The Self Driving Human

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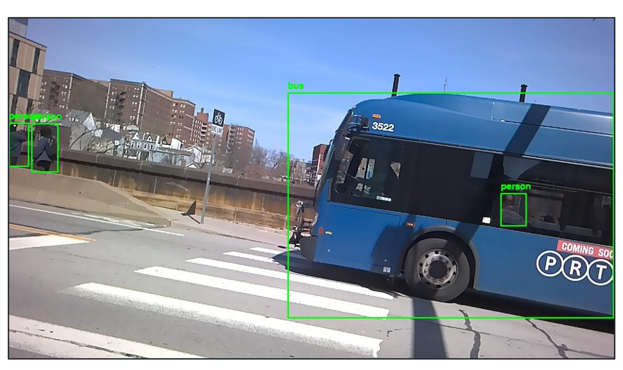
Product Pitch

Visually impaired pedestrians rely on aids like tactile paving, audible signals, and guiding strips to locate crosswalks, determine when it is safe to cross, and stay oriented while crossing. However, many intersections still lack this essential infrastructure. The Self-Driving Human offers a solution: a chest harness equipped with cameras, sensors, and computer vision models that help users identify safe crossing times and navigate around obstacles within the crosswalk.

To ensure user safety, the Self-Driving Human meets certain design requirements such as a 98% walk sign and obstacle detection accuracy, less than 150ms latency, and an 11hr battery life.



