Mid-Year Design Review

Team 1 (AutoUmp)

December 9th, 2016

The Team

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EE

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EE

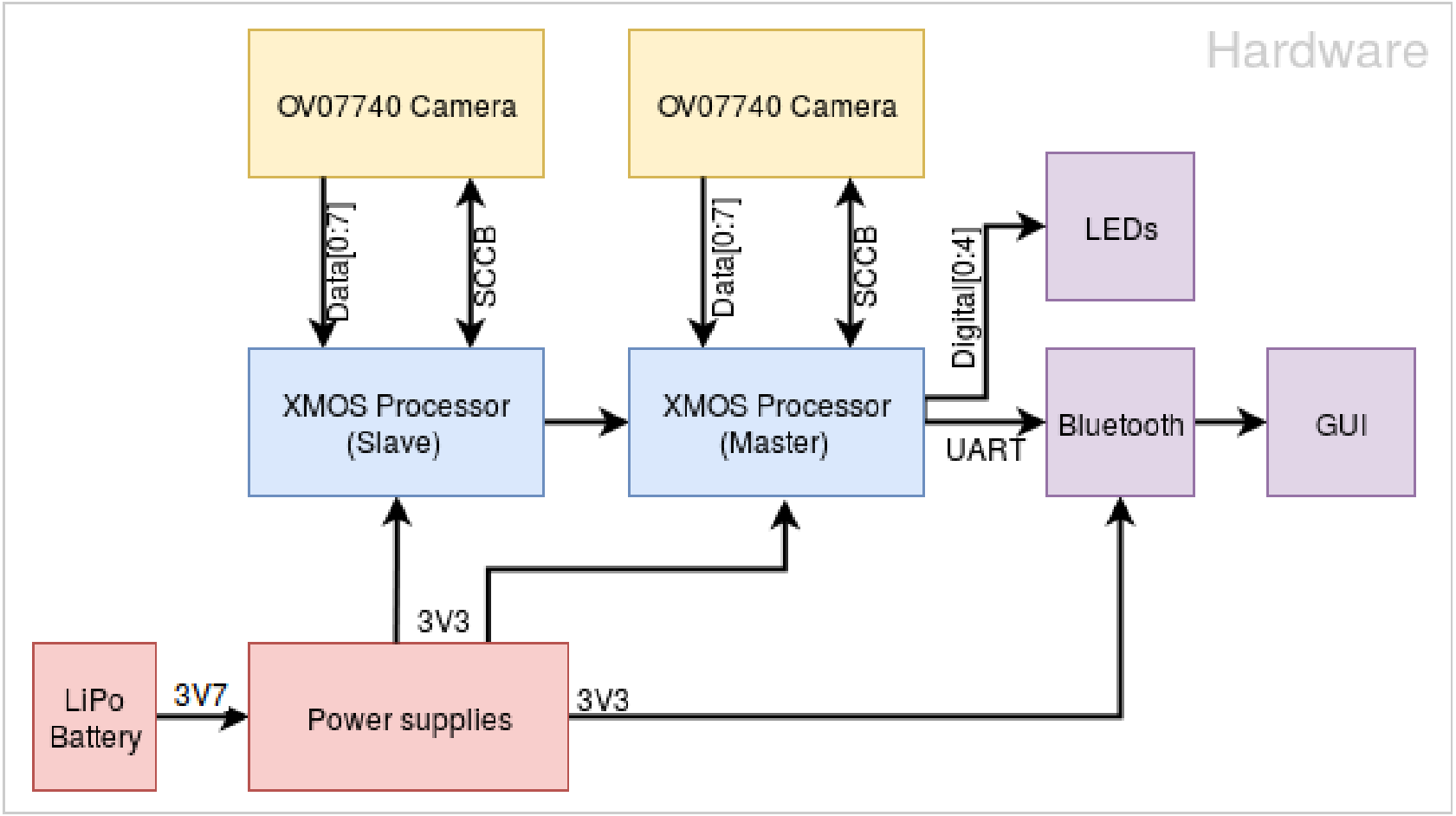
The Problem

- Determining strikes and balls without a professional umpire is difficult and inaccurate
- Current technology solutions are expensive and require extensive set-up
- Incorrectly called pitches lead to angry players

The Solution

- Use a stereo camera and image processing system built into the home plate to determine the baseball's location
- Challenges:
  - Time restrictions for bulk of image processing (16.2ms)
  - High accuracy required for successful use (~95%)
  - Ball detection vs. object detection (e.g. bat)

