

Team 317: Jacob Blackburn, Patrick Canady, Miles Henry, Ruth Massock, Devin Peebles, Billy White
Department of Electrical and Computer Engineering

PROBLEM STATEMENT

Filming dynamic activities like combat sports is challenging due to rapid, unpredictable movements. Without a dedicated camera operator, practitioners must restrict their movement or settle for poor quality footage, limiting performance analysis and content creation.

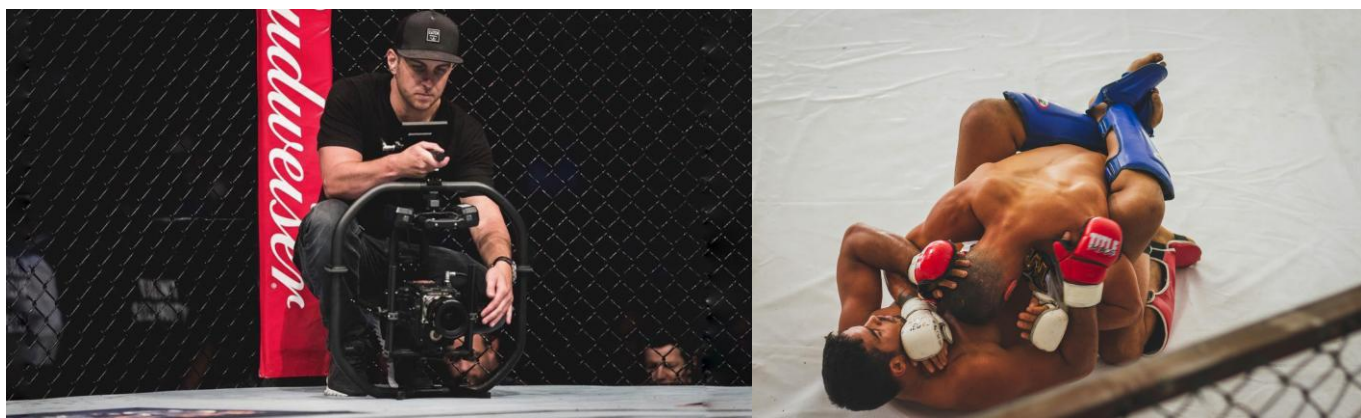


Figure 1: Dynamic movements in combat sports make manual filming difficult

OBJECTIVE

Our goal was to develop a cost-effective and battery-powered real-time tracking system. By integrating Raspberry Pi with YOLO-based vision, the project sought to provide robust target acquisition, recording, and occlusion handling through a configurable web interface.

