SCRAP SORT

Scrapsort: Sorting Recyclables at the Edge

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Background

Waste disposal is becoming an ever greater concern in our modern world, and very little recyclable waste is ever ultimately recycled. We propose Scrapsort, an autonomous system that can sort trash on-site immediately.
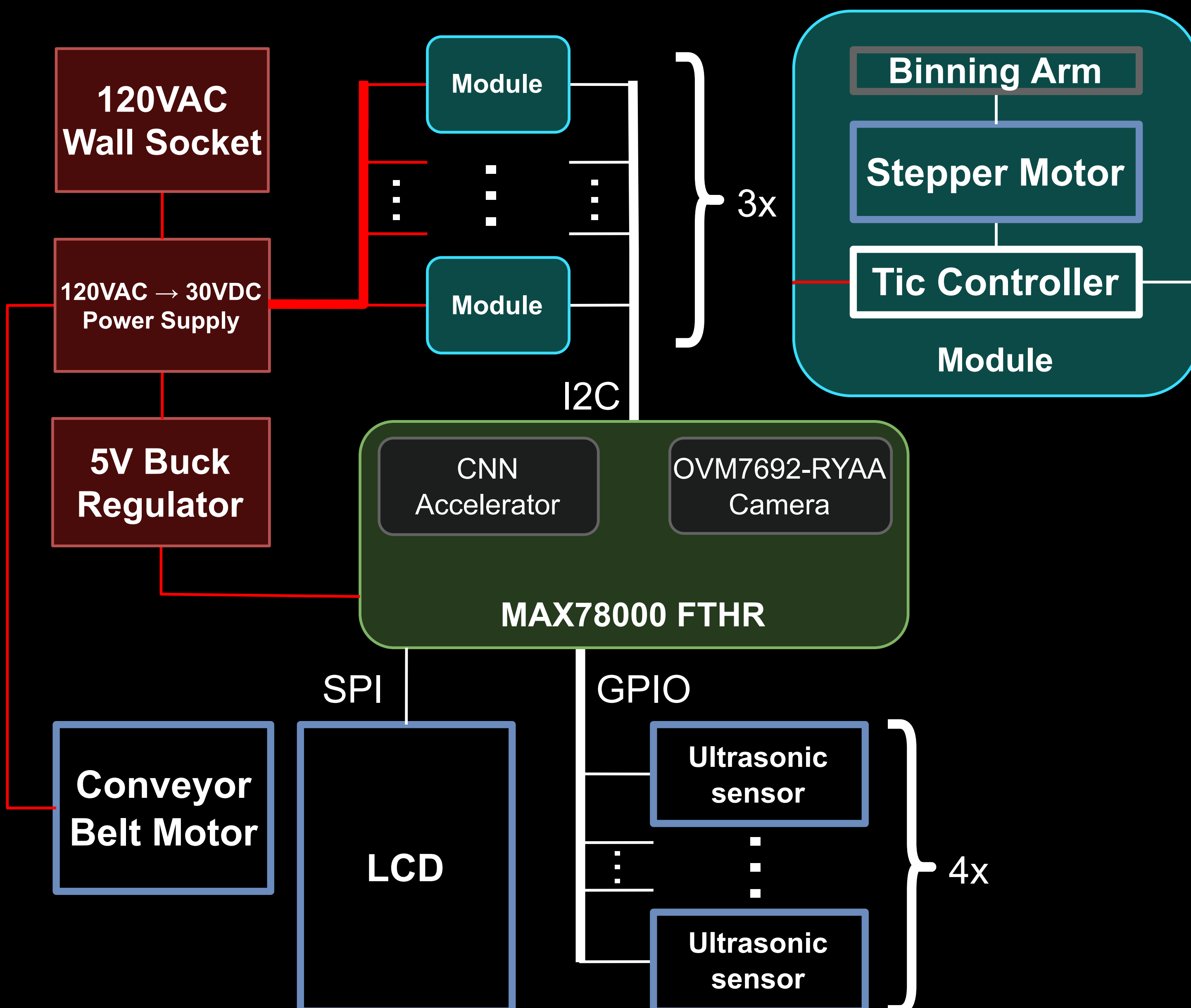
Overview

Scrapsort operates in three stages as objects move along a conveyor belt.

