# Strike Zone 2.0

## ECE 445 : Project Proposal

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# 1. Introduction

## 1.1 Objective

Baseball is so popular among the people of the United States that it is affectionately known as America's pastime. For this reason, it is unsurprising that over one-fifth of adults ages 18- 29  play the sport [1]. This heavy interest in the sport has propped up a large industry in the professional and amature aspects through ticket sales, training, and of course various types of equipment. Engaging in the sport necessitates practicing when possible to improve one's abilities so that the team might have a greater chance of winning. When possible one can practice batting, catching, and pitching with a team or other individuals, but if other people are unavailable one is forced to turn to the use of training equipment. However, training equipment, particularly for pitchers, lacks the type of feedback that training with another individual can provide and is often inconvenient as the baseball once thrown or hit is not returned to the user.

Our goal is to make pitching practice for amature and hobbyist baseball players as beneficial and convenient as possible. Rather than develop a large expensive system that can evaluate a player at a professional level, we will bring to them a system that provides only the essential feedback on their pitching while making ball retrieval as simple as playing catch with another person. This system will use IR sensors to provide feedback on pitching speed and accuracy and return the ball to the pitcher making solo practice informative and easy.

## 1.2 Background

While there are a lot of tools available to pitchers and baseball players alike, none of these options offer the same level of both convenience and training feedback. The two most common receiving tools for pitchers to use when it comes to training, excluding a catcher and coach, are strike zone nets and ball rebounders. The former is a simple and effective way for the pitcher to practice by pitching into a strike zone where a netting collects the ball. However, this requires a bucket of balls, which are expensive if of quality, and does not give much feedback other than location of pitch which can just be the broad area of the strike zone unless it is split up into zones. The latter, ball rebounders, has been found to be extremely unreliable in terms of getting the ball back to the user for pitching and tend to break due to the strain put on the springs or bands unless you are willing to pay a lot of money. Also, since the ball is returning so quick it is not conducive to pitchers for the sole purpose of pitching and is a better tool for fielding practice.

The Strike Zone 2.0 is offering the same convenience as an actual catcher with even more feedback. For example, the ball will not only be returned, major

disadvantage of a normal strike zone net, but will also be able track balls and strikes for the user, as in a baseball situation, and collect and display data such as your speed and zone location, split into nine zones. It is important to note that we are also adding the feedback of speed as well since radar guns are also an important and common tool used for pitchers to train; nevertheless, this also requires an additional person to be able to track speeds unless the system is autonomous. Now, if a pitcher is alone but wants to practice, he would simply need a ball, a mit, and an outlet without the hassle of a bucket of balls and the forever reluctance that all baseball players have of going to fill the bucket back up again. This design combines all important elements and feedback that a pitcher would want for effective and efficient training in one device.

### 1.3 High Level Requirements

- Returns the ball to the user after hitting the strike zone pitching trainer
- Tracks and displays pitching speed
- Detects when and where a ball hits within the strike zone

# 2. Design

The training system requires 4 subsystems for successful operation: Power Supply, Control/Interface, Sensors, and Mechanical. The power supply ensures that each of the other subsystems receives the correct power throughout the duration of use. Control/Interface contains several components which discerns information from sensor readings and allow the user to see the information they desire displayed in an easy and convenient manner. Sensors handle the measuring of ball strike location and speed and pass those measurements to the Control/interface block. Lastly, the mechanical subsystem handles the returning of the ball to the user.