System Architecture

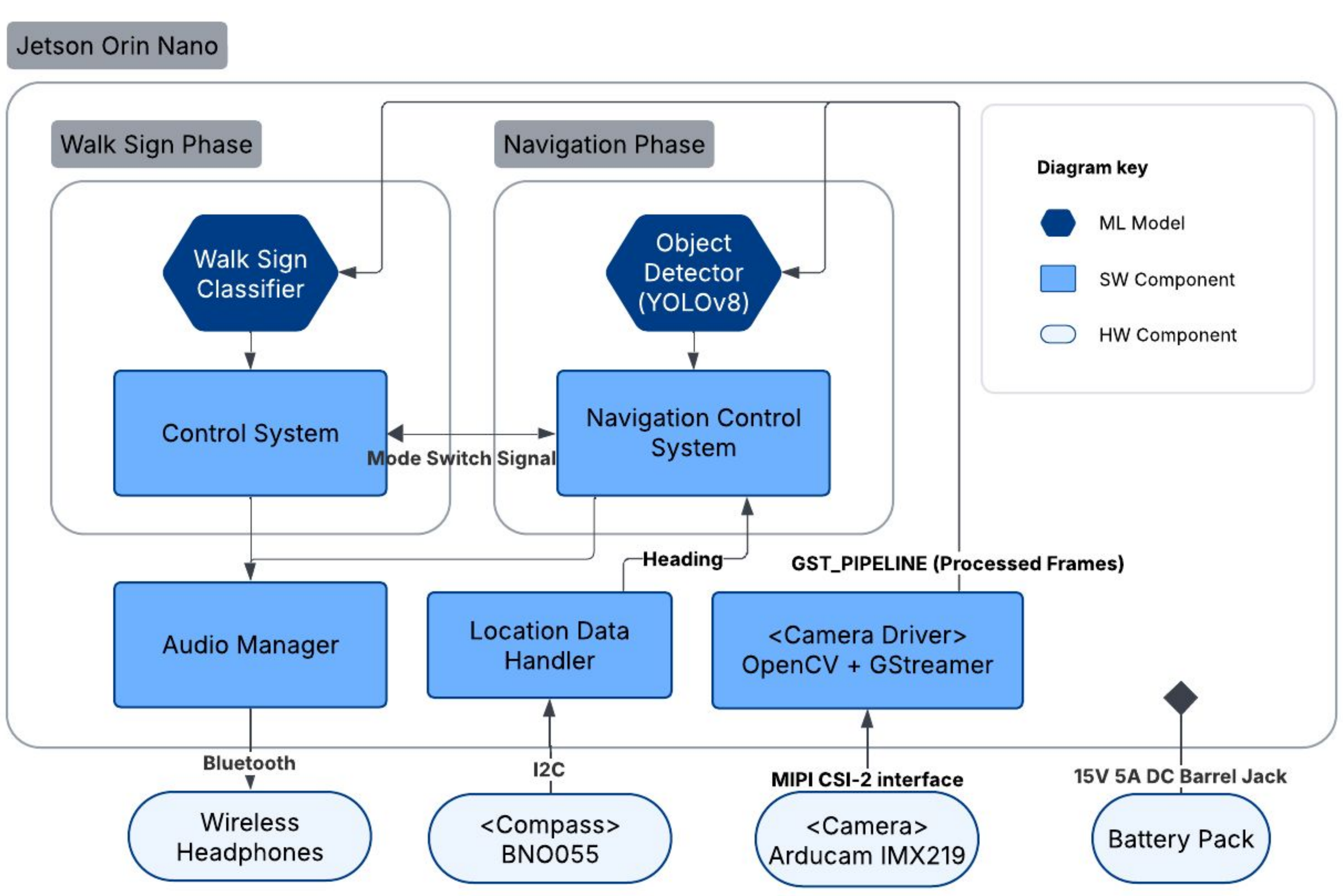


Fig 1: Flowchart Diagram of Our System

The camera feeds images into our software component, which starts in the walk sign image classification phase. When a "WALK" signal is detected, the system passes control to the object detection and navigation subsystem, where audio feedback is relayed back to the user via the wireless headphones. The IMU sensor simultaneously detects the user's heading and helps provide audio feedback to keep them within the crosswalk.

Conclusions & Additional Information

Overall, we were able to meet most of our design requirements and integrate all submodules into one complete system. One lesson we learned was to begin the complete integration process earlier, as submodules that work independently may not alway work together.

https://course.ece.cmu.edu/~ece500/projects/s25-teamd3/

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System Description

The Self-Driving Human uses a Jetson Orin Nano microcontroller, Bluetooth bone-conducting earphones, an external battery, and an IMU sensor. A ResNet50 image classification model and a YOLOv12 object detection model run on the Ampere GPU on board.

