SwimView 2.0

An autonomous camera tracking system for SwimView

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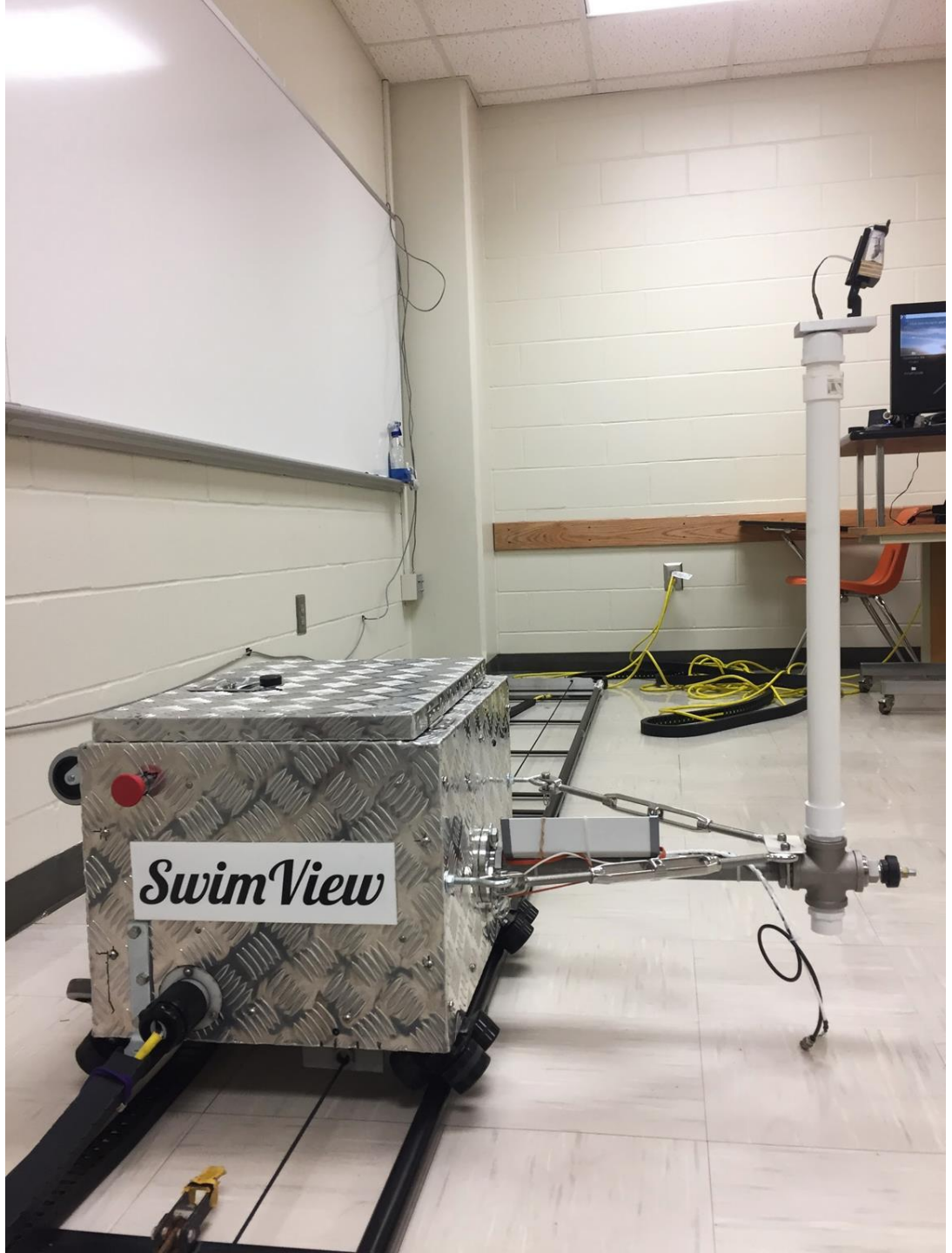
Review of Existing System

- Remote controlled camera system
- Motorized cart
- Marshall CV200-MB camera
- Xbox controller
- Live-stream and Recording capability

Objectives

- Make system completely autonomous
  - Develop camera tracking system
  - Develop autonomous controls system
  - Hardware Integration

