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Personal Radar

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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.

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 Doppler and 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.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

This is a relatively unexplored field for Bose, and when the project is complete, Bose will have a better understanding how radar systems could be used in future projects. Possible products include a radar system for the blind, or headphones that have an integrated radar system that allow the user to continuously stay aware of their situations using auditory feedback. In the future, radar will be one of many types of wearable sensors that will help the user extend their awareness of the world, and in turn will improve the quality of life for everyone.

PROJECT OUTCOME:

The Anticipated Best Outcome was achieved: A portable radar device which warns users of impending collisions.

KEY ACCOMPLISHMENTS:

Power Object Tracking and Angle Measurement: In order to implement collision detection, it was necessary to be able to track objects over multiple frames. The algorithm is able to track multiple objects over any number of frames and pass this information to the collision detection algorithm. The algorithm additionally calculates the angles of movement of all objects in order to increase the accuracy of the collision detection algorithm as well reduce the amount of false alerts.

Collision Detection: Our algorithm compares objects over multiple time frames to predict whether the object will collide with the object. By comparing data frames over time, we are able to remove any background noise, and only alert users of valid objects. The object's position in relation to the user, its velocity, and its angular motion are all used to form a prediction of whether the object will collide, and how dangerous the object is with respect to the amount of time a user will have to react.

Data Visualization: To test the accuracy of the device as well as facilitate our testing, we developed a GUI in Matlab that plots the objects measured by the board in real-time. The GUI is also capable of only plotting objects tracked through multiple frames, logging experimental data for future use, and displaying an alert icon indicating the severity of impending collisions.

Audio Alert System: An audio alert system function was created to inform the user of the severity and location of an incoming object. The user would be alerted via a pair of headphones connected to the device. The alert consists of a beep that increases in frequency as the severity of impending collisions increases.

Radar Mount: A CAD design to reliably mount the radar device to a backpack was created, and then 3D printed. This positions the radar board at the correct angle as well as protecting the connections to the rest of the system.

Serial Communication: Serial communication was established with both the Infineon D2G and the TI IWR1642BOOST radar development kits. A script was created to extract relevant information from raw payloads obtained from the TI board in an infinite loop, and this information is passed to the object tracking and collision detection functions for further data processing.

Radar Testing: Testing was carried out on various implementations of the algorithm in order to allow the team to observe the various situations in which the system was not able to correctly interpret the objects, then to debug the algorithm to achieve the desired results. Real life situations were replicated to see how the board would process this data.

Presenting Project at Student Poster Session at:

http://www.capstoneconf.org

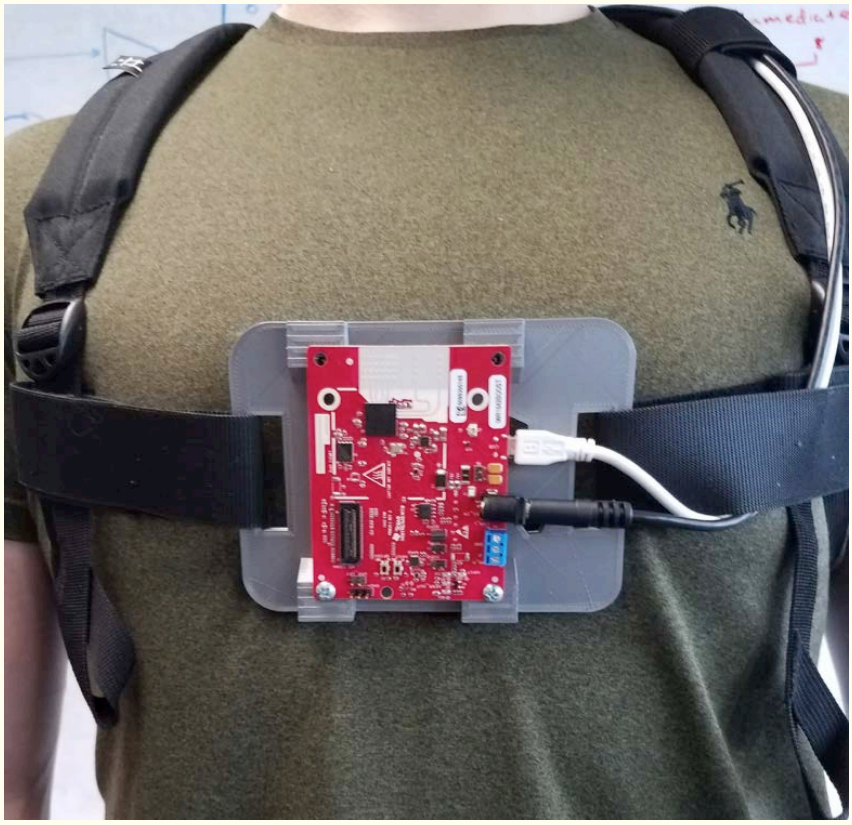

Fig. 1: Radar board & 3D printed standoff, mounted to a backpack.