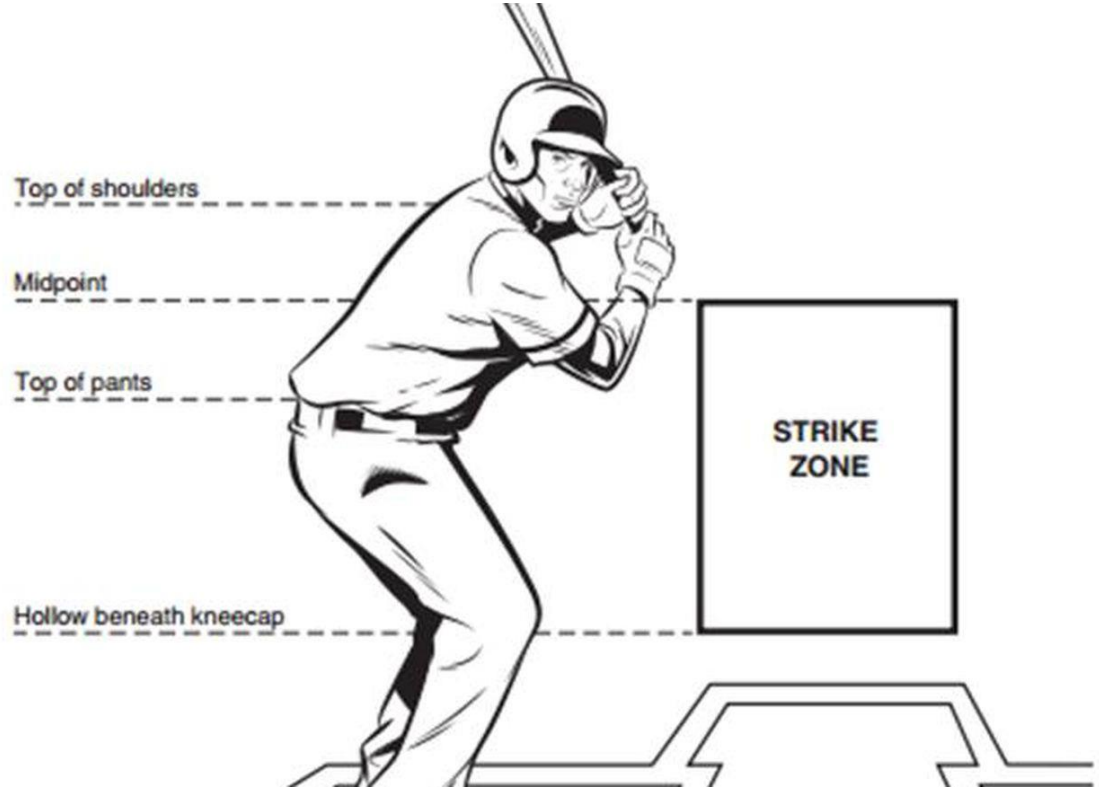
Block Diagram - Hardware



MDR Deliverables

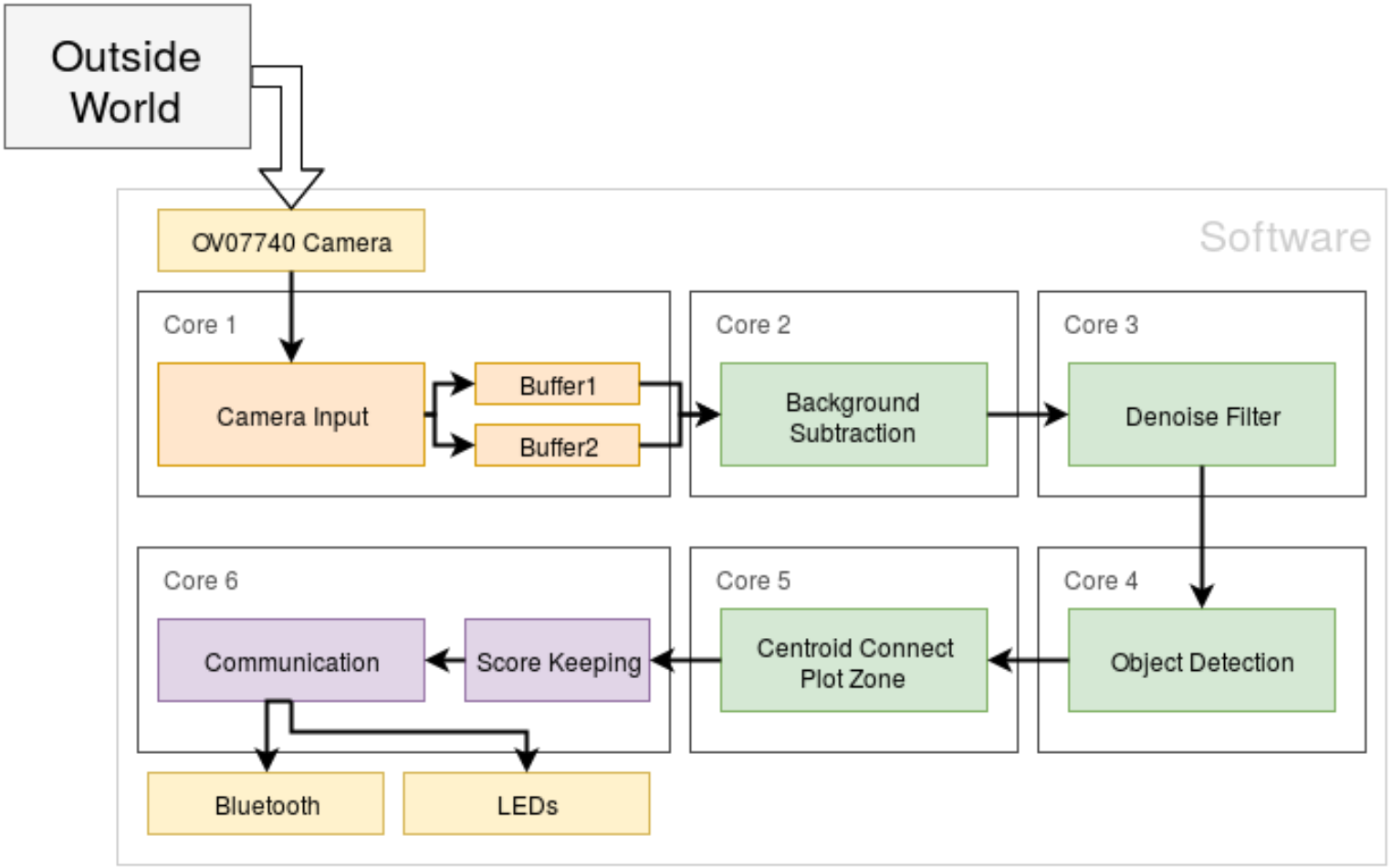
- Demonstration of core image processing algorithm in MATLAB
  - Returns x, y position of ball above plate given two .MOV files
- Demonstration of image collection
  - Create two synchronized video feeds using cameras and collect with processor