- Detection: ultrasonic sensors detect objects
- Classification: MAX78000 microcontroller has an onboard camera & CNN hardware accelerator to classify objects.
- Sorting: stepper motors activate to push objects into bins when they arrive at their destination
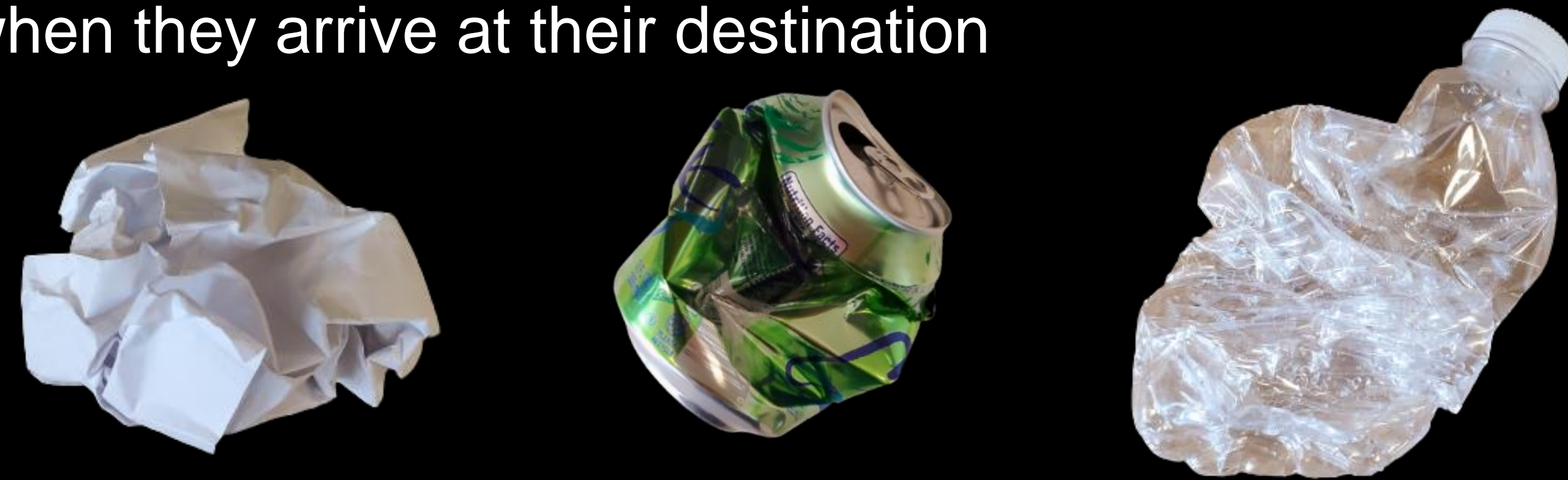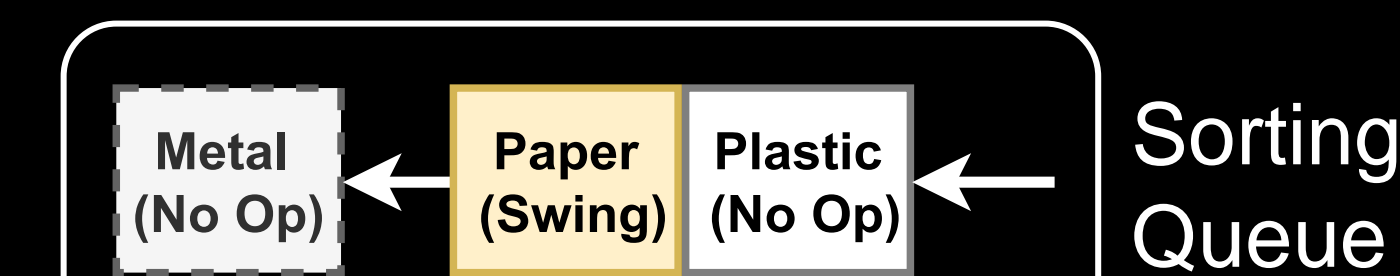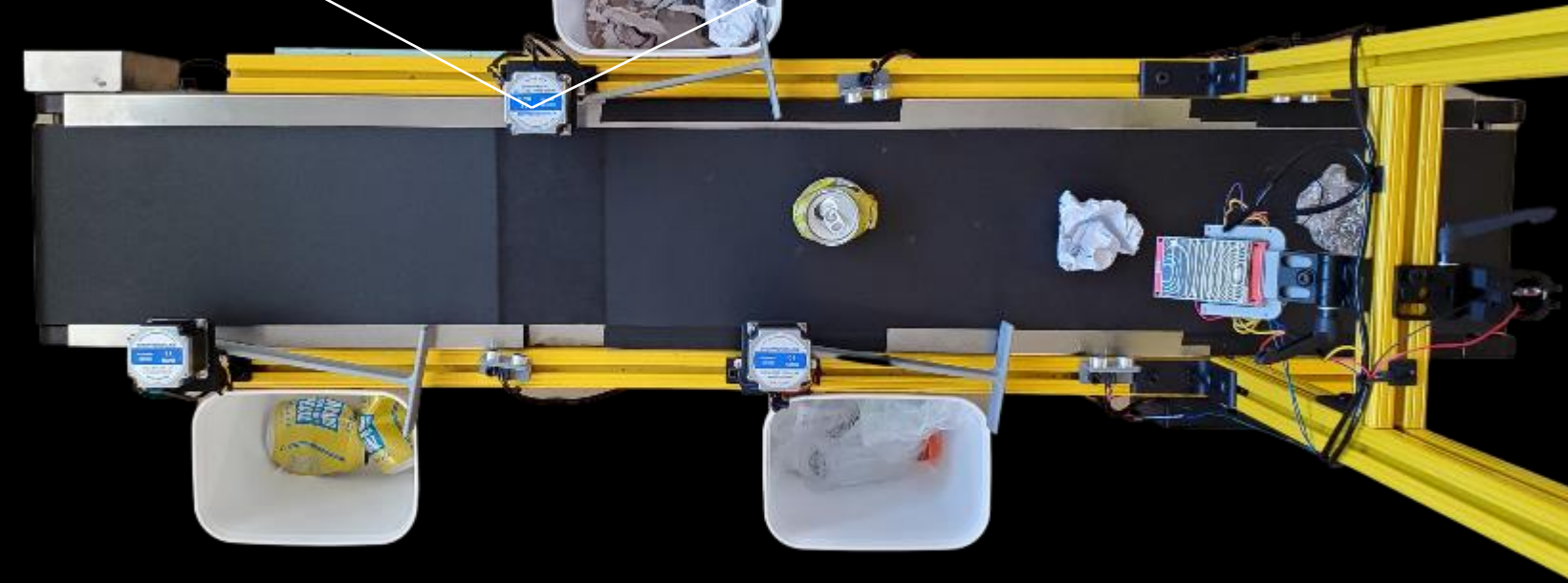
Hardware

