Autonomous Baseball Retriever

Controllers
UCSB ME153 – Spring 2025

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Introduction

After a batting practice, baseballs are often scattered across the field and collecting them manually is time-consuming and tedious. This project automates the retrieval process with an autonomous rover capable of detecting, approaching and collecting baseballs.

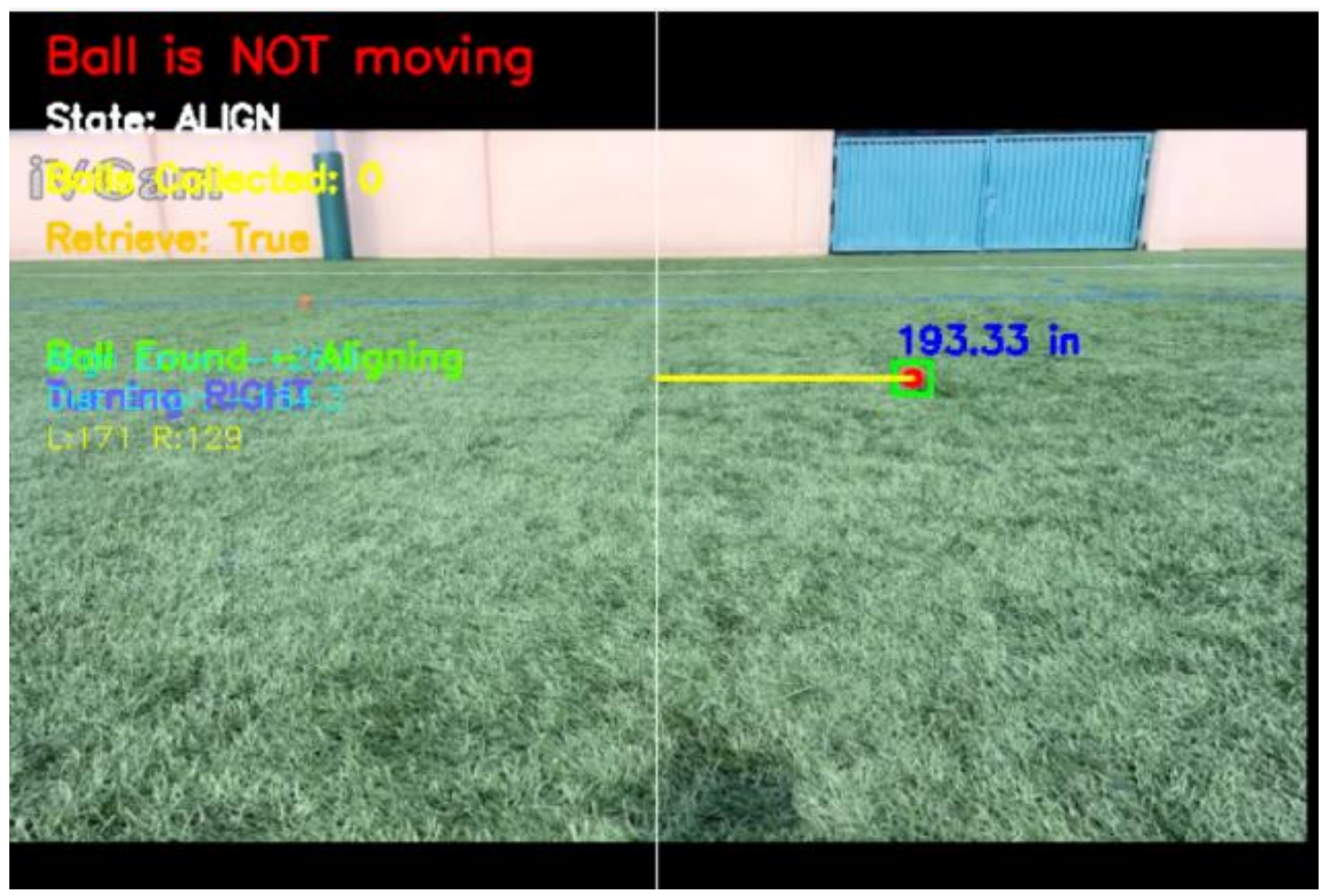

Figure 1. Live video feed with baseball detected

OpenCV and Baseball Detection

To process the high-resolution iPhone video feed, we used Open-Source Computer Vision (OpenCV) to detect baseballs in each frame. To improve accuracy, we spray-painted the baseballs orange, allowing color masking to isolate them from the background. Once detected, simple distance calculations estimated their position relative to the rover, enabling precise retrieval control.

