ELECOMP CAPSTONE SUMMIT
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THE UNIVERSITY OF RHODE ISLAND

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Personal Radar

A wearable radar device to warn users of collisions

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Team Members: Christian D'Ovidio (CPE), James Kiessling (CPE), Marjorie Pickard (ELE), Benjamin Welch (ELE)

Technical Directors: Stephen McDonald, Mike Smith [Consulting Technical Director]

Project Motivation

With an increase in technology, people have become more and more distracted by phones and other mobile devices. This can be dangerous when walking on the road due to cars, curbs and telephone poles. Recent advances in radar and its widespread use for automotive driver assistance have resulted in smaller, lower power, and cheaper systems. This project will investigate whether the technology has developed to the point where a personal, wearable radar is feasible. Using a compact radar board from Infineon Technologies, a personal collision detection system will be created which reads incoming radar signals, analyzes them using object detection algorithms and identifies potential dangers around the user. The personal radar system will be battery powered, self-contained, and able to warns users of potential dangers with a variety of methods. This device can be used by pedestrians who are constantly looking at their cellphone, or who are distracted by music. It could also be useful for people with visual impairment.

Key Accomplishments

- **Serial Communication:** Serial communication was established with the TI radar board, and we were are able to retrieve raw data packets from the device. We then configured the script to communicate with the board constantly over an infinite loop that can be broken by direct user input. This loop constitutes the main loop of our script, and all data processing is done within this loop between frames. Data processing includes plotting, collision detection and object tracking. (Fig. 3)
- **Board Configuration:** Initially, we were forced to use the mmWave Demo Visualizer software to reconfigure the board, which required an internet connection. This was not practical for testing purposes, and so we were able to create a script to configure the board directly in MATLAB. (Fig. 3)
- **Data Parsing:** We can parse the raw packets obtained from the board and extract target information, including (x, y, z) coordinate information, range and velocity. (Fig. 3)
- **MATLAB GUI:** We created a GUI in MATLAB to visualize the experimental data in real-time. The GUI is capable of plotting object data in different formats, logging data to a .txt file, terminating the script, and alerting the user of collisions. (Fig. 1)
- **Object Tracking Algorithm:** In order to develop our collision detection algorithm, a system to track objects over multiple frames was necessary. This algorithm processes any number of frames of data and assigns an ID to each object. Objects that persist over multiple frames will have the same ID in each frame. This function also returns the angle of movement of all persistent objects. (Fig. 3)
- **Collision Detection Algorithm:** One of the most vital components of this project was the collision avoidance algorithm. By taking in both raw and preprocessed data, our algorithm categorizes objects as threats, and predicts whether they will collide with the user. The algorithm also assigns a level of severity and direction of collision to the objects. (Fig. 3)
- **Radar Mount:** The radar mount system was created so the user could comfortably and safely use the radar board. The radar board is screws into a 3D printed mount which angles the radar board upward to the optimum angle. The 3D mount is attached by Velcro to the straps of a backpack which holds the battery pack and Microsoft Surface which does the computations. (Fig. 2)