Strike Detection Concept



Locate point in 3D space where ball intersects with the "Strike Zone" plane

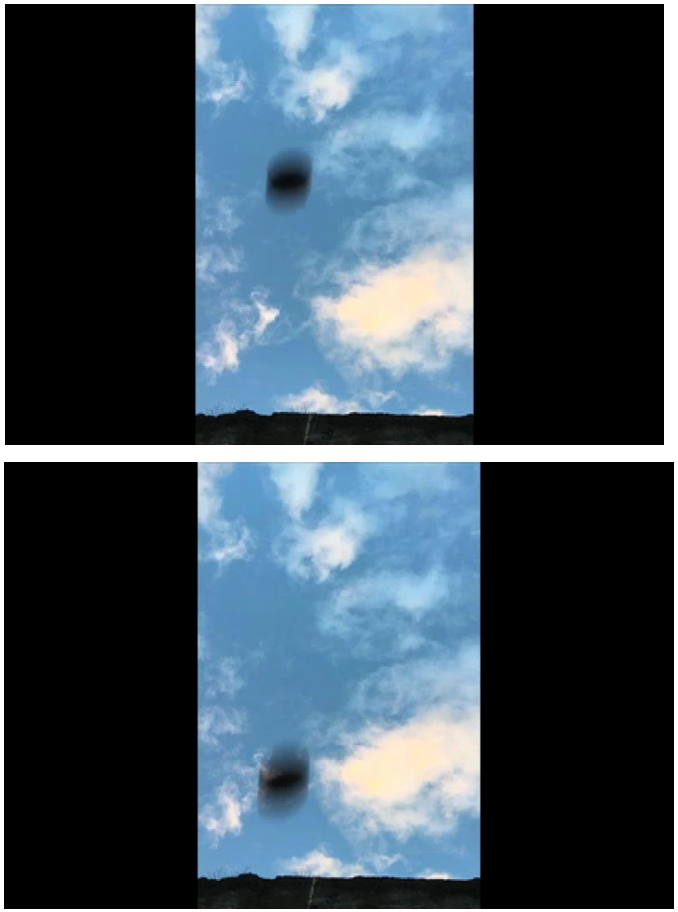
Block Diagram - Software



The Algorithm – Input

Left:

Right:



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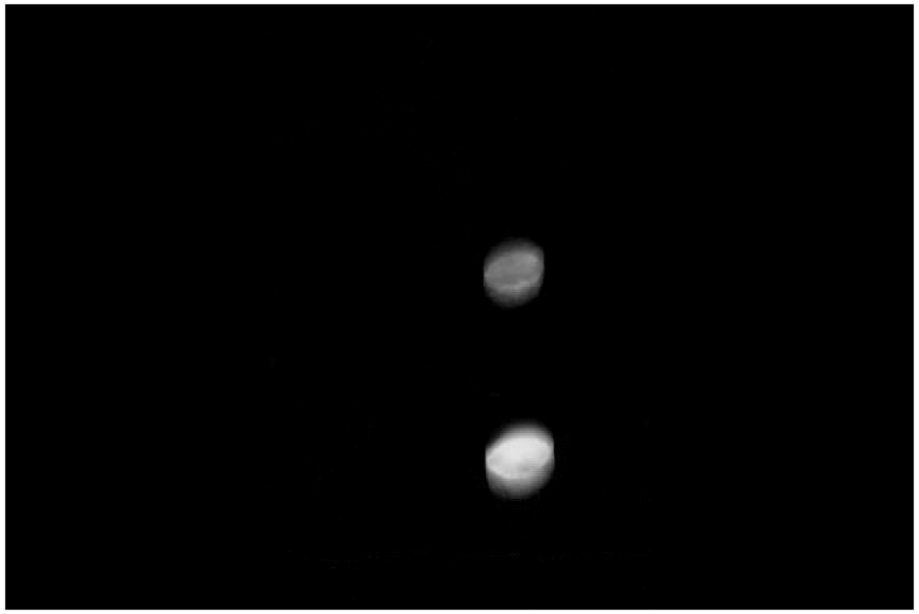
The Algorithm – Background Subtraction

Left:



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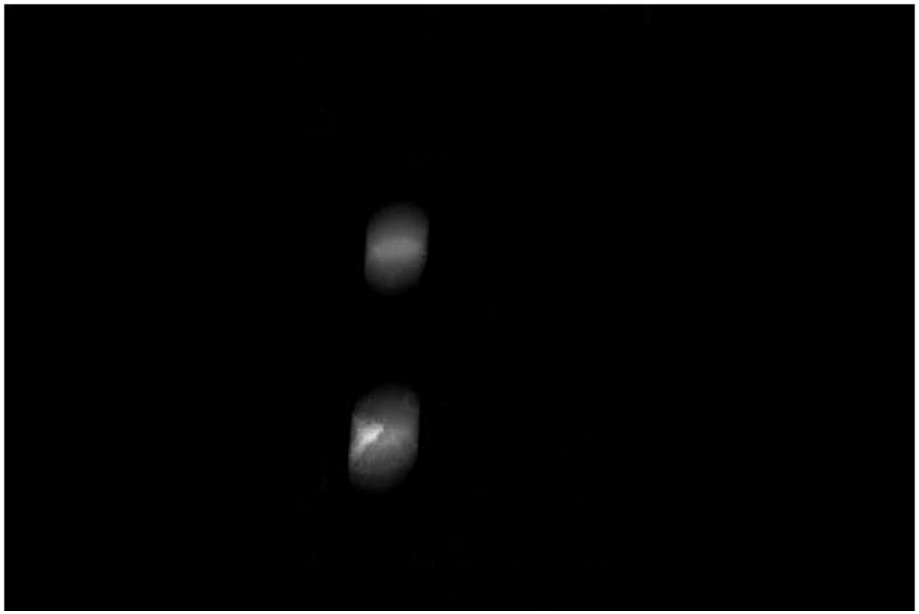
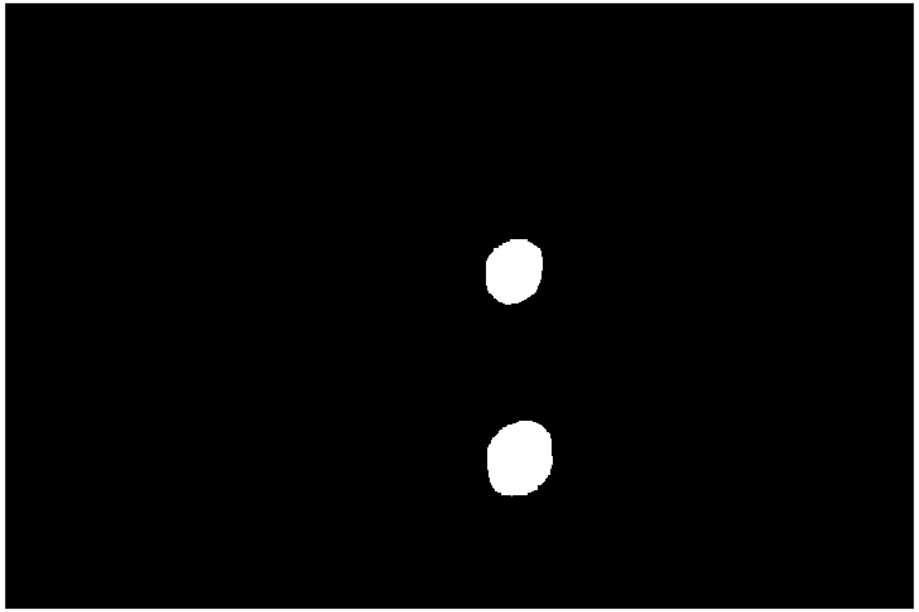