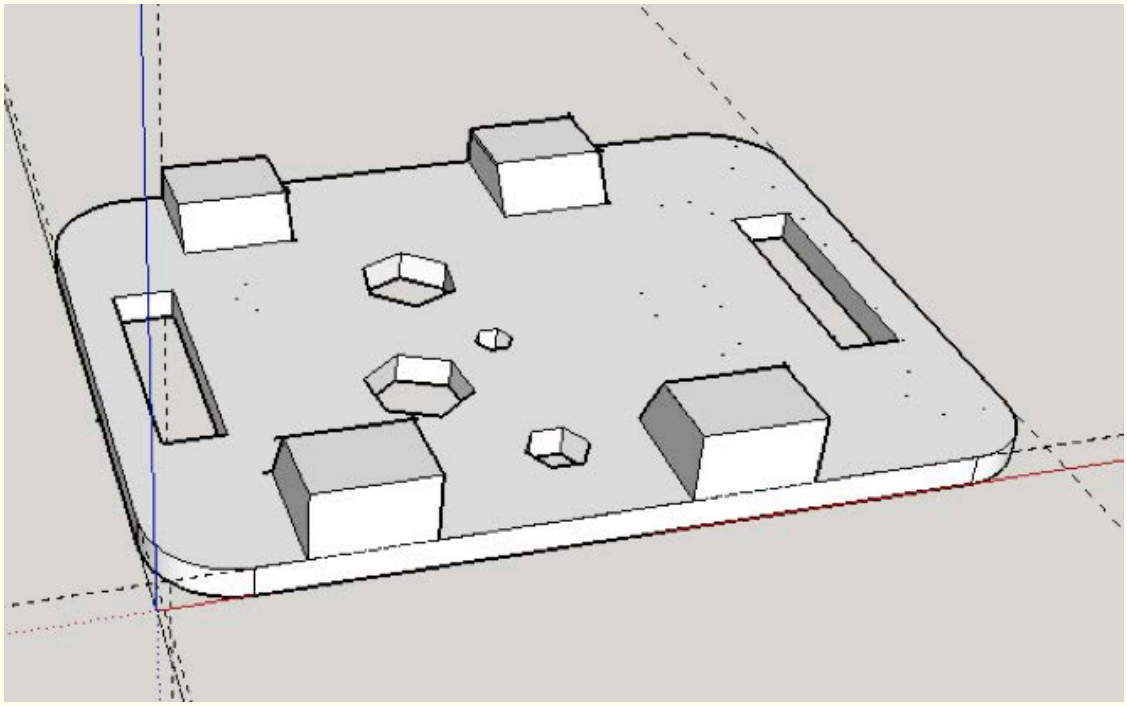

Fig. 2: Radar board standoff was lightweight; allows it to be properly positioned on user's body.

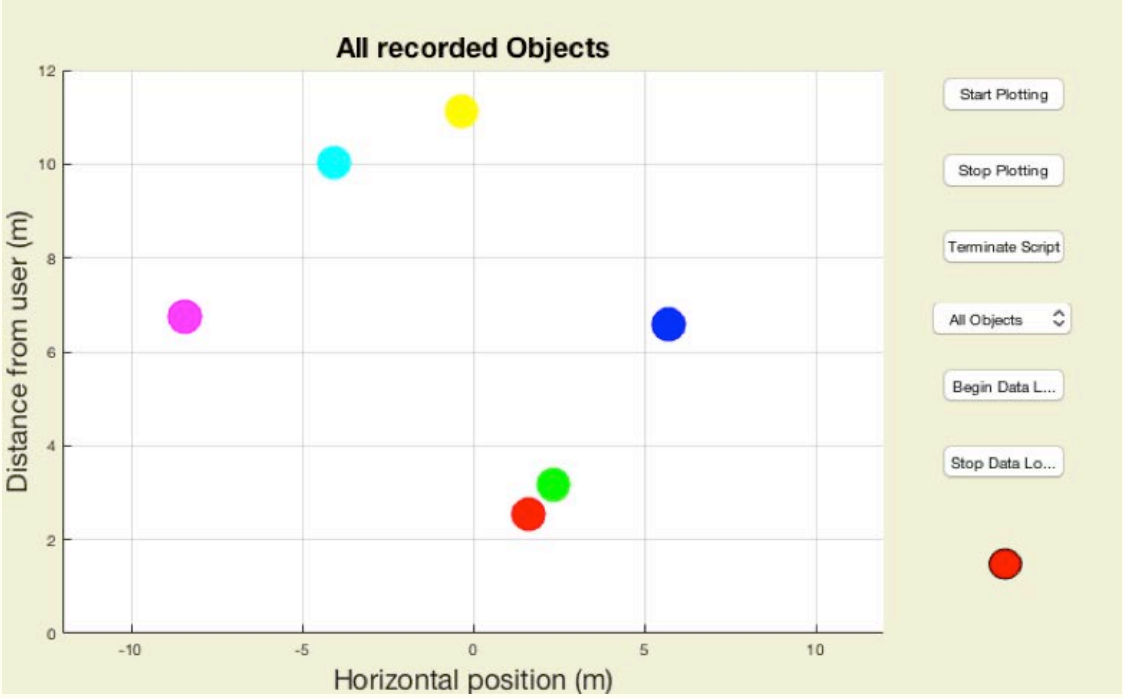

Fig. 3: The MATLAB GUI showing multiple objects at different X and Y positions.

Fig. 4: One of many testing experiments performed in various environments, wide open field.