Sorting Control Flow
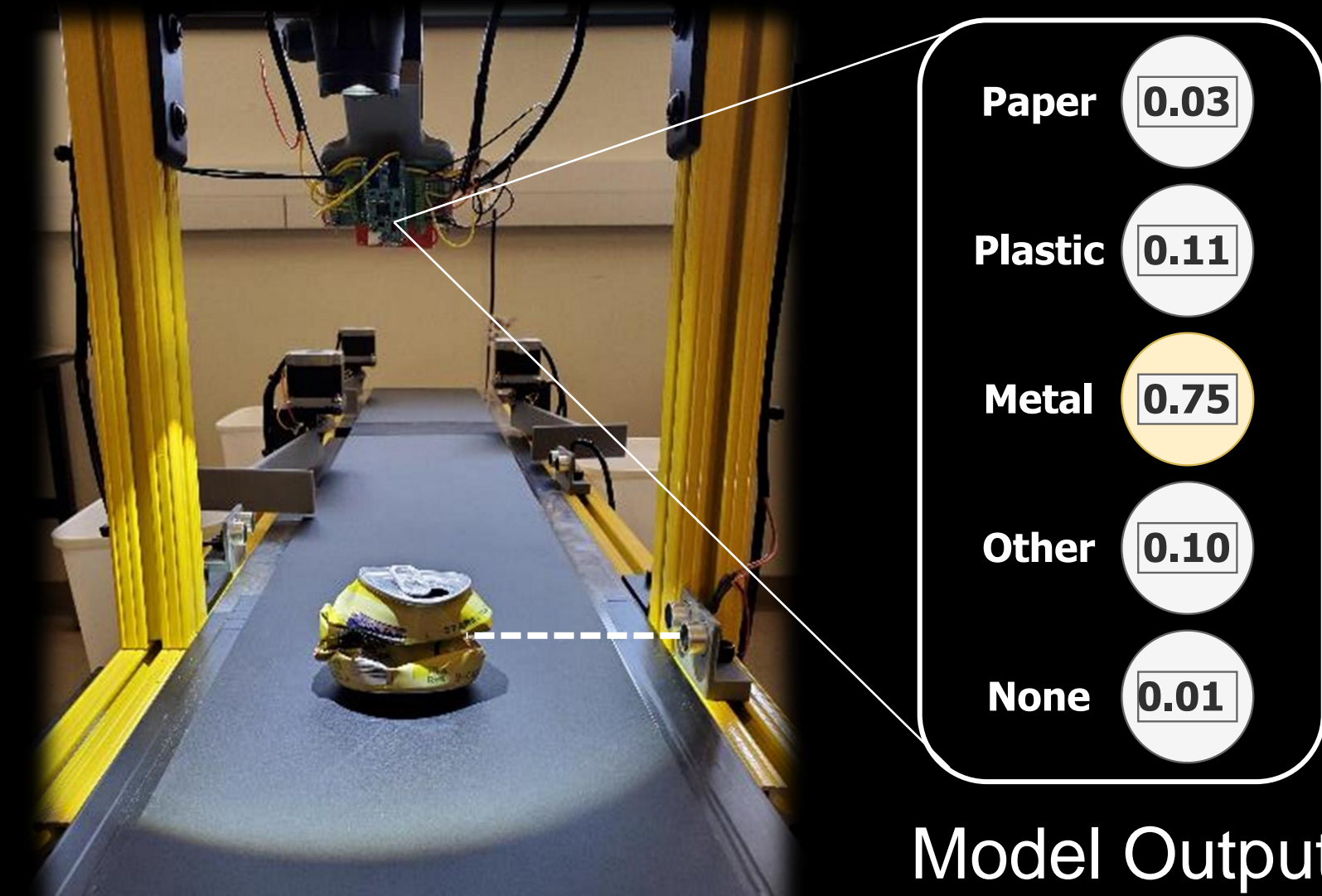
Item Placement and Classification

