developed the possibilities of what it could do are endless. Giving easier access to military so there is no need to lug along pounds of batteries, powering electrical cars with simple plates they could park over that could be attached to the ground and so much more. Image the help third world countries could be from wireless electricity. The possibilities are endless.

1.3. Wireless technology

1.3.1. Inductive Coupling

There are already several forms of technology that could help in the production of wireless electricity. Inductive coupling is something that is already widely used in today's market in things such as electric tooth brushes and charging pads. This technology uses magnetic fields to create the transfer of electricity without wires. Circular magnetic fields are created around a wire whenever the electric current moves through it. Scientist have found that forming the coil into a loop creates a larger magnetic field. Also it has been found that when a second coiling is placed in the magnetic field of the first it forms a current between the two. This is how electric toothbrushes and charging pads work.

1.3.2. Resonance with wireless power

The problems with using the magnetic field that coiled wires give of are many. However it mostly becomes very inefficient to create a larger magnetic field to power one device. However, a new research group at MIT, believe they have found a way to transfer power between coils. They believed they could increase the distance between the coil by adding resonance. Resonance is an natural frequency of vibration that is determined my an objects physical size, shape, and composition. Objects will easily vibrate at their resonance frequency but have a hard time vibrating at different frequencies. Now how this works with the magnetic field is induction takes place differently when you have the electromagnetic fields of the transmitting device and receiving device vibrating at the same resonance. This idea uses a curved coil of wire, as an inductor, plates which hold a charge are attached to the end of the coil. When electricity travels through the coil it begins to resonate. The resonant frequency is a product of the inductance of the coil and the capacitance of the plates.

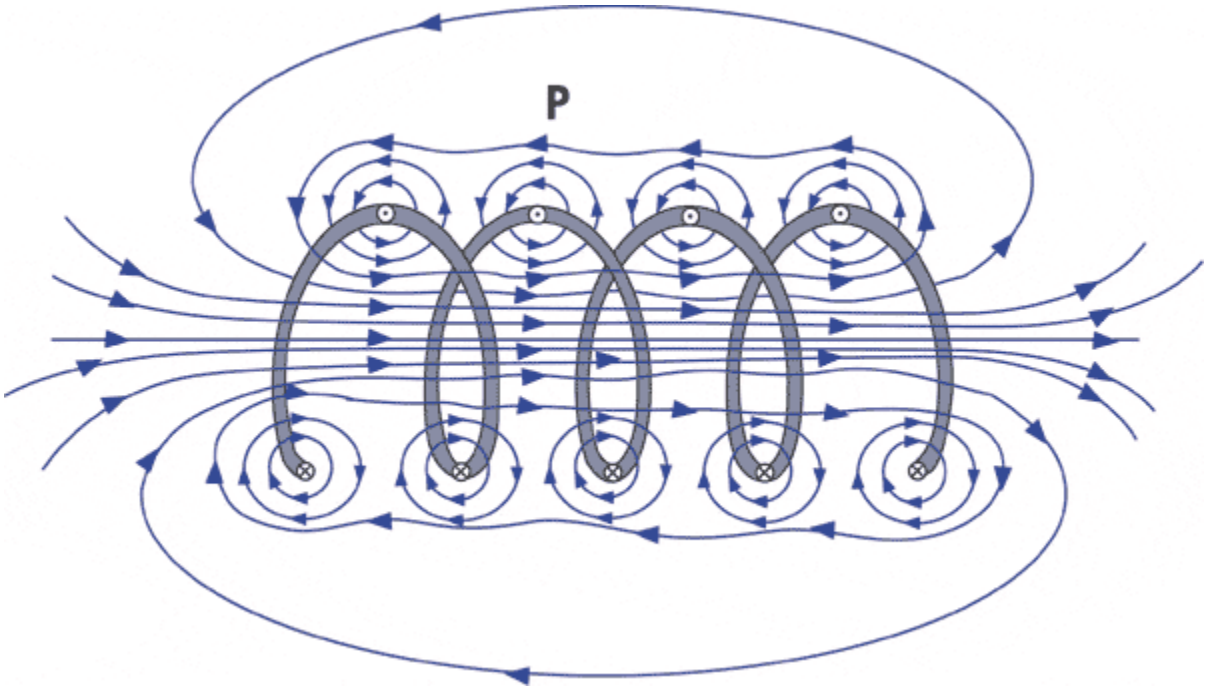
When two coils are brought within range of each other and have the same resonant frequency, electricity can travel along electromagnetic waves from one coil to another. The transmitting coil will cause the receiving coil to vibrate at the same frequency.