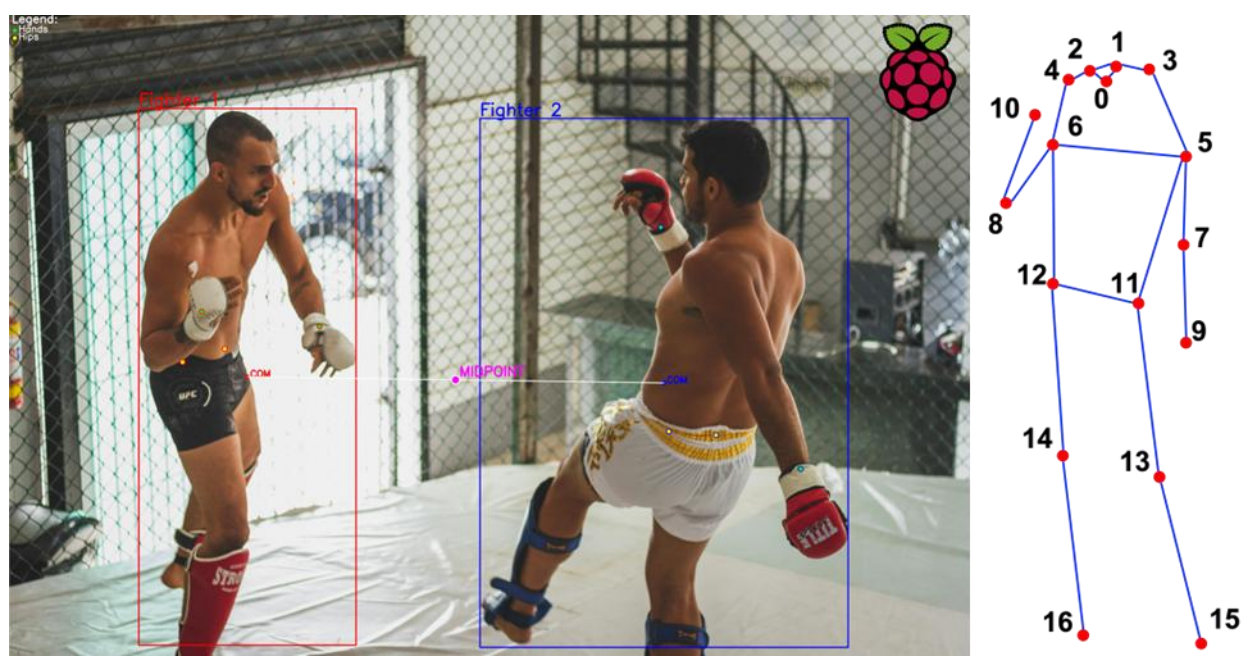


Figure 2: YOLOv11 pose estimation can find center points and draw skeletons

POWER SYSTEM DESIGN

The system operates on a unified 5V power rail powered by a UPS HAT and high-capacity 18650 batteries, enabling fully untethered operation for field use. The HAT acts as both a power source and a high-current buffer, delivering the peak amperage required by the servo motors while simultaneously maintaining a stable voltage for the Raspberry Pi 5. This integrated power management prevents voltage drops and brownouts during dynamic movement, ensuring reliable performance during extended recording sessions. 15 minutes of continuous runtime during vigorous tracking operations, even under maximum mechanical load.

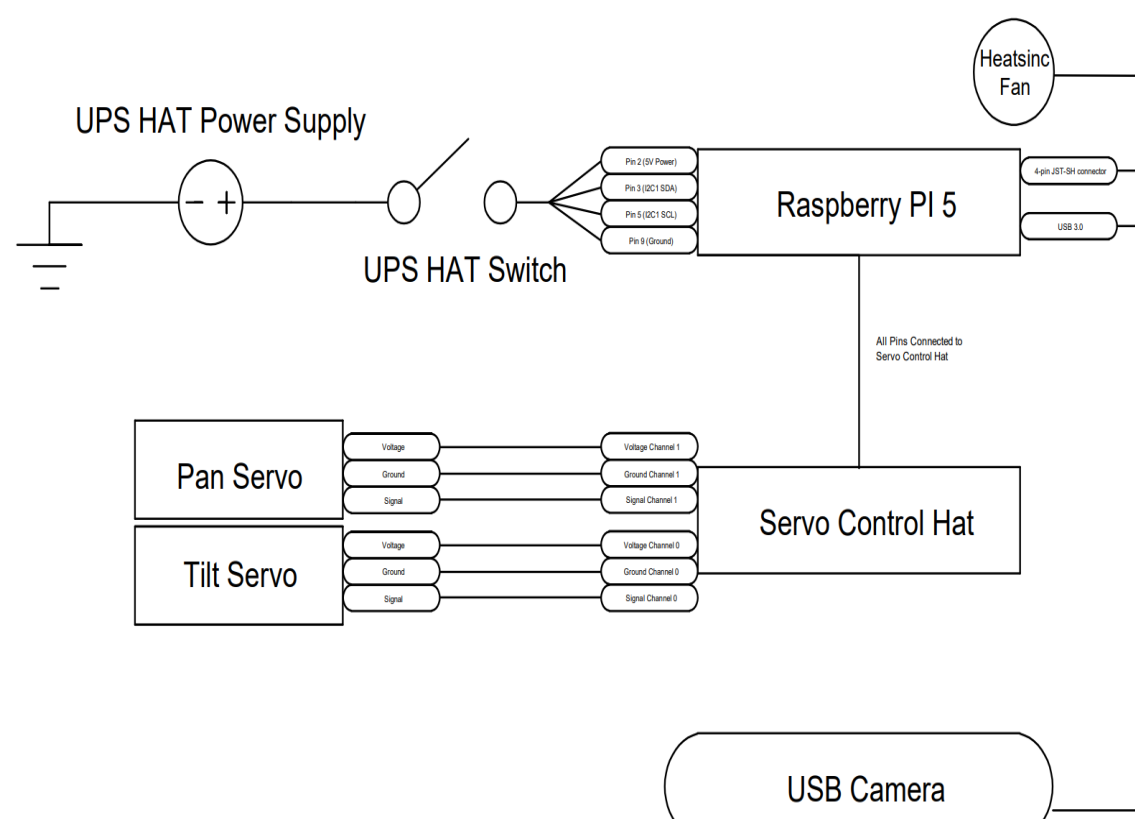


Figure 3: Wiring diagram for one camera node

CAMERA SYSTEM DESIGN

The design consists of four integrated modules connected via Wi-Fi to provide automated target tracking and centralized management:

Module 1: Vision & Motion – A Raspberry Pi 5 node using YOLOv11 for pose estimation, controlling a Pan/Tilt mechanism to track subjects in real-time. This module performs on-device inference to minimize latency between detection and motor response.