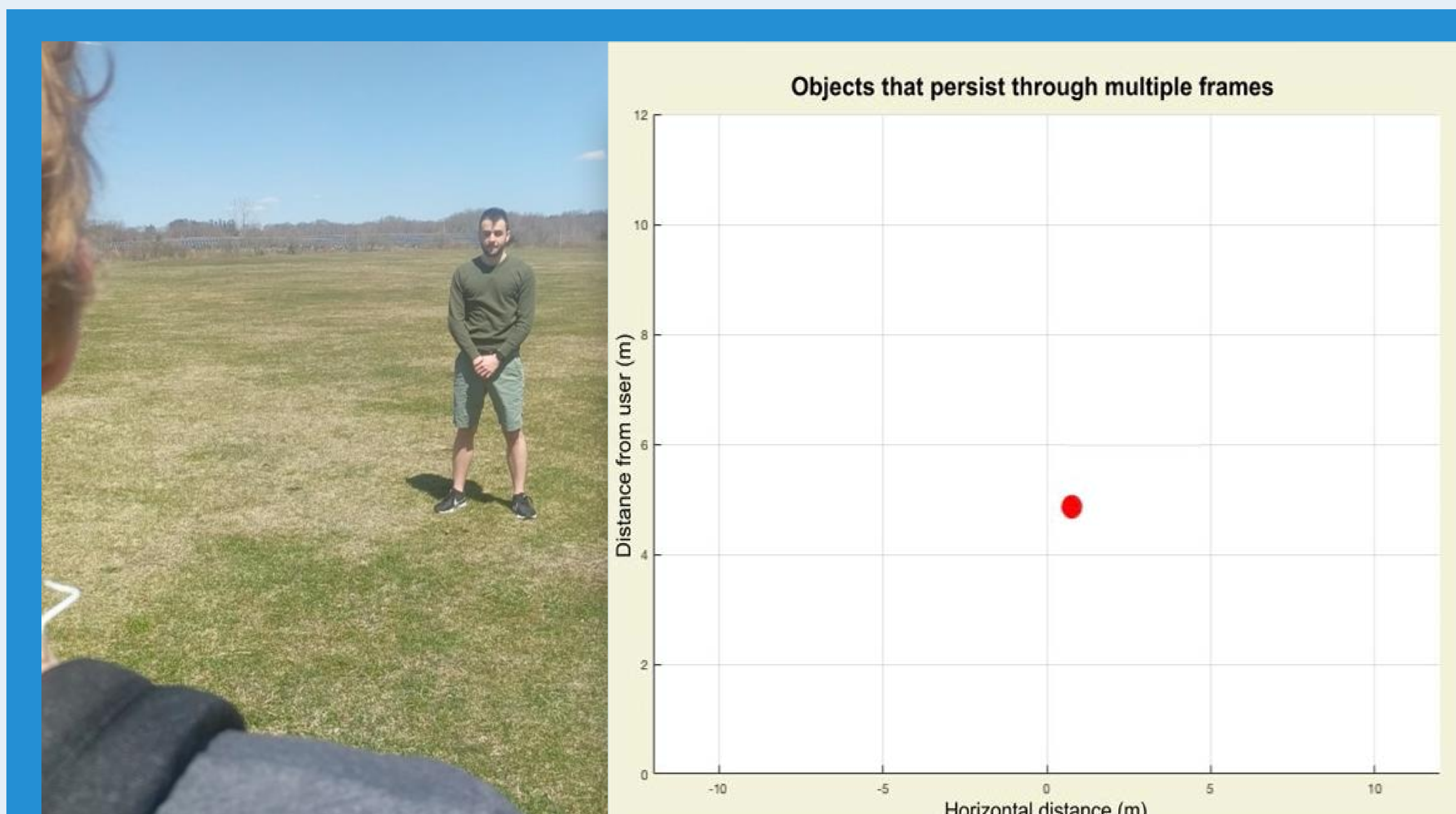

Figure 1 - A side by side comparison between what the user sees and what the radar board interprets. The plot shows the location of the detected obstacle in relation to the user.

Anticipated Best Outcome

The goal of the project is to have a wearable, battery powered, fully portable radar system with a functioning object recognition algorithm. Using FMCW radar in conjunction with automotive radar equations, the wearable device should be able to detect and characterize objects in its range of vision. It should then track the object's location, speed, and acceleration and identify impending collisions. The device should alert the user, either through lights, noises, or vibrations. By the end of the project there should also be a quantifiable set of situations where the device works, and where it needs improvement.

Project Outcome

The Anticipated Best Outcome was achieved: a portable radar system warns the user of impending collisions.

