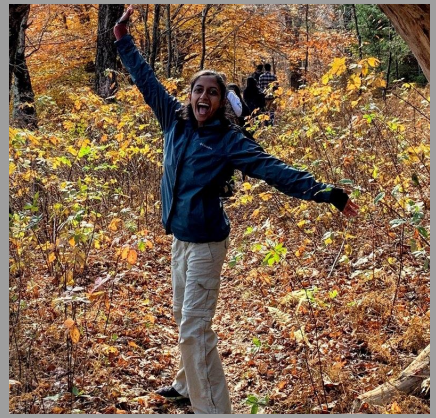
Carma: Final Presentation

Team B7



Jananni Rathnagiri

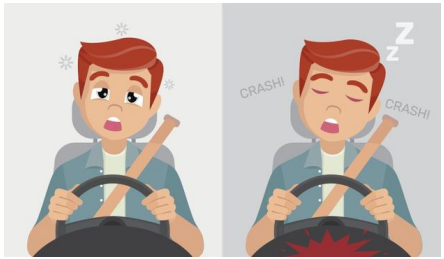
Adriana Martinez

Evann Wu

Application Area

Problem: Drowsy and Distracted Driving

- Sleepy / Distracted Eyes
- Yawning



Applications

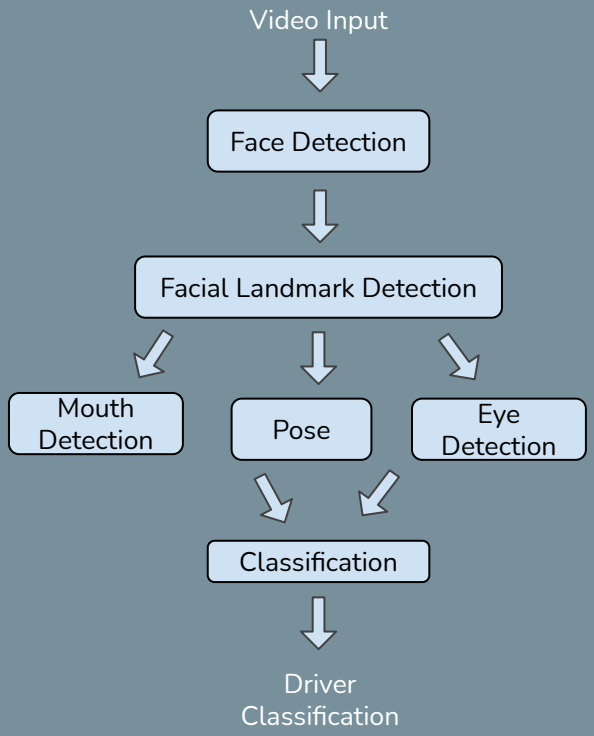
- Trucking industry
- Commercial use for inexperienced drivers

