**A FINAL PROJECT REPORT ON**

**WIRELESS POWER TRANSMISSION**

**BY:**

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**Introduction:**

In the current world wireless transmission plays a major role. Our project is about wireless power transmission, where power is transmitted without any physical medium through air. The power which is transmitted can be used in various purposes such as mobile charging, energy harvesting, mobile to mobile power transmission etc. With the advancement of technology long distance power transmission will have a better scope in future. Energy Harvesting is one of the most important phenomena in wireless power transmission. Energy Harvesting is nothing but harvesting unused energy in communication system to electrical power. This electrical power can be used in various fields.

In today’s communication system multiple input multiple output (MIMO) plays a major role where multiple data can be sent in a single channel. In MIMO antenna is used for multiple transmission and receiving making a full use of multipath. MIMO can play a major role in wireless power transmission where power can be sent in a similar transmission using the same radio channel. Radio frequency plays a key role in wireless communication as it is the most essential frequency used in telecommunications.

Currently wireless power transmission is done by electromagnetic wave using electromagnetic induction. In these two coils are used where one is transmitter coil and the other is receiver coil. These coils provide electromagnetic field which helps in transmission of power. The range of wireless power transmission in this will be very less (few meters) and efficiency will be 40-80%.

**What is Wireless Charging:**

Wireless Charging came into existence since the late nineteenth century, when Nikon Tesla showed the world about full coupling which is nothing but transmitting the power through air by creating an attractive field between a transmitter and recipient. It has been round 100 years since wireless charging came into existence but very less applications are being used. Today there are only six remote charging innovations are being used which included everything from cellphones and workstations, kitchen items and autos.

Wireless charging is based on three important structures:

**Inductive Charging:**

This uses electromagnetic waves to charge the devices wireless. Inductive charging requires the device to be placed on a conductive charging hardware that is specifically associated with a divider attachment. Inductive charging helps in charging gadgets like mobile phones and PDA’s.

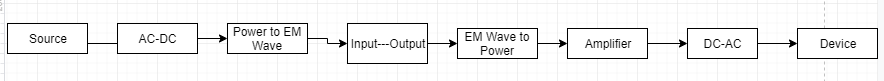
**Radio Charging:**

Same as inductive charging, radio charging uses radio energy to exchange vitality that is used to charge small gadgets and gear. The device is kept on a radio wave transmitter that transmits radio waves used to charge the gadget.

**Resonance Charging:**

This is used for charging heavy devices such as workstations, robots etc. It consists of a sending copper loop and getting copper curl at the receiver end. Both the sender and the receiver must be arranged in such a way that they allow the electronic attractive recurrence.

**Block Diagram:**



**Source:**

Source can be a power generator like batteries (12V), electric source in household (plugs - 110 to 120V). A source can also be magnetic field generator using coils which produces electricity. By using voltage and current regulator we can control the power in the source. This controlled power is sent to AC-DC converter (Rectifier).

**AC-DC Converter:**

This converter is used to convert AC (Alternating Current) into DC (Directing Current). The device

used for conversion is Rectifier. DC helps in converting the power into electromagnetic wave more

efficiently.

**Power to EM Wave and EM Wave to Power:**

In this the power is converted into electromagnetic waves and vice-versa using electromagnetic

concept of two Coils where one is transmitter and the other is receiver coil. These two coils produce

the electromagnetic field and with that medium power is transferred.

**Amplifier:**

It helps in increasing the signal strength. It amplifies the power at the receiver side for desired output or as per the requirement of the device for charging.

**DC-AC Converter:**

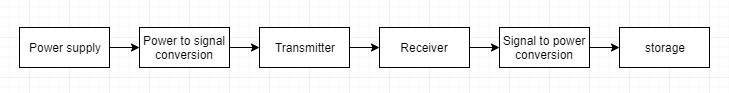
This is used to convert DC power to AC for getting the original output of power for the device which is further used for charging.

**Device:**

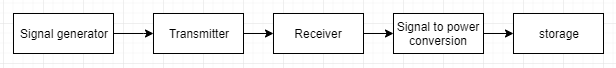
Device can be a mobile or any other electronic or a device to store energy for energy harvesting.

