Machine Learning for Human Biometrics

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Problem Statement

- Surgeons tend to get tired if operate for long periods of time
- They also get stressed when something goes wrong in the surgery
- Our project aims to create a device to identify any abnormalities in the surgeon’s eye movement, and provide appropriate advice to the surgeon to prevent potential human error

Design Context - 3.1.1 Broader Context

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4 Main areas

- Public health, safety and welfare
- Global, cultural and social
- Environmental
- Economic

Design Context - 3.1.2 User Needs

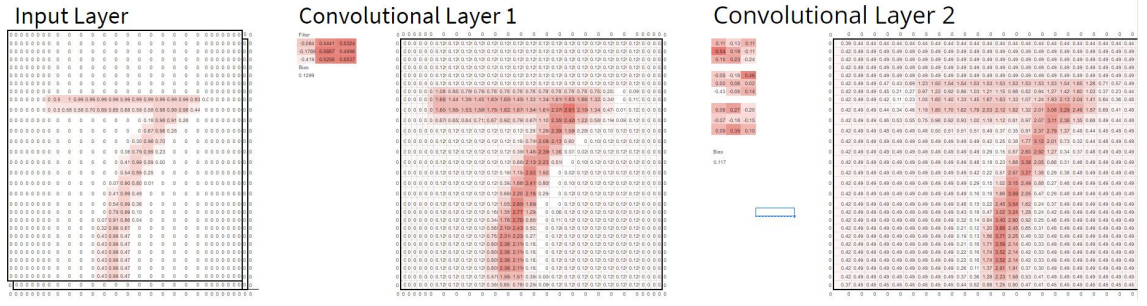
Surgeons - ways to warn them of signs of stress/fatigue

Trainers/Instructors - needs a way to visualize biometrics/emotions of surgeons

Hospital Management - needs a way to evaluate a surgeon’s state/capability in a high risk environment.

Design Context - 3.1.3 Prior Work/Solutions

- Machine learning models such as Convolution Neural Network (CNN), Support Vector Machine (SVM), and Starburst are used.
- CNN is faster than SVM because we can run on multiple threads.
- Possibility of overfitting due to small training set.
- Data augmentation is used to reduce overfitting.



Design Context - 3.1.4 Technical Complexity

Consists of four major components

- Video input
- Pupil detection algorithm
- Eye movement classification algorithm
- Database which stores the eve movement classifications

Design Exploration - 3.2.1 Design Decisions.

- Ultra96 board: It is targeted for machine learning and connectivity for add-on sensors.

- REMoDNaV algorithm: It is one of the most efficient and effective algorithms to classify eye movements.

- InfluxDB: It is optimized for real-time analytics and time-series data.

Design Exploration - 3.2.2 Ideation

- In terms of database, we considered using MongoDB, Postgre SQL and InfluxDB.

- After comparing their pros and cons, we decided to go with InfluxDB since it is optimized for the things we are working with, which are time-series data and real-time analytics.

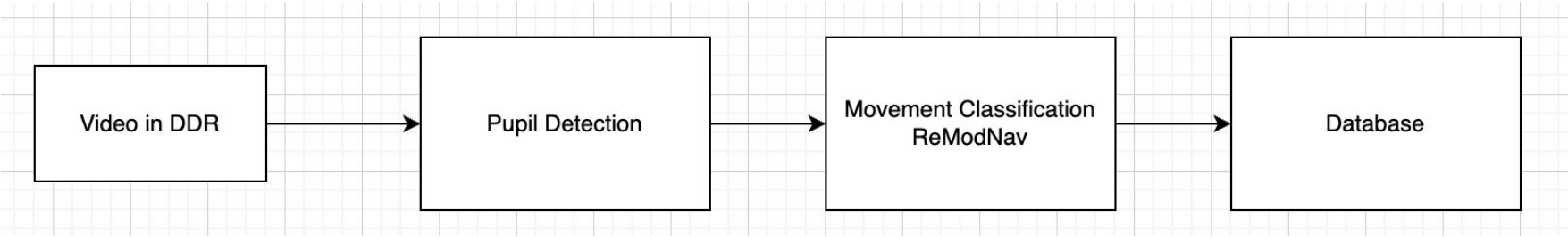
Design Exploration - 3.2.3 Decision-Making and Trade-Off

-Using to identify pros and cons

-With the pros, they were written out to summarize each of the option. Example was when our Database manager Ron delivered a presentation reviewing each of the pros and cons of certain databases.

-After the presentation we then collectively discussed which process we wanted.