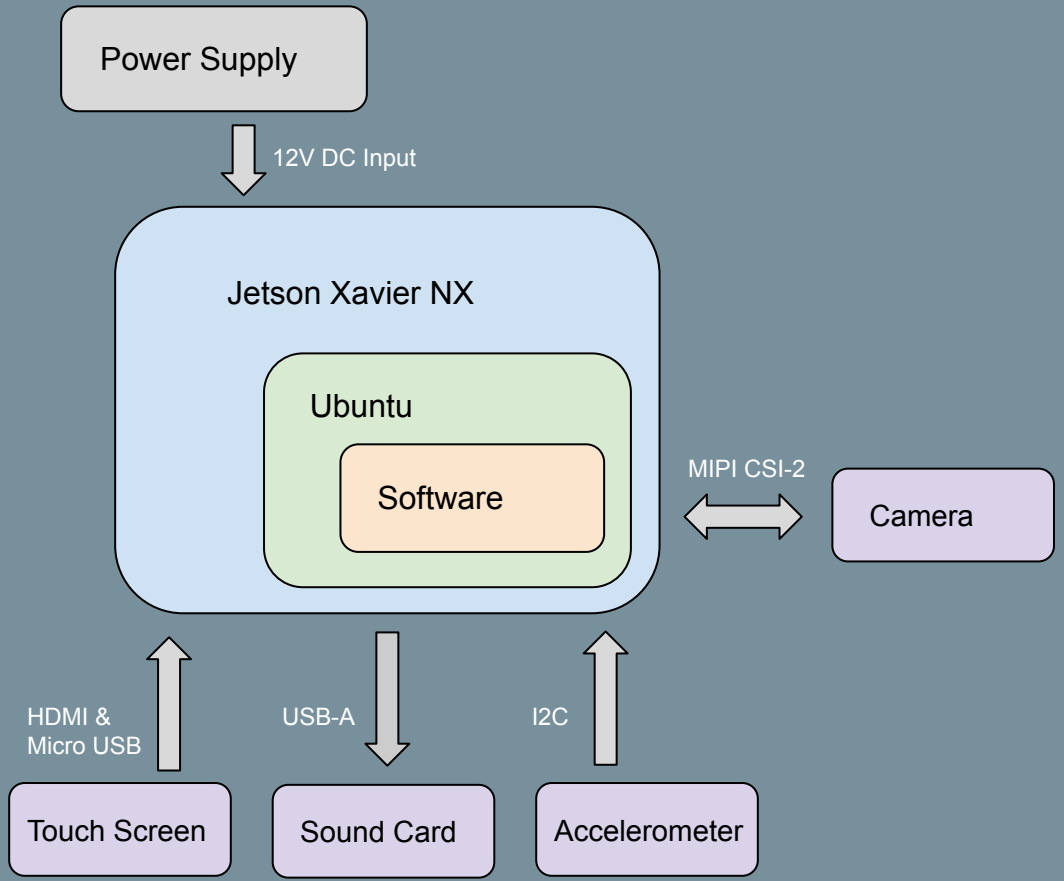
ECE Areas:

- Software
- Signals & Systems

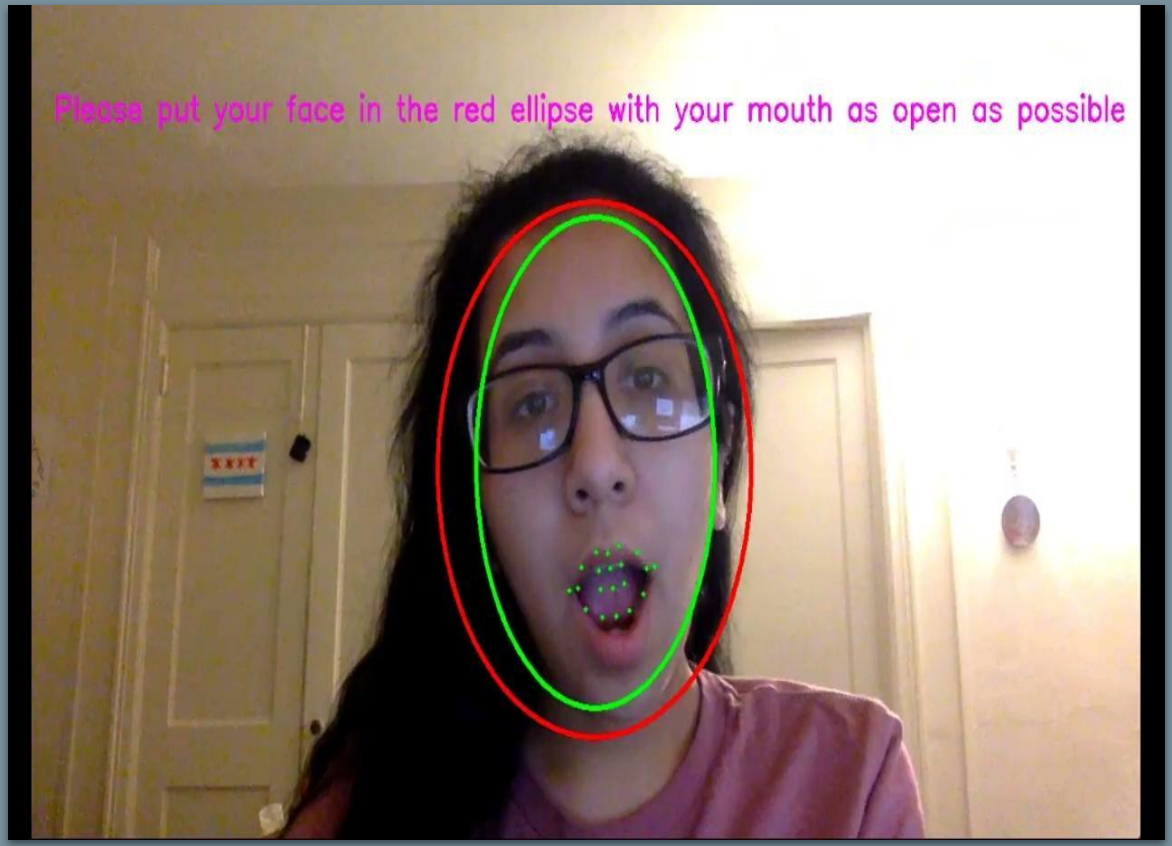
Solution Approach

Block Diagram





Complete Solution (User flow demo)



Metrics, Validation & Testing : Driver

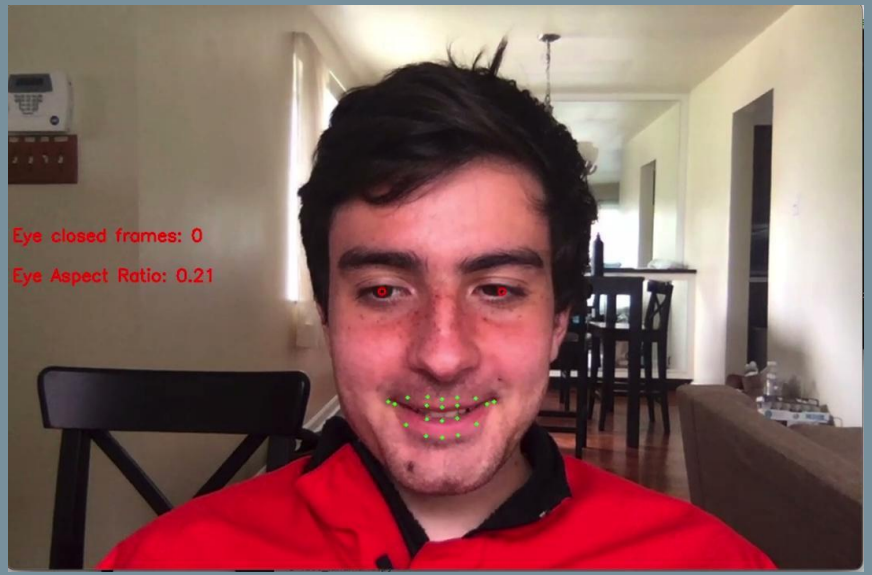
Requirements	Metrics	Test Plan	Test Results
Driver should never take eyes off the road for > 2 secs	Frontal view: Eyes looking away > 2 sec	Error rate <10% False + <9% False - <1%	0.5% 0% 0.5%
Driver should not fall asleep at the wheel	Frontal view: detect eyes closed	Error rate <20% False + <15% False - <5%	47% 19% 27%
Driver should not fall asleep at the wheel	Frontal view: detect yawning	Error rate <20% False + <15% False - <5%	1% 1% 0%
Driver should not fall asleep at the wheel	Side view: turned > 2 secs	Error rate <35% False + <30% False - <5%	Stretch goal - in progress

