Smart Ball Launcher

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Kellogg Honors College Capstone Project

Abstract

In sports, hand-eye coordination is controlled by our body's feedback systems. Our hands, and body, move in response to the visual stimuli received by our eyes and processed by our brain. The goal of this project is to simulate the lead pass play using an open-loop control system. The lead pass play consists of Player One, the passer, analyzing the current position and speed of Player Two, the runner, and anticipating where he/she will be when the ball is to be received and passing accordingly. The machine is designed and constructed to act as Player One, identifying the velocity of an individual (Player Two) moving in a straight line at constant speed and ejecting ("passing") the ball at the appropriate time and trajectory. The system's input is the recorded Player Two velocity which provides feedback to the control system. The Arduino-based control system utilizes passive infrared (PIR) sensors to determine the velocity which is then used to calculate when the stepper motor is to release the ball through the launcher which is powered by two DC motors.

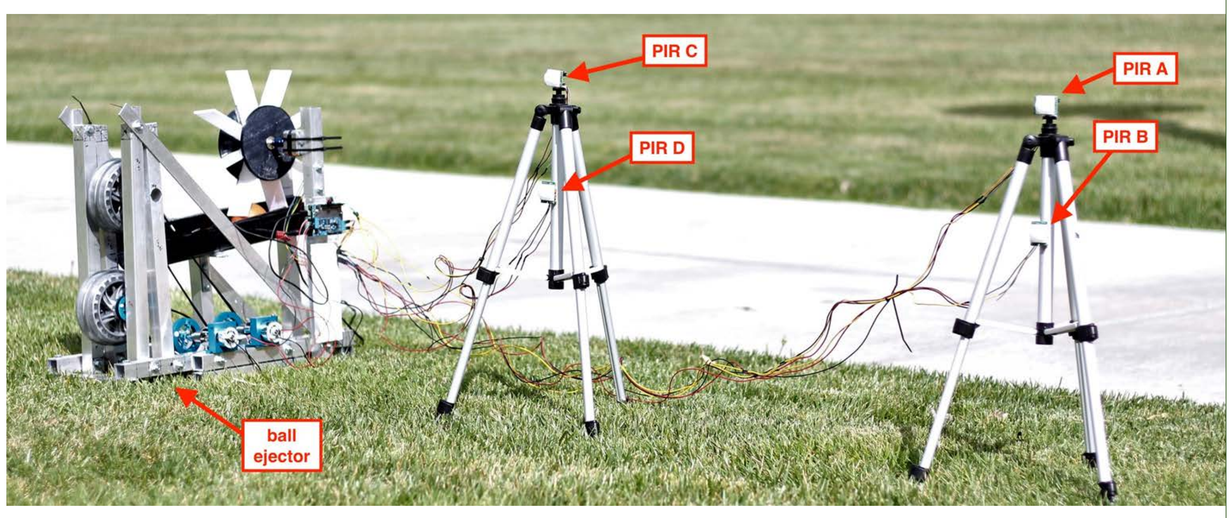

Figure 1:Project Set-Up

Control System

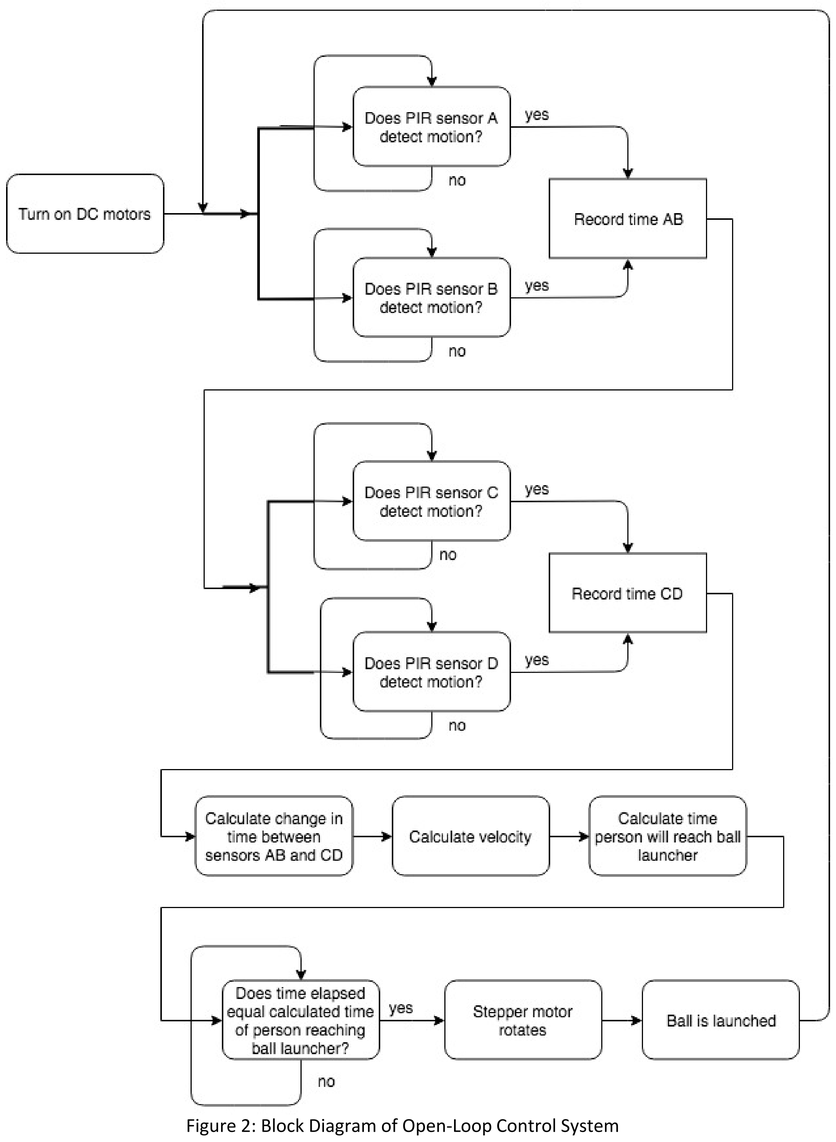

Figure 2: Block Diagram of Open-Loop Control System

Sensors

Each tripod has two sensors as seen in Fig. 1, and the two tripods are placed at a known distance from one another. Since position is the derivative of velocity, the person's position must be known in order to determine the velocity. PIR ("passive infrared", "pyroelectric", or "IR motion") sensors (Fig. 3) sense motion by detecting levels of infrared radiation. Two sensors are mounted on a tripod at varying heights to ensure that the motion detected is a human by filtering out motion detected by only one of the sensors that may be wind or animals passing (Fig. 2). When a human enters the sensor's range it intercepts one half of the PIR sensor, generating a positive differential change between the two sides of the sensor and when the human exits the sensor's range a negative differential change is generated. The sets of sensors are positioned at a distance so that PIR A and PIR B's range does not overlap with PIR C and PIR D's range.