Model Output

- Ultrasonic sensor triggers camera to capture image
- Image passed into CNN model for classification

Item Queuing

Sorting Queue

- Classification result pushed onto queues for sorting
- Items popped off queues as they move past arms
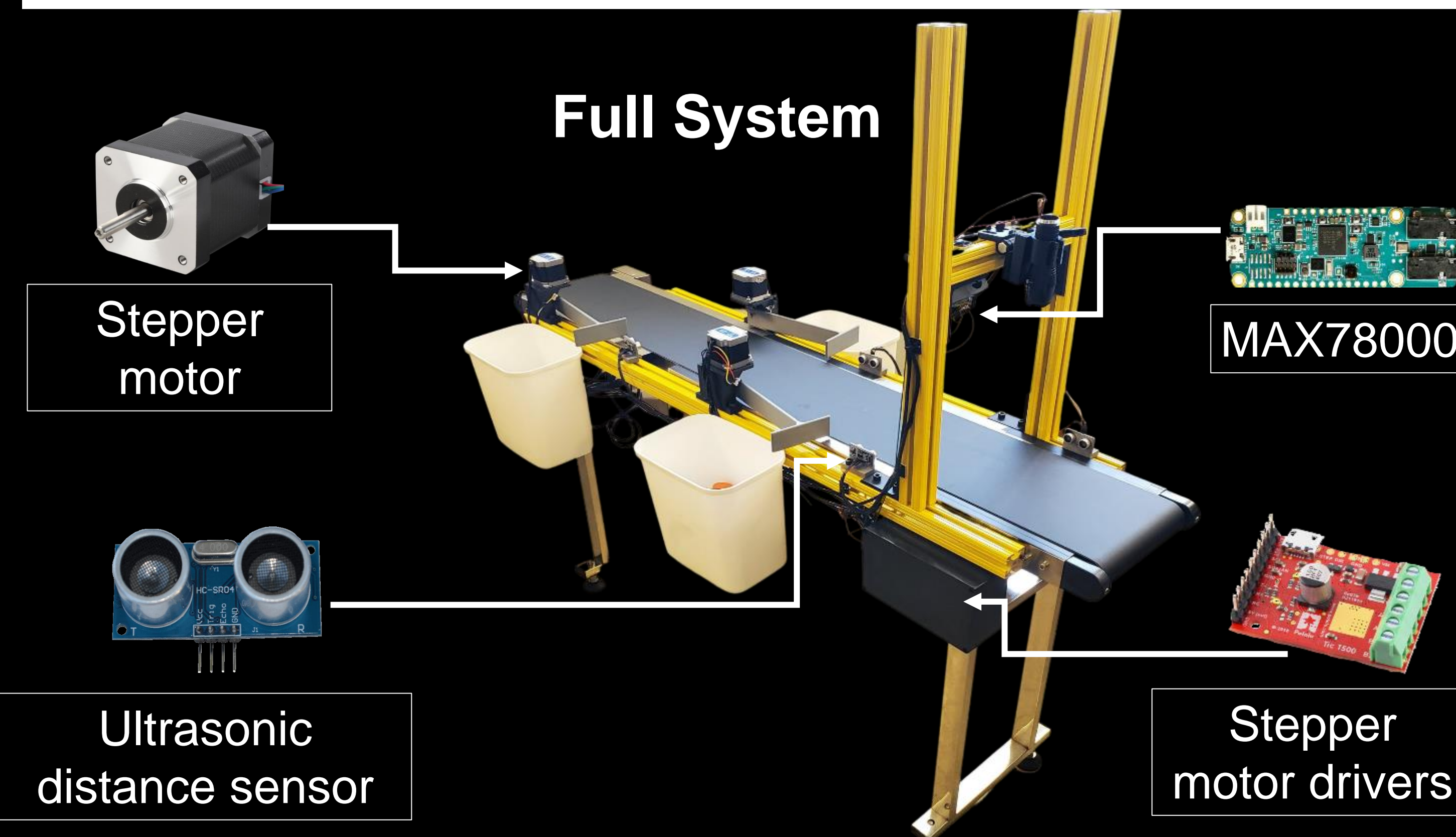
Sorting Arm

Open → high speed
Close → high torque

- Arms swing open when corresponding item arrives
- Arms close and push item into mounted bins
- Custom motor profiles for opening and closing to balance speed and torque