Module 2: Central Aggregator – A laptop-based Flask server that receives video feeds, selects the optimal camera view, and manages recording.

Module 3: Web Interface – A browser dashboard featuring a live video stream, recording toggles, and system status indicators for remote control. It serves as the primary control hub for calibrating tracking sensitivity and viewing playback.

Module 4: Power Subsystem – A UPS HAT battery system integrated into each node, enabling portable, wireless operation for field use.

SYSTEM ARCHITECTURE

The system consists of multiple camera nodes; each built around a Raspberry Pi with integrated vision processing and servo control. Each node captures video, performs pose estimation, and transmits annotated frames to a central server. The server aggregates all camera feeds and delivers them to a web-based user interface for monitoring and recording.

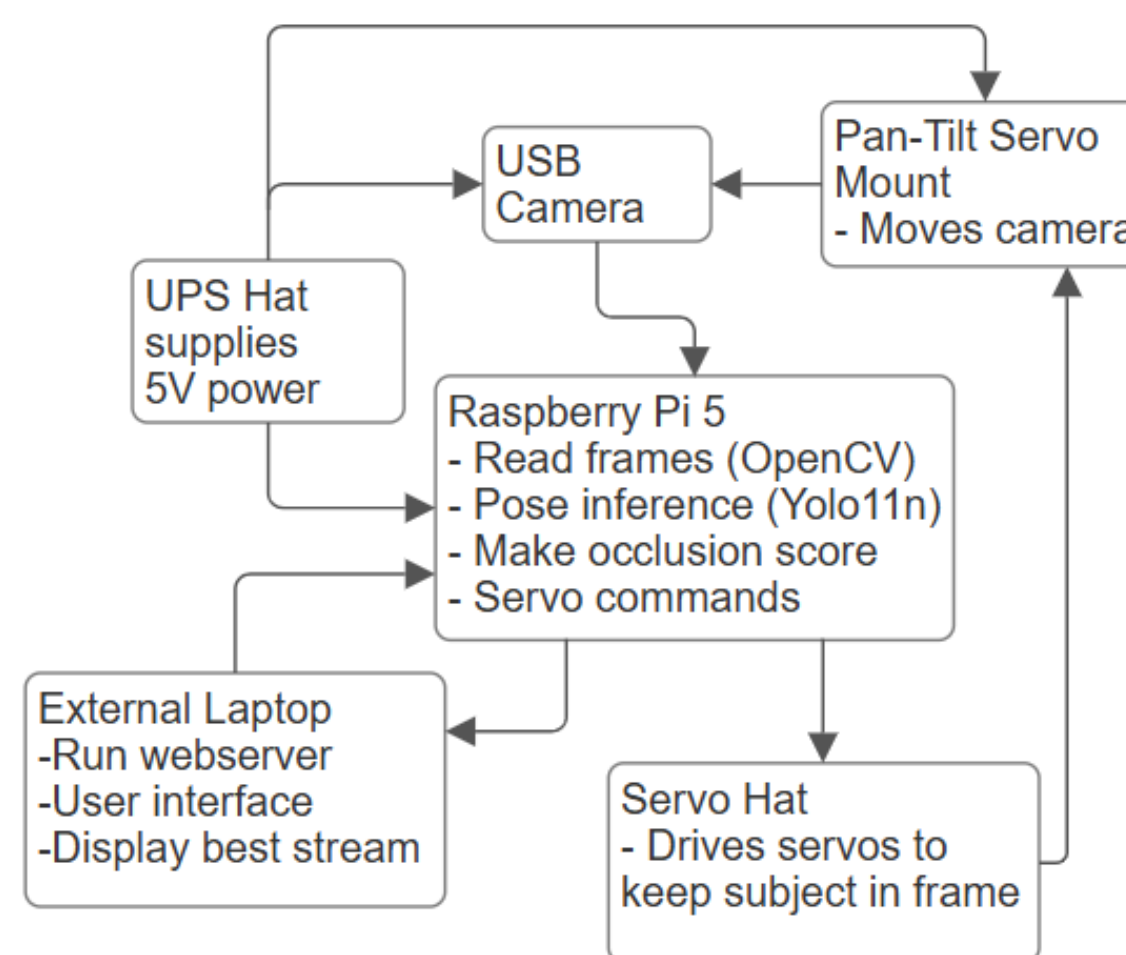


Figure 4: Block diagram of one camera node

COST ESTIMATION

MODULE	Total Cost (USD)
Core Controllers	\$240
Sensors	\$180
Electronics	\$252
Mechanical Components	\$258
Power System	\$235
