



## Introduction

**Project Goal:** To design and build an autonomous race car that uses optical sensing to follow a preset course in the shortest possible time.

The project is separated into three parts:

1. Programming the OpenMV M7, a microcontroller camera, so our car follows the track, turns, and changes speed as necessary.
2. Designing a PCB that contains all components to process the signals from our microcontroller. Our circuit board needs to take signals from the OpenMV and use them to control the car's speed and steering.
3. Assemble an RC Car Kit, modify it to support our custom PCB and microcontroller for autonomous racing. We needed to design a custom adjustable camera holder to find the optimum camera height and angle.

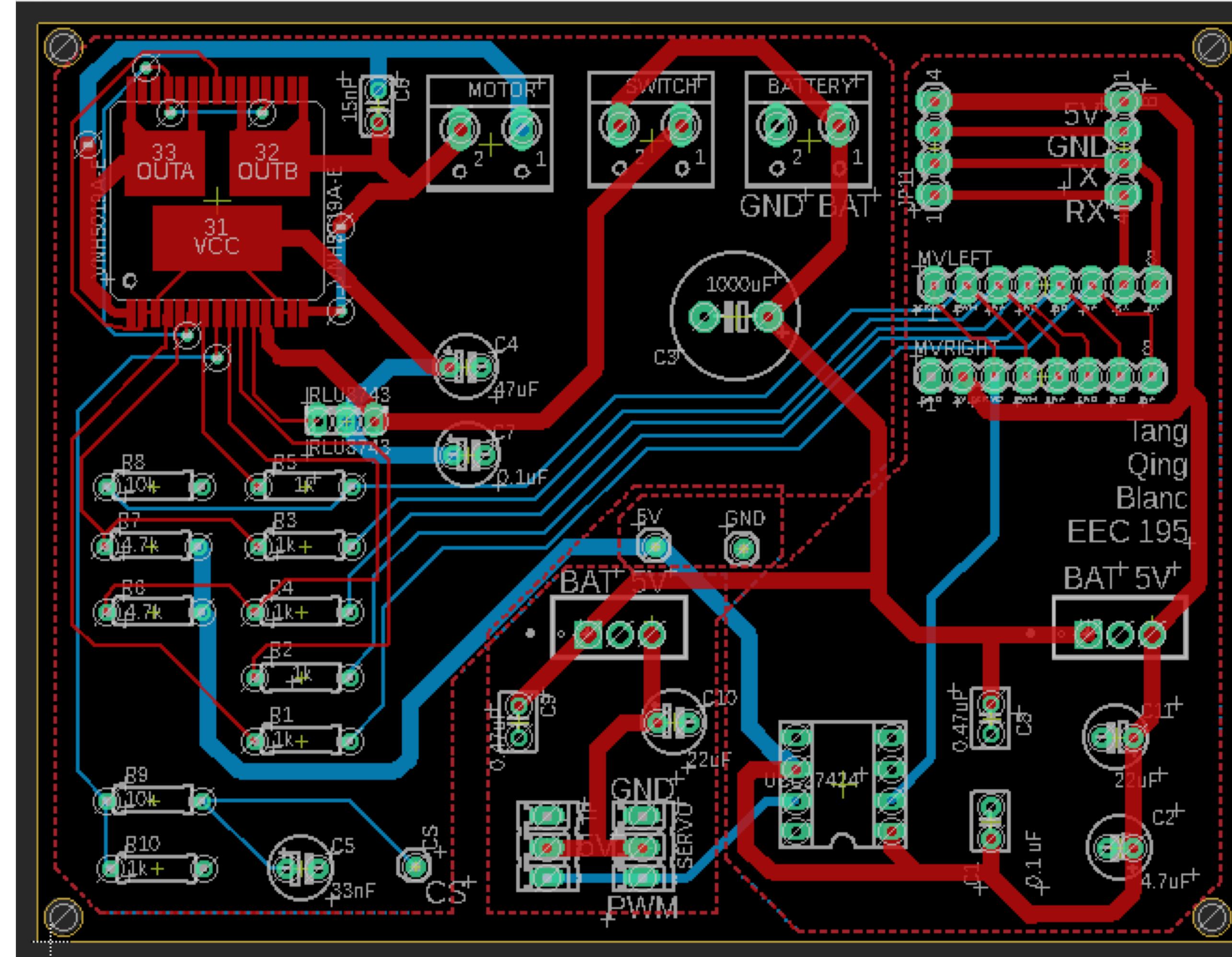
## Design Selection

**Camera Type:** OpenMV Cam M7

**Motor:** Crawler Motor by RC4WD

**Battery:** Traxxas Power Cell, 1200mAh NiMH 6-cell

## PCB Board View



Designed in EAGLE

## Programming Process

- One blob detection: Accuracy trade for fps
- Stop line detection: Three blobs in the roi, and each of them had width smaller than 15 pixels (not crossover)
- Oscillation: PD Control; Deadband; Nearby Error Approximation
- Drifting: Straight Counter; Turn Counter; Drift Wait

