DriveWise

ECE Capstone Spring 2023

Design Presentation

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Use Case/Application

- Current car safety systems don’t give feedback to drivers regarding their attention to the road
- Our project aims to give drivers real-time feedback about their attention levels using facial detection
- Re-scoped since proposal to only consider “ideal” conditions
- ECE areas of software and hardware

Design Requirements

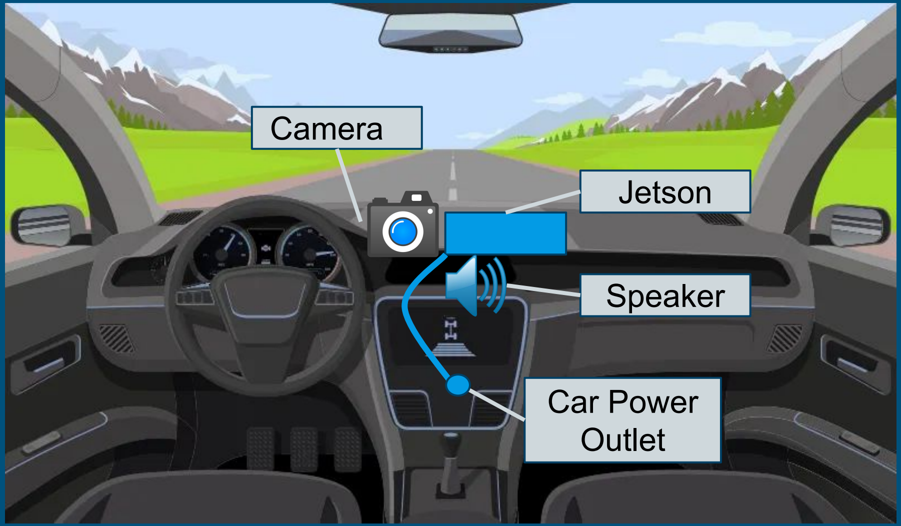
Design Requirement	Use Case Requirement	Justification
Audio feedback should be <1s long	Clear + concise feedback provided for >2s of inattention	Unsafe to keep eyes off the road for > 2s (NHTSA), clear feedback allows the user/driver to adjust behavior
Facial Detection algorithm is unfazed by head movement	Inattention detection accuracy is at least 90% in ideal conditions (background light, eyes uncovered)	Similar research studies using CNNS produced 95% accuracy in ideal conditions
GPU parallelization compatible with Jetson, Facial & landmark detection algorithms run < 1s	Computation time for detecting attention to the road and drowsiness < 1s	NHTSA determined unsafe to keep eyes off the road for > 2s (1s gives enough time for the system to give feedback in under 2s)
Camera can capture video at least 5ps	Frame rate ~ 5 fps	CNN gives more accurate result, but it takes more time.

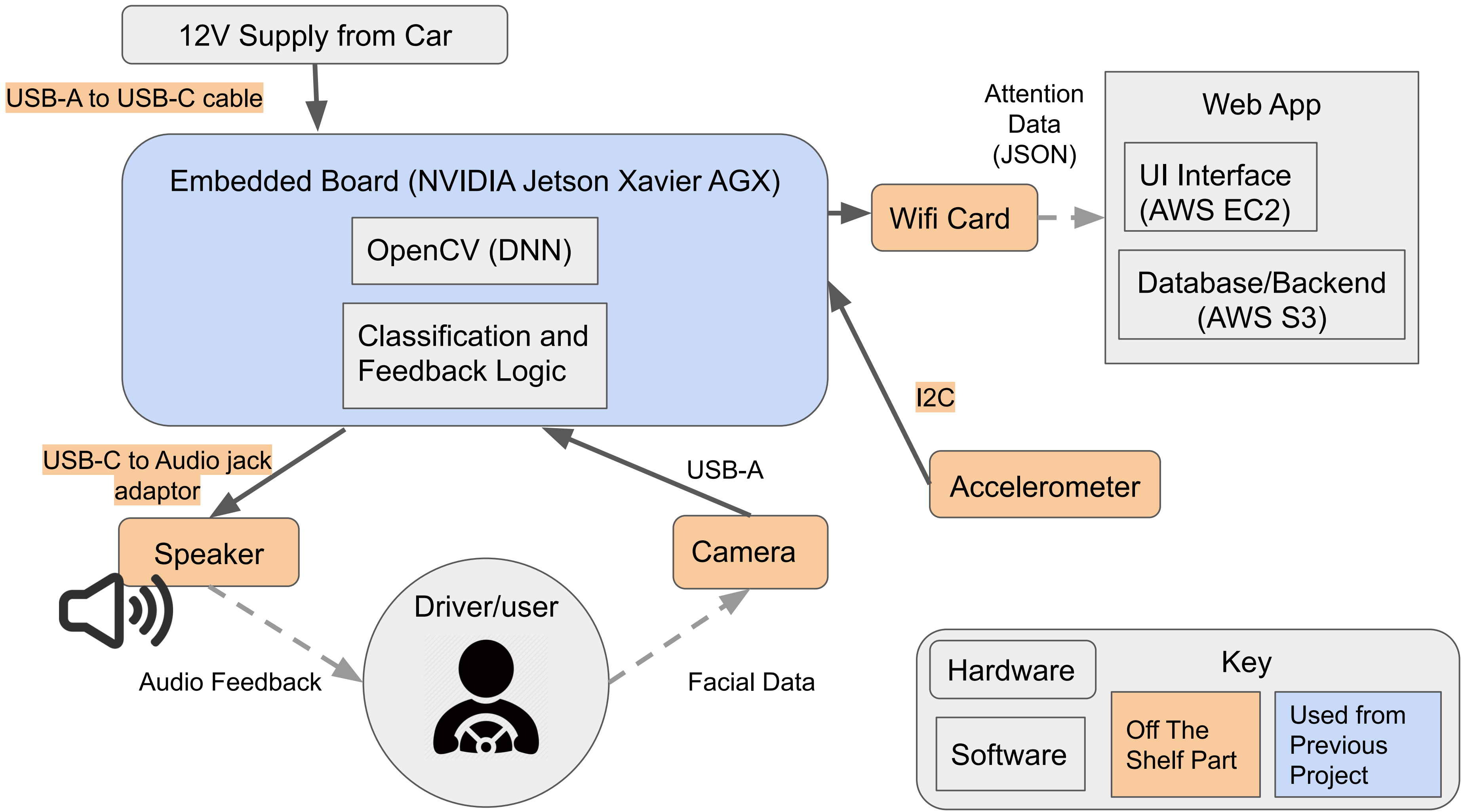
Design Requirements (cont'd)