Metrics, Validation & Testing: Device

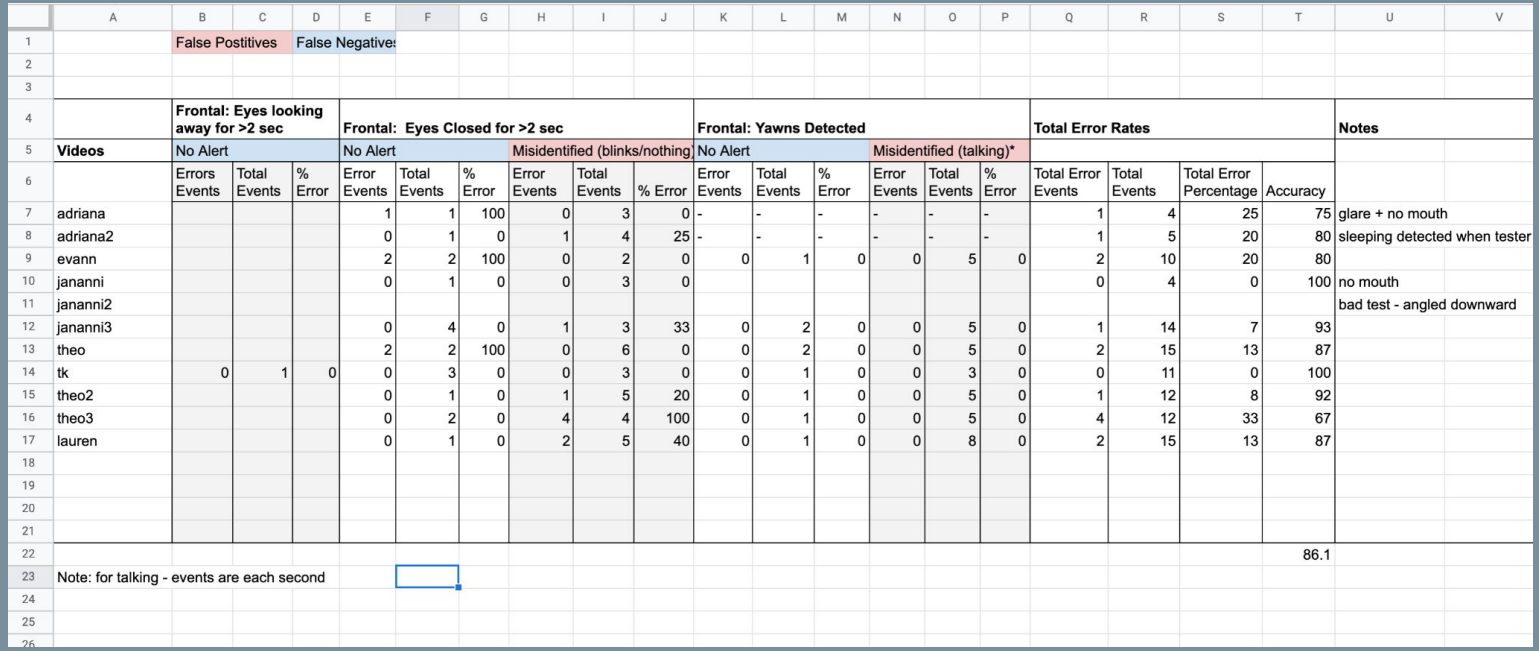
Requirements	Metrics	Test Plan	Test Results
Driver should never take eyes off the road for > 2 secs so computation must be fast	Latency < 1000ms	Measure the time between action and output	183.3 ms
Driver should never take eyes off the road for > 2 secs so computation must be fast	>= 5 frame/sec (fps)	Run the program with a person looking at the camera for 60 seconds. Calculate the frame rate	5.70 fps
Total Device Accuracy	-	Accuracy of model against test suite >= 75%	85.9%

Testing Process

1. Collect Videos of Users following a driving script
    a. Reaching out to friends + family
2. Run videos on our CV application
3. Inspect results and identify occurrences of yawning and eyes closed



Results



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1		False Postitives			False Negatives																	
2																						
3																						
4		**Frontal: Eyes looking away for >2 sec**			**Frontal: Eyes Closed for >2 sec**						**Frontal: Yawns Detected**						**Total Error Rates**				**Notes**	
5	**Videos**	No Alert			No Alert			Misidentified (blinks/nothing)			No Alert			Misidentified (talking)*								
6		Errors Events	Total Events	% Error	Error Events	Total Events	% Error	Error Events	Total Events	% Error	Error Events	Total Events	% Error	Error Events	Total Events	% Error	Total Error Events	Total Events	Total Error Percentage	Accuracy		
7	adriana				1	1	100	0	3	0	-	-	-	-	-	-	1	4	25	75	glare + no mouth	
8	adriana2				0	1	0	1	4	25	-	-	-	-	-	-	1	5	20	80	sleeping detected when tester	
9	evann				2	2	100	0	2	0	0	1	0	0	5	0	2	10	20	80		
10	jananni				0	1	0	0	3	0							0	4	0	100	no mouth	
11	jananni2																				bad test - angled downward	
12	jananni3				0	4	0	1	3	33	0	2	0	0	5	0	1	14	7	93		
13	theo				2	2	100	0	6	0	0	2	0	0	5	0	2	15	13	87		
14	tk	0	1	0	0	3	0	0	3	0	0	1	0	0	3	0	0	11	0	100		
15	theo2				0	1	0	1	5	20	0	1	0	0	5	0	1	12	8	92		
16	theo3				0	2	0	4	4	100	0	1	0	0	5	0	4	12	33	67		
17	lauren				0	1	0	2	5	40	0	1	0	0	8	0	2	15	13	87		
18																						
19																						
20																						
21																						
22																				86.1		
23	Note: for talking - events are each second																					
24																						
25																						
26																						