•Fix slipping of cable/pulley drive system



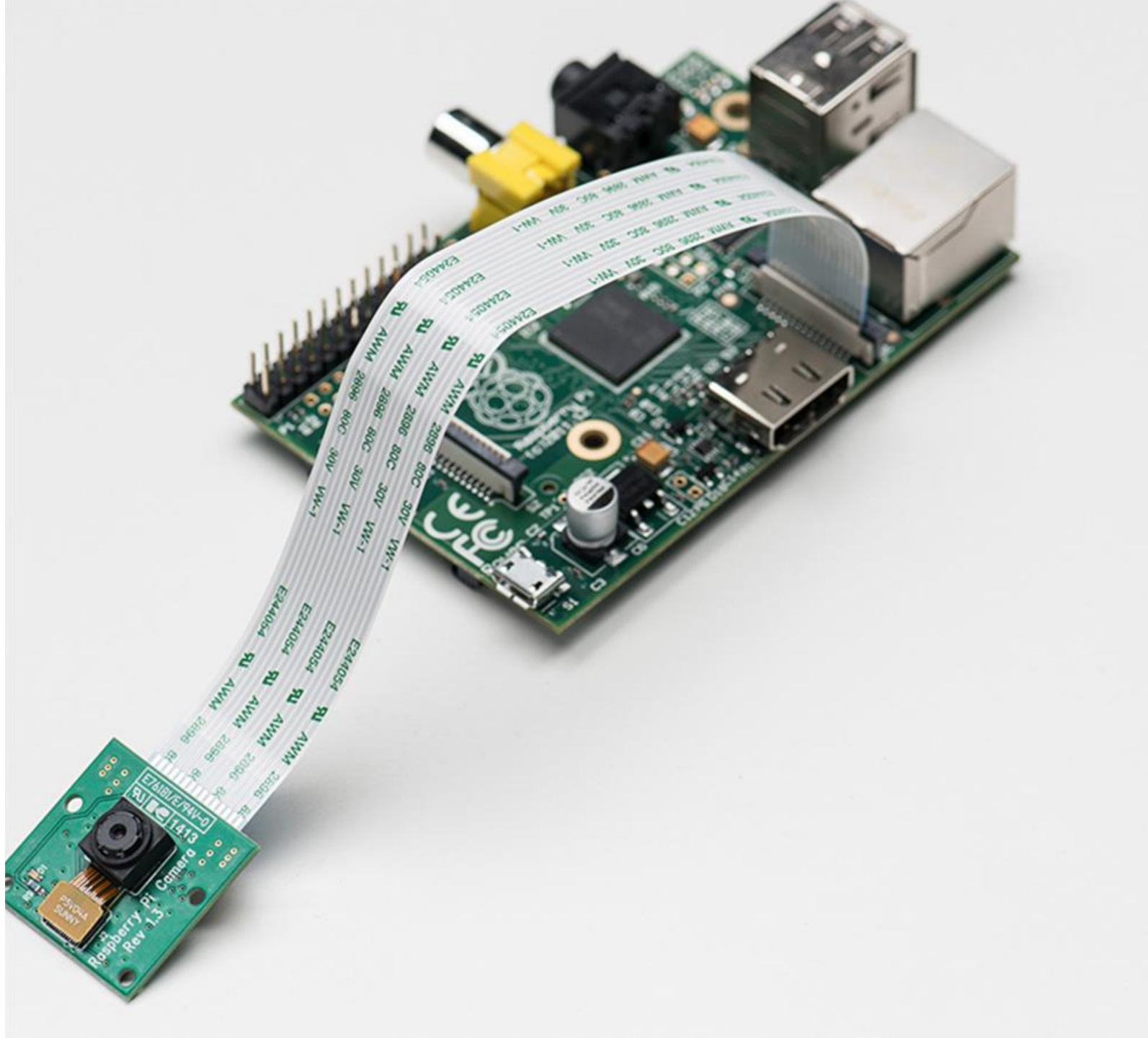
Team Responsibilities

- Software
  - Data acquisition
  - Image processing
  - Controls
- Hardware
  - Mounting new arm/camera
  - Integration of new microcontroller

Team Member	Primary Responsibility	Secondary Responsibility
Harrison Burch	Controls	Image Processing
Demetris Coleman	Image Processing	Controls
Avion Foreman	Controls	Hardware Integration
Jungihn Kim	Hardware Integration	Image Processing
Dustin Spencer	Image Processing	Controls
William Stewart	Controls	Project Management
Nick Thompson	Project Management	Hardware Integration
Dr. Robert Dean	Technical Advisor	
Dr. Wendi Weimer	Kinesiology Department Liaison	

