Wireless Communication Systems for Medical Devices

Luis Carpio 83carpio@gmail.com
Bell Gardens High School, Class of 2022
USC Viterbi Department of Electrical Engineering, SHINE 2021

Introduction

Implantable/wearable medical devices are very important in the medical field and health care system. They allow us to better understand what is going inside the body of a person and accurately monitor their health conditions. This communication is achieved wirelessly and can be created using different methods. Some examples of such methods include inductive coupling, backscattering, and radio frequency (RF) systems. An inductive coupling is a short-range communication technique achieved via mutual inductance between primary and secondary coils. Radiofrequency (RF) communication links can be implemented using miniaturized antennas to achieve higher data rates and a reasonable communication range.

Skills Learned

I was able to learn how Simulink and MATLAB work and how they allow for greater ease on the modeling and simulating of real-world systems. Simulink is a simulation system that allows for the creation of a model, of a piece of technology, without using materials to make. By using Simulink, I was able to see how helpful and beneficial simulating a model will be for a research environment.

Figure 1: Inductively Coupled Communication System Model

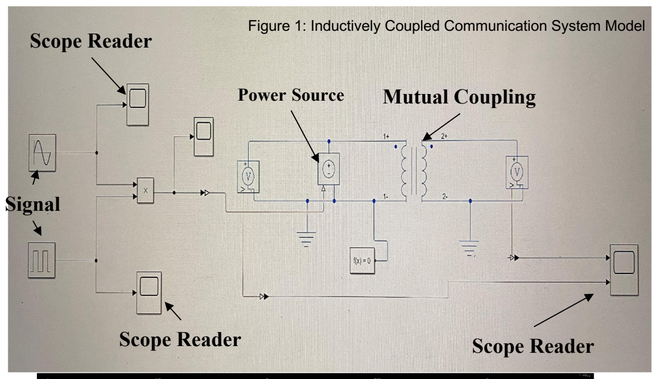
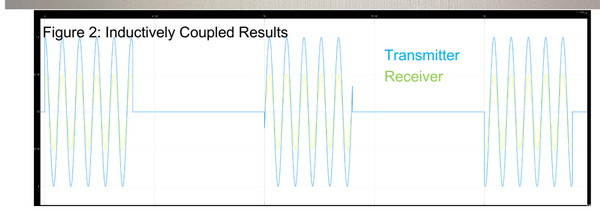


Figure 2: Inductively Coupled Results

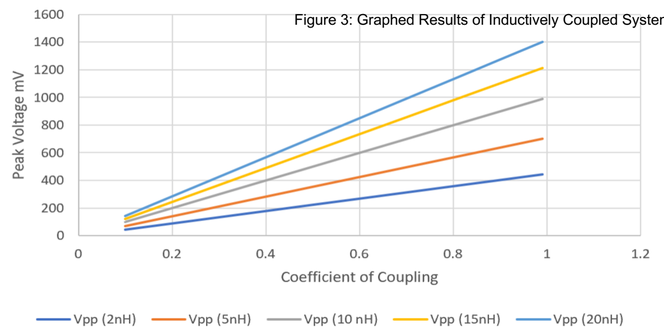


In these results, the inductance values of the primary and secondary coils are same. However, because the coupling coefficient is .5, the receiver end obtains half of the power that was transmitted towards it.

Results

Inductively Coupled Communication System:
With the simulation, I was able to better see what allows for an inductively coupled communication system to work at its best. First off, the greater their coupling coefficient (closer the two inductors are), the larger amount of power will be sent from one to another. Also, the greater the inductance (measured in H) on the receiver end, the larger the power received. Through the chart/graph seen below, you can see how the greater the coupling coefficient, the greater the power the receiver gets. Also, the graph shows how when the inductance of the receiver end goes up or down, the amount of power received varies in that same direction.

Figure 3: Graphed Results of Inductively Coupled System



Radiofrequency Communication System:
In a RF communication system, the signal between the transmitter and receiver is sent through an electromagnetic wave. As the distance between the two is greater, the signal to one another becomes weaker and weaker until nothing is received. To achieve a greater connection between the two ends, amplifiers are placed to allow the signal to be increased as required. In doing so, the signal will not be as weak as originally made.