Design Requirement	Use Case Requirement	Justification
Web app will be hosted on an AWS EC2 with an AWS S3 used for additional data storage	Users should be able to view all of their past data in a web app	Users want to observe/monitor their progress to motivate further safe driving practices
Web app accounts should have a login and be linked to a specific (DriveWise) device	User data is private (not viewable by anyone other than the user)	Address user privacy concerns (negative insurance implications)
Jetson must be powered by the 12V auxiliary port or USB (A or C) in a car	Device is able to plug into a power source in the user's car	Avoid time and burden of recharging and replacing batteries and device is easily integratable into any semi-modern car
Device should be under 100x100x150mm	Device should not significantly obstruct driver's view through windshield	Driver safety is jeopardized when view is obstructed

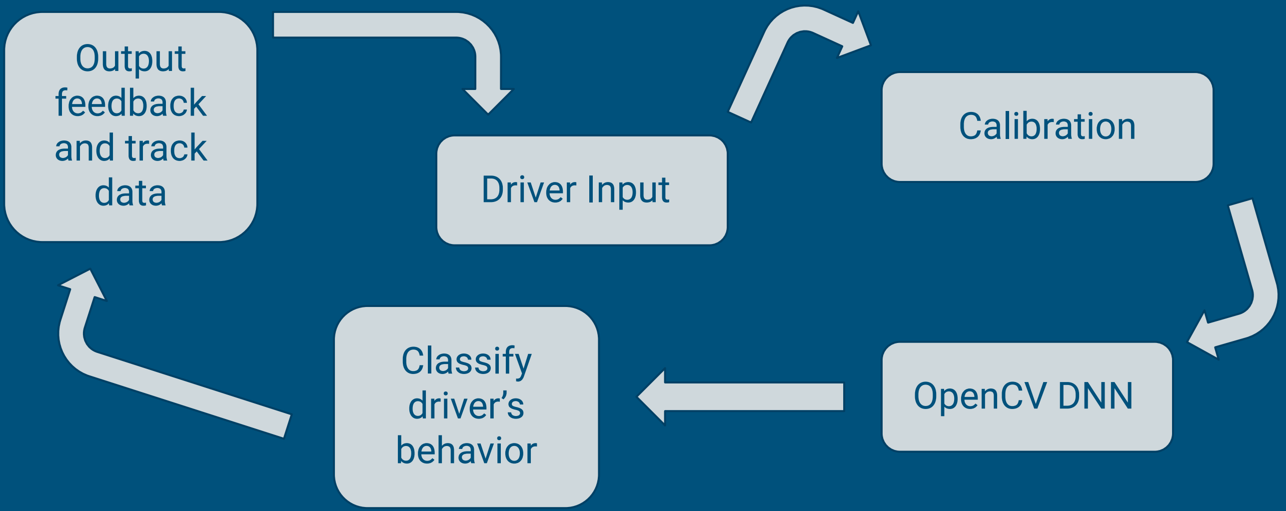
Overall Solution Approach

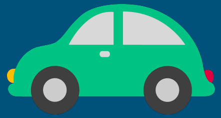
- Device fully powered by car 12v
- Computer Vision to detect driver inattention/sleepiness
- Embedded board for computation
- Camera for gathering data
- Speaker to deliver real-time auditory feedback to driver