Image Tracking Hardware

- Raspberry Pi 3
  - 1.2 GHz Quad-Core ARM
  - 1GB DDR2 RAM
  - 5V, 2.5A
- Raspberry Picamera
  - 8 Megapixels
  - 1080p/720p
- PVC arm



Controls Hardware

- Arduino Uno
  - 16 MHz Core
  - 5V Supply
  - 14 Digital I/O Pins
  - 6 PWM Outputs
  - 32 KB Flash Memory

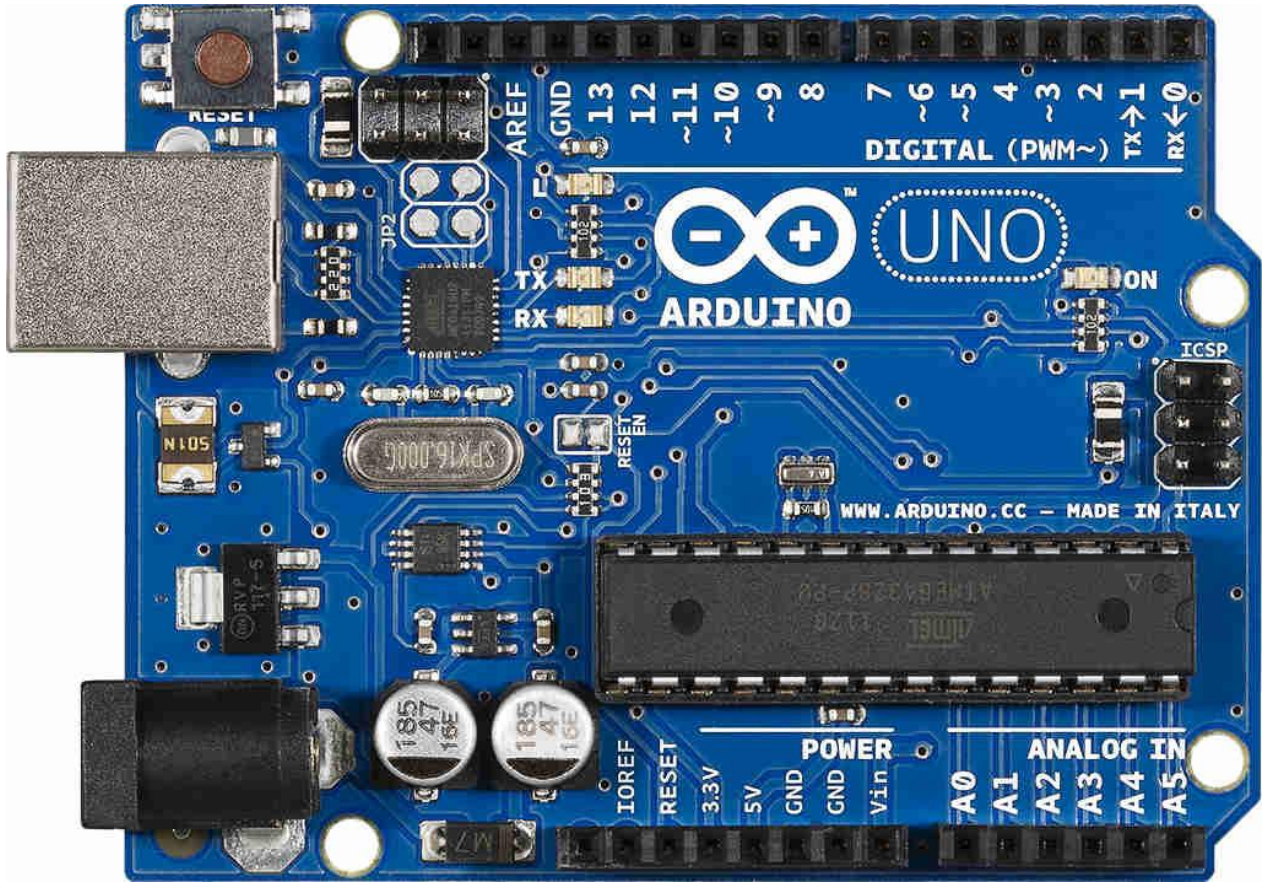


Image Tracking Software

- Python
- OpenCV

Data Acquisition

- Recorded images and videos of swimmers and belts
- Analyzed RGB and HSV color spaces
- Color filtering using color spaces to isolate colored belts
- RangeFinder script was used to provide color bounds