The Algorithm – Filter and Enhance

Left:



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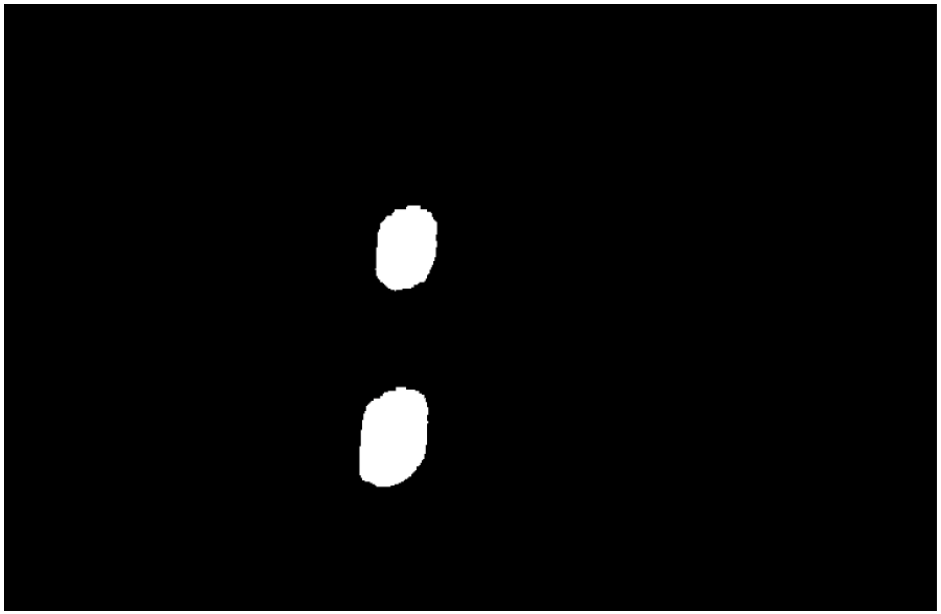
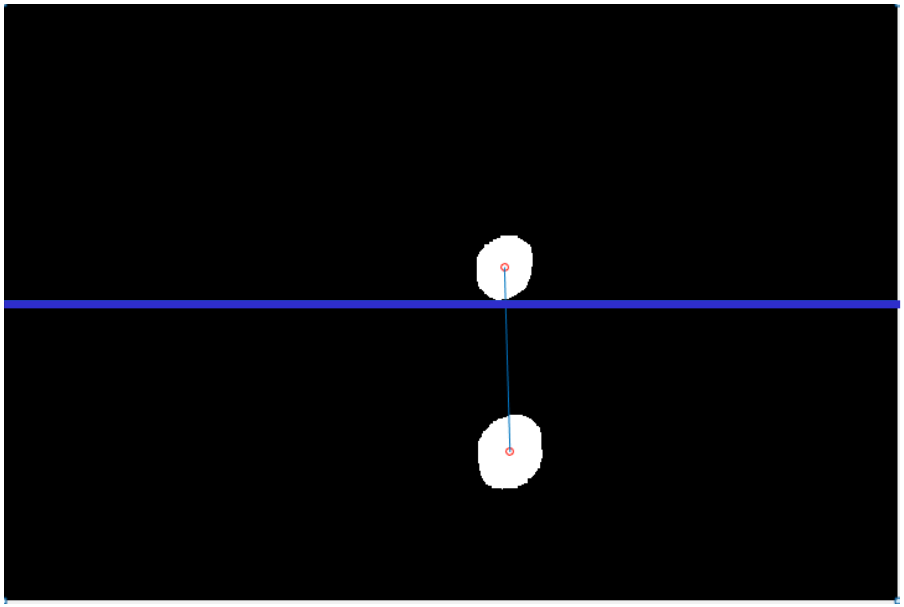


The Algorithm – Intersection with Strike Zone

Left:



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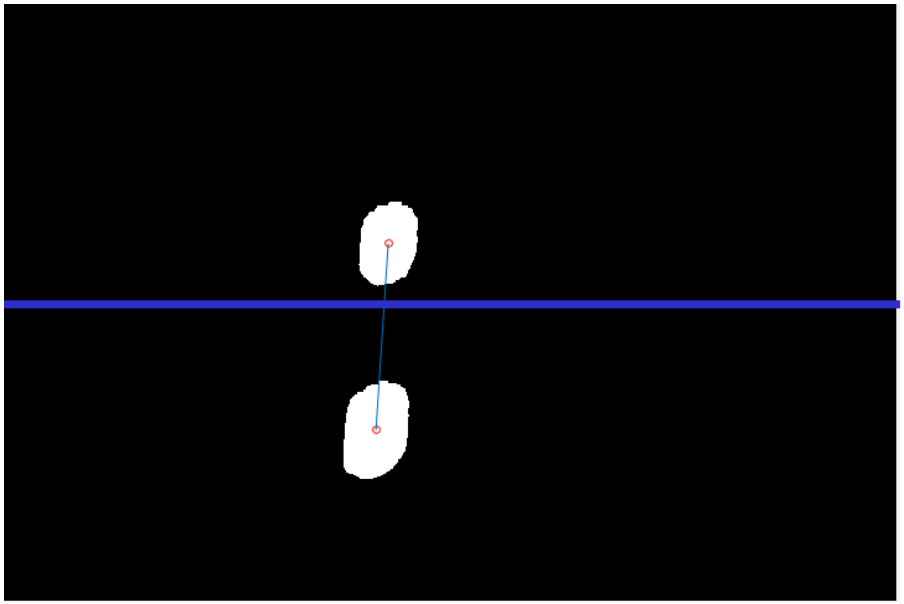
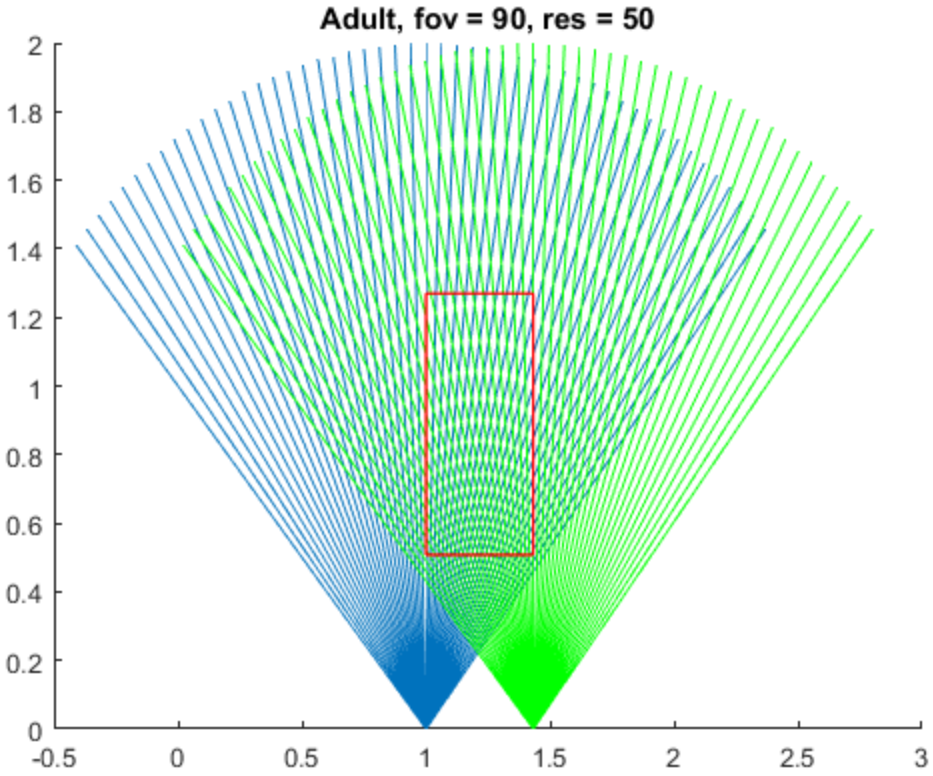
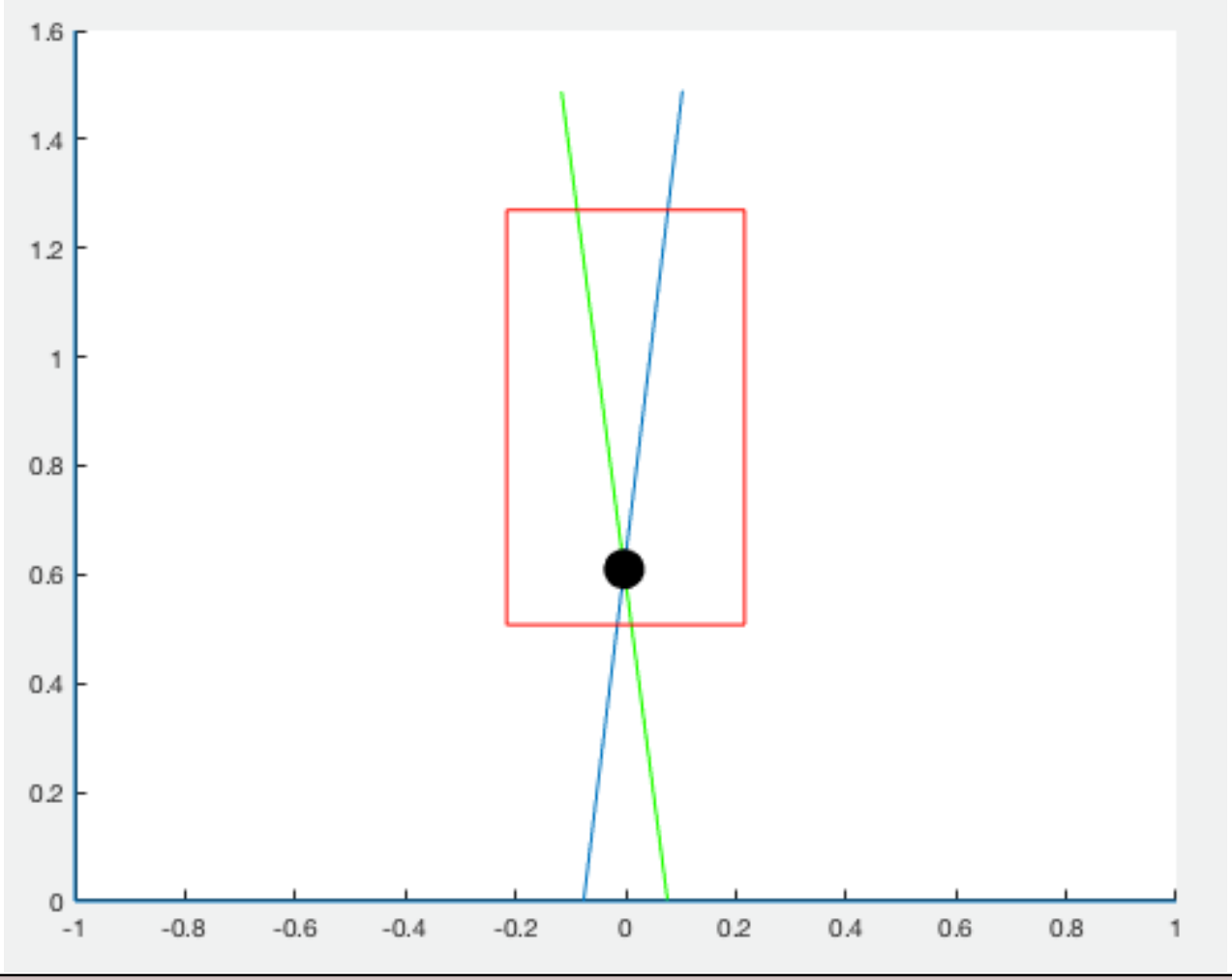


