Team B7 | CarMa

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Use Cases

> 1,550 deaths/yr

> 40% sleepy drivers

> $12.5 billion in losses

Requirements

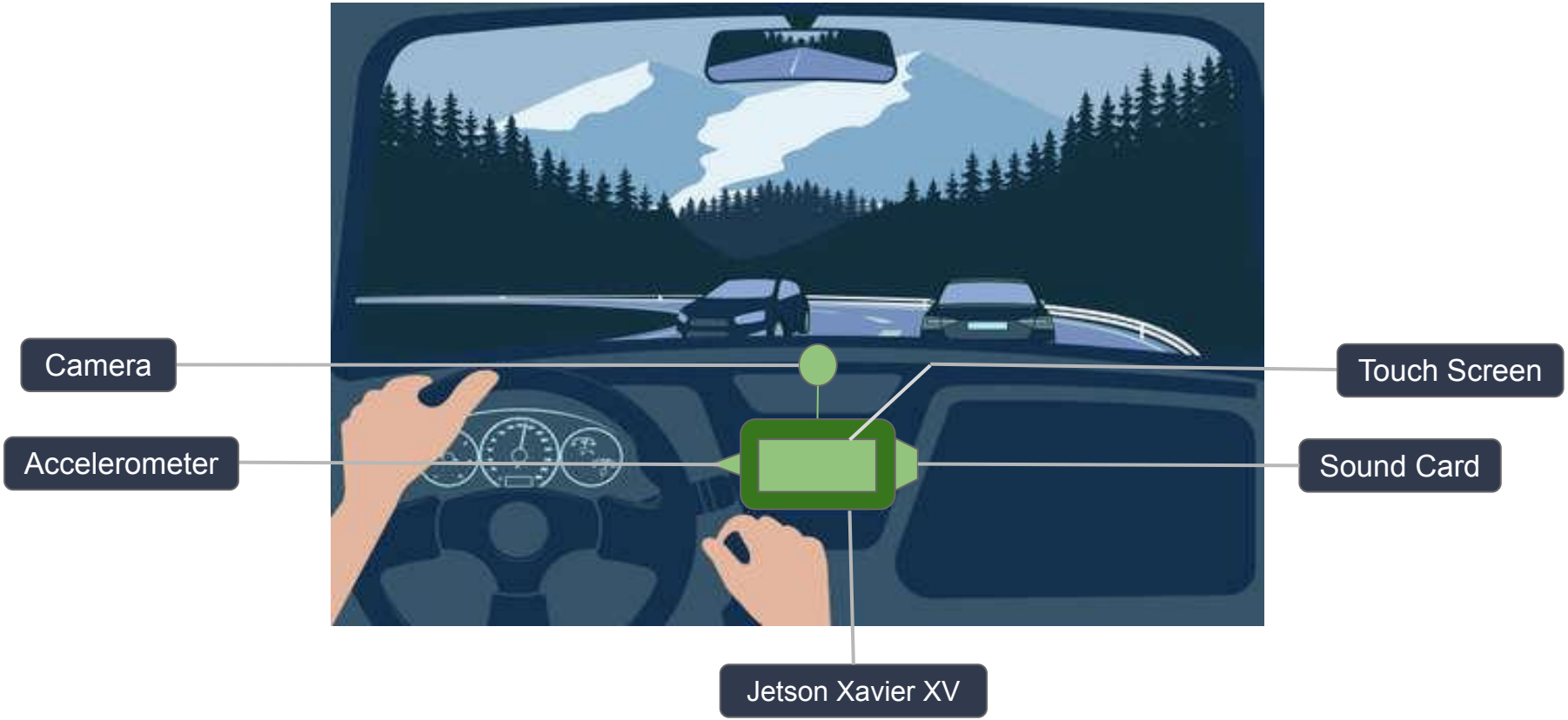
Detect when driver's eyes are distracted for > 2 secs	Drivers should never take eyes off the road for > 2 secs - NHTSA
Computation Time < 1000ms	Drivers should never take eyes off the road for > 2 secs (RTT < 2 secs) - NHTSA
Use accelerometer component to ensure driver monitoring past 55 mph	70% fatal car accidents occur past 55 mph

