Machine Learning for Human Biometrics

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Introduction

Problem statement:
- Truck drivers required constant focus and concentration.
- Hazardous anyone in close proximity if driver dozed off or was too stressed to focus on driving.

Solution:
- To develop a device that monitors the driver's eye movements in real time to predict if the driver is under distress or fatigued and provide appropriate suggestions to ensure the driver and other road users' safety.

Users & Uses

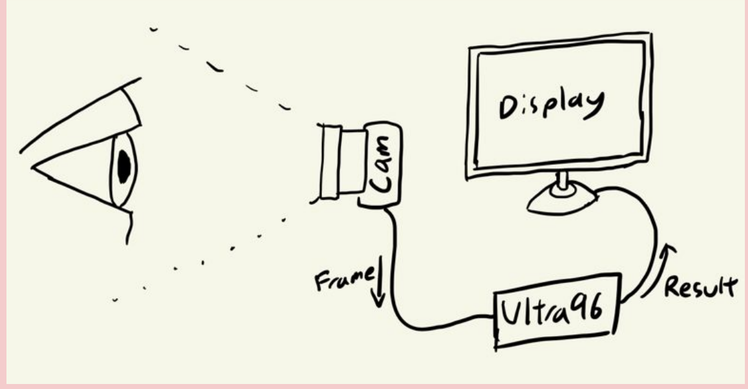
Prospective Users:
- Truck Drivers

Potential Users:
- Pilots
- Surgeons
- Anyone who wants to utilize eye biometric data

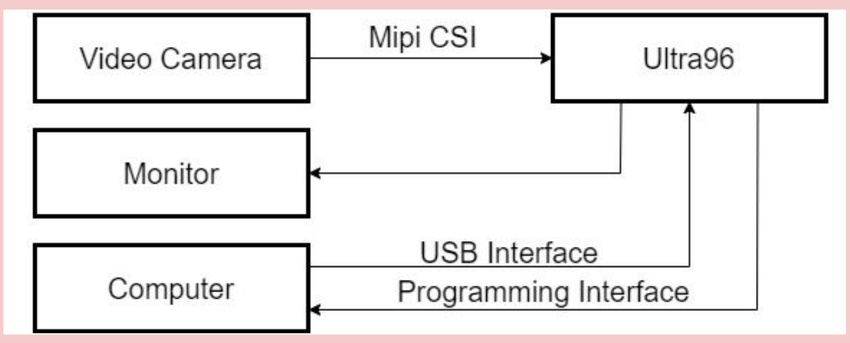
Uses:
- To predict if a person is in distress or fatigued

Design Approach

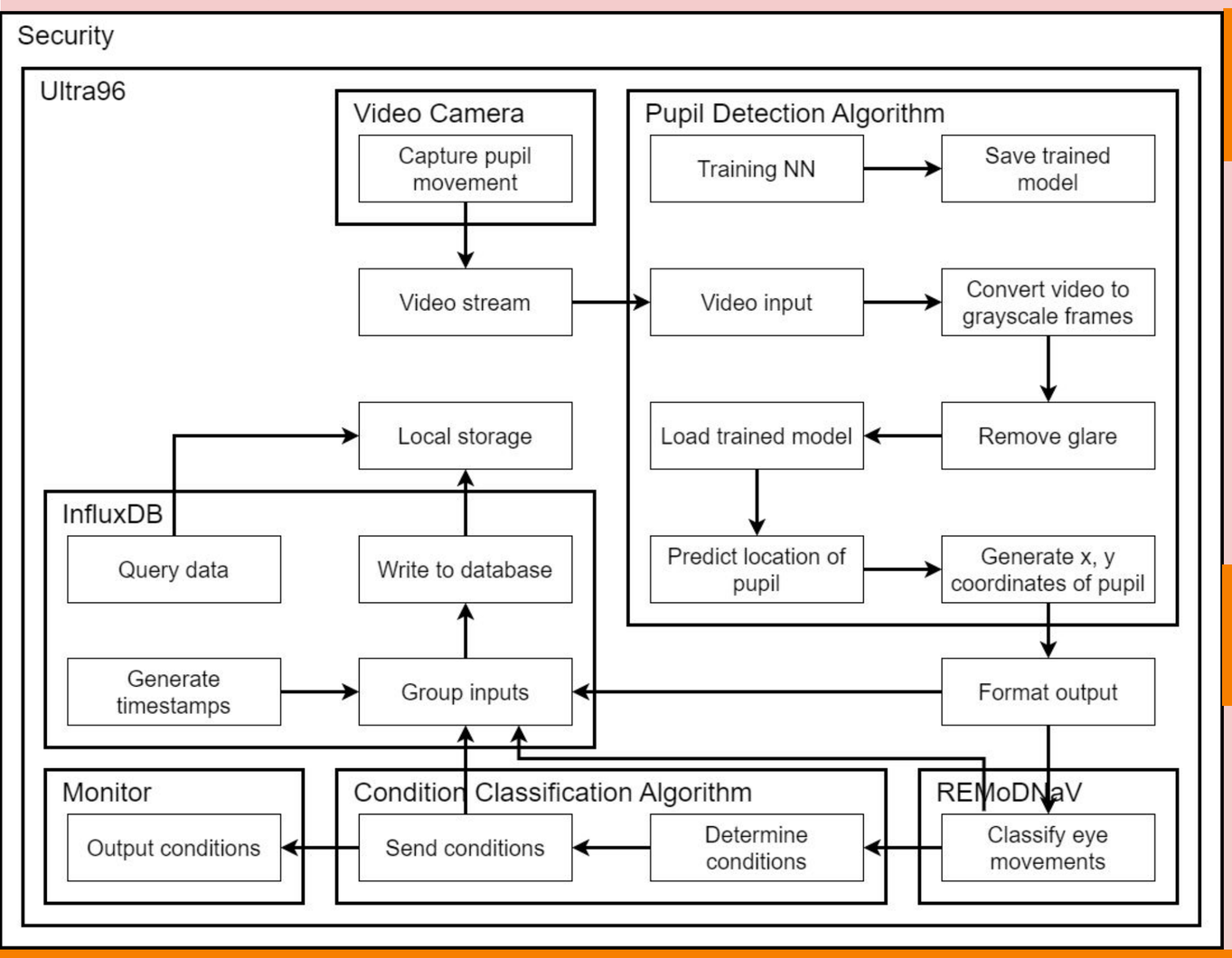
Conceptual sketch:



Hardware flow:



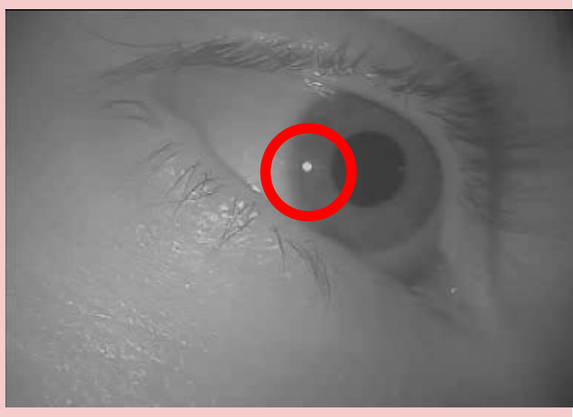
Detailed program flow:



Design Requirements

Requirements:
- The pupil detection algorithm shall process 10-bit grayscale images
- The eye movement classifier shall require a sampling rate of 30 hertz, if a frame is a saccade, fixation, smooth pursuit, or unknown.
- The eye movement classifier shall look for patterns in the data to figure out if a user is stressed or fatigued.
- Our project shall not violate any HIPAA laws
- The display monitor shall output the result to inform user if they are stressed or fatigued.
- Strong encryption of data when working with biometrics

Constraints:
- Video camera is stationary
- Lighting condition of the room
- Glares on the pupil



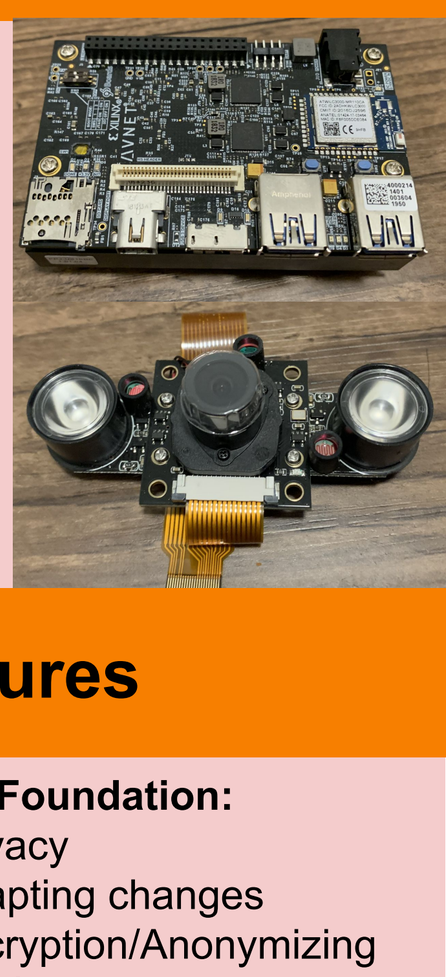
Operating environment:
- Any indoor environment