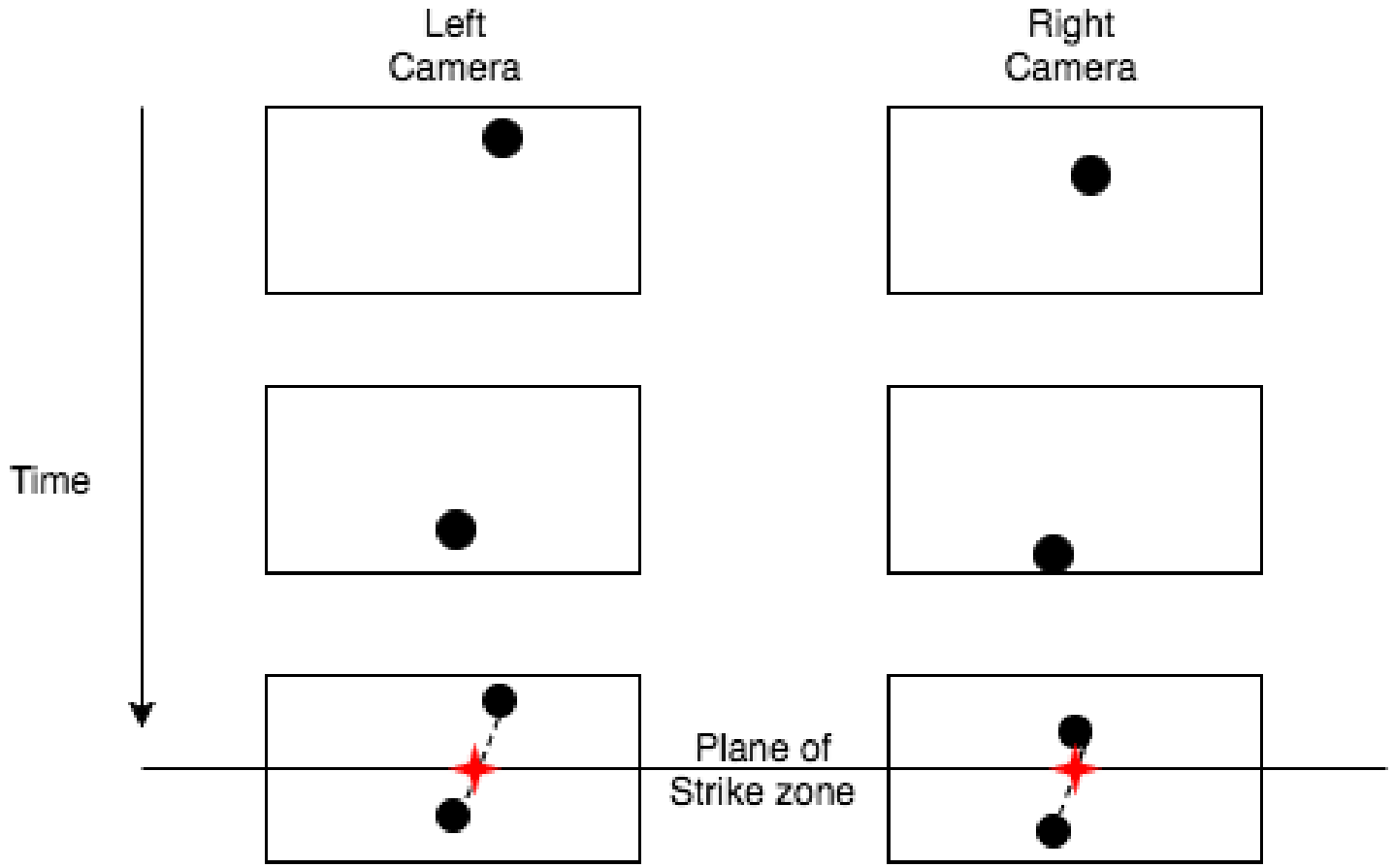
The Algorithm – Find Centroid Pixel



The Algorithm – Determine Ball Location



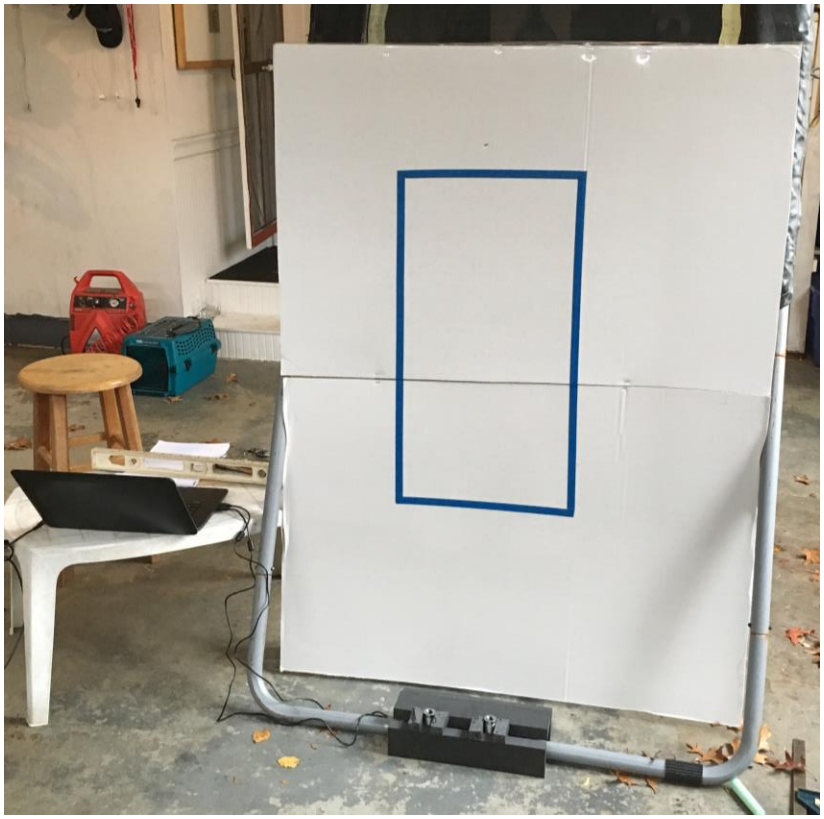
A Word on Synchronization



Android App UI

Indoor Garage testing