Storage	\$39
Accessories	\$39
Total Estimated Cost	\$1243

Note: This total includes spare parts and extra items from a flexible budget, supporting the prototyping needed for a high-quality final design.

EMBODIMENT

The system consists of three autonomous nodes, each camera unit includes a Raspberry Pi 5, USB camera, PCA9685 PWM servo driver, and a 2-DOF pan-tilt mechanism powered by MG995 servos. A UPS HAT with dual 18650 batteries provides portable power. The hardware is designed for efficient thermal management, stable power delivery, and compact deployment in gym environments.

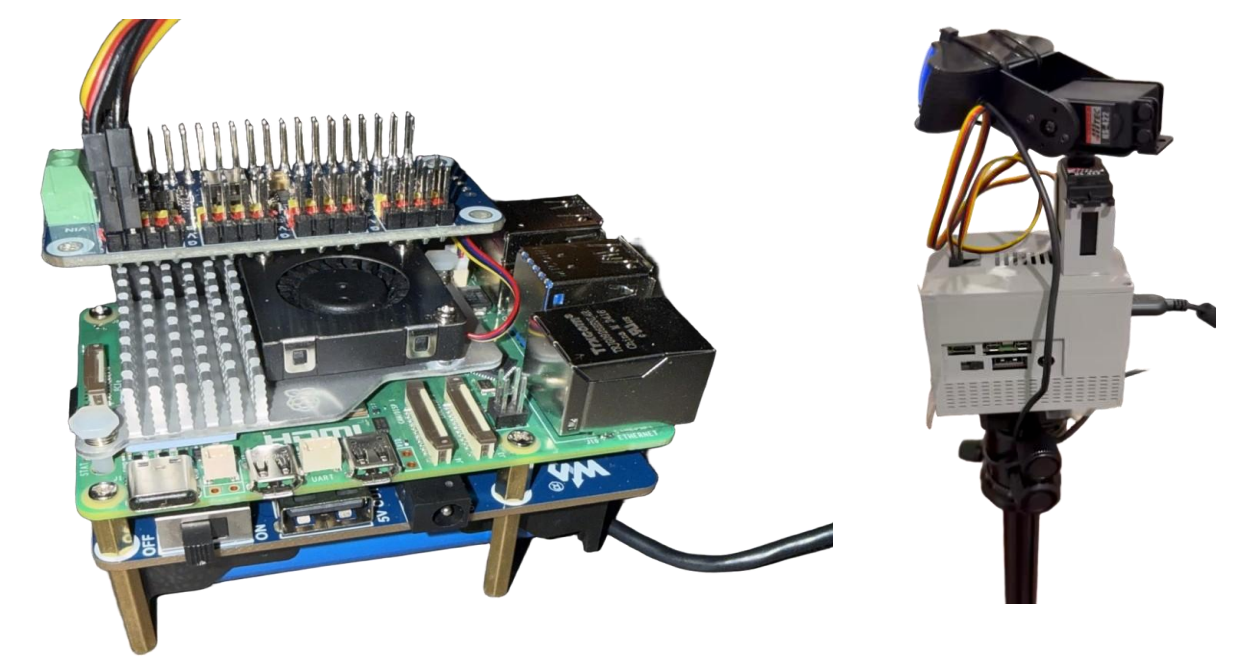


Figure 5: Pictured is the internals of one node (left) and the case and pan-tilt camera (right)

DATA FLOW & CONTROL

Video frames and control data are transmitted wirelessly via a Flask and Socket.IO framework to a central server. This hub manages real-time synchronization, recording, and playback across all camera feeds simultaneously. The web dashboard provides a unified interface for live visualization, allowing users to remotely monitor the system, adjust tracking parameters, and record.