## PCB Design

- Components: Spaced for Replacement
- Motor Control Chip: VNH5019A-E (surface mount)
- 2-layer board
- Star Ground: 3 ground pours
- Traces: Up to 50mil for the source current; up to 10mil for the signal current

## Car Mounting

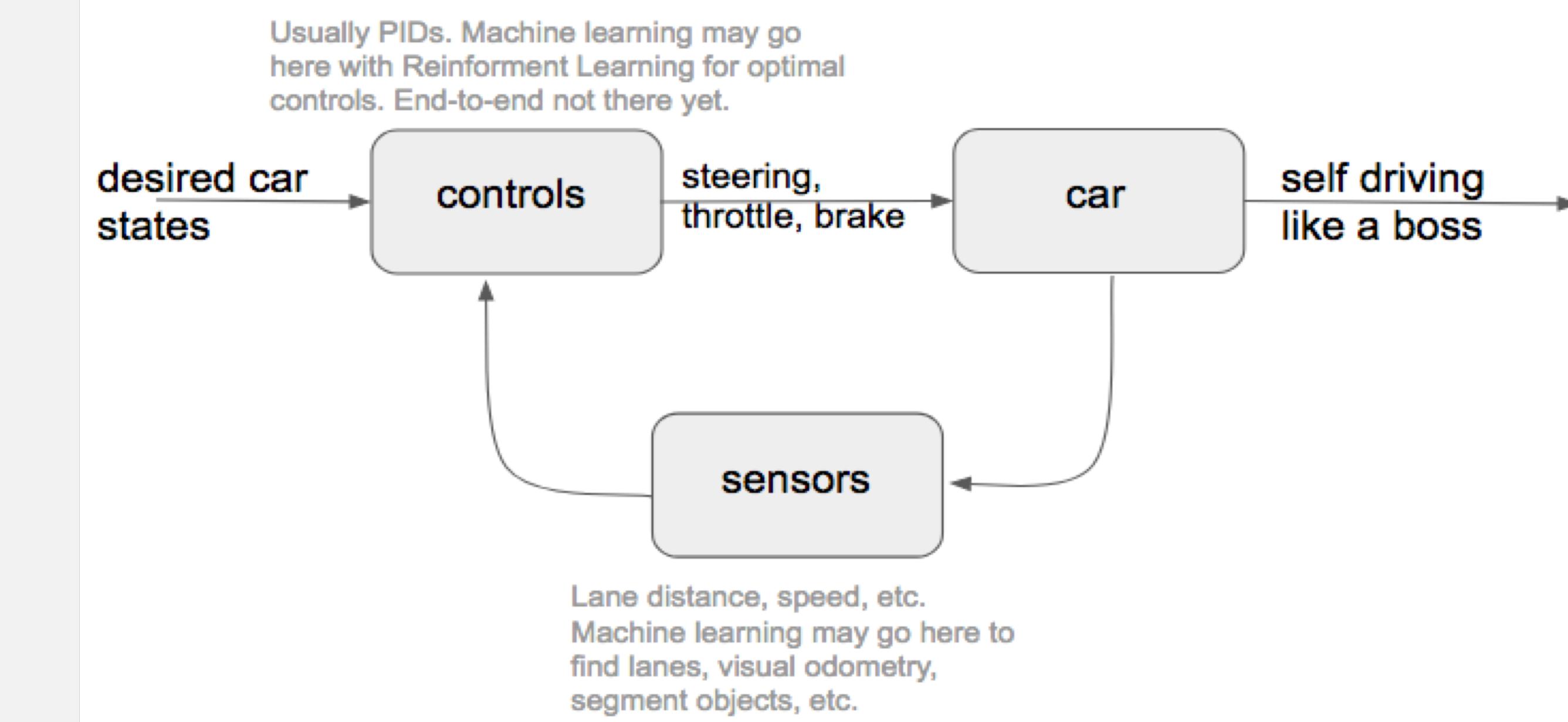
- Two separate platforms
- Stability vs. Weight
- Selfie stick and 3D-printing camera holder
- Wooden dowels support
- Laser cut speed sensor wheel



## Wireless Control

- Safety: Emergency Off
- Tuning: Adjust PID control while testing; Speed up or Slow down at turn
- Real-Time Feedback: Monitor the program running process

## Control Operations



## PID Steering Control

Only PD Control is used in this project.  
The equation will be:

$$\text{Current Error} = E(n)$$

$$P \text{ term} = K_p * E(n)$$

$$D \text{ term} = K_d * (E(n) - E(n-3)) + 3E(n-1) - 3E(n-2))$$

## Final Product

