EE/CprE/SE/CYBE 491 WEEKLY REPORT 03

2/14/2022 - 2/20/2022
Group: 07
Project: Wireless Energy Harvesting
Client: Dr. Jiming Song
Team: Benjamin Brown, Christopher Marting, Greg Schmitt, Jacob Walczak, Sam Runkel, Tanner Garity

Weekly Summary:

During our advisor meeting, Dr. Song answered a number of our questions that we had about antenna functionality. We discovered that as frequency increases the penetration of that wave decreases respectively by the inverse square. Additionally, we learned that an ideal antenna length is going to be the length of the wave or either ½ the length of the wave. Dr. Song informed us that we are going to need to think about having more than 1 antenna to work with multiple frequencies. Dipole and Yagi-Uda antennas seem to be the best fit for our project.

During our weekly team meeting we discussed individual tasks for this week. We determined that Chris, Jacob, and Sam should research antennas for the project. Specifically, Dipole, Yagi-Uda, and microstrip antennas. We determined that Ben, Greg, Tanner, and Sam should find similar energy harvesting evaluation/test boards similar to the one Dr. Song provided (https://www.rfdiagnostics.com/store/rfd102a-tb-60hz6ghz-energy-harvesting-test-board)
In order to buy the desired board and antennas we will need to talk to ETG.

Weekly Accomplishments:

Benjamin Brown -
researched for additional radio frequency energy harvesting evaluation boards.

- P2110-EVB
  https://www.digikey.com/catalog/en/partgroup/p2110-powerharvester-evaluation-board/81522
  Comes with an evaluation board and antennas to test, develop, and convert RF energy into DC power and store it in a capacitor to provide a voltage output.
- AEM40940 QFN28
  https://e-peas.com/product/aem40940/
  The evaluation boards include 7 passive components and jumpers to easily configure the RF harvesting AEM. Screw connectors allow the user to simply connect the load to the output voltages, storage element, or battery. The SMA connector allows an attachment for an antenna to harvest RF.
- STEVAL-ISV021V1
  https://www.st.com/en/evaluation-tools/steval-isv021v1.html

This kit consists of a complete energy harvesting module and a battery charger. This allows the user to show the electric performance of the power converter. A power monitoring board along with a software GUI are used to monitor and to graph both PV panel and battery voltage and current.

- https://www.mouser.com/c/?m=e-peas
  This link provides a place to look at even more additional evaluation boards. It includes a description of the boards, datasheet, availability to check to see if the board is in stock, and the pricing of the boards.

Christopher Marting -
Researched dipole and yagi-uda antennas, along with an antenna I personally own to see if we can use it for testing.

- Personal antenna
  https://www.tp-link.com/us/home-networking/pci-adapter/archer-tx3000e/
  This PCIe wifi adapter comes with 2 dipole antennas which are dual band for both 2.4 and 5 GHz which will work to be able to test proof of concept with our project.

Sam Runkel -
Researched dipole, yagi-uda and very briefly micestrip antennas. Learned more about how they function and that dipole will likely be our best bet for testing because of its affordability and ease of use. Down the line a yagi-uda or microstrip antenna will be a great thing to design because it will allow us to concentrate the RF waves and harvest more power as opposed to the single dipole antenna.

Jacob Walczak -
I researched basic antenna theory in order to get a basic understanding of antennas. Even though I am in EE 417, which is an antennas class, this furthered my understanding. This will help me better describe how antennas work to the rest of the group. I also looked through my EE 417 notes for the equations of antennas in order to get the equations we will most likely need to measure the gain of the receiving antenna.

Tanner Garity-
Identified component parameters in order to potentially model the system with cadence virtuoso. Researched dipole antennas at 2.5 GHz and refreshed my understanding on rectification circuits in order to convert the RF signal to a DC current. Briefly viewed comparable RF receiver boards to the RFD102A-TB such as the Powercast's WSN-EVAL-01 and the P2110 evaluation board.

Greg Schmitt -
I researched RF receiver boards that could potentially be suitable for our application. Finding receivers that operate at the 2.4 GHz frequency band, and have usable interfaces to test output provided few options. However, I did find a few that show promise if need arises.

- P1110 Energy Harvesting Board
  P1110-EVB Powercast Corporation | Development Boards, Kits, Programmers | DigiKey

Board receives RF signals to built in antenna jack, converts signals to DC and outputs a voltage reading.

- P21XXCSR-EVB
  P21XXCSR-EVB Powercast Corporation | Development Boards, Kits, Programmers | DigiKey
  Board contains 6 signal band receivers that could be used to test multiple antennas at once, as well as take advantage of a potential additive effect

Plans for upcoming week:

1.) Order our decided test board with ETG so we can begin testing and designing
2.) Determine if we need to obtain a different antenna that functions solely on the 2.4GHz band
3.) Research simulation software to simulate possible antenna designs down the road

Individual contributions:

Name	Individual Contributions	Hours this week	Hours cumulative
Benjamin Brown	• Researched for additional radio frequency energy harvesting evaluation boards - 2hours	2	9
Jacob Walczak	• Researched basic antenna theory and went through my EE 417 notes for equations -3 hrs	3	9
Greg Schmitt	• Researched energy harvesting board alternatives that provide options for research and testing • Conducted research into energy harvesting processing circuitry to gain a better understanding of what these RF receiver boards are actually doing, and see if it would be viable to print a custom board ourselves if needed	3	9

Christopher Marting	• Researched different dipole and yagi-uda array antennas to see how they would best implement into our project. -2 hours • Researched personally owned dipole antenna to see if we could use it as a testing antenna. -.5 hours	2.5	9
Sam Runkel	• Researched dipole, and yagi-uda array antenna to better understand their function -2 hours • Searched for other similar wireless harvesting test boards to use as opposed to the one Dr. Song recommended. Found a number of surface mount chips and a few very expensive test boards -1 •	3	9
Tanner Garity	• Conducted research on half wavelength dipole antennas and rectification antennas. - 1.5 hrs • Researched multiband rectennas in order to determine their efficiency. - 0.5 hrs • Compared RFD102A-TB to the WSN-EVAL-01 and the P2110 to find which board is the right fit. - 1 hrs.	3	10