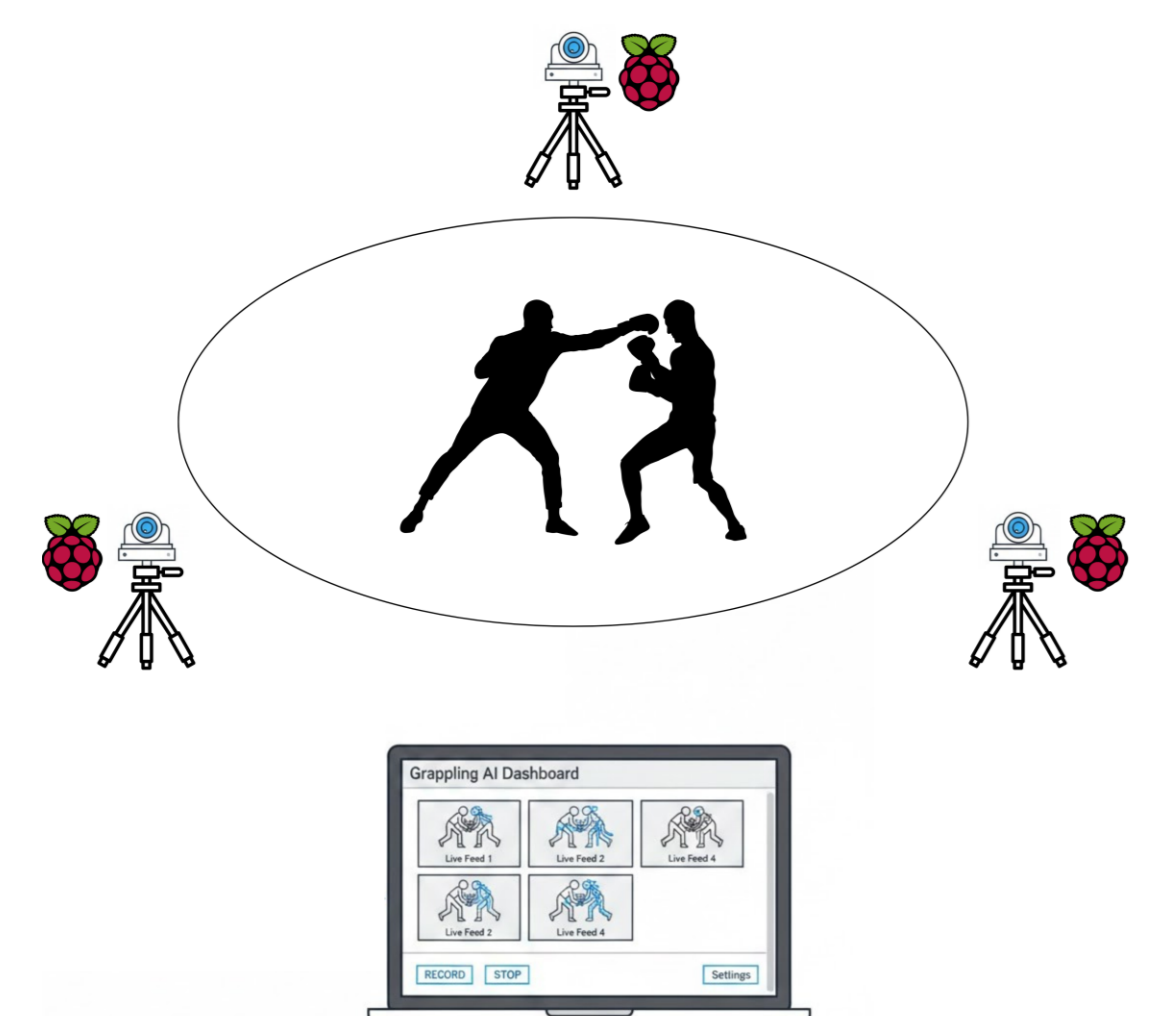


Figure 6: Visual representation of overall system with three nodes

CONCLUSION/ACKNOWLEDGEMENT

In this project, we developed a portable, embedded vision-based camera tracking system capable of real-time pose estimation and automated tracking, providing a cost-effective solution for capturing high-quality footage in dynamic environments. We would like to extend a massive thank you to Dr. Hooker for instruction, Dr. Roberts for advising, Dr. Chuy for review and feedback, Dr. Noroozi for support, and the FSU Brazilian Jiu-Jitsu Club for assisting with system testing. Without their assistance this project would not be possible.