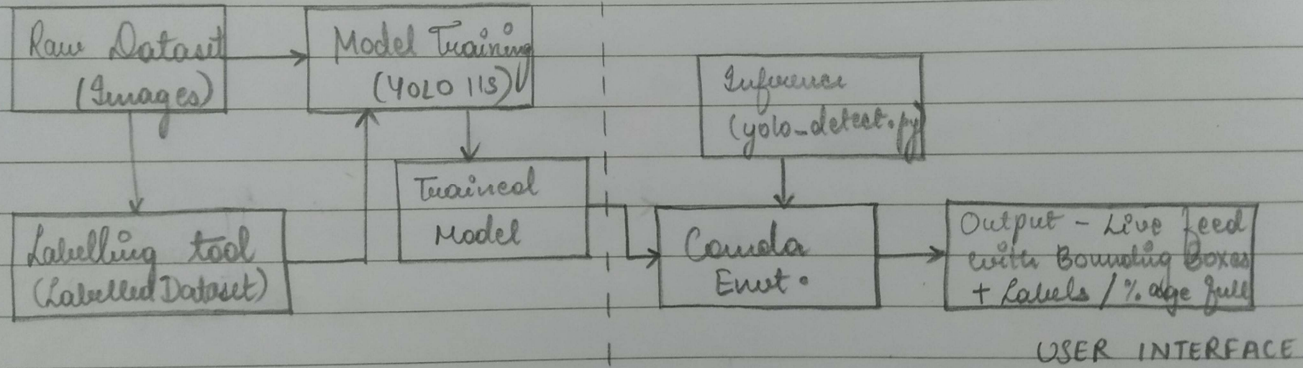


High-level Architecture Diagram for both tasks

DATA & TRAINING PIPELINE

REAL-TIME OPERATION



Describing the components

① Input Layer : Data capture

COMPONENT	ROLE IN THE SYSTEM	KEY DESIGN CONSIDERATIONS
Camera	Captures the live video stream	Resol ⁿ & Frame Rate: 720p at 30FPS
Illumina ⁿ	Performs uniform & consistent lighting	May require LED arrays for consistent color & brightness

② Processing Layer : Computer Vision Algorithm

COMPONENT	ROLE IN THE SYSTEM	MY SPECIFIC IMPLEMENTATION
Object Detect ⁿ Model + Inference Engine	The core algo. that localizes items and classifies them. + The live envt. that runs the model	Trained YOLO model + yolo-detect.py (.pt file) : Performs obj. detect ⁿ (locating BBS) and classifica ⁿ (identifying plastic, paper, metal & glass)

③ Output Layer : Results & Action

COMPONENT	ROLE IN THE SYSTEM	EXAMPLE OUTPUT/ACTION
Visualiza ⁿ / UI	Displays the detect ⁿ results / Real time monitoring	Bounding Boxes & Categories / Labels (TASK 1) displayed on screen % of trash bin filled (TASK 2)

Why YOLO11 for Smart waste management?

- ① Its very fast : Detects objects in the single pass of image, making it fast enough to process live video frames.
- ② High Accuracy : Accurately draws bounding boxes and correctly identifies the objects.
- ③ Works on simple hardware : Can run well on affordable hardware like Raspberry Pi or an industrial embedded system.
- ④ Easy to use : Framework is well documented and simple to train with custom data.
- ⑤ It detects multiple objects : Can see and identify multiple objects in the single frame at the same time.

Mitigating Lighting Variations and Glare (Plastic & Metal) :

While dataset collection we can place a polarizer filter on the camera lens and a linear polarizer on the light source. This cancels out most of the unwanted surface glare and makes surface features more visible.

Ethical Consideration & Environmental Impact

Surveillance Scope

A camera intended for waste could be repurposed for surveillance (eg: tracking who throws away what, or who passes by).

We'll have to ensure that system runs only for trash detection.

Hardware disposal

The cameras embedded devices (eg: Raspberry Pi) and cameras used in the system will eventually become e-waste themselves.

We will have to design the long lifespan & plan for responsible recycling.