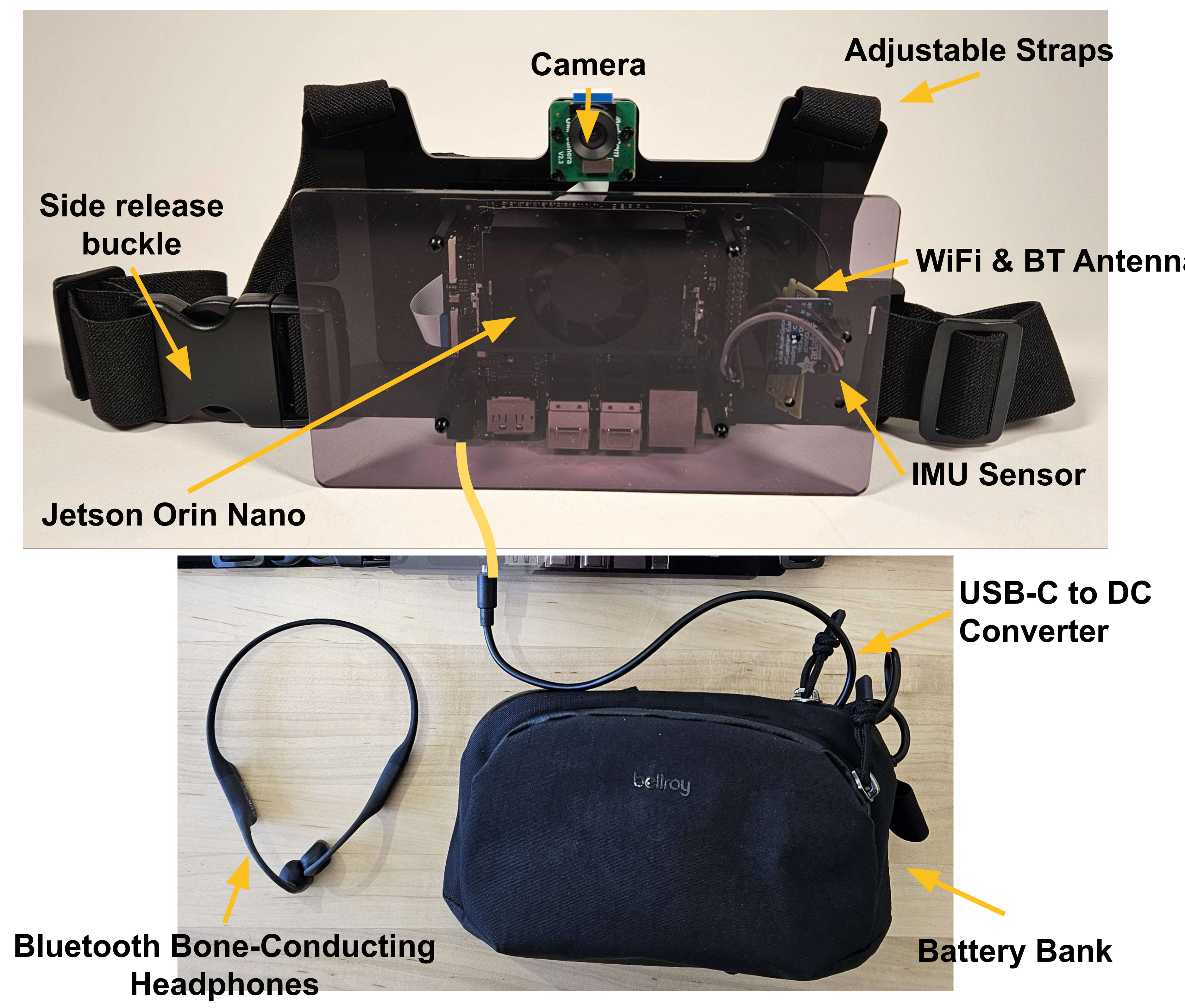

Fig 2 and 3. System Diagram - Harness, Headphone, and Battery Pack

System Evaluation

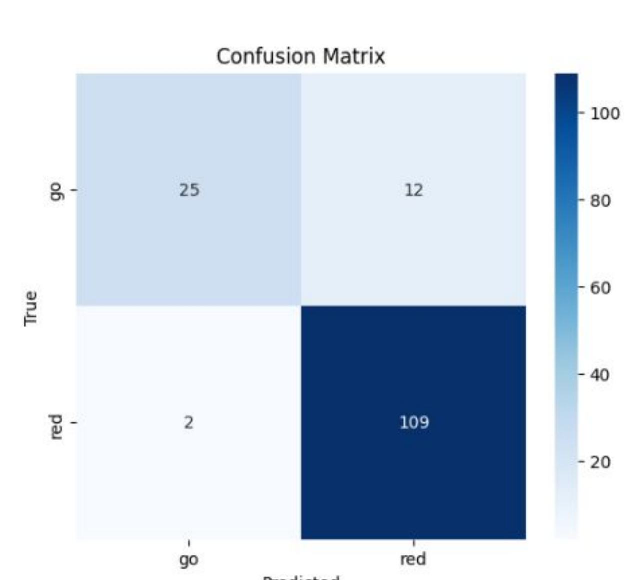

Fig 4. Confusion Matrix for Walk Sign Classification, evaluated on test data collected around CMU

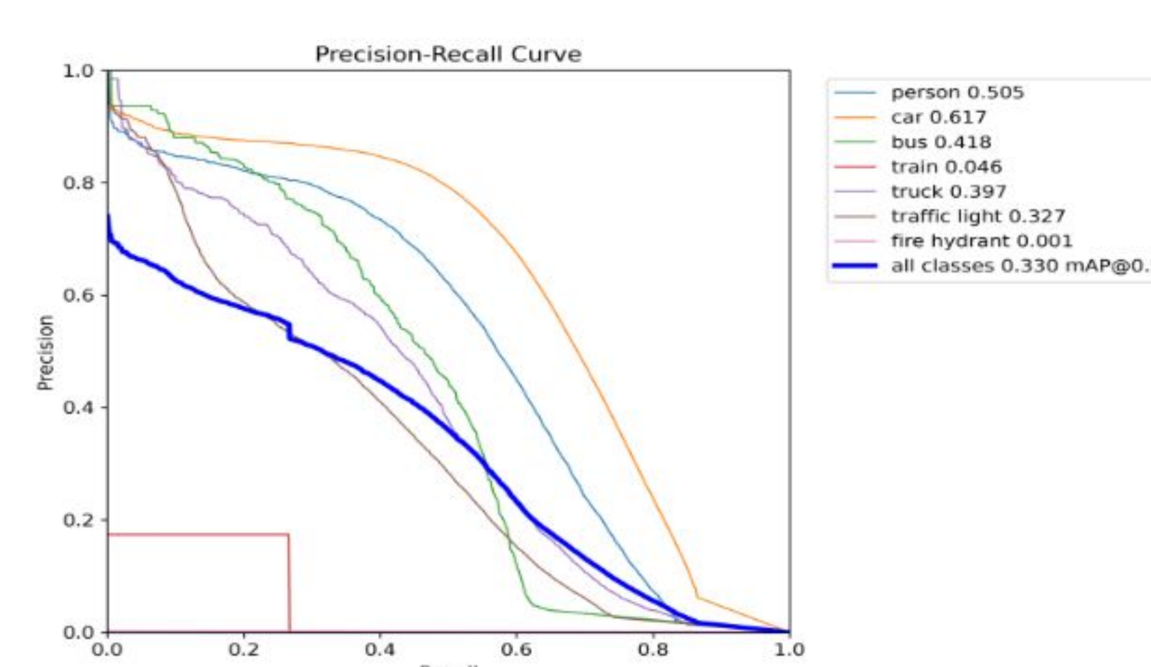

Fig 5. Precision-Recall Curve for YOLO Object Detection Model, evaluated across all relevant classes on a held out test dataset around CMU

Use Case Requirements:

Metric	Target	Actual
Classification AUROC on a Single Test Frame	≥ 0.9	0.936
Classification Accuracy on Sequences of Test Frames	≥ 95%	98.2%
Model Inference Latency	≤ 100 ms	Walk Sign: 33 ms Object Detection: 90 ms
Audio Latency	≤ 500 ms	100 ms
Veering Angle Detection	≤ 20°	80°
Battery Life	≥ 6 hrs	8 hrs