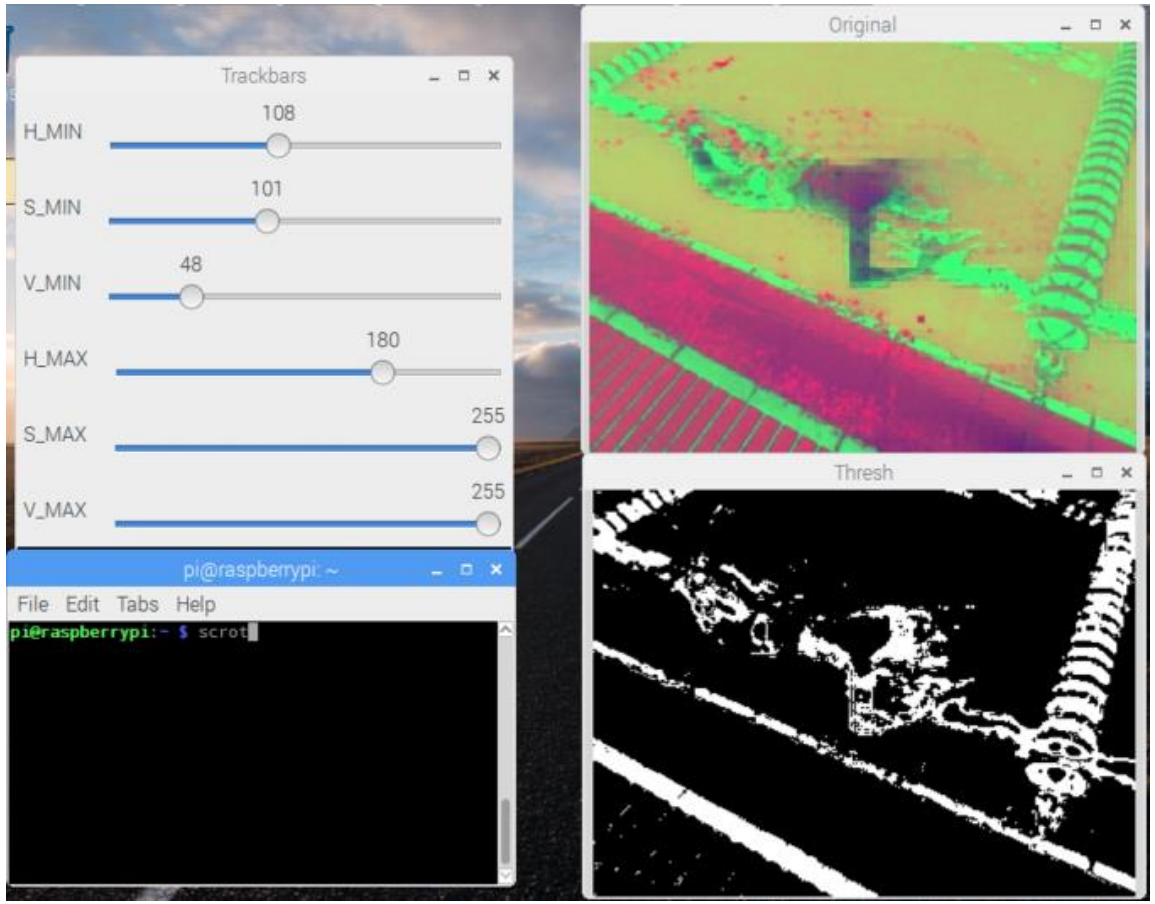
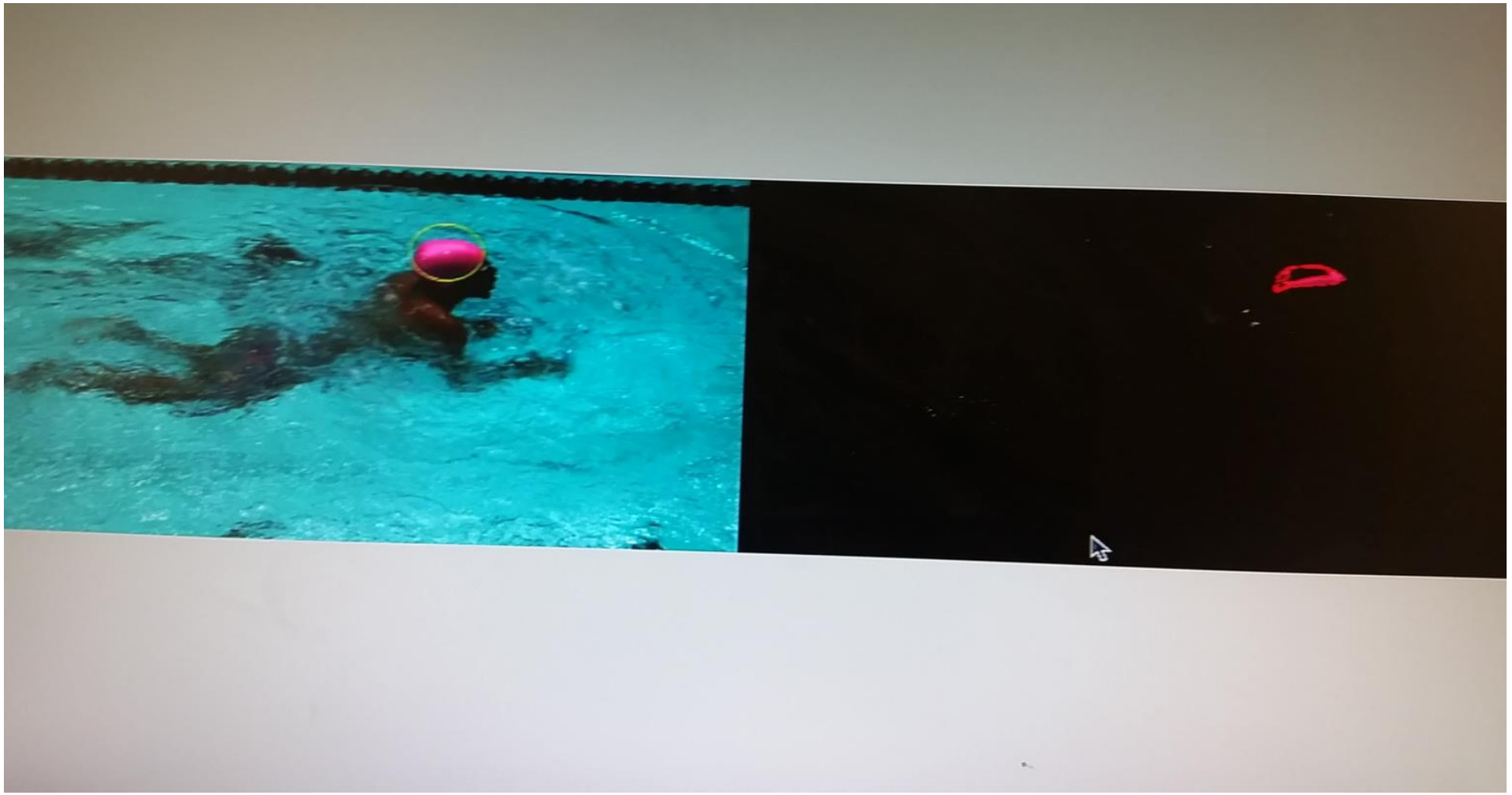