Figures

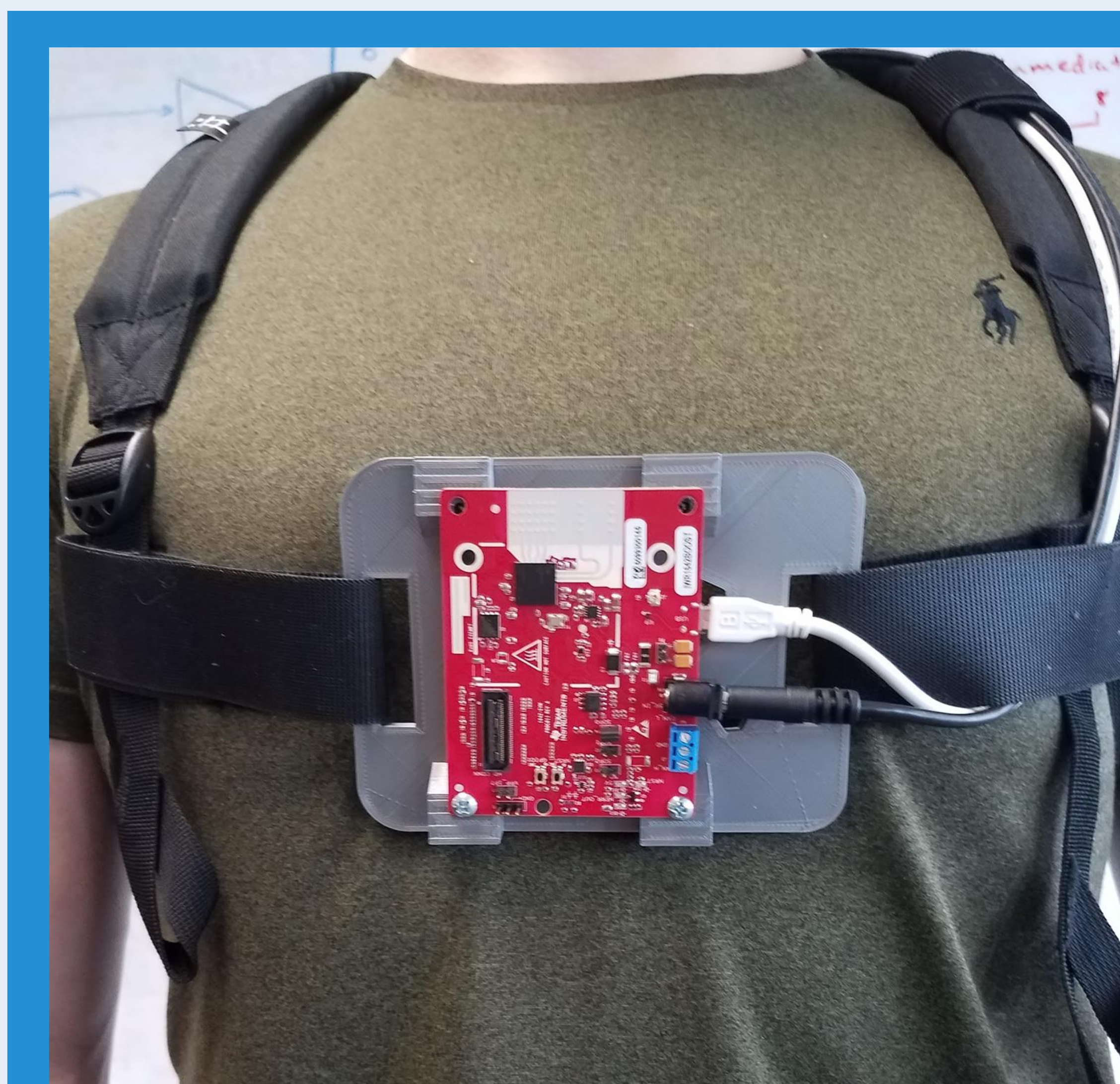

Figure 2 - Our radar board and 3D printed standoff, mounted to a backpack for a student to wear.

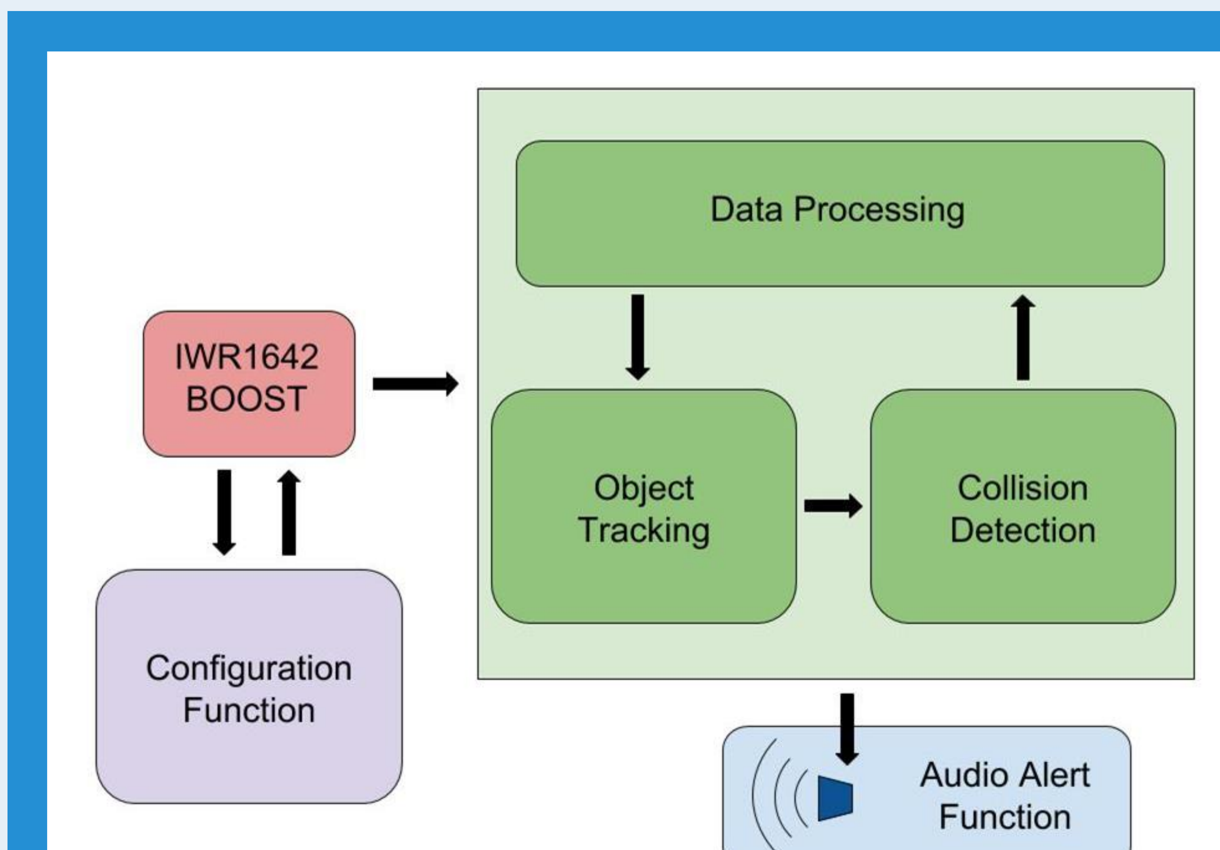

Figure 3 - Block diagram of the radar detection and tracking system. Data received from the radar board is processed, potential collisions are identified and the user is alerted through audio output.

ELECOMP Capstone Program Director: Professor Harish R D Sunak

email: sunak@ele.uri.edu telephone: 401-874-5859

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