# B1: FocusEd Final Presentation

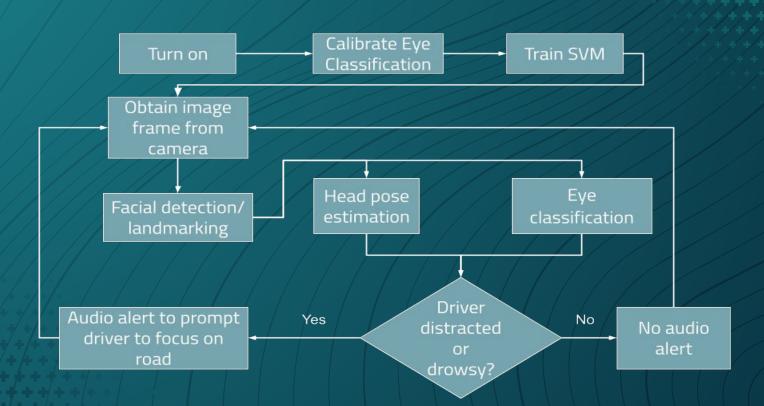
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#### Application Area

FocusEd serves as a way for drivers to curb their distracted day driving while simultaneously improving road safety and their own driver education.



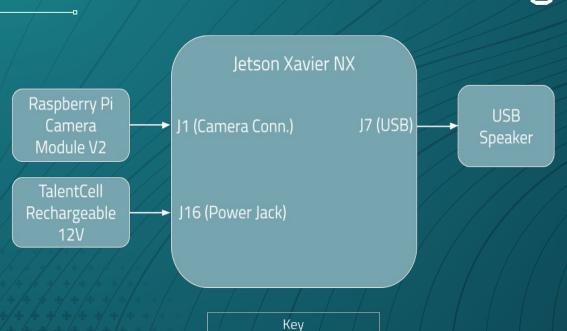
# Solution Approach (User Flowchart)



# Solution Approach

1	Real-Time Facial Detection	<ul> <li>Histogram of Oriented Gradients + Support Vector Machine (HOG + SVM) algorithm</li> <li>OpenCV + Dlib</li> </ul>
2	Real-Time Eye Classification	Calibrate/train SVM model to predict open/closed eyes based on Eye Aspect Ratio (EAR)
3	Real-Time Head Pose Estimation	<ul> <li>Triangular areas of face used to calculate ratio for estimation</li> <li>Pre-trained SVM model</li> </ul>
4	Focus Timer	<ul> <li>Alert driver if eyes closed for &gt;=1 s</li> <li>Alert driver if head pose is classified as distracted for &gt;= 2 s</li> </ul>

#### Hardware Block Diagram

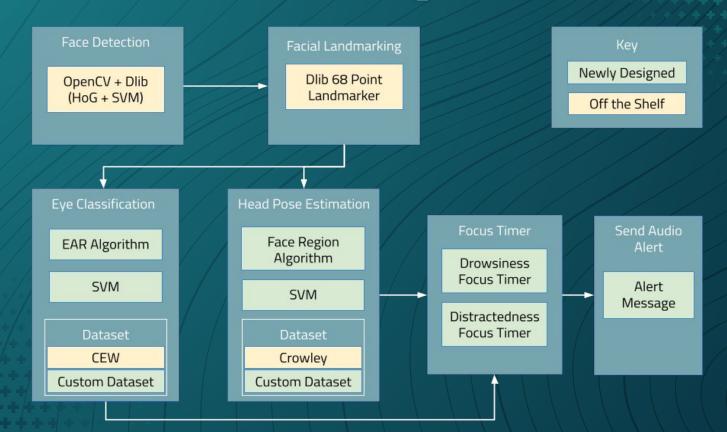


Off the Shelf

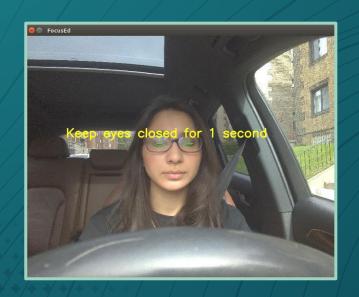




### Software Block Diagram



# System Demo





Calibration for Drowsiness

# System Demo



Falling Asleep



Looking Down at Phone

#### Metrics and Validation

Requirement	Test	Metric	Testing Result		
Face Detection	Detect faces in various daytime light	Face is detected >=90% of the time in all light conditions	94% accuracy (5 datasets, 4355 photos)		
Eye Classification	Compare open/ closed classification to truth	Classification & truth match >=90% of the time	91% accuracy (4 datasets, 3403 photos)  93% accuracy (2 datasets, 1451 photos)  87% accuracy (100 trials)		
Head Pose Estimation	Compare direction of head to estimation	Estimation & truth match >=85% of the time			
Focus Timer	Distracted vs normal based on 1s drowsy or 2s not focused	Distinguishes distracted vs normal >=90% of the time			