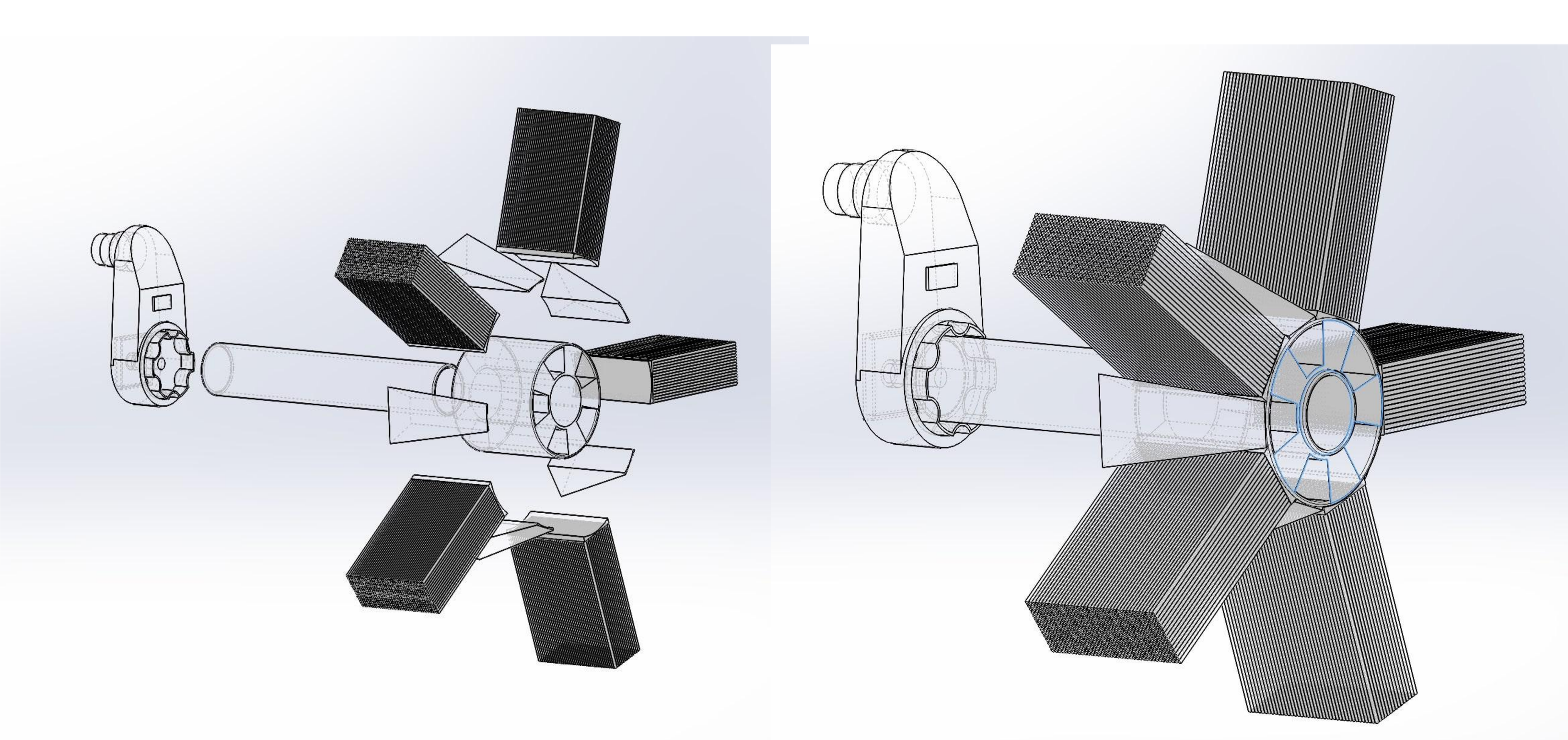

Figure 2. Visualization of Pick-Up Mechanism

Figure 3. Final Prototype of Autonomous Baseball Retriever

Autonomous Retrieval Process

Our rover uses an iPhone camera to capture the field, with real-time processing in Python and Arduino to control movement. The system begins in standby mode, scanning for baseballs. When a stationary ball is detected, it transitions to align mode, using a proportional controller to center the ball. The rover then advances towards the ball while a motorized broom mechanism deposits it into the rover for storage. After each pickup, it rotates to search for additional balls. Once a set number of baseballs are collected, the rover autonomously returns to its home location.