Proposed Design - 3.3.1 Design Visual and Description



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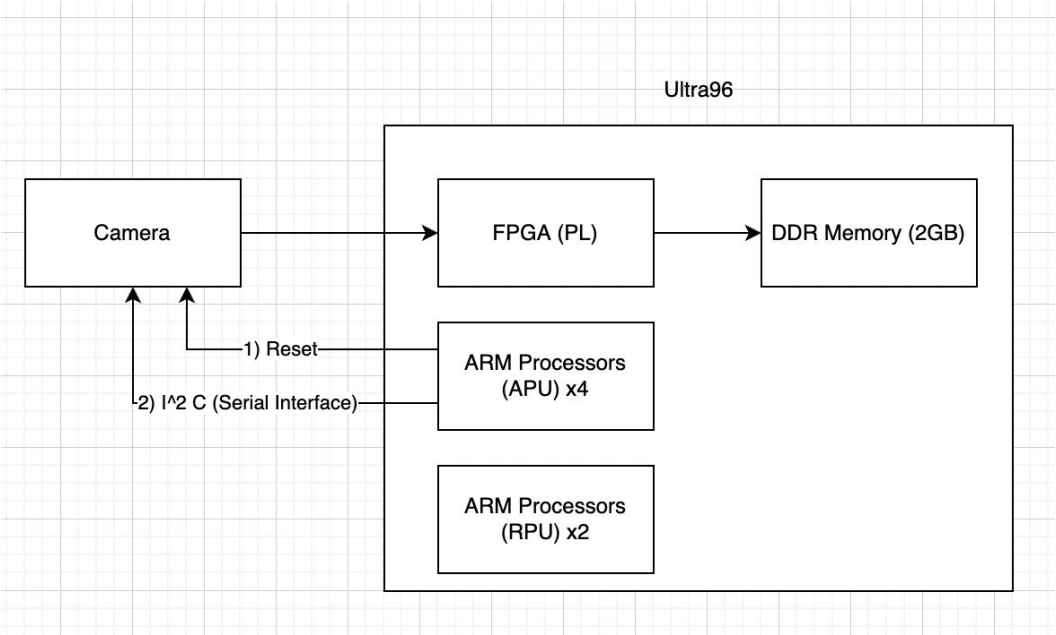

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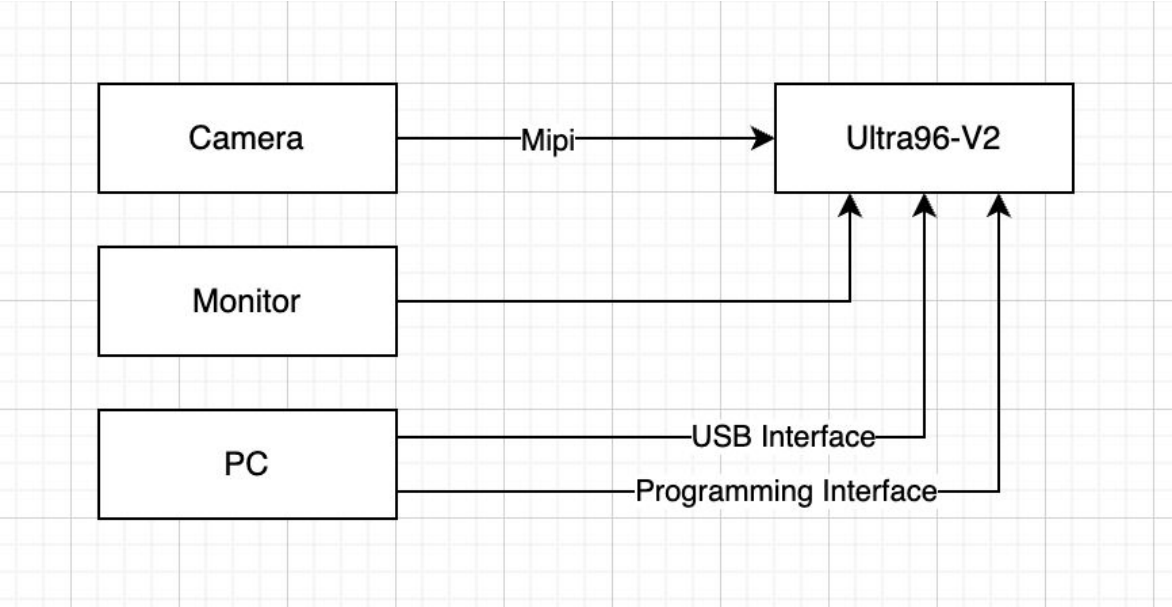

Proposed Design - 3.3.2 Functionality

The device is intended to be used in a surgery room while a surgeon is performing surgeries.

- The device will take input from a camera and perform some data processing to determine if a surgeon is stressed or fatigued.
- The device will then output appropriate suggestions/advices to the surgeon to reduce the risk of human error.

Proposed Design - 3.3.3 Areas of Concern and Development

Concern: What camera will be used?

Solution: We will use a camera that can have a wired input into the Ultra96 board.

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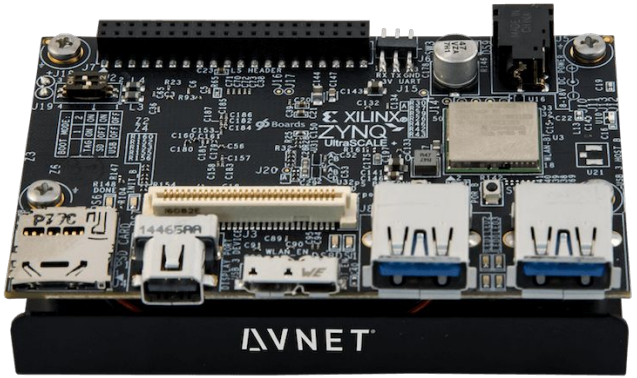

Proposed Design - 3.3.3 Areas of Concern and Development

Concern: How do we ensure accurate predictions about the surgeon being stressed?

Solution: Talk to the surgeon after surgery and review times where the system determined that they were stressed.

Design Analysis

- We have not implement the whole project far enough to check if our design works well or not.
- Working on smaller tasks now to build towards the project.
- So far, the proposed design is the best choice.
- Will continue to fine tune the proposed design over the semester when we start building towards the final product.

Thank You