ENSC 440 — Written Progress Report

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Introduction

This report details the progress of our project, with emphasis on developments since the oral progress report (Thursday, February 23rd, 2012).

Subsystems Progress

1. *Radar Hardware*
   The radar hardware of this project consists of the radio-frequency components, the function generator chip used to create the modulated waveform, and the two amplifier stages. The function generator chip and amplifier stages have been assembled on a solder-less breadboard with wires connecting to the designated radio-frequency components. The components of the radar hardware were built early on as according to the specifications laid out by Dr. Gregory L. Charvat at Lincoln Laboratories. The hardware's functionality was tested and confirmed near the beginning of January and has been continued to be used to analyze and verify the signal processing algorithms that are being designed.

2. *Signal Processing*
   Since the oral progress report, the 1-D range profiler has been completed. The data parsing algorithm is functional and has had its processing time improved, and the data analysis block pre-conditions ("cleans up") the frequency domain data to allow for further processing. The peak detection algorithm satisfies the robustness and accuracy requirements outlined by the functional specifications document. Lastly, the deinterleaving algorithm efficiently constructs trajectories, using "persistence events" and motion estimation through data extrapolation , to track multiple targets; this module is time-optimized as well.

3. *Firmware and Interfacing*
   Currently, we have been able to convert all of the Matlab functions for 1-D signal processing into objective C. Also, we have implemented about 80% of the built in Matlab functions such as FFT, min and max finder and matrix manipulators. Lastly, we have created a display function to graphically display the processed data but to also help us to troubleshoot and debug. We have not yet been able to test the functions on real data as we are currently waiting on the arrival of the *GuitarJack* accessory which we are using as a work-around to provide stereo line in.

4. *Hardware Packaging*
   The hardware packing of our system encompasses housing for the radar components, a mounting slot to secure the iPhone, and a handle for the user to hold. The housing for the radar has been designed and built out of ABS plastic. This case is able to contain all of the radar components and hold the user's iPhone. Furthermore, a master on/off switch has been implemented with the radar hardware that will be mounted on the outside of the case. This model is only a proof-of-concept and has not been designed to be able to withstand harsh environmental forces that emergency response personnel could face.

Budget

Due to unforeseen hardware constraints on the iPhone, Shift Technologies will not be able to complete this project on budget. As of now, we are projecting to be $50 over our $750 limit. Large items that have been purchased so far include the radar hardware, an Apple iOS software development kit, and hardware to allow the iPhone to read in two input channels. Although we accounted for unforeseen costs in our initial budget, we were unable to foresee having to buy additional hardware for the iPhone. Shift Technologies received $700 in funding from the ESSEF and we plan to split the remaining costs evenly between the five team members.

Human Resources

The Shift Technologies team works well together. On average, we meet once a week in person, but we communicate frequently with e-mails and through our Google Groups page. These meetings are primarily used to keep the group updated on progress as well as to bring up any encountered issues , as most of the work is done on an individual basis or in pairs on separate components of the project.

Future Plans

1. *Radar Hardware*
   It was decided as a group that one of the possible methods to reduce the noise seen from the antennas was to convert the bread-boarded circuit into a two-layer printed circuit board. Most of the parts will be converted to surface-mount devices however some will remain as a through-hole components. After parting-out specific surface-mount equivalents, all components' printed circuit board footprints were created in Altium Designer and a circuit board layout is currently being designed. Once complete, the design will be sent off to a manufacturer where they will create the circuit board and assemble the necessary components. Once completed, the circuit board will be integrated back with the radio-frequency components. There has been discussion about converting the current radio-frequency components to surface-mount devices and to place them on a printed circuit board, however no final decision has been concurred upon yet.

2. *Signal Processing*
   The next module to be worked on is the 2-D range profiler. A correlation algorithm needs to be developed which matches multiple trajectories between "slices" of 1-D profiles so as to track moving targets in 2-D. The other module that needs to be developed is a modeling scheme for close-quarters and small or cluttered rooms to filter out multipath and be able to differentiate

targets. The room compensation model will likely be built up through trial-and-error, requiring many test cases.

3. *Firmware and Interfacing*
   Looking forward, the arrival of the *GuitarJack* accessory should allow us to complete all of the matrix manipulation function in objective C and to start debugging the code on real data. Once the functions are tested, we will aim to integrate the recorder, the signal processing, and the displaying into a coherent and functional app. From there, we will aim to reduce bugs, to increase stability and optimize for performance.

4. *Hardware Packaging*
   Once the printed circuit board with the radar hardware has been manufactured, all of the radar components must be mounted on the inside of the housing. The case has sufficient space to hold the cantennas, battery packs, radio-frequency components, and circuit board, however different configurations will be tested to see which presents the best layout. Once all components are mounted, measures will be taken in order to reduce the effect of internal and external noise on the system. Possible methods to reduce this noise include shielding the circuit board with a metal box and placing a metal sheet on the outside of the case, between the two cantennas, in order to reduce any “warp-around” interference.

Summary

We have covered a lot of ground, but still have a lot left to cover. That being said, we currently feel comfortable in meeting our goals.