Senior Project ~ Electrical Engineering ~ 2020

Smart Tennis Net Using RF Wireless Power

Tal Pezzuco

Advisor ~ Professor Hedrick

INTRODUCTION:

- Radio frequency (RF) energy is ambient electromagnetic waves from radio towers, cell phones, wifi routers etc.
- RF harvesting is when a transmitting antenna reflects an RF signal which is collected by a receiving antenna and turned into a DC voltage
- The use of energy harvesting to power low-powered sensors would eliminate the need for electrical wiring as well as be energy efficient
- RF harvesting is extremely difficult at long distances because the output power is directly related to the inverse of the distance squared
- Using wireless power transmission can help assist energy harvesting by providing an additional source of power
- With the ability to harvest enough RF energy to power a motion sensor, I would be able to build a system that can track how many times a tennis player hits a ball over a net in a rally
- If a player can simultaneously keep track of how consistent they are in a point while performing at their best, they would be able to record and improve their tennis ability

DESIGN REQUIREMENTS:

- Output of 3-5.75 V and at least 3 mA
- Frequency band of 145 MHz
- Only can use RF signal from transmitting antenna
- System must not get in the way of the people playing tennis when in use
- Must be able to power sensor at 10 feet from transmitter

CURRENT DESIGN:

- A picture of my current transmitter and receiver is shown below on the left
- A picture of the receiving circuit is shown to the right

Figure 4. Transmitter and Receiver

Figure 5. Receiving Circuit

- The receiving circuit needed two boards, so the sensor, LED, and voltage regulator are on the other side
- The current design is also able to handle a 20 V radio

ACKNOWLEDGEMENTS:

Thanks you to Union College, Professor Hedrick, Professor Hanson, Professor Cotter, and Dr. Budka of RF Diagnostics

DESIGN:

- The overall design set-up is shown in Figure 1

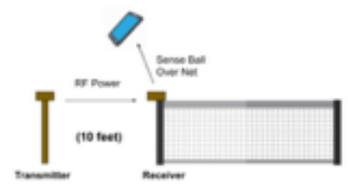

Figure 1. Overall System Design

- The block diagram for the system is shown in Figure 2

Figure 2. Block Diagram of System

- The transmitter uses a VHF FM transceiver that is powered at 5 V
- The matching circuit is an LC lowpass filter
- The RF-DC circuit is a quadrupler with four 1N21C diodes
- The storage unit consists of a 1F super capacitor
- The transmitter and receiving circuit uses a half-wave length antenna to communicate that is 3.2 feet
- A schematic of the receiving circuit is shown in Figure 3

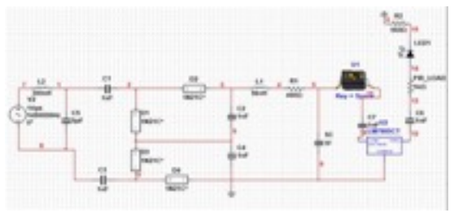

Figure 3. Schematic of Receiving Circuit

- There was not time to put in the display system, so the sensor is connected to an LED for motion detection

CURRENT RESULTS:

- The design with the quadrupler was tested at various distances from the transmitter, shown in Figure 6

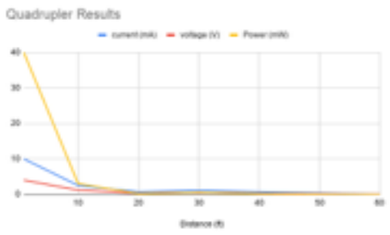

Figure 6. Results of Quadrupler Circuit

- The circuit was also tested with two different transmitters
- With the 5 V source, it took 16.20 minutes to get to 3 V with a 3.4 mA charging current
- With the 20 V source, it took 7.55 minutes to get to 3 V with a 5 mA charging current

FUTURE WORK:

- Add in the display system with a microcontroller and bluetooth
- Test at different temperatures
- Fix wiring and add a weather resistant box