Image Processing: Color Tracking

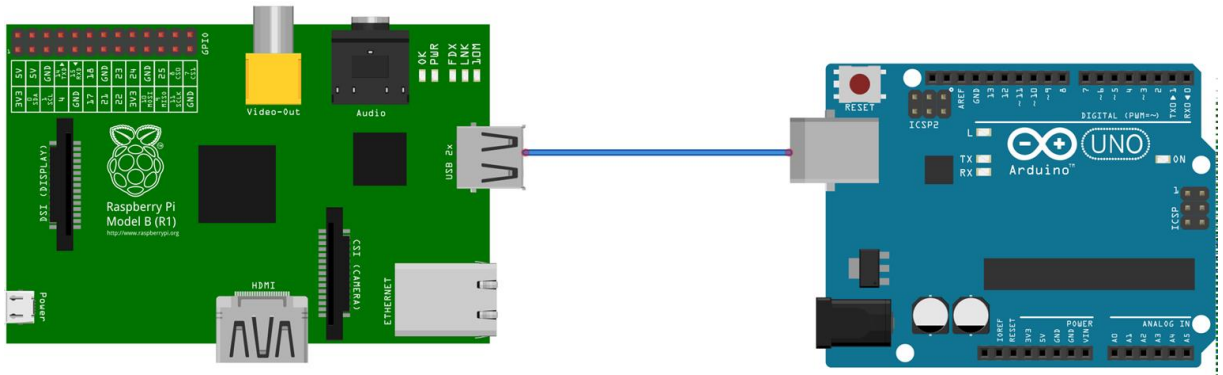
- Contour
  - a curve joining all the continuous points along the boundary with the same color or intensity
  - Swimmer Identification
    - Wear colored band around waist/torso
    - OpenCV detects this color, and calculates its center of gravity (CoG)
    - The x-axis value of the CoG is sent to the motor control system