If both coils are out of range or vibrating at different frequencies then nothing will happen, however when two coils resonate at the same frequency get with range of each other(e few meters) energy will in streams move from the transmitting coil to the receiving coil. The theory may even allow one coil to transmit to several receiving coils resonating at the same frequency, power several devices at once. This theory is called non-radioactive energy transfer because it uses single point fields around coils, instead of fields that spread in all direction.

If the theory works in could recharge any device in range, possibly being able to power or charge any device in a room.

1.3.3. Electromagnetism

Electromagnetism is the magnetic affect of a current which means electricity produces magnetism. The electromagnetic effect is created when a current is run through a conductor, such as copper wires. When there is no current running through the wiring it will do nothing but when a current is run through it the wires give out a magnetic field. This field is intensified by the coil shape of the wires causing a magnetic field current to run through the center of the loop or coil along longitudinal axis, the current then circles back to the outside of the coil. The magnetic fields for each loop combine together and produce a concentrated field down the center. The tighter the coil is banned the more uniform the magnetic field is.



The lines of force are circular near the wire, but they become straight as we get to the middle point of the coil. Each segment of the coil is surrounded by similar magnetic lines of force. At the center of the coil, all the lines of force aid each other strengthening the magnetic field.

2. Problem Statement

The problem with wireless technology at this point is that it is not available yet, as well as several technical problems, such as increase the distance between the coils, are not solved yet. As stated earlier the uses of this technology would not just be a game for scientist to play, it would have a resounding effect on on our world and improve life in so many ways for so many people.

However, we are getting a bit ahead of ourselves. The final problem we will be trying to solve in this supercomputing challenge project is a complete model of a city power wirelessly, using real world applications. However as we soon came to realize this project could not just be completed in one year, with all the research and information that had to be gathered and learned. We decided to change our project into a three year project.

This year's goal was to create a realistic model of a wireless electricity transmission device and a receiving device. We wanted to make a realistic simulation with real world factors of the electric transfer between two coils and how it might work. We wanted to gain an understanding of how some of the modern theories of wireless electric transfer work, as well as model some of the theories of our mentor from the past, Tesla.

3. Model

Our model was created in netlogo. This code is visualization code. A simple explanation of the code follows.

When starting code the code you will see a cartoon type background of a pole with a wireless power source at the top. There will also be houses and factories in the "town" that have smaller power sources connected to them. The point of the simulation is to model the possibility of electricity moving from one point to another wirelessly. Before running code you first have to set the parameters, the number of 'houses' and factories" as well as the power variables- voltage, current, and resistance. All these variables will determine the total output power. Each power variable has independent and dependent factors related to its variable load and current, which can be monitored then controlled, through changeable variables on the code.

Once set the code can start, upon start a current at the level selected will run through the main power source. As the coil is powered it will began to give of a magnetic field, this field will reach out to receive power stations on the "houses' and "factories." The receiving power stations will send out their own magnetic fields, which will power the home or factory they connect to. The code will measure the total output power from the main power station, as well as the power output from the receiving stations.

3.1. Netlogo experimentation

3.1.1. Turtles

3.1.1.1. Main power Source

Starting with our main power transmitter, we began by sending out a magnetic field. This magnetic field is what allows for the wireless transmission.

3.1.1.2. Receiving power source(s)

The receiving power sources are a variable that is set prior to running the code. The number of houses and factories is the main factor in affecting the final outcome. These sources have to catch the current sent out by the main power source and send out their own field, powering their home.

3.1.1.3. Electric current

The electric current was created simply to show the connection between the main power source and the receiving power sources. It also is used to measure the total output power. It is a visual aid to make it easier see the current between sources.

3.1.2. In-puts and Out-put

Our inputs variables help create a different scenario. Our input variables are the number of houses and factories, as well as out power variables-voltage, current, and resistance. This allows us to see the output when we have twelve houses or two factories. We also see at what resistance or current we get the most power for the least amount of effort.

The main part of our experiment is the outputs. We are attempting to measure the amount of power that is used in wirelessly powering a town. Our out puts are the Total Output Power, which is the measure of the amount of Watts that are used during the simulation. The power output from the individual receiving stations is also measured so we can tell the individual power that is used per house or factory(the is dependent open randomly selected amounts.)

3.2. Mathematical Model

For this part of our three-year project, we used one simple equation to find the power.

$$V=IR$$

Voltage =Current*Resistance

Voltage is the universal power variable the total output of voltage will vary with the amount of commercial and residential house consumption. Each power variable has independent variables which will fluxuate the consumption output rated in its equation. These factors that change the variable are the amount of current which is the speed of which the electrons will flow through our simulated model. An additional factor to the variable change is the amount of resistance, which is the load factor of each consuming entity. This will give us our Total Output Power we will rate in Watts.