#### Metrics and Validation

Requirement	Test	Metric	Testing Result		
Power Supply	Run Xavier until supply runs out	Xavier powered for 8 -10 hrs	8.5 hours of runtime (1 trial)		
Audio Alert	Input distracted alert and ensure audio output	Audio output when alert is received >=99%	Audio outputted 100% of the time (30 trials)		
System Latency	Time the full system run through	System should detect and output audio alert within 3s	3.9s average (30 trials)		
Driver Response	Test that audio alert does not send when driver refocuses	Check that alert no longer triggered within 3 iterations	Alert no longer triggered 100% of the time (100 trials)		

#### Design Trade-Offs

- Used HoG + SVM instead of Haar Cascades
- Used pre-trained head pose estimation model instead of calibration
- Used facial areas to determine head pose rather than 2d to 3d
   landmark conversion
- Used EAR for eye classification
- Used Jetson Xavier NX

<u></u>	1		8	FEBRUARY	MARCH		APRIL	MAY	
TASK	ASSIGNED'	START	END						
Proposal Presentation	All	2/15	2/21						
Research design specifications	100	2/22	3/1			Daniella	Hatali	Vahanahaa	AII
Research face detection, landmarking, headpose examples	Heidi	2/22	2/24			Danielle	Heidi	Vaheeshta	All
Research eye classification examples	Vaheeshta	2/22	2/25						1
Write eye classification algorithm (on laptop)	Vaheeshta	2/26	3/9						
Order hardware components	Vaheeshta	3/1 3/2	3/1 3/4						
Write simple face detection (on laptop)	Heidi								
Design Presentation	All	3/2	3/7						
Write simple face landmarking (on laptop)	Heidi	3/3	3/5						
Write face detection algorithm (on Xavier)	Heidi	3/7	3/10						
Write simple head pose (on laptop)	Heidi	3/9	3/12						
Design Report	All	3/10	3/17						
Test eye classification algorithm (on laptop)	Vaheeshta	3/10	3/16						
Test face detection algorithm (on laptop)	Heidi	3/12	3/16		The state of the s				
Write face landmarking algorithm (on Xavier)	Heidi	3/16	3/19						
Find and download dataset for open/closed (DROZY)	Vaheeshta	3/17	3/20						
Test eye classification on self, partners, and dataset	Vaheeshta	3/20	3/22						
Test face landmarking algorithm	Heidi	3/21	3/24						
Write head pose estimation algorithm	Heidi	3/24	3/26						
Set up Jetson/Camera/Static IP	Danielle	3/25	3/27						
Test head pose estimation with different cutoffs	Heidi	3/27	3/31						
Write calibration and training system for eye classification	Vaheeshta	3/29	4/3						
Integrate head pose estimation with landmarking	Heidi	4/1	4/2						
Create custom dataset for face detection	Danielle	4/1	4/3						
Write focus timer (2) classification based on time not facing forward		4/2	4/7						
Integrate eye classification + head pose estimation v1	Vaheeshta	4/3	4/9						
Write focus timer (1) classification based on time eyes closed	Danielle	4/7	4/10						
Write calibration and training system for head pose	Heidi	4/7	4/11						
Integrate and test eye classification on Xavier	Vaheeshta	4/8	4/9						
Prepare for interim demo	All	4/10	4/12						
Integrate eye classification + head pose estimation v2	Heidi	4/10	4/11						
Integrate head pose + eye clasification with focus timer	Danielle	4/10	4/11						
Create audio prompts for calibration	Danielle	4/10	4/14						
Create audio alert system	Danielle	4/12	4/18						
Implement feedback from interim demo	All	4/13	4/17						
Integrate custom data set with LFW dataset	Danielle	4/15	4/20						
Test with Xavier with power bank	Vaheeshta	4/15	4/17						
Test audio alert and audio prompts on Xavier with speaker	Danielle	4/18	4/19						
Implement GPU acceleration	Danielle	4/18	4/23						
Implement threading	Danielle	4/18	4/23						
Integrate all parts	All	4/19	4/23						
Slack	All	4/20	4/27						
Test in controlled environment and gather metrics	All	4/24	4/25						
Test in car and gather metrics	All	4/25	4/26						
Final Presentation	All	4/27	5/3						
Final Video + Poster	All	5/3	5/10						
Final Report	All	5/9	5/14						
Public Demo	All	5/13	5/13						