EyeMatic

Eye Anatomy Recognition

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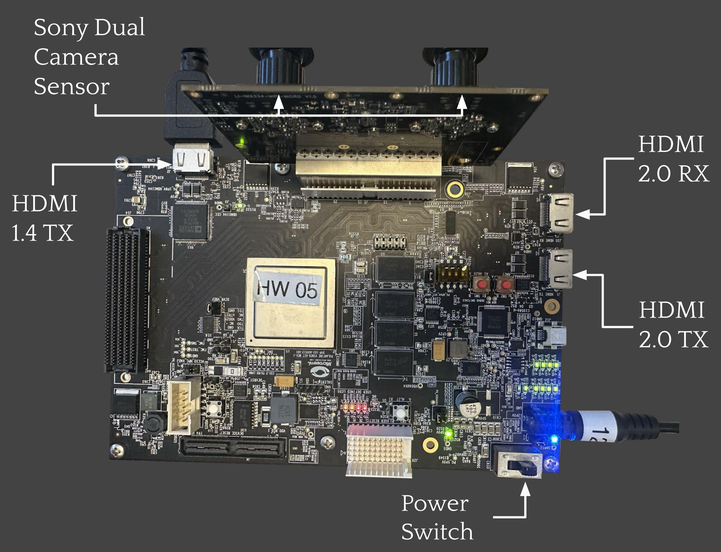
ABSTRACT

Cataract surgery is largely affected by the rotation of the eye of the patient. The rotation of the eye changes when the patient lays down for operation. Through the use of machine learning, the surgical camera system can be taught how to differentiate the anatomy of the eye's anterior structure, which consists of the pupil, iris, and sclera, and detect the eye's rotation and movement. By utilizing videos of real eye surgeries, we will be training the neural network model with tagged images of the different parts of the eye's anatomy after evaluating different neural network models and selecting one for use.

OVERVIEW

EyeMatic is a camera system that utilizes machine learning in order to detect eye anatomy on a patient's eye. Our system employs a Tiny YOLOv3 model, which is implemented on a custom FPGA, enabling precise classification of eye anatomy. This can be achieved through our dual camera setup or by analyzing existing surgical footage.

HARDWARE



WORKFLOW

Start

Gather and Tag Images
- Convert footage from Alcon into stills for annotation
- Source additional datasets to annotate for data diversity

Train a YOLOv3 (Tiny) Model and Generate a HEX File to Flash
- Train model on tagged images
- After training convert the .weights file into a usable .hex file that can be uploaded to the FPGA

Upload the HEX file onto the FPGA using Libero SoC Software
- Connect FPGA to computer and make adjustments to memory address space where necessary
- Upload the model to the FPGA

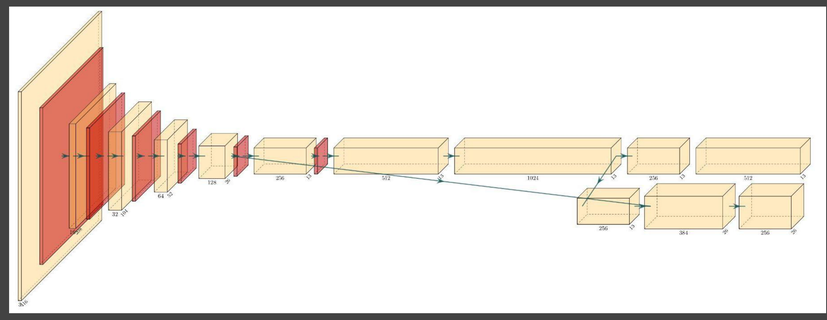
Adjust Model Specific C Code using SoftConsole
- Modify C code for firmware running the model
- Changes need to reflect differences in model architecture to run properly

Flash Compiled Software onto FPGA
- Changes are finalized into compiled firmware that is flashed onto FPGA using Libero SoC

Finish

NEURAL NETWORK

Tiny YOLO v3 Model trained on our own dataset provided by Alcon as well as outsourced datasets to increase data diversity. All are annotated by us.



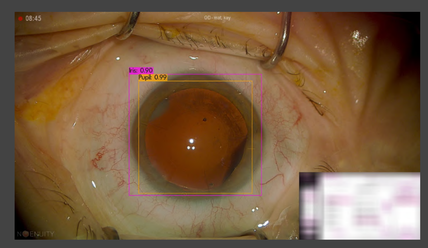
Model Details:
- Tiny YOLOv3 Darknet model
- 13 Convolutional Layers
- 6 Pooling layers

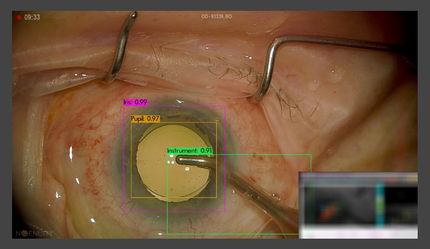
Input:
- Video stream from FPGA

Output:
- Bounding boxes of object prediction

MODEL SAMPLES

Detection of Iris and Pupil





Detection of Iris, Pupil, and Medical Instrument

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Special thanks to Yogananda Isukapalli Yuepei Hu Ky Nguyen Alex Lai Garo Janir

Alcon