

HAML: Heterogenous and Accelerated Computing for Machine Learning

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Problem and Requirements

Problem: Client wants to create a system to help people with disabilities complete day-to-day activities by tracking eye movement.

Requirements:

1. Create a system with 3 models (blink, pupil detection, semantic segmentation) running in parallel. No timing requirements.
2. Create a system with blink and pupil detection running in parallel, and achieve throughput of 200 FPS.

Constraints:

- Client provides 2 ML models (blink and pupil tracking)
- Client wants it implemented on the Xilinx Kria KV260 evaluation board

Blink & Pupil Tracking

Pupil Tracking

- Regression model
- Return the X and Y coordinates of the location of the pupil within the image frame
- Slower run time than blink algorithm

Blink

- Classification model
- Output two class: blink/no-blink

Semantic Segmentation

Model type:

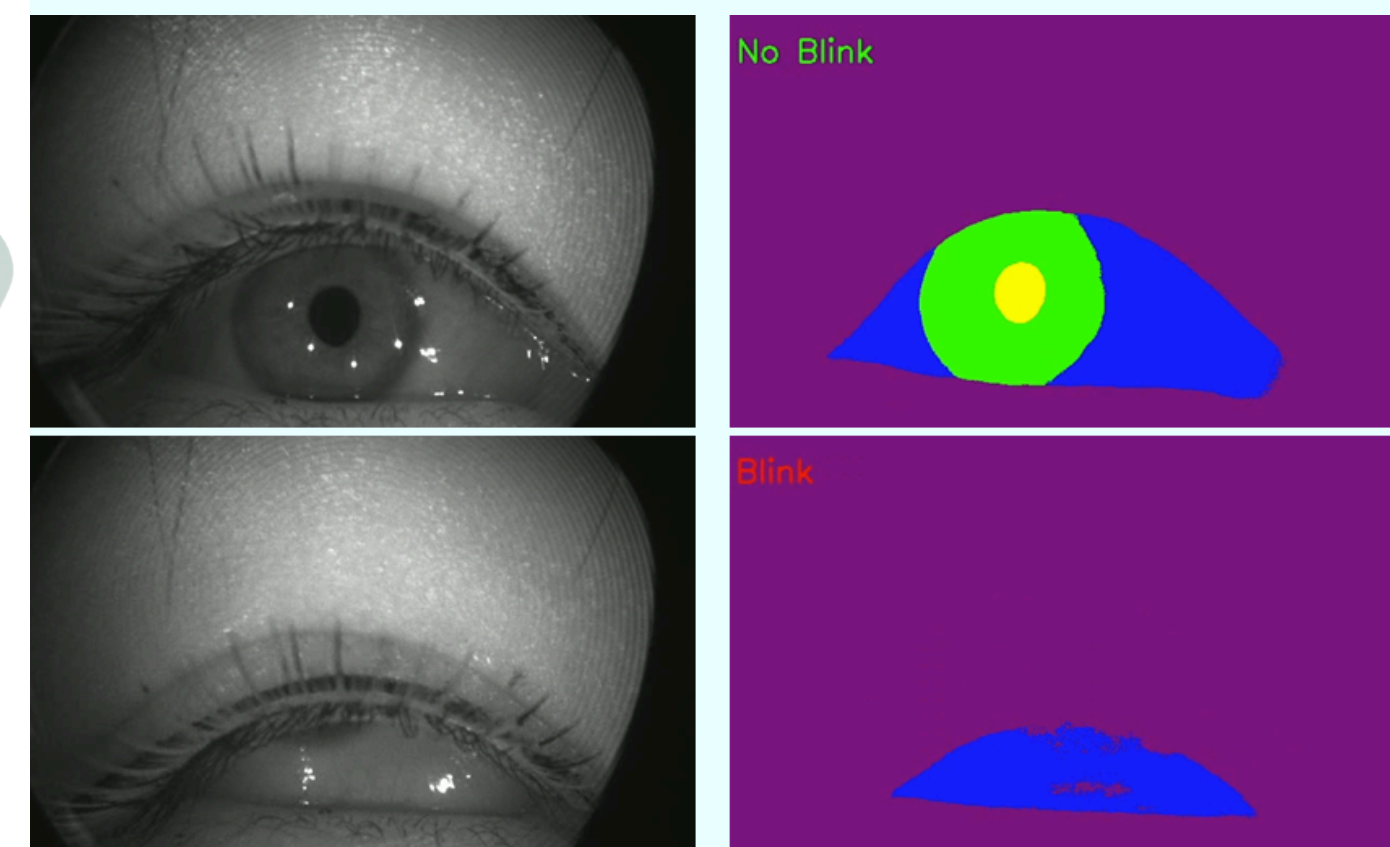
- Pixel-wise classification model

Input:

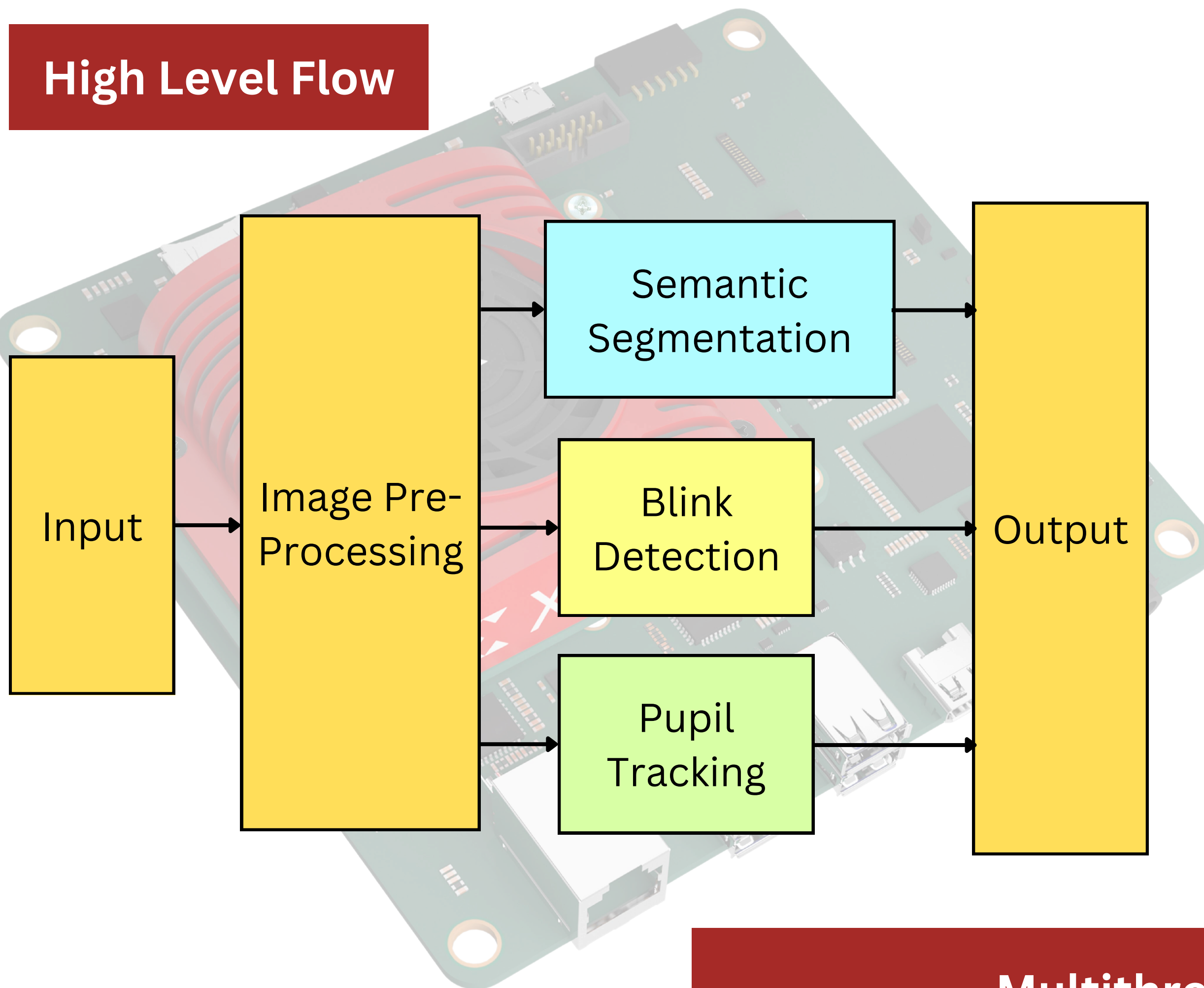
- Frames extracted from a given video
- 1-channel image (grayscale)