12V Supply from Car
USB-A to USB-C cable
Embedded Board (NVIDIA Jetson Xavier AGX)
OpenCV (DNN)
Classification and Feedback Logic
Wifi Card
Attention Data (JSON)
Web App
UI Interface (AWS EC2)
Database/Backend (AWS S3)
I2C
Accelerometer
USB-C to Audio jack adaptor
USB-A
Speaker
Camera
Driver/user
Audio Feedback
Facial Data
Key
Hardware
Software
Off The Shelf Part
Used from Previous Project

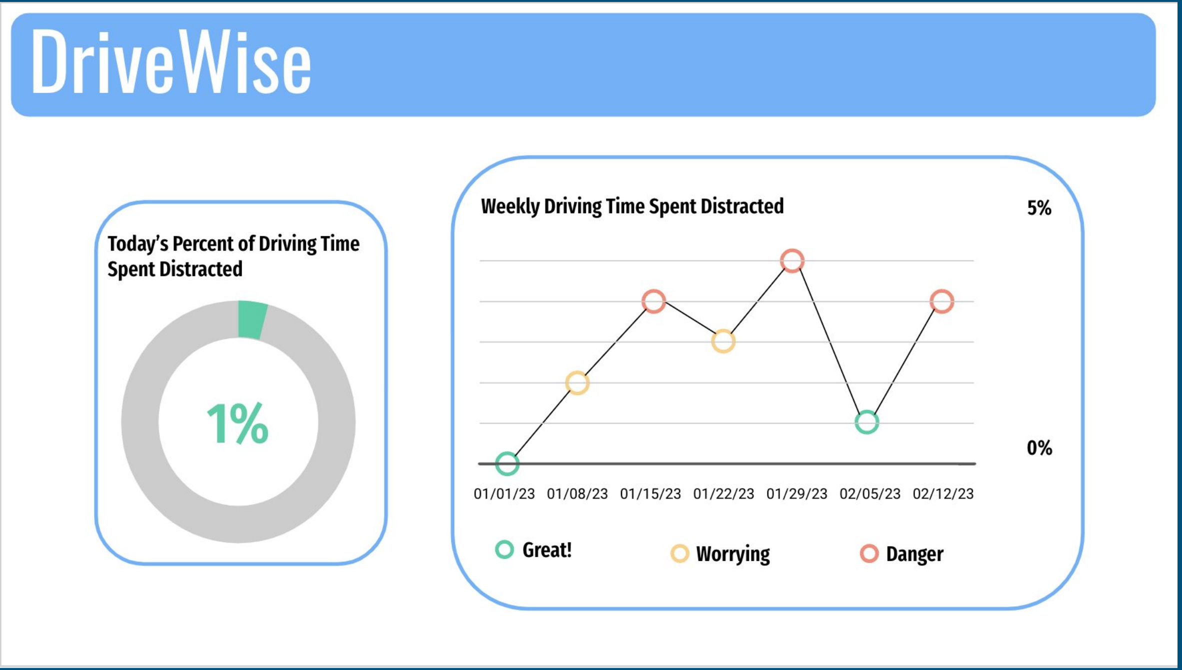
System Specification – Software (General)





Web Application

- Register with DriveWise device ID
- View all past distraction data
- 1 driver associated with each device
- Hosted on cloud



Implementation Plan

- Components to Buy/Borrow
  - NVIDIA Jetson Xavier AGX (already have)
  - Small speaker (ordered)
  - USB-C to audio jack cord (ordered)
  - Logitech C920 camera (ordered)
  - Method of powering device in car (already have charging cables)
  - Accelerometer + I2C (need to buy)
- Components to Download
  - OpenCV DNN
  - TensorFlow
  - Nvidia CUDA Drivers
- Components to Design/Implement
  - Calibration system
  - How to use OpenCV's DNN to detect and track eyes and mouth
  - Classification of safe vs. unsafe behaviors
  - How to integrate the software with hardware

Test, Verification, and Validation

Requirement	**Testing Strategy**	**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 frequency of blinking or length of blinks, yawning, 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 (to meet time safety requirement)	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 Frame rate ~ 5 fps

Risks and Mitigation

Risk	Mitigation
Malfunctioning hardware components	Repurchase with budget (~$500 left) since the most expensive component was able to be borrowed
Front face detection with OpenCV DNN does not reach our desired accuracy	Use Dlib instead of OpenCV DNN for Facial Detection
OpenCV DNN GPU Parallelization not compatible with Volta GPU	Use Dlib instead of OpenCV DNN if OpenCV isn’t fast enough
Calibration process for first-time users may be unclear	Extensive user testing and changing audio responses from Jetson during the calibration process according to user feedback

Project Management

- Sirisha
  - Software (UI)
  - Software (ML)
- Elinora
  - Hardware
  - Software (UI)
- Yasser
  - Software (ML)
  - Software (CV)