DriveWise

ECE Capstone Spring 2023

Final Presentation

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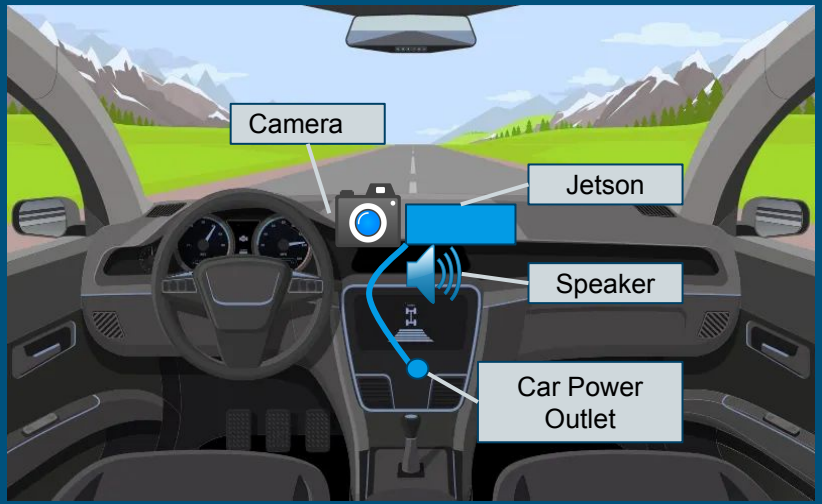
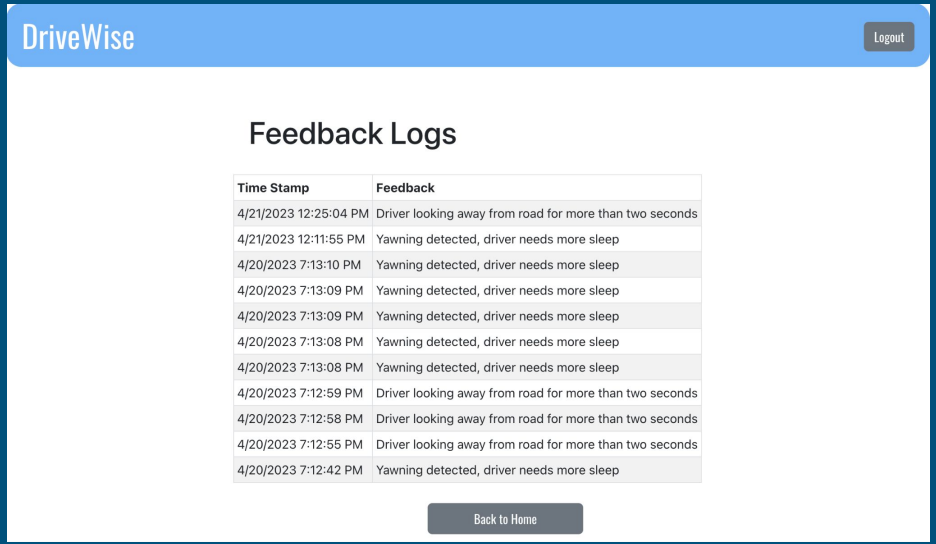
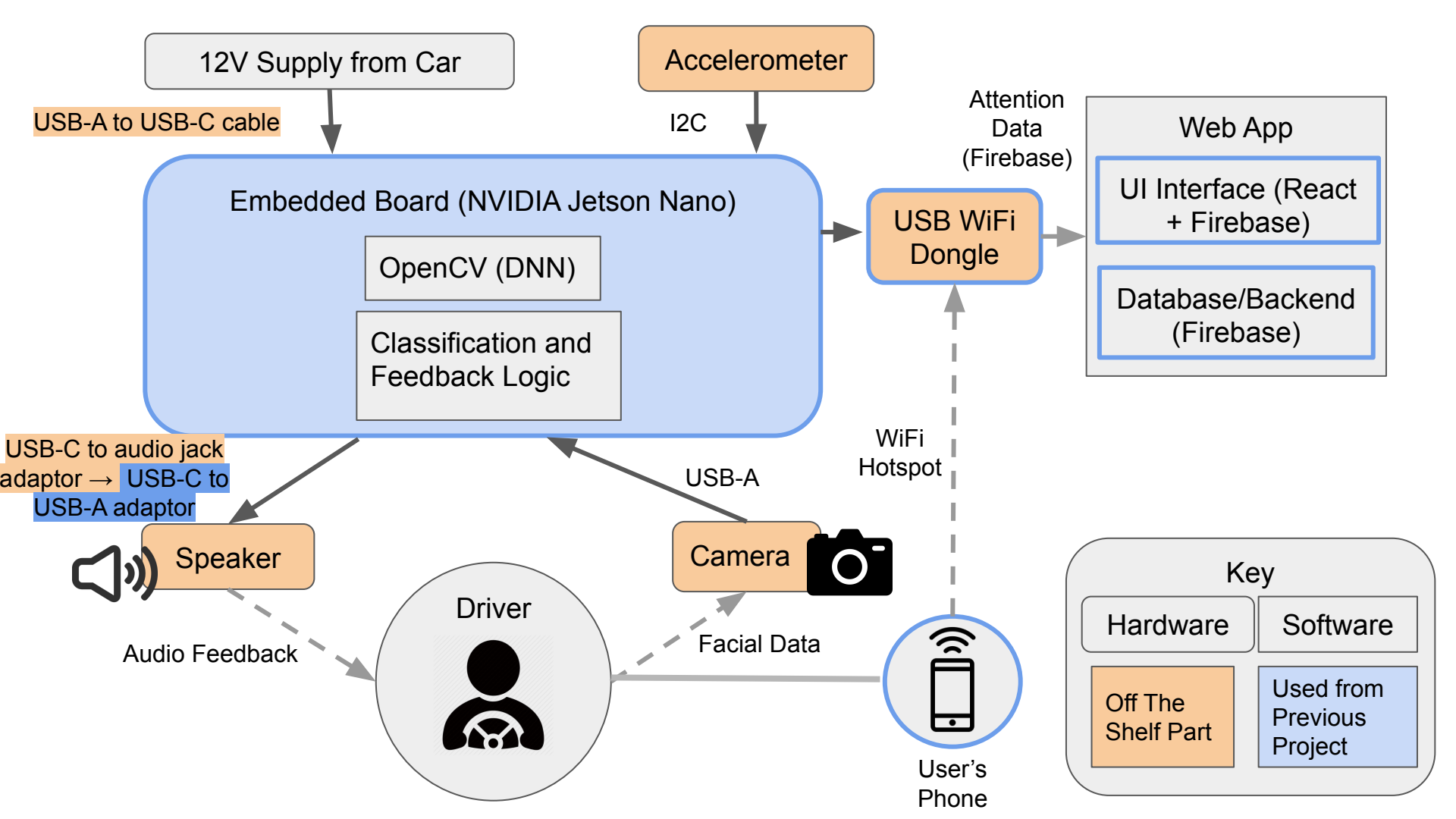
Use Case Requirements