[Spreadsheet]

Trade-offs

Option 1	Option 2	Decision	Reasoning
False Negatives	False Positives	Prefer False Positives	Extra alerts is better than missing alerts
Use of touch screen as UI	Use of speaker as UI	Using a touch screen	We want users to have a simple UI and accurate calibration process
Simple UI with 1 screen and 1 start button	Verbose and detailed multi-page UI with 4 pages	Chose to use verbose and detailed multi-page UI	Based on ethics discussion, need to clearly indicate to the user when we are taking in video input
Build custom classifier for identifying drowsiness	Use heuristics and geometric ratios to determine drowsiness	Chose to use heuristics	We wanted a high FPS for real time detection and to improve the FPS as much as possible we decided to go with the option requiring the least computation
Extensive CUDA usage	Limited CUDA usage	Chose to use CUDA in the face detector	Already reached our FPS goal and given the time we had left, we wanted to focus on other items

Sat, 3/6/2021

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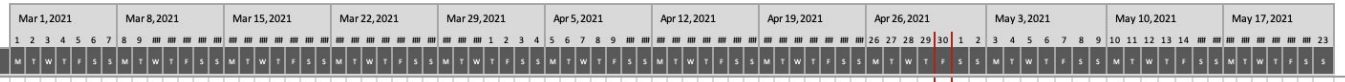

TASK	PROGRESS	START	END
Adriana			
Implement Preliminary Computer Vision Algorithm	100%	3/6/21	3/1/21
Implement Eye Detection	100%	3/1/21	3/15/21
Implement Landmarking	100%	3/16/21	3/27/21
Implement Facial Pose Detection	75%	4/18/21	5/3/21
Parallelize CV Code for GPU	100%	4/7/21	4/17/21
Design Review Slides	100%	3/4/21	3/7/21
Testing and Verification for CV Algorithms	100%	3/28/21	4/10/21
Implement Stretch Goals	100%	4/14/21	4/21/21
Slack Time	100%	4/22/21	5/1/21
Evann			
Finalize Initial Bill of Material	100%	2/22/21	2/24/21
Order Materials	100%	2/24/21	2/25/21
Setup Hardware	100%	3/5/21	3/10/21
Verify that I/O works	100%	3/10/21	3/14/21
Integrate CV application to run on Xavier board	100%	3/15/21	4/5/21
Optimize CV code	100%	4/7/21	4/17/21
Implement Speaker Output	100%	4/5/21	4/8/21
Implement Accelerometer Input	100%	4/14/21	4/18/21
Implement Stretch Goals	100%	4/14/21	4/19/21
Slack Time	100%	4/20/21	4/30/21
Final Presentation Slides	100%	4/28/21	5/2/21
Jananni			
Research into Machine Learning Classifier	100%	2/21/21	3/1/21
Create Test Data Set	100%	3/11/21	3/20/21
Explore AWS Cloud Processing	100%	3/8/21	3/14/21
Implement Machine Learning Classifier	100%	3/15/21	3/24/21
Thresholding/Optimization	100%	3/25/21	4/4/21
Create interface for Calibration	100%	4/4/21	4/10/21
Implement Calibration Code for CV	100%	4/8/21	4/16/21
Implement Stretch Goals	100%	4/12/21	4/21/21
Slacks Time	100%	4/20/21	4/30/21

Project Takeaways

- Our system satisfies most of our requirements but there could be improved in the eye classification accuracy
  - Taking into account the current environment lighting and thresholding respectively
- Testing is a very important part of the process and should be prioritized as such
  - Start gathering test data early
- Hardware project in a remote setting can be difficult to manage
  - One person has the board, difficult to help them debug over Zoom