Output:

- 4-channel segmented image
- Class indices array



High Level Flow



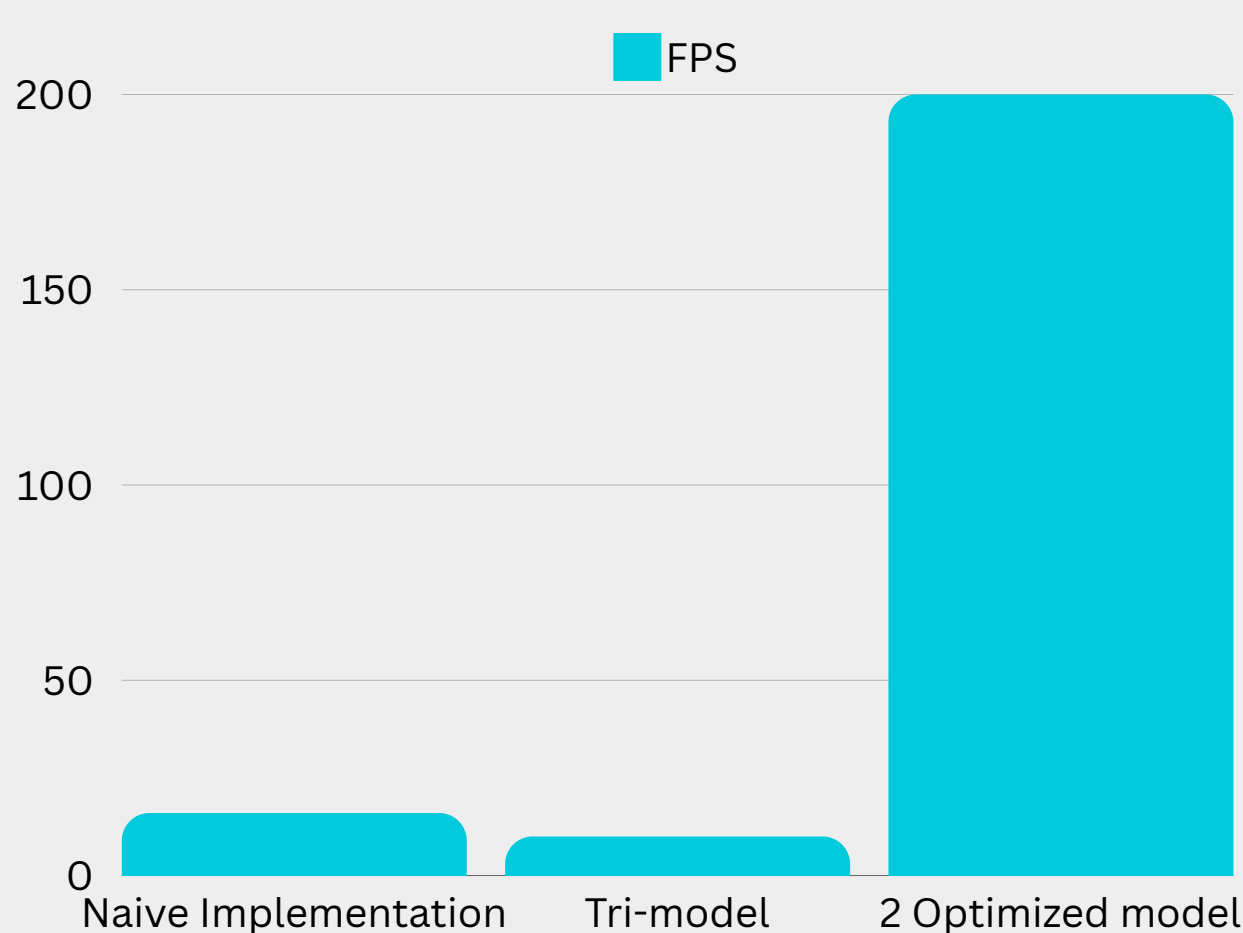
Results

FPS Results:

- Naive: 16 FPS
- Tri-model: ~10 FPS
- 2 Optimized models: ~200 FPS

Accuracy:

- Semantic segmentation: 98%



Multithreaded Application