Requirement	Justification
Clear + concise feedback provided for >2s of inattention	Unsafe to keep eyes off the road for > 2s (NHTSA), clear feedback allows the user/driver to adjust behavior
Inattention detection accuracy is at least 90% in ideal	Similar research studies using CNNS produced 95% accuracy in ideal conditions
Computation time for detecting attention to the road and drowsiness < 1000ms	NHTSA determined unsafe to keep eyes off the road for > 2000ms (1000ms gives enough time for the system to give feedback in under 2000 ms)
Device should be under 100x100x150mm	Device should be shorter than a phone to minimize obstruction of the driver's view
Device is able to plug into a power source in the user's car.	Avoid time and burden of recharging and replacing batteries

Solution Approach



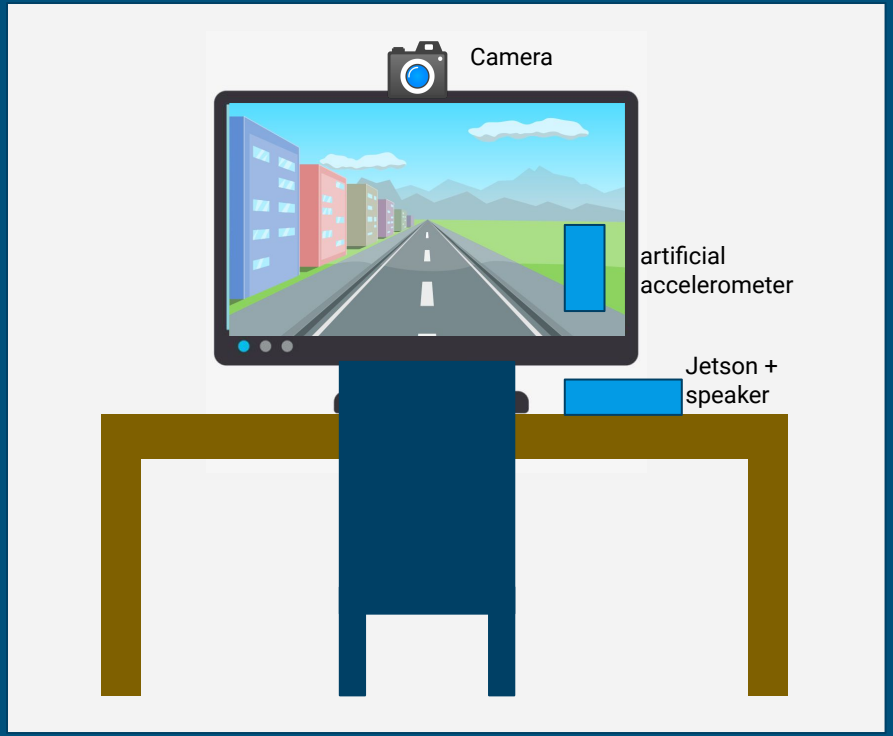



12V Supply from Car
Accelerometer
USB-A to USB-C cable
I2C
Attention Data (Firebase)
Web App
UI Interface (React + Firebase)
Database/Backend (Firebase)
Embedded Board (NVIDIA Jetson Nano)
OpenCV (DNN)
Classification and Feedback Logic
USB WiFi Dongle
USB-C to audio jack adaptor → USB-C to USB-A adaptor
USB-A
WiFi Hotspot
Speaker
Camera
Driver
Audio Feedback
Facial Data
User's Phone
Key
Hardware
Software
Off The Shelf Part
Used from Previous Project

Solution Approach

- Evolution of thinking/solution
  - The biggest changes to our solution since the proposal presentation include the hardware we chose to use and the scope of our project
- Ethical Considerations
  - Potential power usage while car is off
  - Camera could be a distraction
  - Over reliance on the system → self-monitoring of safety practices could decrease
  - Language/accent options
  - Doesn't cater to deaf/hard of hearing community

Complete Solution



(Public demo setup, not complete solution in car)

Testing, Verification, and Metrics - Overall

Requirement	Testing Strategy	Passing Metric
Driver shouldn't take eyes off of road for more than 2 seconds	After having identified eye position for looking at the road (from calibration step), time how long the driver's eyes are not in scope	Eyes looking away from car for more than 2 seconds
Driver shouldn't fall asleep at the wheel	After having identified eye position for looking at the road and distance of lips when , test for signs of closed eyes, yawns, changes in blinks based on CV detection	Changes in yawning and eyes closed
Device accuracy in ideal conditions	For three separate users (us), do driving tests and record correctness of feedback	90% accuracy of identification of driver inattention
Driver is classified and feedback is given in under 1 second	Measure how long it takes from start to end to produce a result (Repeat 5x). Run computation for one minute and get average fps (Repeat 5x)	Feedback is given in <1s so user can react in <2s