Results of the RF simulation are below:

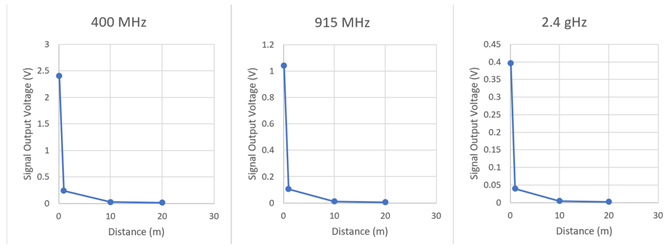


Figure 4: Graphed Results of RF System

As the chart shows, the closer the communication systems are to one another, the greater the signal output. The lower the frequency, the greater the signal output. As they all start at .1 m away, the 400 MHz received the highest output at 2.4 V, higher than the other two.

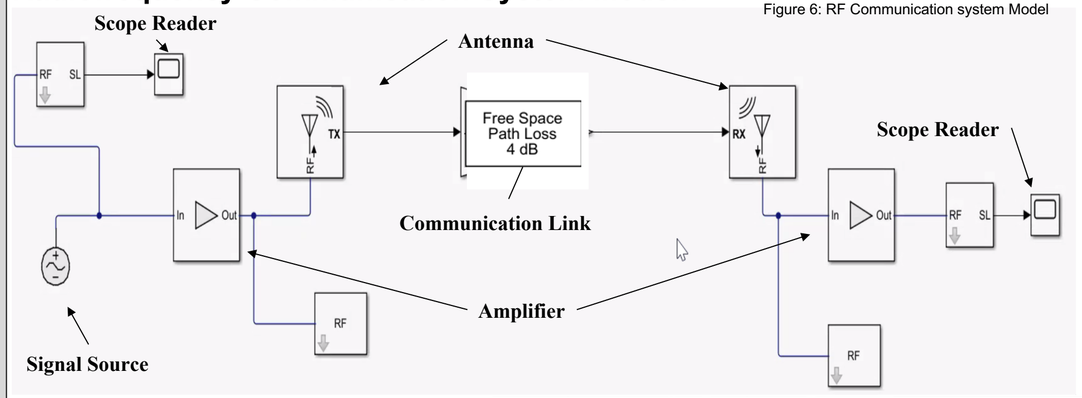
Objective of Professor's Research

My professors research focuses on what can be the best type of medical devices to understand what is wrong with a human being's health and how to handle them. Technology advancements are allowing for smaller and smaller bio-chips to be inserted into the human body that will also consume less power. This would benefit the consumer and environment as it will be more efficient and need less parts to make.

Figure 5: Professors Work
Link to
website: https://imedelab.org/

Radiofrequency Communication System Model:

Figure 6: RF Communication system Model



In the image above, the left side is the transmitter side and the right side is the receiver end of the radiofrequency communication system. The signal source first goes into an amplifier to boost the signal power. Then it goes through the antenna, travels through a certain space, and is then received by the other antenna. After the signal is received, it goes through another amplifier to increase, and is then read by the scope.

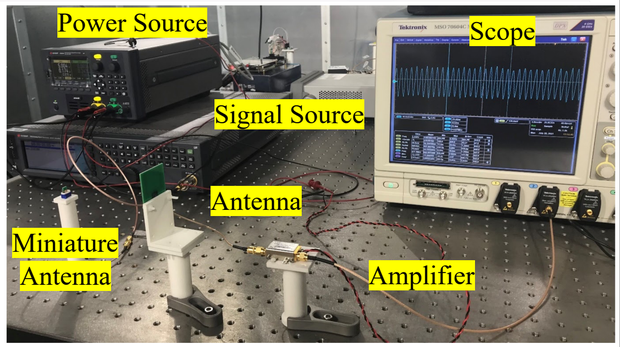


figure 7: Real life RF system PC: NIlan Udayanga

My Advice for Future SHINE Students

My advice to future SHINE Students would be to not pressure yourself. Make a plan before hand step by step and follow it through. Don't try doing too much as it'll feel like too much. Work hard at your project but enjoy the experience as it goes on.

Acknowledgements

I would like to thank Professor Monge for accepting me into his research group, my mentor and postdoctoral scholar Nilan Udayanga, my sub cohort mentor Emily Yamanaka, and Dr. Katie Mills for giving me this opportunity to learn how scientific research works and apply it.