Contour Color Tracking Results



Control System - Proportional

- Tracking system finds center of gravity (CoG) of swimmer
- The CoG is compared to the target location
- The difference between these locations is the error signal
- The error is sent to the phase lead compensator

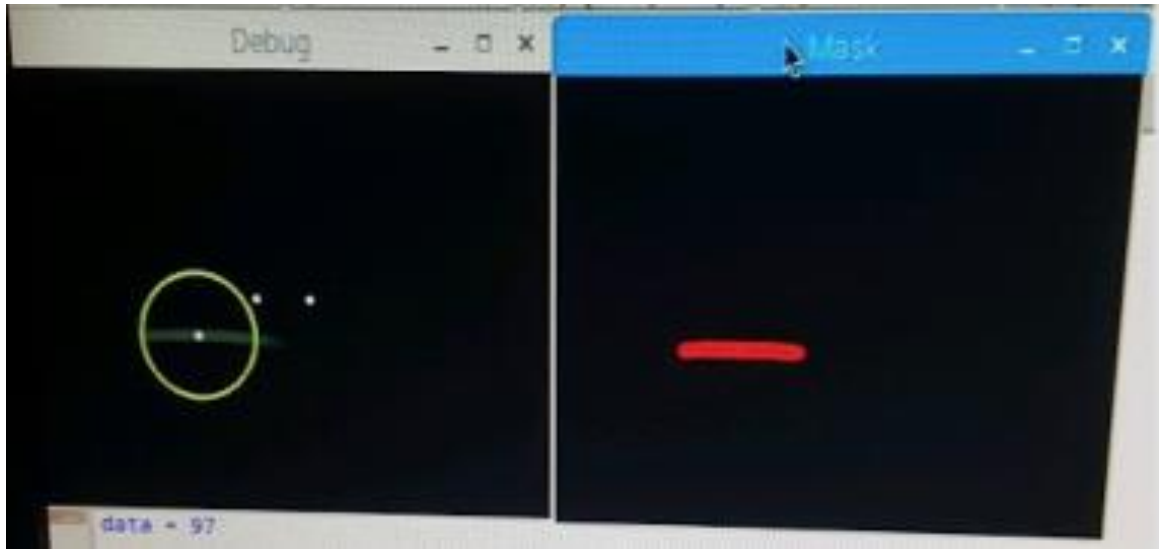


Control System - Phase-lead Compensator

- A compensator that consists of one zero and one pole, where the zero is closer to the origin.
- Advantages
  - Increased bandwidth and gain
  - Improved dynamic response
- Converted the transfer function from frequency to discrete time domain.
- Discrete-time:
  - Position = a0*last_position + b0*current_error - b1*last_error