Requirements

>= 5 frame/sec (fps)	Dlib detection expects 5 fps with the Intel i5 which has a slower GPU compared to the Jetson Xavier
Accuracy of model against test suite >= 75%	Given the time frame and complexity of the project

Technical Challenges

- Given limited latency, need to be able to detect if eyes are closed for 2 seconds
  - Determined by the algorithm we go with + board
- Variations that exist while driving
  - Shadows
  - Bad lighting
  - We are limiting our scope to daylight driving
- Board needs to handle the computation
- Need to power the board in moving car



Solution Approach: Hardware

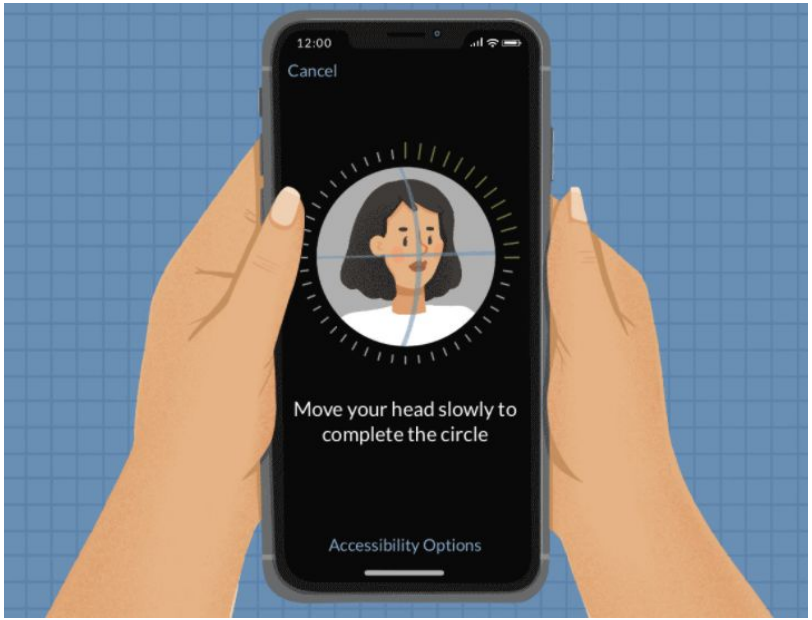
Solution Approach: Software

Warning Signs of Drowsy / Distracted Driving

- Blinking frequently → Eyes detection
- Head movement → Pose detection

Step 1: Calibration Process

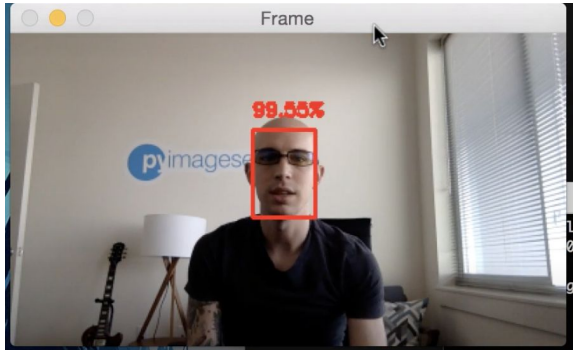
- Get user's face dimensions & background lighting to improve facial detection
- Thresholding to find an optimal value against which we can segment out the eyeballs in current setting