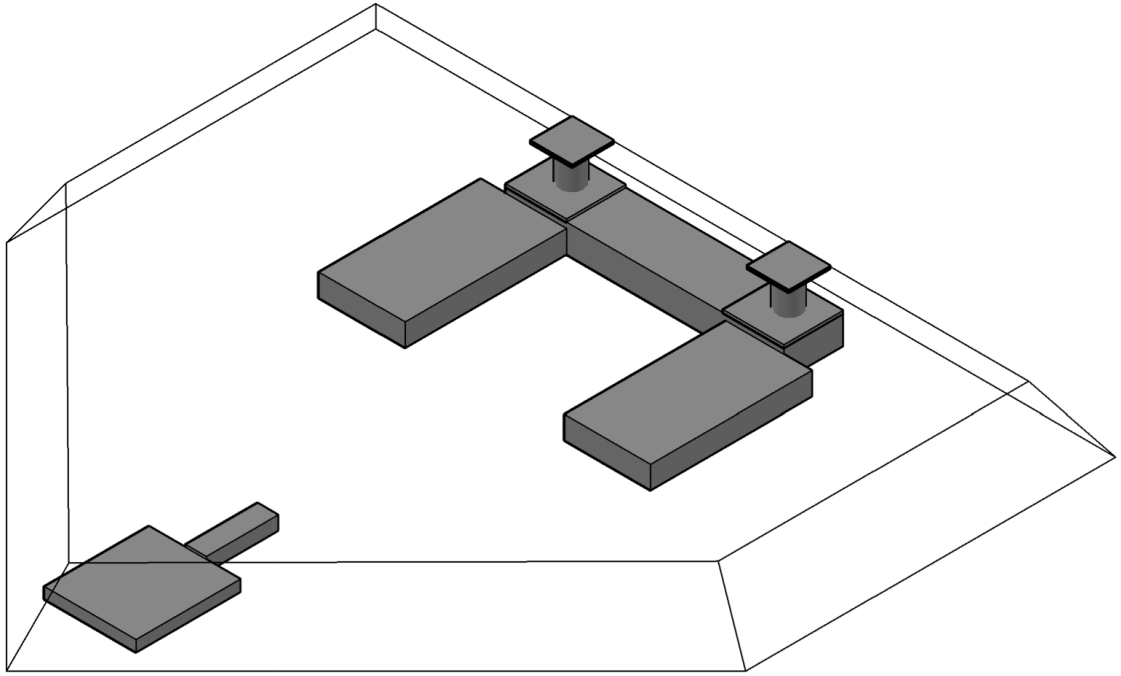
- Choose aperture and exposure time for outdoor use
- Cameras will need to be securely fastened to the plate in addition to each other
- Frame rate of 60fps required for accurate testing