Full System

Stepper motor

MAX78000

Ultrasonic distance sensor

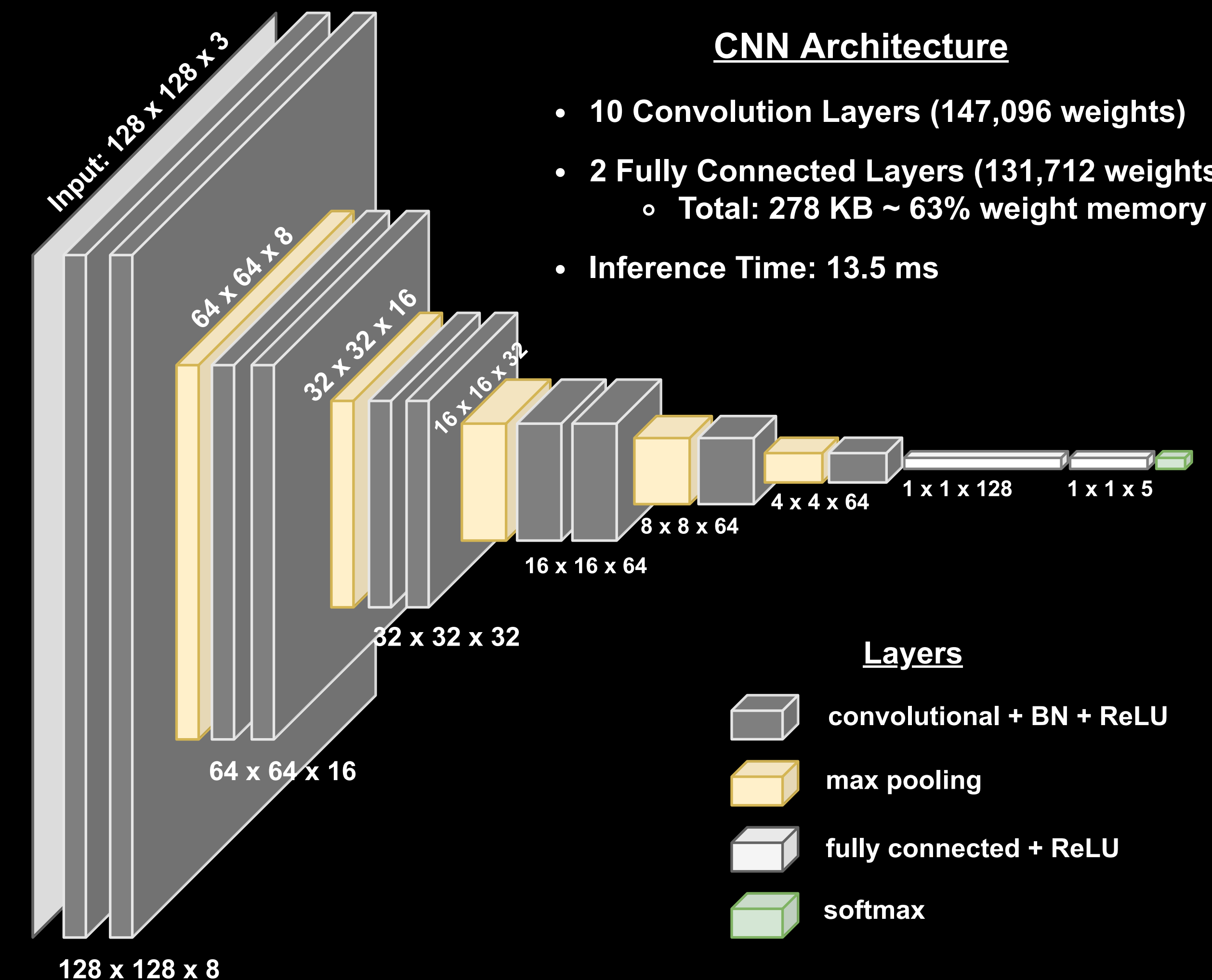