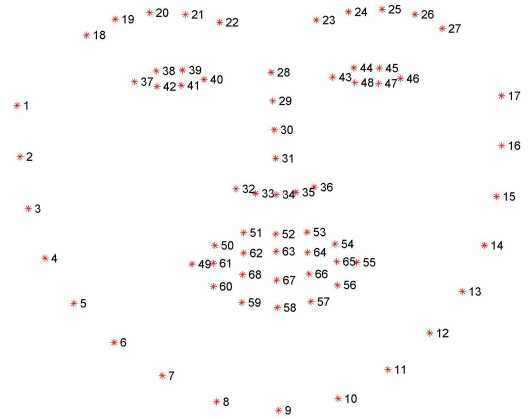
Solution Approach:
OpenCV's DNN Facial Detection

First Choice: OpenCV's DNN

- Use Caffe model and utilizes the SSD framework with ResNet as the base network
  - Works with side faces and occlusion
- Recent support with NVIDIA GPUs, CUDA, cuDNN
  - Requires Ubuntu
- Face detection: 12.95 fps



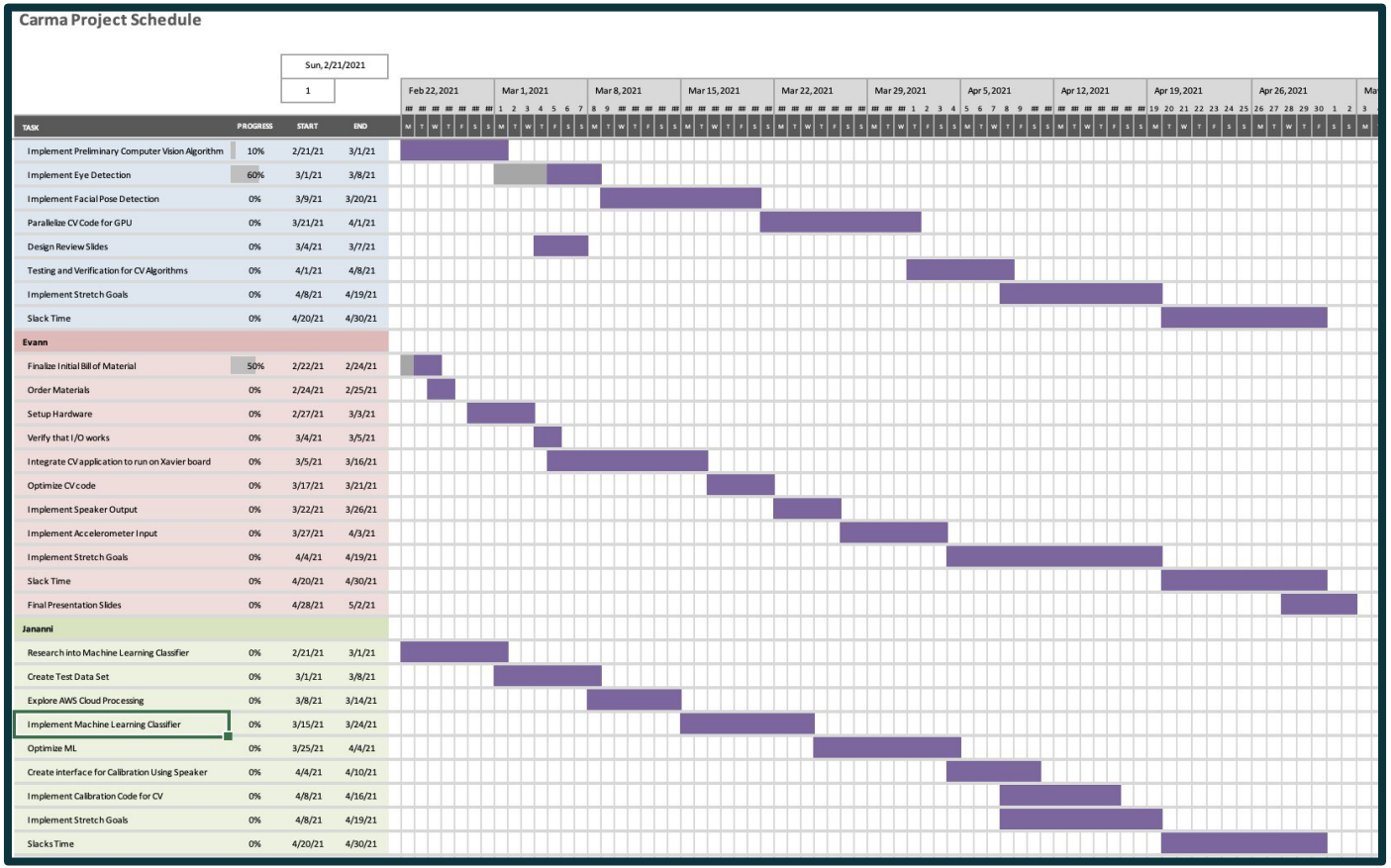
Solution Approach:
Dlib's Facial Detection



