Team 312: Operation Manual

Project Overview:

The drowsiness-sensing rear-view mirror aims to reduce motor vehicle accidents attributed to drowsy driving. The rear-view mirror uses a radar system to record the driver's biometrics and determine if they are drowsy according to various factors.

Component/Module Description:

Position2Go Board:

The Position2Go board uses an FMCW radar system to record the distance between itself and a target. It also has a microprocessor to perform the signal processing needed to extract biometrics from the driver and run the decision-making algorithm to determine drowsiness. The board is currently discontinued so there is a limited supply of these boards available and tech support does not make this board a high priority.

<u>Caution: Radiation from the board could potentially cause harm if held too close to a person's eyes or body in general when it is on.</u>

Mirror Housing:

The housing is a 3D printed, slightly modified, variant of a standard rear-view mirror. The length and height are very similar; however, the width is deeper to account for any other physical hardware to be added in other iterations as well as working as a physical filter which facilitates filtering of noise. The housing contains a slot to hold the Position2Go in place as well as a slot to run its micro USB cable through so that it does not interfere with anything inside.

Data Extraction:

The board transmits a wave at 24 GHz out into the world and receives the reflected wave from objects in its way. The board then finds the difference between the transmitted and received radar signals on its own and outputs this into MATLAB. The raw data is then processed with techniques such as windowing and filtering to reduce unwanted noise. Then, the displacement of the chest and head can be found within the data by looking at the plotted frequency domain. These variables and their respective state is then fed into the algorithm.

Algorithm:

The algorithm used to predict drowsiness is a Bayesian Network. This network uses Bayes Theorem to calculate the probability of a dependent event occurring given the knowledge of various independent event outcomes. The dependent event is drowsiness. The independent events are the driving time, head position, breathing rate, and time of day. The biometric events are initially determined during the data extraction process and are constantly polled to check their updated status and assign a new state. The numerical values for the driving time, head position, and breathing rate are one-hot encoded, meaning we assign a specific state dependent on the value we get after processing the radar data. A posterior probability calculation is performed to obtain the probability of drowsiness based on the given evidence. We then use this probability to encode three different drowsiness states: awake, falling asleep, and asleep. The decided state is then assigned to a specific LED color and unique alert indicator sound.

Integration:

MATLAB is used to interface with the Position2Go board to process the raw data received from the driver. The incoming data is preprocessed to eliminate noise and filter out higher-frequency data. Next, frequency isolation is performed to extract the driver's head position (and breathing rate). The head position and breathing rate are monitored over time to observe any changes that the decision-making algorithm may attribute to drowsiness. In addition to these factors, the decision-making algorithm gathers evidence of the other relevant events to determine drowsiness. Lastly, the Position2Go board is placed inside the mirror housing so that it is secure during a typical drive and has a clear view of the driver.

Operation:
There is only one mode of operation for the device. To use the drowsiness-sensing rear view mirror, first place the mirror to the interior of a car windshield near where the existing rear view mirror is. This should be a safe distance for the driver to not be affected by the radar radiation. Once securely fastened to the interior of the windshield, connect the device to a personal laptop using the micro USB connector. Next, select the desired "test conditions" for this drive in MATLAB by setting the current drive time. Finally, run the MATLAB script to analyze the biometrics of the driver and determine their drowsiness in real-time.

Troubleshooting:
(1) Broken mirror housing: Due to average wear and tear of setting up the 3D printed chassis in the vehicle, there were issues with portions of the housing chipping or breaking. To resolve this, modify and download the stl file. Then send it to the FSU Innovation Hub for free 3D printing.

(2) MATLAB issues: There were two issues that impacted our device's functionality. The first issue was the radar data pulling in MATLAB. There was built-in Infineon code that would send an error and break out of the loop if there was a bad byte when pulling data. This, luckily, was resolved by allowing it to rerun more than once to pull functional data. We decided on 10 reruns. The second issue was that after a few updates of the virtual LED plot, the MATLAB program would pause indefinitely. To resolve this, simply close

the plot and it will re-open the updated plot and continue running the algorithm. We are looking into a permanent fix for this error. If either of the issues persists, terminate the program, unplug the board from the computer, and rerun it until the issue goes away.

(3) If drowsiness detection is very inaccurate, make sure that the mirror is properly aimed at the driver. Consider changing the location or angle at which the radar is in view of the driver. The board is very sensitive to changes in location so make sure not to be moving the mirror around once initialization begins. During the initialization process, the driver should be very still to ensure that the radar is getting the proper location of its environment. Failure to do so may result in the board not getting proper initial readings resulting in all future comparisons being inaccurate.