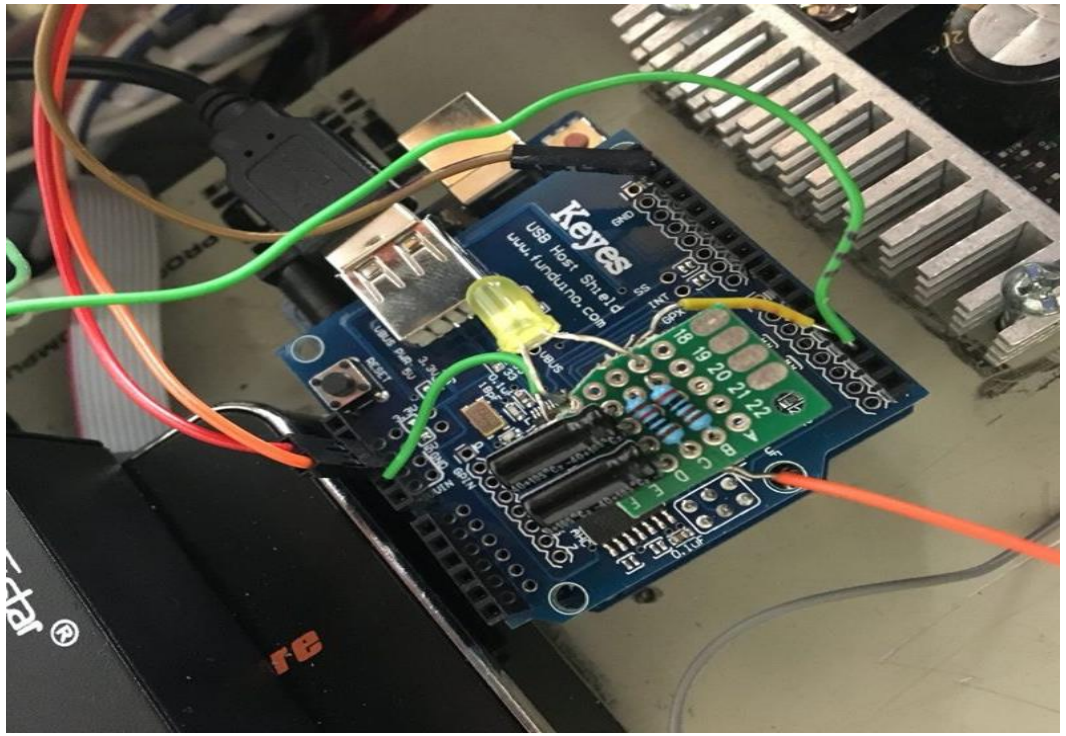
Control System - Compensator Testing

- Developed a specialized tracking system to test the constants.
- Tested 12 sets of constants.
- Monitored oscillations and system response.



Manual Operation

- Manual Control
  - Xbox Controller to Arduino
    - Radio Communication
  - Arduino to Sabertooth
    - Analog Signal
  - Implement Proportional control



Hardware Integration

- Power (Raspberry Pi 3)
  - 5V supply
  - 2.5A current draw
    - 5V Power Supply connected to Xbox receiver.
- Slippage
  - Athletic Tape around wheel

Hardware Integration (Raspberry Picamera)

- Mounting
  - Above water
  - PVC pipe onto previous camera mount
    - Aluminum plate with selfie stick hinged mount
- Electrical Connection
  - 2m Ribbon cable to Pi 3

Complete System Testing

- Software/Hardware
  - Interaction between the tracking algorithm and control system
  - Test indoor with color detection
  - Tracking speed and turnaround
- Functionality
  - “A” - stop
  - “Y” - manual/autonomous switch
  - “B” - starts/stops recording

Complete System Testing

- On-site (limited access)
  - Image tracking underwater with movement
  - Pool lighting and reflection
  - Camera angle and distance

Final Results

Proposed vs. Final Budget

Item	Price
Raspberry Pi Camera Module	$24.78
Adafruit Flex Cable (2m)	$7.97
Raspberry Pi Camera Case	$8.49
Rubber	$10.00
PVC Pipe	$50.00
extension cord	$70.00
Raspberry Pi Camera Lens	$30.00
Safety Seal for Ext Cord	$15.00
Colored Athletic Tape	$20
Overhead	$58.54
	$270.00

Items	Price
Raspberry Pi Camera Module	$29.99
Adafruit Flex Cable (2m)	$11.96
Raspberry Pi Camera Case	$8.49
PVC Pipe	$12.00
Athletic Tape	$10.00
USB-to-Micro USB Cable	$6.95
Pink Belt	$11.00
Micro SD Card	$6.99
	$97.38

Timeline

Phase	Week No.	Wednesday Date	Objective
Proposal	1	11-Jan	Organizational Development
	2	18-Jan	Requirement Gathering
	3	25-Jan	Final Proposal
Phase One	4	1-Feb	Data Acquisition
	5	8-Feb	Data Acquisition
	6	22-Feb	Algorithm Development
	7	1-Mar	Image Processing Code
	8	8-Mar	Image Processing Code
	9	15-Mar	Spring Break
	10	22-Mar	Control Process Development
Phase Two	11	29-Mar	Hardware Integration
	12	5-Apr	Hardware Integration
	13	12-Apr	System Testing
	14	19-Apr	System Testing
	15	26-Apr	Presentation Development
	16	28-Apr	Senior Design Fair

Conclusion

- System is functional
- Limited testing environment
- Gained valuable teamwork experience