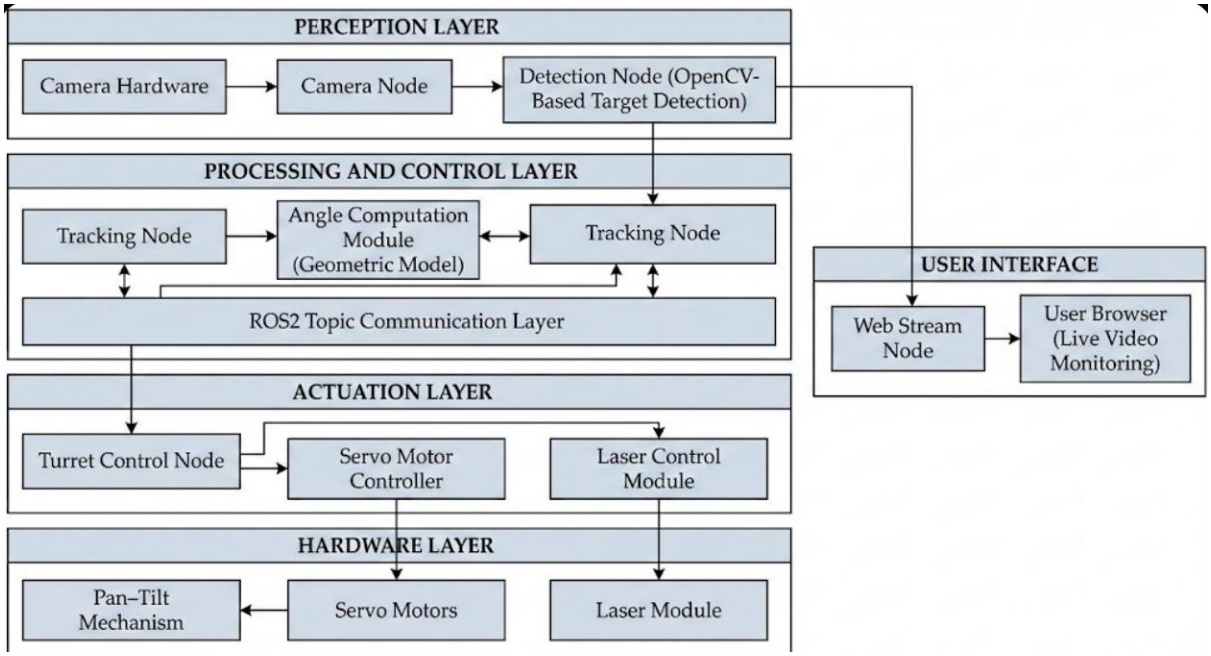
Auto Aim Laser Turret

Group Number: 06

System Architecture



Explanation of Components:

The system architecture is organized into multiple layers, where each component performs a specific function and contributes to the overall operation of the automated turret system. The components are described below according to their respective layers.

1. Perception Layer

The perception layer is responsible for acquiring visual data from the environment and detecting the target. It consists of the camera hardware, camera node, and detection node. The camera hardware captures live video frames, which are published by the camera node as raw image data. The detection node processes these images using OpenCV-based computer vision techniques to identify the target. Once detected, the target's position and annotated image are generated and forwarded to the next layer for further processing.

2. Processing and Control Layer

The processing and control layer handles decision-making and motion planning for the turret. It receives target coordinates from the perception layer and computes the required pan and tilt angles using geometric and trigonometric models. The tracking logic ensures smooth and stable movement by continuously updating angle commands and handling target loss conditions. This layer acts as the core intelligence of the system, converting perception data into actionable control commands.

3. ROS2 Topic Communication Layer

This layer enables communication between all software components using ROS2 topics. Nodes exchange image data, target coordinates, angle commands, and status information through publisher-subscriber mechanisms. By using only topic-based communication, the system maintains loose coupling between components and supports real-time data flow without blocking operations.

4. Actuation Layer

The actuation layer is responsible for converting control commands into physical movement. It includes the turret control node, PWM/GPIO interface, and control logic for the servo motors and laser module. The turret control node subscribes to the computed pan and tilt angles and generates appropriate PWM signals to drive the servo motors. It also controls the laser module based on tracking status. Here we used Bread board and jumper wires to achieve.

5. Hardware Layer

The hardware layer contains all physical components of the system. This includes the pan–tilt mechanism, servo motors, and laser module. The pan–tilt mechanism provides two degrees of freedom, allowing the turret to rotate horizontally and vertically. Servo motors execute precise angular movements based on PWM signals, while the laser module visually indicates target alignment.

6. User Interface Layer

The user interface layer provides real-time visualization and monitoring of the system. The web stream node subscribes to annotated images and streams live video over HTTP. This stream is displayed in a user browser, allowing observers to monitor detection and tracking performance without affecting the control pipeline.