EE 491 WEEKLY REPORT 2   *Date: 10/4/16-10/10/16*

Group number: 18

Project title: Radio Frequency Readout Device (RFRD)

Client &/Advisor: Dr. Qiao

Team Members/Role: Brandon Baxter/Team Leader, Vaughn Dorsey/Team Webmaster, Luke Myers/Team Communication Leader, Kurt Turner/Team Key Concept Holder, Aaron Haywood, Robert Buckley, Mehdy Faik, Kellen Yoder, Michael Miller

o Weekly Summary

The IC group met to continue testing on our initial bread-board prototype circuit simulating an integrated circuit. We utilized a schmitt trigger in the hopes of producing a PWM output. Mehdy also designed a circuit with a more efficient means of identifying the capacitance. He presented it at both the our team meeting on Sunday and advisor meeting on Monday. On our Sunday meeting, we made plans for the initial antenna testing and also began documenting our project plan. On Monday we met with our advisor to discuss the state of the project, clarify some details, and determine which circuit design for the tag would be best to pursue at this point.

o Past week accomplishments

- Brandon Baxter: Met with the IC team to do simple circuit design.
- Vaughn Dorsey: Worked with the reader team to do more research into what the hardware that we're considering purchasing can do. Also started forming up the information for the website and looked into the Materialize CSS/JS libraries to speed up web development.
- Luke Myers: Met with the IC group to do some testing on a circuit designed by Kurt to simulate the IC circuit. I also studied a number of documents that were sent to us by Dr. Qiao including a thesis on RFID and documentation on a readout circuit for capacitance sensors.
- Kurt Turner: Designed and tested a circuit to convert a changing voltage level on the sensor capacitor to a PWM amplitude modulation for backscatter, using a Schmitt trigger.

- Aaron Haywood: Continuing research on power harvesting, and added to the Project Plan.
- Robert Buckley: The reader team has been looking into RFID UHF Reader Modules to purchase. We have decided to go with the [ThingMagic Micro-LTE](#) module, as it looks like it can do everything we want and more. It is also one of the cheaper modules that looks like it will work. The main concern I have is the Mercury API required to work with the module, and we have not found a cost for it.
  We have also been looking into more antenna options, the [Laird Patch Antenna](#) or [Laird Dipole Antenna](#) look like viable options and have a price point of about $100. However, we are looking into making the antennas ourselves.

  This week we want to purchase the [Raspberry Pi 3](#).
- Mehdy Faik: Developed tag circuit that could make determining the capacitance value of the capacitance sensor much simpler. The basis of the method is the determination of the test capacitance via determination of the resonant frequency.
- Kellen Yoder: Met with module group on Thursday. Researched types of antennas that we could use and are comparing multiple options to figure out the best fit for the module to use.
- Michael Miller: Tested circuit designs for feasibility, researched other design ideas

- **<u>Pending issues</u>**
  - Brandon Baxter: Need to finalize IC circuit prototype.
  - Vaughn Dorsey: Awaiting final decisions on reader hardware.
  - Luke Myers: The IC group needs to do further testing on Kurt's schmitt trigger circuit
  - Kurt Turner: The DC boost circuit needed for the Schmitt trigger is not performing, probably needs more inductance. Collecting enough power for the IC may be a problem.
  - Aaron Haywood: Building vs buying circuit components
  - Robert Buckley: The RFID module is doing multiple things - modulating the signal, demodulating what is returned, reading the backscatter, and sending what it gets back to the controller. However, we do not fully understand how this works, especially how it is receiving data while transmitting on the same antenna.
  - Mehdy Faik: Feature creep. We need to transmit capacitance information in some form, right? But we want an abstract layout that is adaptable to any transducer for a wide variety of types of data measurements. And we want to be able to transmit the ID of the tag as well. As well as be able to discriminate between information from tags that are very close together. And the whole tag needs to cost less than a candy bar. The degree to which new features and specs not directly stated in the project description are being introduced is concerning, especially at such an early stage.
  - Kellen Yoder:

- Michael Miller: There seems to be some shortage of power in the IC design.
o **Individual contributions**

NAME	Individual Contributions	Hours this week	HOURS cumulative
Brandon Baxter	Testing with IC group	2	16
Vaughn Dorsey	Further research into the capabilities of the Thingmagic RFID module and interfacing with it. Fleshed out website design and learned more about the Materialize CSS and JS libraries to speed up website development. Meetings with professor, whole group, and reader team.	1 .5 3	16.5
Luke Myers	Helped with some testing on Kurt's circuit design. Conducted research. Met with IC group, met with whole group to discuss project plan.	6	18 hours
Kurt Turner	Designed a prototype circuit to measure and output a PWM modulation to the antenna. Built and tested circuit.	1.5 2.5	19.5
Aaron Haywood	Found potential RF power harvesting components.	2.5	15
Robert Buckley	Continued research into RFID modules. We want the ThingMagic Micro-LTE UHF RFID module. We plan to buy the module and Pi this week.	6	21
Mehdy Faik	Developed tag circuit that stands to make determining the capacitance value of the capacitance sensor much simpler.	3	13

Kellen Yoder	Reader research, Antenna research	5	20
Michael Miller	Worked on IC feasibility, power harvesting, and project plan	5	20

o **Comments and extended discussion**

Five of our group members were able to make it to the weekly group meeting on Sunday, 10/9. We discussed an alternate possibility to the IC for obtaining the capacitance measurement from the tag. We also addressed whether purchasing the antennas or making them ourselves would be the best route and how we could go about doing some testing for the antennas. Finally we began documenting our project plan.

o **Plan for coming week**
  ● Brandon Baxter: Read documentation provided by Dr. Qiao
  ● Vaughn Dorsey: Begin reading into the documentation on the Thingmagic APIs and understand how to work with the device. Complete the software portion of the project plan to the best of my ability. Implement the basic structure and design of the website.
  ● Luke Myers: Meet with group to finish the project plan. Will be returning to tag circuit for testing with the IC group.
  ● Kurt Turner: Check on direction of group toward the key project idea. Design a better DC boost circuit.
  ● Aaron Haywood: Continue research on powering tag.
  ● Robert Buckley: Continue research into what the RFID module is doing. Create lower level block diagram if possible.
  ● Mehdy Faik: I want to know my options with hardware implementations of antennas. I want to perform simple tests at the lowest level in the RF lab just to ensure I know what I'm doing. From here I can test some higher level prototype antennas. Testing antennas also means developing matching networks; the hard part here will be the implementation of these matching networks to minimize t-line length. Do we have any-boards and ceramic components here? I need to find out that as well then; my prototypes are going to be pretty dodgy if they depend on axial leaded components.
  ● Kellen Yoder: The module team will be looking more in depth into the processes that we will need to make the module perform. Will be researching how these processes work and how we can accomplish them in the best most efficient way

with the materials we will be purchasing. Also will help Robert with further research.

- Michael Miller: Continue working on power harvesting circuitry, finish project plan, continue testing designs.

o **Summary of weekly advisor meeting**

For our advisor meeting, we started by getting some of our questions answered about the capacitor sensor. Dr. Qiao wants us to limit ourselves to using two plates (a simple capacitor) since a commercial capacitor sensor will be too expensive to include in the tag. The most important parts for the tag will be power efficiency (since it will be passive without a battery source) and cost (<$0.50). Next, Kurt presented his circuit design for the tag (the one that the IC group conducted testing with last Thursday). We discussed our inability to detect the capacitance value in those initial tests, and how we will need to test each subcomponent to diagnose the problem. Mehdi also presented his circuit design for the tag. A lot of time was spent discussing the range of capacitance values that could be measured with it. Dr. Song pointed out how it would be difficult to differentiate among tags with that design, and then presented some slides he had prepared on further RFID information.