Testing, Verification, and Metrics - Subsystems

Subsystem	Inputs	Testing Strategy	Passing Metric
Jetson	12V power from the car, personal hotspot, ssh command from laptop	Plug the Jetson into the car and determine that it turns on and that we are able to ssh into the Jetson when it is connected to our WiFi hotspot (repeat 3x)	Green LED turns on, successfully ssh into the Jetson
Accelerometer	Car driving at speeds of: 3, 4, 5, and 6 mph	Look away from road for ~2s at each of these speeds to test whether feedback is triggered for ONLY speeds >= 5mph (repeat 5x)	80% accuracy
Web App	Test data for 2 different device IDs and 2 user test accounts	Log into two different users for two separate driving tests and see how the measurements are	Check website logs

Testing, Verification, and Metrics – Results

Requirement	Metric	Testing Plan	Results
Driver shouldn't take eyes off of road for >2 seconds	Eyes looking away for >2 seconds using frontal view	Aimed for 80% accuracy due to difficulties of tracking pupil movement	90% accuracy
Driver shouldn't fall asleep at the wheel	Changes in yawning, eyes closed	Aimed for 95% accuracy because it didn't provide issues when coding	100% accuracy
Device accuracy in ideal conditions	90% accuracy in ideal conditions	Test a random combination of gestures in various conditions	Ideal: 95% accuracy Non-Ideal: In progress
Driver is classified and feedback is given in under 1 second	Feedback is given in <1s so user can react in <2s	Print start and end times from when a classification is made to when the feedback has been played	~ 0 seconds, virtually no latency between classifying and providing feedback

Specifications and Performance

Specification	Our Goal/Required Value	Actual Value	Meets Initial Requirement?
Jetson Dimensions	100mm x 100mm x 150mm	100mm x 80mm x 40mm	**Yes**
Webcam Dimensions	100mm x 100mm x 150mm	90mm x 40mm x 20mm	**Yes**
Frame Rate	~ 5 fps	~ 3 fps	**In progress**
Latency	<1 second	~ 0 seconds	**Yes**

Design Tradeoffs

Option 1	Option 2	Decision	Reasoning
Jetson Xavier	Jetson Nano	**Jetson Nano**	Power requirements, ease of setup, more documentation as first-time users
DLib	CNN-FACIAL-LANDMARKS	**CNN (at the moment, this will change)**	It detects facial landmarks when the head is at different angles and the fps wasn't quite an issue
Cellular dongle	Wifi dongle	**Wifi dongle**	Cellular dongle required purchase of cellular data plan
AWS (for hosting and database)	Firebase (for hosting and database)	**Firebase**	Easily integratable with React app, built-in Google OAuth, includes hosting + cloud storage

Project Management

- Main changes since Design Presentation
  - More time for integration of software with hardware
  - More time for tuning the classification
- What remains to be done
  - More testing (specifically in the car) and tuning for higher accuracy