Stepper motor drivers
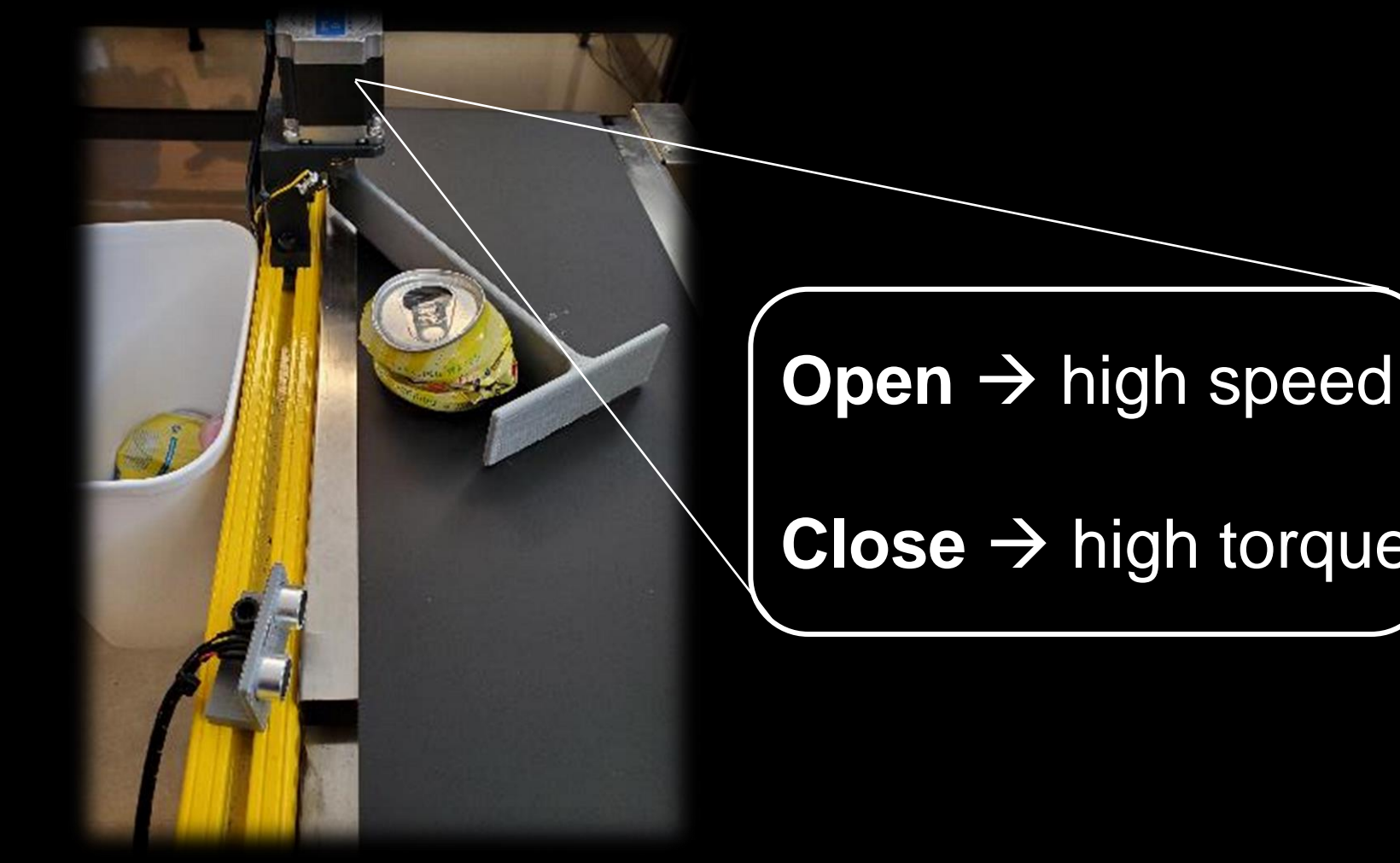
Software