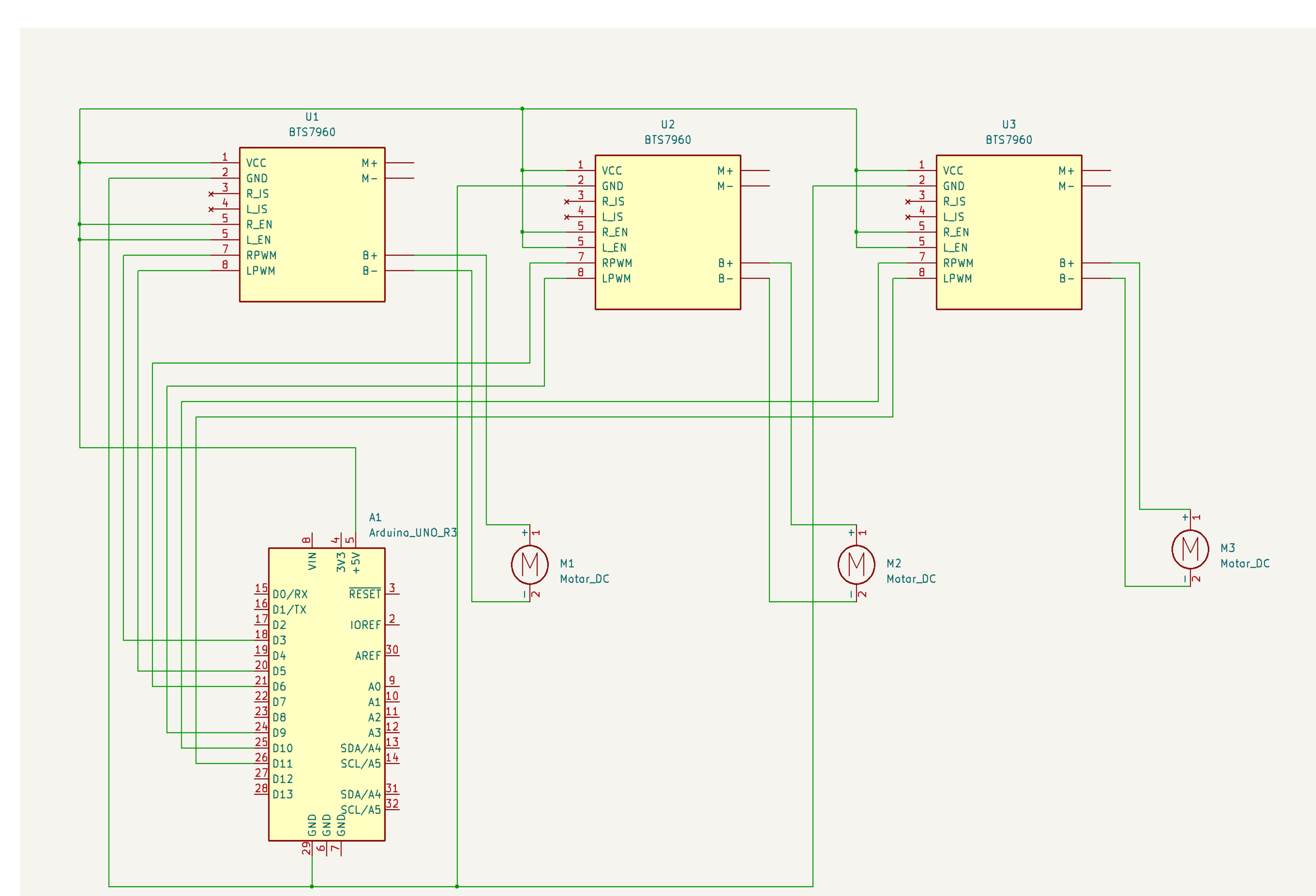

Figure 4. Circuit Diagram for Rover Electronic System

Adapting Control to Surface Conditions

To navigate toward an off-center baseball, our rover adjusts its orientation by turning, using a proportional controller to modulate the relative speeds of the motors. However, because different surfaces have varying effective coefficients of friction, the rover must adapt its response to maintain control. In extreme cases—such as concrete, turf, and grass—the system's behavior noticeably differs, highlighting how surface conditions impact control dynamics which necessitates gain adjustments to ensure consistent performance.