**Energy Harvesting:**

Energy Harvesting is a process where unused energy from the various source from wireless device is stored for different users like wireless charging and other electronic applications which requires small amount of power. This process is used to provide energy for electronic devices with low power. This process contains a procedure where the power is converted into signals and is transferred to receive a device in the form of packets where the device stores that energy. This energy can be saved from the unused energy which is used in normal transmission of messages over wireless communication which is generally wasted and stored for the future purposes.



Energy Harvesting can be done using various methods like storing solar energy, powerplant waste energy, Industrial waste energy, etc. But in this project, we are using energy that is wasted in wireless communications.



In wireless communications there are two methods used for energy harvesting. In the first method power is converted into signal and transmitted to receiver where the signal is converted to the power again and stored whereas in second method a signal is transmitted to receiver where signal will be converted into power which is used in signal generator and the power is stored. In second method the efficiency of power is lower when compared to that of first method.

**Multiple Input Multiple Output (MIMO):**

Multiple input multiple output works on the phenomena where multiple data is sent in a single channel at the same time. MIMO depends on the number of antennas for the transmission of data in a single go. The data which is sent through MIMO can be of various types and does not affect the other data in the channel. MIMO can be used for transmission of power in same channel where normal messages are transmitted. The power can transmit with other data in same channel without affecting the data and efficiency of the power.

**Mathematical Analysis:**

A close up of a map

Description automatically generated

**Charging Using Electromagnetic Waves:**

In this method, two coils are used that produce electromagnetic field which helps in transmission of power through wireless (air). This method has few limitations one of them is range of transmission which will be only few meters but as the modern system it has the highest efficiency in wireless charging. To show this we are using MATLAB coding and its graphs which gives a clear idea of how it works.

**MATLAB CODES:**

close all;

clear;

f = 50; % frequency

w = 2 \* pi \* f; % angular velocity

tf=5.\*1/f; % transfer function

% Input code for power transfer:

t = 0:0.05e-3:tf;

y = sin(w.\*t);

figure;

subplot(2,1,1);

plot(t,y);

xlabel ('Time (sec) ');

ylabel ('Volt (V) ');

% Output code for power transfer:

clc;

%close all;

vo = 1;

c = 45e-6; % capacitance

r = 1800; % resistance

n = length (t); % variable to store length of time

state = 'on ';

for(i = 1:n)

    vs(i) = vo \* sin(w \* t(i)); % vs: sampling voltage ; vo: output voltage

    if state == 'on '

        vr(i) = vs(i); % v = voltage through resistance

        ir = vs(i)/r; % ir = current through resistance

        ic = w \* c \* vo \* cos(w \* t(i)); % ic = current through capacitance

        sumi = ir + ic;

        if sumi <= 0

            state = 'off';

            ta = t(i);

        end

    end

    if state == 'off'

%        vr(i) = vo \* sin (w \* ta) \* exp(-(t(i)- ta)/(r \* c));

        vr(i) = vo \* exp(-(t(i)- ta)/(r \* c));

        if vs(i) >= vr(i)

            state = 'on ';

        end

    end

end

% figure;

subplot(2,1,2);

plot (t, vs, ':',t,vr,'k','linewidth',1);

xlabel('Time (s)');

ylabel ('Voltage (v)');

In the above MATLAB code, the input code shows that an input message is sent in the form of a sinusoidal wave, so a sine function is used with a time interval, frequency of 50HZ and w which is the angular velocity.

Whereas output code gives a condition to show that the transmission is successful and there is a communication established between the transmitter and receiver by using the electromagnetic coil theory with a given capacitance, resistance, sampling voltage and by using current and voltage equations enclosed in an if else statement it is shown that the signal is converted into power.

A screenshot of a cell phone

Description automatically generated

As the first graph in the figure is the result of the input where a message is sent, and it is shown int the form of a sinusoidal wave. The second graph in the figure shows the output that the signal is sent from transmitter coil to receiver coil has been successful. So, we can clearly see a similar sinusoidal wave that is received in the output graph which was transmitted from the input. In the output we have converted the message signal into power, so this graph shows when the state is on that means we have converted the message signal into power and the black curve also shows the power transmission at the receiver end.

