CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
J0906

Project Title
Resonance Wireless Energy Transfer for Biomedical Application

Abstract

Objectives/Goals
The objective is to investigate the effect of the separation distance between the transmitting and receiving coils on the efficiency of resonance wireless energy transfer. My hypothesis is that the efficiency of the wireless energy transfer will decrease as the coils separation distance increases.

Methods/Materials
The first step of the project was to design the circuit. After consulting my mentor and the internet search, my final circuit design settled on a Colpitts oscillator circuit for the transmitter and a parallel LC tank circuit for the receiver. The coils were hand-wound identically and the inductance was measured using an HP 4395A impedance analyzer. The inductor and capacitor on the receiver LC circuit were chosen to be the same as those on the LC circuit on the oscillator, to ensure the wireless energy transfer took place at the same resonance frequency. The transmitter and receiver circuits were built onto two separate prototype breadboards, according to the circuit diagram. The transmitting and receiving coils were connected to the two different voltage probes of a PC oscilloscope USB module. The USB module was connected to the PC to display the voltage waveforms. The circuit was switched on and the voltage measurements were performed by placing the transmitting and receiving coils at specified separation distances from 1 cm to 5 cm. There were a total of 10 trials preformed in the experiment at five different distances with two repetitions at each separation distance.

Results
As the separation distance increased, the transmitter coil#s voltage increased while the receiver coil#s voltage decreased. A voltage transmission ratio was computed by dividing the receiving coil#s voltage by the transmitting coil#s voltage at each distance and averaged from the two repetitions. The voltage transmission ratio was high at small separation distance of 1-2 cm, but decreased steadily as the separation distance increased.

Conclusions/Discussion
The results confirmed my hypothesis, i.e. the wireless energy transfer efficiency measured by voltage transmission ratio decreased with increasing separation distance between coils. It was further observed that energy transfer efficiency was relatively high at a distance between 1-2 cm. Since the human heart resides only a couple of centimeters beneath the skin, this technology shows great promise to directly power devices implanted inside the heart wirelessly.

Summary Statement
My project investigated the effect of the separation distance between the transmitting and receiving coils of a resonance wireless energy transfer system on its efficiency in order to optimize efficiency for biomedical applications.

Help Received
I used lab equipment at the University of California, Irvine under the supervision of Professor William Tang. He also provided different papers to read, explained the concept of wireless energy transfer, and helped with circuit design selection. My parents drove me to the lab and purchased the supplies.