4. Conclusion

Using possible theories on wireless energy transmission, we have developed a program that models the movement of electricity from point A, a transmitting coil to point B, a receiving coil. We have also created a physical model of a Tesla coil and other magnetism and electric models to help us and others in our understanding of how electricity works. We have been able to experiment with possible theories from the past as well as new theories. During our time working on this project we also gained a detailed understanding of electricity in all forms and the possible methods for wireless power being created in the near future. This experiment has been very rewarding for all people involved, we have all become inspired to learn as much as we can and do our best to help bring this new idea into a reality for our world. Above all our goal was to learn something new and within the past year we have gone from knowing nest to nothing about how electricity works and the theories behind wireless power to being well educated and knowledgeable on the subject. We have succeeded in our goals and can't wiat to continue on with our experimenting.

5. Future Years

Our plans for this project turned out to be two large to fit into one year so as a group we decided to extend the project to three years. This year's goal was to gain an understanding of electricity and theories of wireless power and to create a basic simulation modeling a wireless transmission of power from point A to point B in the form of powering a city. Next year we plan to take this experiment to a completely new level. Since we will already have an understanding of how everything works we will be able to cut back on the research a little a review this year's project. We will then work on designing a code that can power a home using real world parameters so that we can possibly use this information to create a real model of a wireless transmitting device. That is part of our third year goals as well as model powering an entire city, like we did this year, only in a realistic setting. We plan to figure out how large an area an single transmitting device can cover, how much power it will need, and many other questions. Although we may still be a few years of from running our world of wireless power we can take this time to assist top researchers in our common goals of transferring electricity without wires.

6. Appendix

- Acknowledgements

Team 106 wants to thank the parent and teachers who give many hours of their time to support this project. This project could have not gone so far without the parents, teachers, and volunteers. Thanks! Thanks for giving your valuable time to support the challenge and all the great ideas that come from the project.

- Bibliography(references)

1) Jezek, Geno. "Electromagnetism." *Electromagnetism*. Geno Jezek, n.d. Web. Winter 2012.
2) "Magnetic Field of a Coil." *Magnetic Field of a Coil*. Integrated Publishing, n.d. Web. Winter 2012. <http://www.tpub.com/neets/book2/1b.htm>.
3) "Field from a Coil." *Coil Feild*. National Science Foundation, n.d. Web. Winter 2012. <http://www.ndt-ed.org/EducationResources/CommunityCollege/MagParticle/Physics/CoilField.htm>.
4) "Magnetic Field of Coil." *Magnetic Field of a Coil of Wire*. N.p., n.d. Web. Winter 2012. <http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/magcoi.html>.
5) Grotz, Toby. "Wireless Transmission of Power: Resonating Planet Earth." *TESLA: Wireless Transmission of Power. NCOIC*. NCOIC, n.d. Web. Winter 2012. <http://ncoic.com/theory.htm>.
6) "WIRELESS TRANSMISSION THEORY." *Wireless Transmission Theory*. N.p., 17 July 2011. Web. Winter 2012. <http://www.teslaradio.com/pages/wireless_102.htm>.
7) Wilson, Tracy. "How Wireless Power Works." *HowStuffWorks*. N.p., n.d. Web. Winter 2012. <http://electronics.howstuffworks.com/everyday-tech/wireless-power1.htm>.
8) "Wireless Power." *Wikipedia*. Wikimedia Foundation, n.d. Web. Winter 2012. <http://en.wikipedia.org/wiki/Wireless_power>.
9) Bismarck, Stephen. "The Mathematics behind Electricity." *The Mathematics behind Electricity*. University of Georgia, n.d. Web. Winter 2012. <http://jwilson.coe.uga.edu/emt668/EMAT6680.2003.fall/Bismarck/6690 folder/Electric/electric.html>.
10) *Basic Mathematics for Electricity*. Rep. N.p.: n.p., n.d. *Basic Mathematics for Electricity*. MEBA Engineering School. Web. Winter 2012. <http://www.mfoww.org/down%20meba%20math.pdf>.
11) *Henry, Tom. "The History of Electricity." N.p.: n.p., n.d. N. pag. Electrical History. Web. 23 Oct. 2012. .*
12) *Merica, Dan. "DoD Official: Vulnerability of U.S. Electrical Grid Is a Dire Concern." CNN Security Clearance RSS. CNN, 27 July 2012. Web. Fall 2012.*
13) *"How to Build a Tesla Coil." How to Build a Tesla Coil. N.p., 18 Apr. 2009. Web. Fall 2012. .*
14) *“The Tesla Coil." PBS:Tesla-master of Lightening. PBS, n.d. Web. Oct.-Nov. 2012. .*
15) *"Six Ways Wireless Power Can Change the World." TechNewsDaily.com. N.p., 05 Sept. 2012. Web. Fall 2012.*