**MATLAB CODE FOR MAGNETIC FIELD DISTRIBUTION:**

clc  
ln = 20;

d = 2;

m = 1;

n = -1;

N = 20;

dl = ln/N;

xCm = (d/2)\*ones(1,N);

xCn = (-d/2)\*ones(1,N);

yC = (-ln/2+dl/2) : dl : (ln/2-dl/2);

zC = zeros(1,N);

Lx = zeros(1,N);

Ly = dl\*ones(1,N);

Lz = zeros(1,N);

NP = 125;

xPmax = 3\*d;

zPmax = 2.5\*d;

xP = linspace(-xPmax,xPmax,NP);

zP = linspace(-zPmax,zPmax,NP);

[xxP,zzP] = meshgrid(xP,zP);

Bx = zeros(NP,NP);

By = zeros(NP,NP);

Bz = zeros(NP,NP);

for q = 1:N

    rxm = xxP - xCm(q);

    rxn = xxP - xCn(q);

    ry = yC(q);

    rz = zzP - zC(q);

    rm = sqrt(rxm.^2+ry.^2+rz.^2);

    rn = sqrt(rxn.^2+ry.^2+rz.^2);

    r3m = rm.^3;

    r3n = rn.^3;

    Bx = Bx + m\*Ly(q).\*rz./r3m +n\*Ly(q).\*rz./r3n;

    Bz = Bz - m\*Ly(q).\*rxm./r3m -n\*Ly(q).\*rxn./r3n;

end

B = sqrt(Bx.^2 + By.^2 + Bz.^2);

B = B/max(max(B));

figure(1);

pcolor(xxP,zzP,B);

colormap(jet);

shading interp;

axis equal;

axis([-xPmax xPmax -zPmax zPmax]);

xlabel('<-- x -->');ylabel('<-- z -->');

title('Magnetic Field Distribution');

colorbar;

figure(2);

surf(xxP,zzP,B,'FaceColor','interp','EdgeColor','none','FaceLighting','phong');

daspect([1 1 1]);

axis tight;

view(0,30);

camlight right;

colormap(jet);

grid off;

axis off;

colorbar;

title('Magnetic Field Distribution - Simulation and Visualization')

figure(3);

quiver(xxP,zzP,Bx,Bz);

colormap(lines);

%axis tight;

axis([-d d -0.75\*d 0.75\*d]);

title('Magnetic Field Distribution');

xlabel('<-- x -->');ylabel('<-- z -->');

zoom on;

This code shows the magnetic field distribution between two coils which is useful in power transmission.

A picture containing screenshot

Description automatically generated

This graph shows magnetic field distribution between two coils in the form of circular rotation. In this we can clearly see a magnetic field is produced in between two coils which starts at the center. It also shows the distance between the coils cannot be more than few meters as it requires a distance for strong wireless connections.

**A screenshot of a cell phone

Description automatically generated**

This gives a clearer 3D view of magnetic field distribution. This first two graphs also show the area having the strongest connection using color visualization. The Red color represents the strong connection whereas the blue color represents the weak.

**A screenshot of a social media post

Description automatically generated**

This graph shows the magnetic field distribution in the form of arrows where two circular centers are the coils and shows the direction of the magnetic field. Which shows one coil gives the clockwise direction of magnetic field and the other gives anti-clockwise. This phenomenon is completely based on the magnetic field distribution of two coils.

**Advantages:**

* Highly efficient power transfer (efficiency-40 to 80%).
* Device-Device power transfer.
* Energy-Harvesting.

**Disadvantages:**

* Limited range (few meters).
* Less trustworthy.
* Widely not in use.

**Conclusion:**

In the project we are showing wireless power transmission using magnetic field and giving a clear idea about wireless power transfer. We also gave a brief description about energy-harvesting and wireless power transmission. We are using a MATLAB code to show the wireless power transmission using electromagnetic field.

**Reference:**

* Design of a Wireless Power Transfer System using Inductive Coupling and MATLAB programming- International Journal.
* Simultaneous wireless information and power transfer: Recent advantages and future challenges-IEEE paper.

**Individual work:**

We are a group of three and have an equal responsibility for getting a good MATLAB code and to design a Mathematical Analysis and completing the project successfully by making it a good upgrade for the recent/past work but due to the lack of resources in the current situation our main aim was not achieved but tried our level best to complete this.

Three of us have done a good amount of research about the project and collectively made a report.