- When an event happens, an interrupt triggers and pushes a task onto a queue
- Tasks are handled in the main loop which constantly checks for items on the task queue
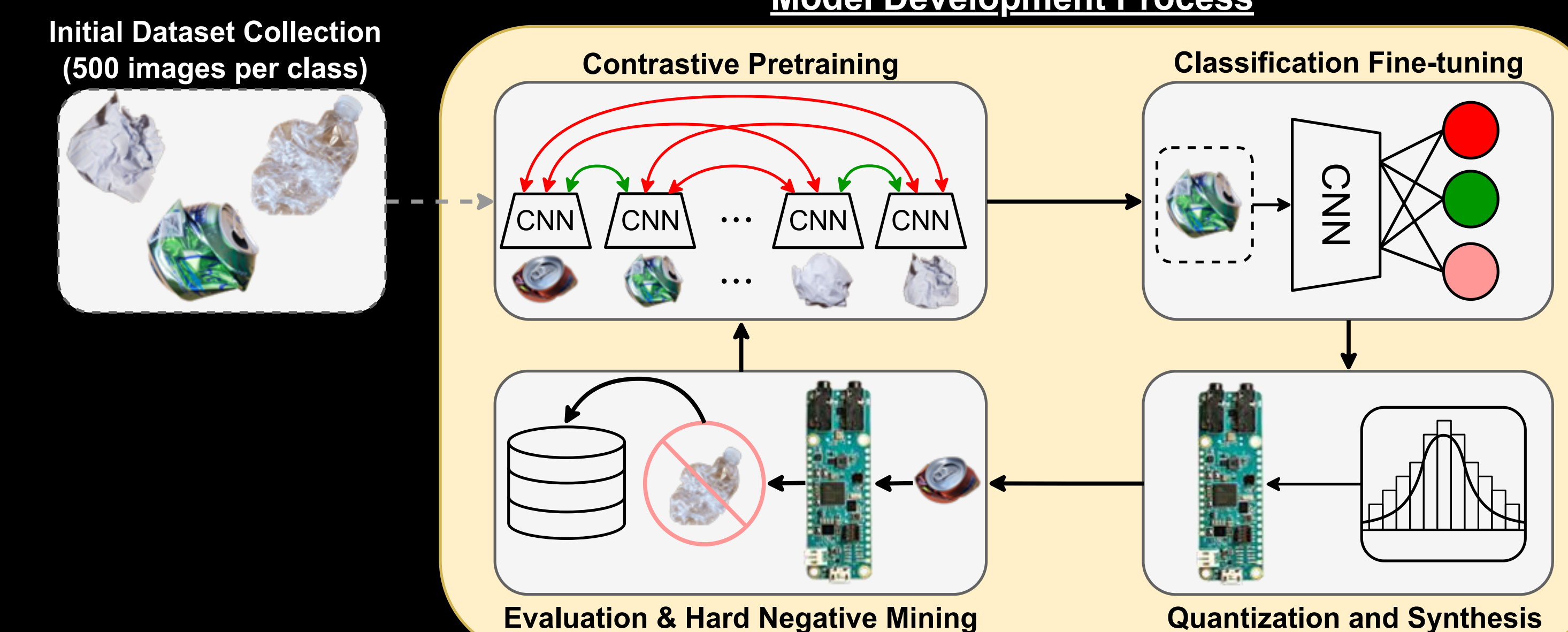- Tasks are prioritized by the order (in time) of occurrence
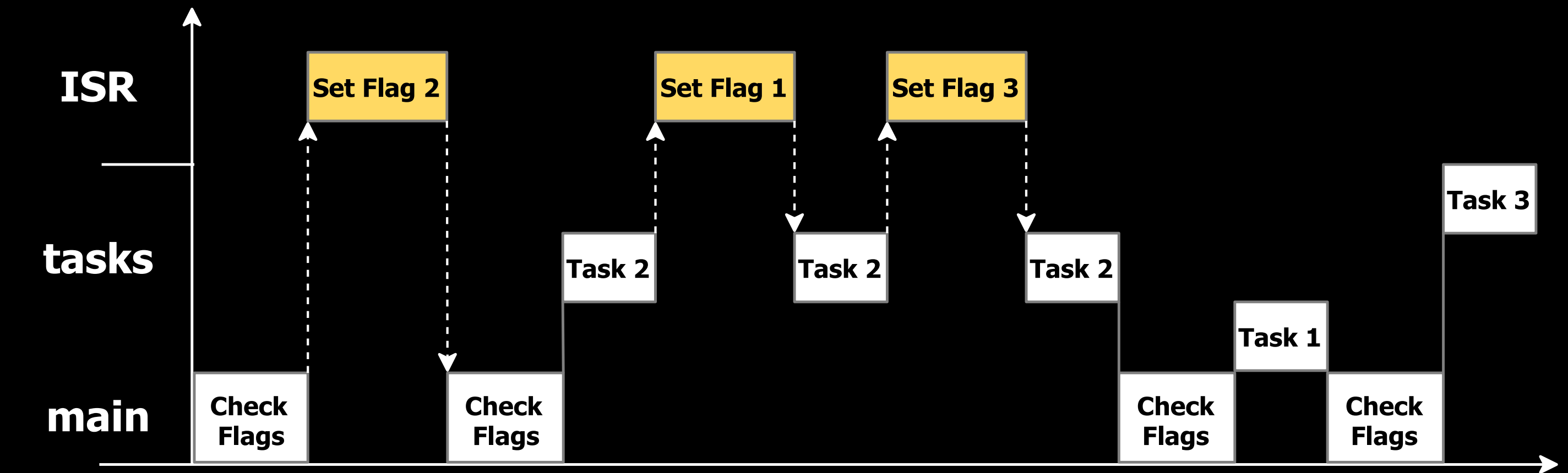
Machine Learning

CNN Architecture

- 10 Convolution Layers (147,096 weights)
- 2 Fully Connected Layers (131,712 weights)
  - Total: 278 KB ~ 63% weight memory
- Inference Time: 13.5 ms

Layers

- convolutional + BN + ReLU
- max pooling
- fully connected + ReLU
- softmax

Model Development Process

Initial Dataset Collection (500 images per class)

Contrastive Pretraining

Classification Fine-tuning

Evaluation & Hard Negative Mining

Quantization and Synthesis

ANALOG DEVICES

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