- Dlib’s 68 Face Features
  - Locates human face & returns x,y,w,h
  - Match 68 face features to points
- OpenCV for tracking the pupil
- Utilizes HOG and linear SVM
  - Good “frontal” face detector
- Runs on Jetson Xavier GPU
- Face detection: ~5 fps

Testing, Verification and Metrics

- Test suite of videos to show that it accurately accomplishes behaviour
  - DrivFacce: DB of videos to test blinking eyes when people are driving
  - Verify on different sets of people
  - Contains shadows/different lighting conditions
- For each algorithm, for the same environment test and compare:
  - Latencies
  - Accuracies of the models
- Keep track of actual vs. expected accuracies
  - finding driver's face, detecting "sleepy eyes" for frontal, detecting "sleepy eyes" for turned face, detecting driver's pose detection


Carma Project Schedule
Sun, 2/21/2021
1
Feb 22, 2021
Mar 1, 2021
Mar 8, 2021
Mar 15, 2021
Mar 22, 2021
Mar 29, 2021
Apr 5, 2021
Apr 12, 2021
Apr 19, 2021
Apr 26, 2021
TASK
PROGRESS
START
END
Implement Preliminary Computer Vision Algorithm 10% 2/21/21 3/1/21
Implement Eye Detection 60% 3/1/21 3/8/21
Implement Facial Pose Detection 0% 3/9/21 3/20/21
Parallelize CV Code for GPU 0% 3/21/21 4/1/21
Design Review Slides 0% 3/4/21 3/7/21
Testing and Verification for CV Algorithms 0% 4/1/21 4/8/21
Implement Stretch Goals 0% 4/8/21 4/19/21
Slack Time 0% 4/20/21 4/30/21
Evann
Finalize Initial Bill of Material 50% 2/22/21 2/24/21
Order Materials 0% 2/24/21 2/25/21
Setup Hardware 0% 2/27/21 3/3/21
Verify that I/O works 0% 3/4/21 3/5/21
Integrate CV application to run on Xavier board 0% 3/5/21 3/16/21
Optimize CV code 0% 3/17/21 3/21/21
Implement Speaker Output 0% 3/22/21 3/26/21
Implement Accelerometer Input 0% 3/27/21 4/3/21
Implement Stretch Goals 0% 4/4/21 4/19/21
Slack Time 0% 4/20/21 4/30/21
Final Presentation Slides 0% 4/28/21 5/2/21
Jananni
Research into Machine Learning Classifier 0% 2/21/21 3/1/21
Create Test Data Set 0% 3/1/21 3/8/21
Explore AWS Cloud Processing 0% 3/8/21 3/14/21
Implement Machine Learning Classifier 0% 3/15/21 3/24/21
Optimize ML 0% 3/25/21 4/4/21
Create interface for Calibration Using Speaker 0% 4/4/21 4/10/21
Implement Calibration Code for CV 0% 4/8/21 4/16/21
Implement Stretch Goals 0% 4/8/21 4/19/21
Slacks Time 0% 4/20/21 4/30/21

Schedule

Jananni Rathnagiri

Adriana Martinez

Evann Wu

Use CarMa for better karma on the road :)