EE/CprE/SE 491 WEEKLY REPORT #6

3/5 – 3/12

Group number: 12

Project title: Application Exploration of 5G-and-Beyond Wireless Systems and Rural Broadband

Client &/Advisor: Hongwei Zhang

Team Members/Role:

Caleb Kitzelman - Undefined
Cristofer Espinoza - Undefined
Andrew French - Undefined
Jake Roskopf - Undefined
Samuel Rettig - Undefined
Vibhu Dhavala – Undefined

Weekly Summary

Due to midterms, we only met once this week. In our last meeting from the previous week, Dr Hongwei had recommended we meet with a couple of his graduate students to get more information on the current applications of the ARA network for agriculture. We were able to schedule and meet with Joshua Boateng and Sarath Babu this past Wednesday.

Joshua and Sarath are both graduate students researching for Dr Hongwei and contributors to the ARA project. Sarath's role lies more in software as a data scientist whereas Josh had more experience in infrastructure whether it was hardware or the optimization of the software stacks within the UE and base stations for the best performance.

One current application is with their partnership with John Deer. At the moment, they are trying to realize real-time imaging when harvesting via Insta360 Pro camera on a tractor. When attempting to transmit data on commercial 5G there are regulations that "nerf" the full potential of transmission (ie prioritization, types of data transmitted, etc). They want to be able to use a private 5G system to allow for greater bandwidth, greater throughput, and lower latencies. Eventually they would like to automate the tractor with low latency. When given a command to turn, it should be almost instantly without delay despite being remote from the actual location of the tractor.

Another application they currently have is phenotyping bots. These bots collect images of plants for plant monitoring. However, images are saved physically and locally. They want to be able to have these images immediately uploaded to be viewed remotely. They are currently required to go in every couple week to retrieve data or transfer the memory when the storage is full.

We also discussed the project of last semester's senior design team. We had heard earlier this semester from Dr Hongwei that they had turned their project from an application to a learning resource for others who want to learn about 5G. We were able to receive some feedback that they thought contributed to the original project not being followed through. For starters, Josh told us that contributions from a team of seven or eight heavily relied on only two people. We hope to learn from their mistakes and hold each other accountable. Another important aspect he mentioned in making this a successful project is knowledge and understanding of 5G, both the RAN and mobile core network. Dr Hongwei provided a plethora of valuable resources in the beginning of the semester to develop our knowledge of 5G and Networks.

In discussing the previous semester's incomplete project, we were able to get some of the resources that it was based off of. There are open-source codes for BS-UE connection that Josh recommended we start with. These are in C and C++, which is a familiar language to everyone in our team. He had also provided a text "5G in Bullets" which supplements the code by explaining. A basic task would be to test for a connection first and speed, then get into modifying the code. Speeds are dependent on aspects like modulation scheme, which is fortunate for the electrical engineers we have on the team that are pursuing sequences in communication systems.

Past Week Accomplishments

Samuel Rettig: After midterms, as well as meeting with the graduate students, I decided to dive into the open-source code to familiarize myself with the code base. Since we may need to make specific changes to optimize it for our project, it is my goal to know it as well as I can.

Cristofer Espinoza: This week I had mostly been focused on midterms but was able to do some research in the utilization of drones for agriculture/smart farming and set up and attended the meeting with the graduate students Josh and Sharath. In the previous week we were introduced to the concept of sensor fusion. I believe we could use a Normalized Difference Vegetation Index (NDVI) map and in-ground sensors measuring mineral content to get accurate data regarding affected crops (NDVI maps measure live green vegetation). Say we utilize soil sensors to measure the K, P, N content and are alerted that there is an alarming amount (excessive or insufficient), we can use a NDVI map to be able to know if the crops are truly being affected by this amount of mineral content.

Jake Roskopf: This week I spent some more time reading about Computer Networks. I also began looking at the open-source code for "OpenAirInterface5G" and "srsRAN". These were provided to use by Josh and Sharath as a first step of our project. Once we understand the code, we can begin thinking of ways we can utilize it and make it better.

Vibhu Dhavala: This week I spent time familiarizing myself with the OpenAirInterface5G codebase. I spent time looking at the currently implemented feature list. I also looked at the documentation for implementing the first two layers of OpenAirInterface. I was unfamiliar with a lot of the terminology used in the documents so I had to familiarize myself with the terms. I hope to be able to understand and try and implement a simple use of the functions after dpring break

Caleb Kitzelman: This week we met with some grad students doing research in the ara wireless field, and we were introduced to some applications currently being worked on. Our talk led to 5G code

(srsRan and OpenAirInterface5G) and how to optimize the code for specific applications. I've been looking into the 5G stacks and trying to better understand how it works using an explantory document called "5G in Bullet." We also talked about using 5G connections to transfer data from another departments "Phenobots" so they didn't have to go to farms to collect data from their robots. I've looked a bit into how to implement the data transfer over 5G using the srsRan stack.

Andrew: I read through Microsoft's paper on "Democratizing Data-Driven Agriculture Using Affordable Hardware". Then after the meeting with the grad students I read through the information on the srsRan Project website to learn about the software we will likely be using for our project.

Individual Contributions

NAME	Individual Contributions	Hours this week	HOURS cumulative
Jake	Looking over open-source code	4	19
Samuel	Open-source code research	3	19
Cristofer	Research drones in agriculture and set up the meeting with Dr Hongwei's grad students.	3	19
Caleb	Open-source code research and overall research about 5G via "5G in Bullets" source	4	21
Andrew	Read through "Democratizing Data-Driven Agriculture Using Affordable Hardware" and looked over the information in the srsRAN website.	5	32
Vibhu			

Plans For the Upcoming Week

Samuel Rettig: Look more into the open-source code base so it can be changed later as necessary.

Cristofer Espinoza: I have been busy with midterms, so I have not yet finished reading *Computer Networks: A Systems Approach.* I want to continue reading this and checking out the new resources provided by Joshua and Sarath in our meeting. I want to draft an idea about how we can use these open sources codes in our application.

Jake Roskopf: I plan to take a little deeper look at the different open-sourced code that was provided to us. Also, since it will be spring break, I want to take a step back and think about everything we've learned so far and begin using that to focus and redefine our next steps for our project.

Vibhu Dhavala:

Caleb Kitzelman: I plan to look more into the open-source code and the 5G in Bullets documents. Spring break is here so I plan to take a more laid-back approach to research this upcoming week. I also have a big exam after coming back from spring break so that will be a priority. I want to learn more about the phenobots that were mentioned during our meeting.

Andrew: I will continue to look through the srsRAN project website and over the other resources that the grad students recommended in their email.