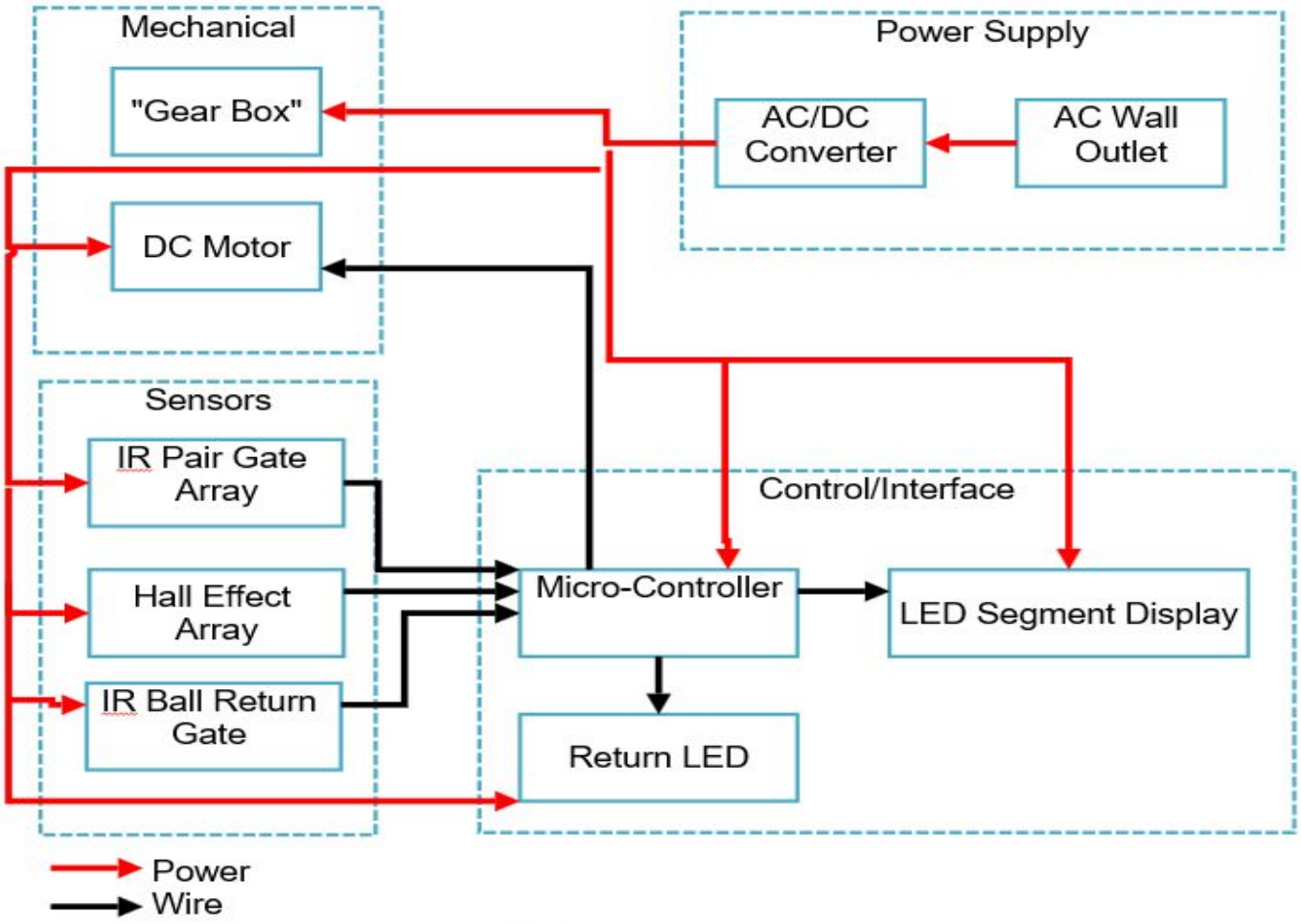


*Figure 1. Block Diagram*

## 2.1 Power Supply

A power supply is required to power the various sensors and components of the system. Power from a wall outlet will be converted to DC, routed, and stepped up/down as needed by the subsystems.

### 2.1.1 AC/DC Converter

Convert standard wall power from AC to DC to provide continuous power to subsystems.

*Requirement 1: Convert the 110 VAC from the wall outlet to required DC voltage.*

## 2.2 Control/Interface

Manages sensor output conversion and displays relevant data through an LED display to the user.

### 2.2.1 Micro-controller

The microcontroller handles sensor output processing and data display. It will take serial input from the IR gate pairs to discern ball position and speed as it enters the strike zone. The microcontroller also handles ball return detection to signal the return system should be activated and notifies the user of an impending return.

*Requirement 1: Handle multiple serial input from the IR gate pairs to determine ball speed.*
*Requirement 2: Can turn on ball return system*
*Requirement 3: Can output data for display on the LED Segment display*

### 2.2.2 Return LED

Notify the user that a ball is being returned

*Requirement: Turn on when a ball is going to be returned and stay off at all other times*

### 2.2.3 LED Segment Display

Primary source of feedback for the user. Used to display Speed, Top Speed, Ball, Strikes, Outs and other data as desired by the user.

*Requirement 1: Display output received from microprocessor*
*Requirement 2: Three 7-segment LED displays to display ball speeds*
*Requirement 3: Large enough to be seen from a distance of about 60 ft.*

## 2.3 Sensors

### 2.3.1 IR Gate Pair Array

IR receiver and emitter pairs used to detect an object passing between them such that the distance between the gates can be divided by the time it took for the object to pass between them, providing a speed.