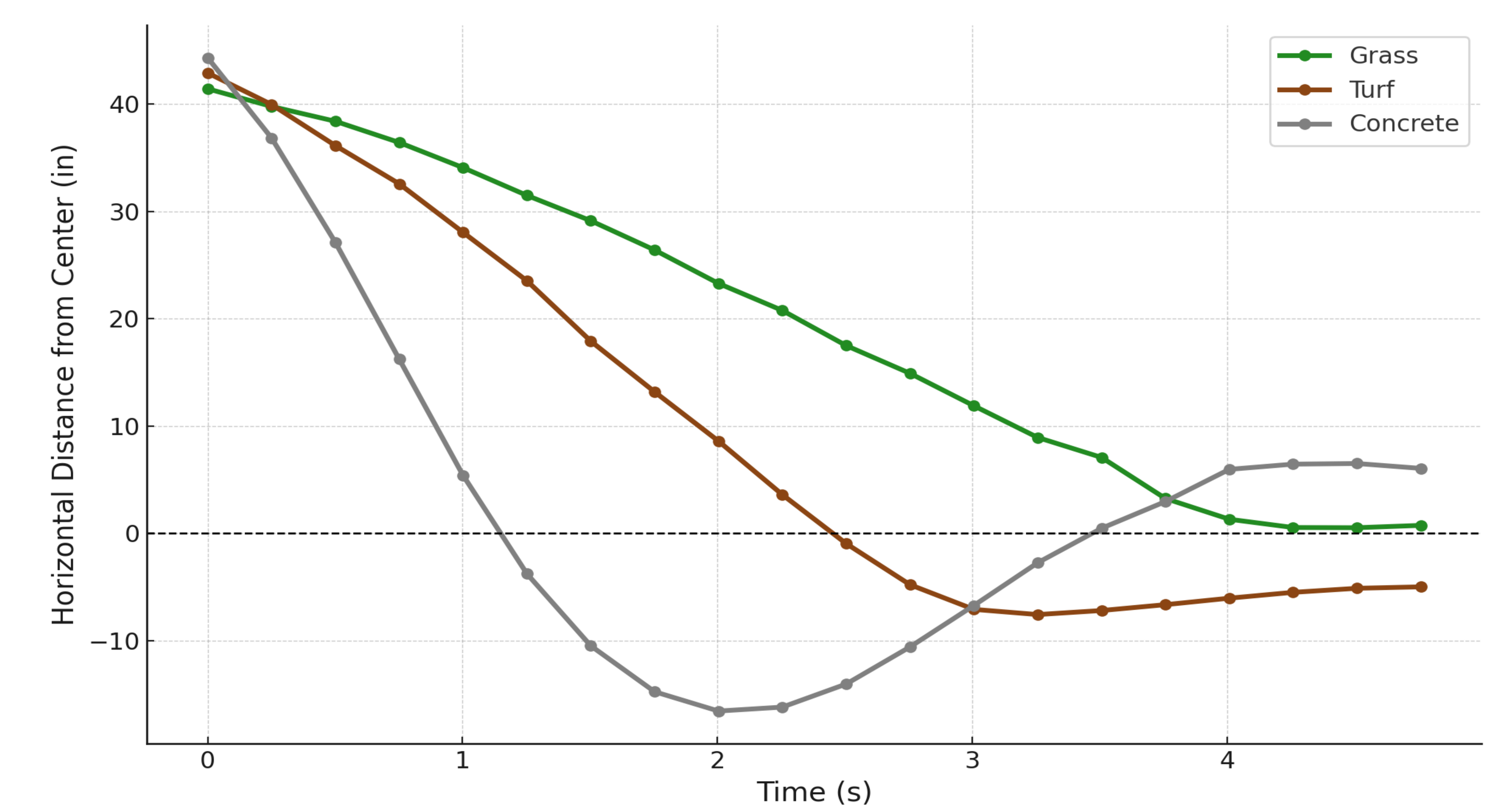

Figure 5. System Response to Varying Surfaces

Project Potential and Future Vision

This project demonstrates strong functionality given limited resources. With additional support, the rover would first be upgraded mechanically, focusing on a more robust ball collection mechanism. A self-tuning control algorithm would be implemented to adjust for varying surface conditions. A convolutional neural network (CNN) would be integrated to improve white baseball detection and tracking. This system has the potential to be a perfect automated training tool for youth baseball skill development.

Acknowledgments

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References

Bradski, G. "The OpenCV Library." Dr. Dobb's Journal of Software Tools, 2000.