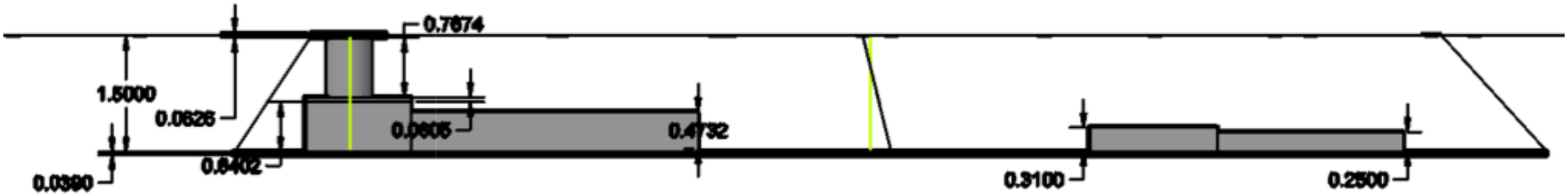


Wall Testing

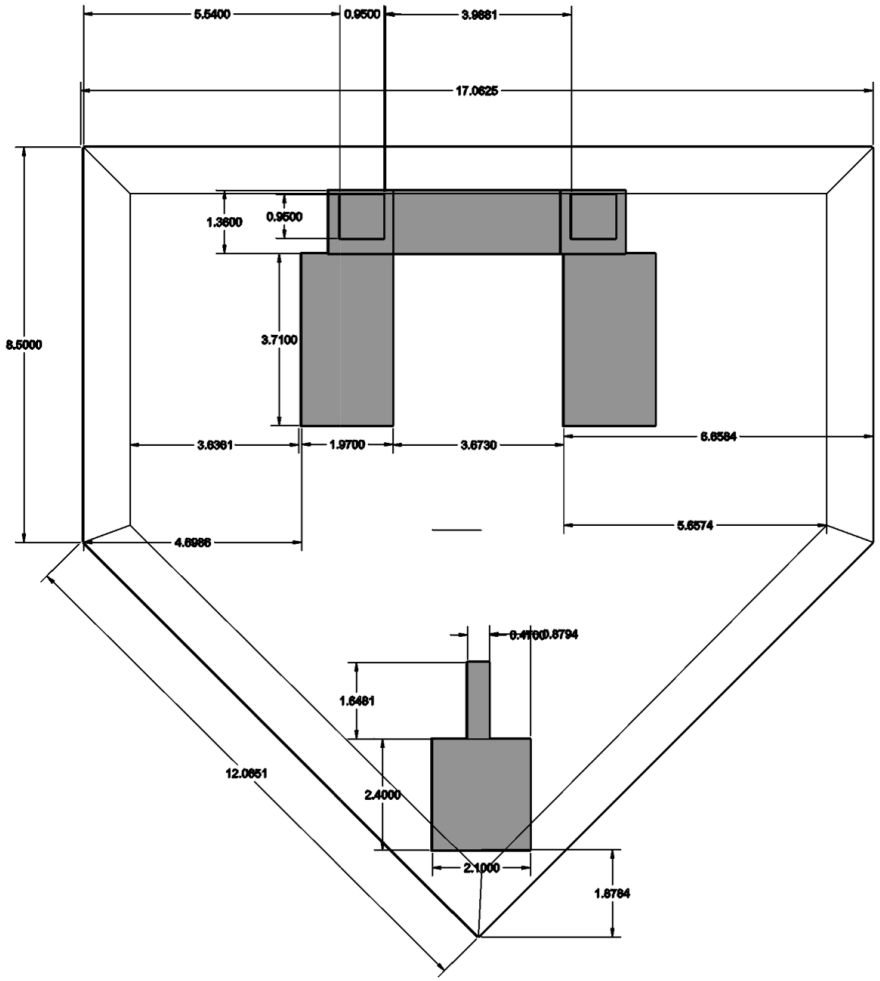
- Using two iPhones spread 6 inches apart and defined axis on a cement wall.
- Marked and measured pitches using chalk on the wall
- The data collected is used to perform validation of the location algorithm
- Sources of error that will affect perfect validation include
  - Camera movement/angle orientation
  - Ball arc between camera and mark on wall a distance of approximately 18 inches.
  - Human error in the marking of the position on wall

Enclosure



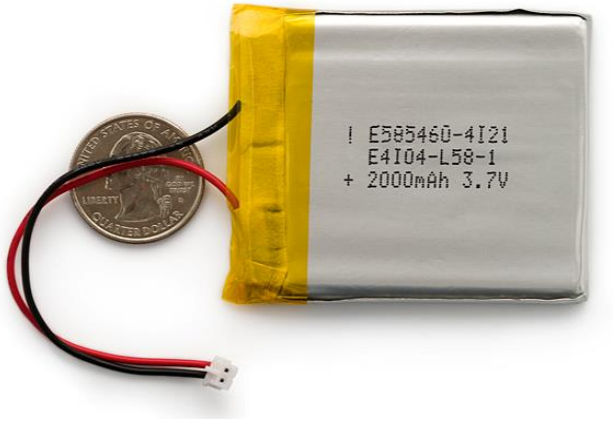


Enclosure Top View



Power Requirement

- Power consumption for processors
  - 3.7V*0.45A = 1.65W
- 4 hour game time: 6.75Wh
- Charge: 1824mAh
- Result: Choose a 2000mAh battery



Required Parts List

- OV7740 Camera Chip (x2)
  - 60fps
  - SCCB Interface
- XEF216-512-TQ128 (x2)
  - 2MB flash
  - 512kB RAM
  - 16 cores
- OV7440 Lens (x2)
- OV7440 Mount (x2)
- 2000mAh battery

CDR Deliverables

- Demonstrate complete system functionality
  - Implement ball detection, strike zone intersection, and baseball height functions in C (Tim)
  - Functioning PCBs (Justin)
  - Capable of detecting balls/strikes with hardware at 60fps
- Implement full app functionality (Jason)
  - Pair to plate, complete viewer and umpire views
  - 2-way Bluetooth communication established
    - App receives ball/strike information
    - Plate receives batter height
- First iteration of enclosure built (Matt)

Timeline

- Complete orders for final system
- Design and send out order for PCB

Dec 21st

- Implement full algorithm in C
- Achieve image collection on PCB system
- Receive second round of PCB if needed

Jan 21st

- Bluetooth communication established
- App functionality completed
- Implement full algorithm in XC

Feb 21st

- Enclosure completed

Feb 28th

Demo – Image Collection and Object Detection

- Image size: 176x144
- Frames per second: 30 -> ~33.3 ms/frame
- Limited memory space: can only store two images at a time