*Requirement 1: Able to detect an object passing between the gate pairs*

### 2.3.2 Hall Effect Array

A 3x3 array used to detect where the ball struck in the strike zone. This will be accomplished with the use of hall effect sensors mounted behind plates attached to springs. In this way, a ball striking the plate will cause motion which the hall effect sensor can pick up from magnets attached to the plates.

*Requirement 1: Output a voltage higher than a designated threshold such that the position of the ball can be determined to within a distance of one baseball radius.*
*Requirement 2: Springs and 3-9.5 lbs of force.*

### 2.3.3 IR Ball Return Gate

IR receiver and emitter pair used to detect when the ball has been launched, allowing the motor to be powered down.

*Requirement 1: Able to detect a ball passing between the the IR beam and the sensor.*

## 2.4 Mechanical

### 2.4.1 “Gear Box”

This is the mechanism to direct the ball to the user, resembling a ramp or chute in design.

*Requirement 1: Direct the ball after it has been launched by the motor such that it lands near the user.*

### 2.4.2 DC Motor

Primary source of torque and momentum for the ball to be launched back to the user. This motor will need to satisfy certain minimum requirements for being capable of launching the ball the requisite 60 feet from machine to user, as well as consuming minimal power.

*Requirement 1: Minimum rated speed of 1000 RPM*
*Requirement 2: Minimum rated torque of 10Nm*
*Requirement 3: Maximum power draw of 1600 W (assuming wall outlet at 110 V, 15 Amps)*

## 2.5 Risk Analysis

The microcontroller poses several challenges to the successful completion of this project. The microcontroller is central to the project as it does all calculations based on measurements taken from the sensor block and handles the display peripherals and the powering of the mechanical system. So if this should fail, all other subsystems would be rendered inoperable. The first challenge the microcontroller poses is in its development. It will be custom made so that it is able to interface with the other subsystems in the various ways that are required. This flexibility poses difficulties as each subsystem requires that the microcontroller be able to do calculations quickly and output to a display or as an electrical signal to a switch or other component. Care must be taken during the PCB design stage of the microcontroller in order to ensure that the desired functionality can be met using a well organized layout. Additionally, defects in design and manufacture are obstacles in the functionality of the microcontroller. These challenges can be mitigated in part by properly testing the functionality of the design prior to having it manufactured. Repeat testing once the microcontroller is manufactured will ensure that the microcontroller can do what is desired and that no defects are present. Once the microcontroller is designed and manufactured, precautions must be taken when integrating the controller with the other subsystems in order to prevent the microcontroller from being damaged due to power surges or the load being placed on it by the various components it is interfacing with.

# 3. Safety and Ethics

Due to the fact that our device is launching a projectile back at you, there are many safety precautions that must be taken before use. First off, we are designing the return in such a way where the ball is not returned at high speeds, and those using this machine should be prepared and able to catch the ball with a baseball glove. Additionally, we are further warning the user that the ball is being launched through the use of an LED warning light that will switch on when the return mechanism is ready to throw back the ball. We do not intend on having an individual being hurt by the return system as that is in direct violation of #9 of IEEE Code of Ethics [2].

Along with the return system, we have to make certain that we do not want to overload the motor or get too close to the rated current and voltage of the specific motor. Since the return system is close to the net, we do not want the motor to overheat such that the netting catches on fire. To avoid this, we will stay well within rated currents and voltages and connect the return system in a way that it is not touching the net. This is more attainable due to the fact that we are not covering a wide range of loads being put on the motor since we are only using baseballs. Additionally, to assure that the motor does not overheat and cause further damage, the motor will only be turned on

and accept a baseball after a ball has entered the net and is in position to be launched back.

Another factor that must be taken into place is that this mechanism can be used outdoors. In order to avoid any possible short-circuiting, we will advise that the device is not to be used in the rain and must be stored inside.

In order to adhere by #3 of the IEEE Code of Ethics, we will report our expected range of error as well as note that the motor may undergo wear and tear through use over time and will eventually need maintenance [2].

We are fully aligning our design with the desire “to assist colleagues and co-workers in their professional development and to support them in following this code of ethics”, #10 of the IEEE Code of Ethics [2]. Even though the device has safety concerns, it is certain to assist in the training and development of amatuer pitchers, and the progress and gain to be made is well worth the safety precautions that must be taken.

REFERENCES

[1] Statista, “Share of People Who Play Baseball Regularly in the U.S. 2018, by Age | Statistic.”, 2018.[Online].Available:www.statista.com/statistics/227429/number-of-softball-players-and-baseball-players-usa/. [Accessed: 19-Sep-2018]

[2] Ieee.org, "IEEE IEEE Code of Ethics", 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 29- Feb- 2016].