Relevant standards:
- IEEE 1012-2016/Cor 1-2017: Draft Standard for System, Software and Hardware Verification and Validation - Corrigendum 1
- IEEE 3652.1-2020: IEEE Guide for Architectural Framework and Application of Federated Machine Learning
- P3167: Standard for Secure Biometrics Device Interface

Technical Details

Technology:
- Ultra96v2
- Display Monitor
- ArduCam Camera Module

Software Modules:
- Python
- Jupyter Notebook
- Tensorflow
- REMoDNaV
- InfluxDB



Security Measures

Authentication Methods:
- Physical Tokens(NFC)
- Universal 2nd Factor

Encryption Methods:
- PKI(Public Key Infrastructure)
- OpenPGP
- AES

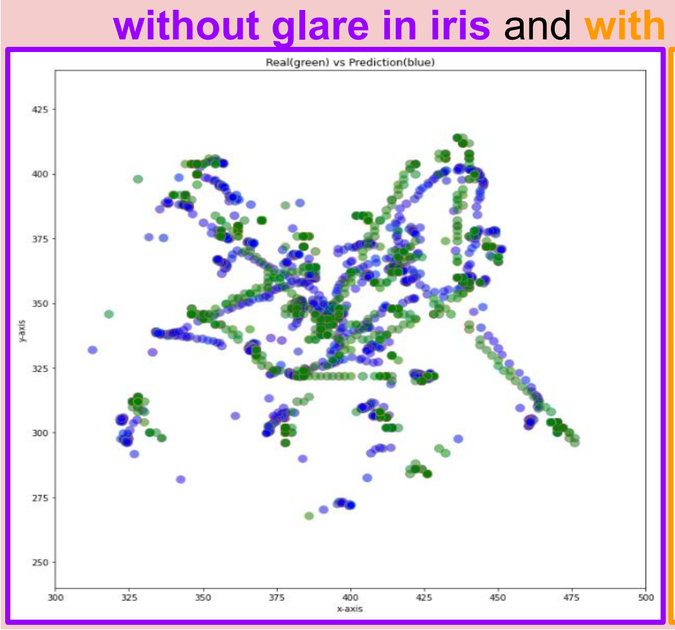
Rules/Foundation:
- Privacy
- Adapting changes
- Encryption/Anonymizing
- Disclosures
- Breach Notifications
- Following Laws especially Biometric specific laws

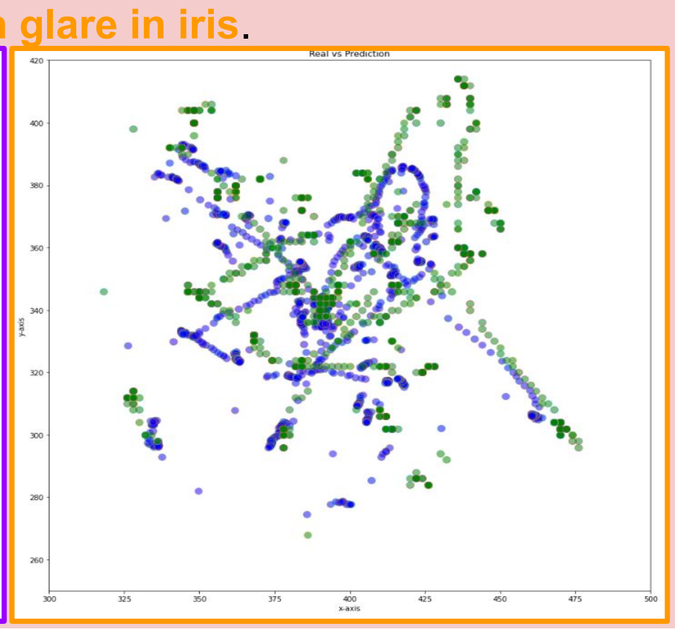
Testing

Strategy:
We were planning to carry out unit testing, integration testing, and security testing to make sure all components are working and risk assessment is done after integration of Ultra96.

Observation

Pupil Detection Algorithm Results:
- Comparison between **real** and **predicted** data **without glare in iris** and **with glare in iris**.





REMoDNaV Algorithm Results:

A .tsv file with the onset and duration of certain eye-movement classifications:
- Fixations
- Pursuits
- Smooth Pursuit Events
- Post Saccadic Oscillations

The algorithm also outputs extra data that can be used:
- Amplitude of the eye
- Peak, Mean and Average Velocity