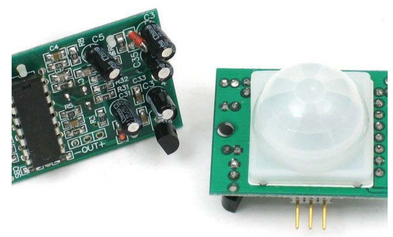

Figure 3: PIR sensors

Mechanical Design and Build

As seen in Fig. 4, the mechanical design of the ball launcher was modeled after baseball pitchers, utilizing 2 wheels rotating at high speed to eject the ball. The frame of the ball launcher was built from 1"x1" aluminum square tubing for stability and support of the components. The roller hockey ball is placed on a chute and released through the launcher by a 3D printed wheel powered by a NEMA 17 stepper motor for position control. At the end of the chute, the ball passes through two vertically aligned polyurethane wheels. Polyurethane is a tough and abrasion resistant material with a relatively high coefficient of friction, good for ejecting the ball. The sets of wheels are at different levels to eject the ball angled upward, creating a projectile. They rotate about a shaft, utilizing 608-Z deep groove ball bearings, which can operate at high speeds and carry both radial and axial loads. The wheels are powered by two 24V high speed DC motors, connected by a timing belt.The entire system is utilizes an Arduino UNO with an Adafruit motor shield V2, powered by a wall outlet and using a 12V power adapter.

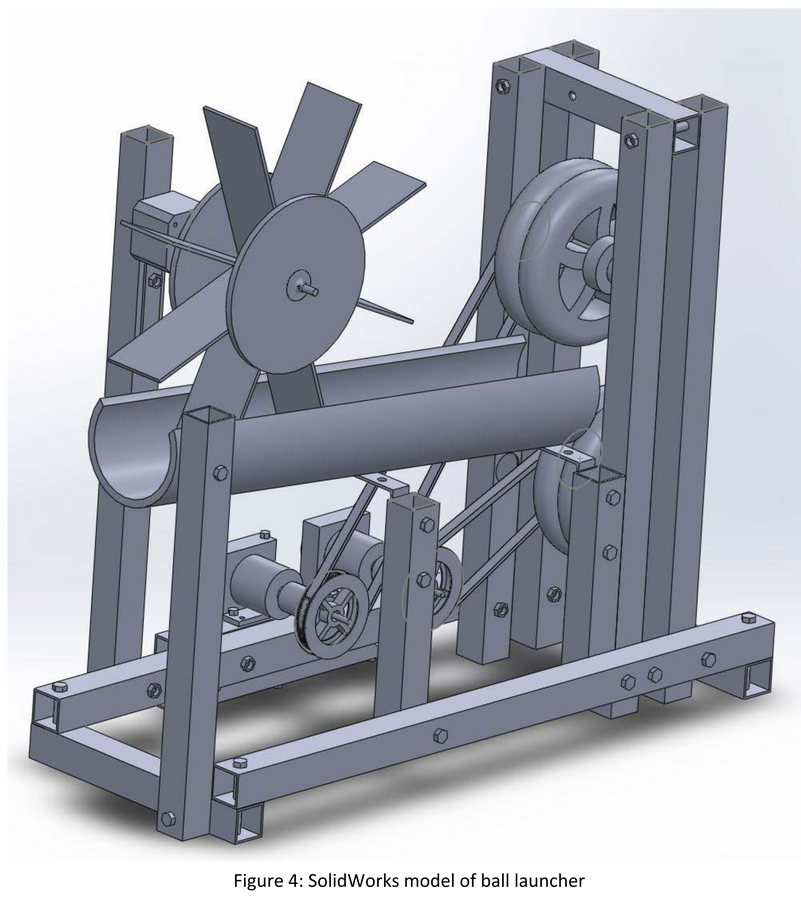

Figure 4: SolidWorks model of ball launcher

Conclusion and Future Work

The smart ball launcher accurately senses the motion of the person passing by and calculates the approximate time the person will approach the ball launcher. However, the system makes the assumptions that the person to moving in a straight line at constant speed. These assumptions limit the system's usability and accuracy. Future work and further iterations of this project will include using long-range distance sensors to determine the how far the person is from each of the sensors, accounting for angled runs. To further optimize the system, the two DC motors could powered with 24 volts instead of 12 volts to increase the distance the ball is ejected, the motors and sensors could be powered by a battery rather than a wall outlet to make the system easily transportable, a bluetooth connection could be utilized to communicate between the sets of PIR sensors and the stepper motor ejecting the ball, and a Fitbit could possibly be integrated to continually acquire the person's position and speed. These would make the smart ball launcher easier to use and potentially more accurate.