EE/CprE/SE 491 WEEKLY REPORT 04 02/12/2018 – 02/18/2018
Group number: *18*
Project title: *Deep Learning with Radar for Object Recognition and Tracking*

Client &/Advisor: Michael Olson (Danfoss) and Dr. Wang
Team Members/Role:
Tucker Creger - Project Manager
Eric Bishop - Software Developer
Kellen O'Connor - Deep Learning Architect
Clayton White - Hardware Design Engineer
Mitch Hagar - Radar System Lead
Nihaal Sitaraman - Hardware Developer

o **Weekly Summary**
This week we were able finally start testing with a camera and neural network. We have not yet spoken to Vayyar either, we have rescheduled it for 3 pm on 2/19. We have decided to not use the Walabot kit with the Vayyar chip, but are looking into if Vayyar can provide a development kit that would meet our requirements.
On 2/18, Kellen, Tucker, and Nihaal tweaked the single object detection neural network to collect training data for multiple classes of objects. We successfully localized and classified people, chairs, water bottles, etc. by using the pretrained network discussed last week. We were also able to decide on what sort of detection method we wanted to use and which neural network topology would be ideal. Based on our research, we think a topology similar to You Only Look Once (YOLO) is suitable for our task due to its improved speed relative to single-shot detectors and region proposal networks. Further research will be done to adapt the YOLO architecture for our task rather than simply retraining YOLO on new data, which could possibly take weeks.

o **Past week accomplishments**
- Kellen, Tucker, and Nihaal were successfully able to get a neural network to detect two objects rather than one, however it is not a scalable solution.
    - Uploaded code to GitLab so the rest of the team can test other solutions.
- We are still reaching out to radar companies to find suitable hardware.
    - Ghostwave, Omniradar, Ainstein, Arbe Robotics, Metawave, Oculii, Steradian Semiconductor, Lunewave, and others.
- We are looking into how to order parts for our project.
- Understood the differences/advantages of single shot detection (SSD) and YOLO.
- We are ready to order our SOC, Nvidia Jetson TX2. Just need to speak with either Danfoss and ETG to get it ordered.

o **Pending issues**

- Determining a scalable approach for generating labeled image data to train another neural network.
- Meeting with Vayyar on 2/19
- Finalizing system requirements for our application
- Preparing our lightning talk presentation
- Ordering the Nvida Jetson TX2
- Finalizing a Radar System

o **Individual contributions**

Name	Accomplishments	Hours This Week	Hours Cumulative
Tucker Creger	Handled communications with the client/advisor. Reached out to 10 companies about possible radar systems. Had a phone call with Ghostwave about their product offerings. Setup Kellen's single object recognition python project on my system. Modified the single-object recognition project to try to detect two objects in an export format that could train another neural network, committed to GitLab. Discussion with Nihaal and Kellen regarding our next steps with the deep learning development.	14	48.25
Eric Bishop	Worked on Interpolation between our radar stream and our camera stream by using math and OpenCV to detect easier how far away an object is in our camera stream using our radar data. In its current state, it is only hypothetical as we don't have great radar data yet or our final radar chosen for the project. Continued to learn more about Deep Learning and various python libraries such as Keras and Caffe. Also looked into various bootstrap templates to improve the look of the website.	7	28
Kellen O'Connor	Wrote a full-process neural network including data acquisition, training, and real-time prediction using Keras and OpenCV. The system utilizes a pre-trained Single-Shot Detector to collect labeled training data on an	12	35.5

	RGB camera. The goal of this was to see if we can use a pre-trained system to collect meaningful labeled data and apply it to another input, such as the radar image we are still researching. The neural network, in its current state, predicts the bounding box surrounding a single object of a single class. This is not a scalable approach, but serves as a good foundation for looking into more advanced techniques, discussed below. Researched next steps for implementing our own object detection network rather than retraining an existing network. YOLO's approach of treating detection as a regression problem (rather than classification) is an approach that may be well suited for the NVIDIA Jetson TX2 we may use due to its improved speed relative to sliding windows or region proposal networks (FRCNN). In the design-thinking workshop, brainstormed alternate solutions to using radar alone, such as combining radar depth data and a classification performed with a camera.		
Clayton White	Continued research on radar systems that would best fit our criteria. I learned that cost of a radar system that meets our client's specifications is going to quite large. In the meantime, I have installed programs on my PC that will allow me to run the detection scripts that Kellen has been tweaking. This step will allow me to gain a deeper understanding of data collection and labeling. We will use this program when we train the system once we have a physical radar system that we can use.	5	24
Mitch Hagar	Looked for different radars that meet our requirements. In case we are unable to find a radar system from a manufacturer, I began to learn how to make our own. I found out this would be nearly impossible to do on our own because of the microwaves at this level of frequency. I thought about backup plans during the design thinking workshop. This revolved around short range radar (15 meters) for construction equipment. The	6	29.5

	Omniradar would work for this application. In addition to the radar findings, I learned about Kellen's object recognition platform.		
Nihaal Sitaraman	Brainstormed and provided a solution for our vision system. Due to a lack of working radar, we decided to just use a webcam and run the images through a neural network. Provided the idea of using multiple camera systems linked with our radar system to collect data and imagery. This would be helpful to focus the radar system. The camera would provide a 2D image, and the radar would be able to provide depth. With the two outputs, we can superimpose them to get a better and more accurate image. Found another YouTube channel which explains how neural networks, and shared this information with the team. Attended a meeting with Kellen and Tucker who explained how the test code we are using works, and how to navigate PyCharm. Began setting up Kellen's script on my home desktop.	9.5	29.5

- **Plan for coming week**

This week we will look into purchasing hardware and talking to more radar companies. Hopefully this will be completed by the end of the week. Tucker will be discussing this with our client, as well as Dr. Zambreno. Kellen and Tucker will continue to work on development for detecting multiple objects with a neural network in an scalable export format. Mitch will be looking further into radar signal processing to understand what kind of outputs we can produce which will be useful for our application. Kellen will be looking into how to link the radar and camera to each other. Nihaal will be looking at alternatives for detection systems which can be coupled with the radar.

- **Summary of weekly advisor meeting**

In our weekly advisor meeting we review the week's progress and what our next steps were. We also had a technical discussion related to what possible alternatives we have if we can not find a radar system that would meet the specifications for our application.