ELEC 4000-003
Phase One Report – Swim View 2.0
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The primary purpose of this project is to extend a previous senior design group's project of designing an automated camera tracking system for the Auburn University Kinesiology Department. The current system, SwimView, includes a remote controlled camera system that allows the user to capture video footage of a swimmer. The system provides a live-stream of the video while simultaneously storing the footage for later use. This project will focus on designing and integrating a tracking system that will allow SwimView to be completely automated. The main objectives of Phase One were to develop the tracking and control algorithms.

The original idea for developing the tracking algorithm was to train a Haar cascade classifier using one of Auburn's supercomputers - *CASIC*. This classifier was trained on approximately 10,000 images in attempt to detect the swimmer as he/she swam through the water. The first step in this process was data acquisition, which lasted approximately two weeks. In order to collect 10,000 images, videos were taken of group members swimming in Auburn's olympic pool. These videos were then separated into individual frames and each member was responsible for cropping a subset of the images to isolate the swimmer. Training the classifier took approximately two days of continuous operation. Unfortunately, the Haar classifier did not function as desired. The images unexpectedly trained the classifier to detect splashes in the water. This resulted in excessive noise in the images, and an unacceptable level of false positives.

Multiple classifiers were then trained with a focus on shape detection. Several shapes were considered, including: squares, circles, and crosses. The Haar classifier on the cross was successful and consistently detected the desired shape; however, there were too many cross shapes in the background environment for useful detection. Similar results were obtained with the other shapes, as well. The final attempt at using a Haar classifier involved training on the Auburn University logo, which appears on the swim caps used by the Aquatics Department. This classifier functioned properly, but it could not be realised due to financial impracticality. The system will be used to record approximately 500 swimmers each year, not all of which are associated with Auburn University. Required hygiene practices dictate that a swim cap be purchased for each individual swimmer. The cost of these swim caps making the annual price of the project unacceptably high.

The repeated failures of the Haar cascade classifier have forced the team to investigate other tracking options. Moving forward, the team intends on using red, green, blue (RGB) color tracking rather than training a new Haar classifier. The color tracking algorithm uses OpenCV's predefined color masks to detect a specific range of RGB values in the image. The current plan is to have the swimmer wear a specific color around their torso or waist, which will correspond to the range of RGB values tracked by the software.

The other primary objective of Phase One was to develop a control algorithm to operate the motor autonomously. Two control algorithms are currently being considered. Both systems are still in the development phase and are waiting to be thoroughly tested. The first control algorithm is being tested using OpenCV with the face detection classifier until the tracking system is fully functional. As a face moves in front of the camera, the OpenCV software - running on a Raspberry Pi (RPi) - detects the face in the image. The RPi then calculates the x-axis value associated with the center of the face, and scales this value between 0 and 255. This 0-255 integer is sent to the Arduino microcontroller via serial communication. The Arduino produces a pulse-width modulated (PWM) signal proportional to the received integer value. The PWM signal is sent through a low-pass filter to the Sabertooth motor controller which operates the cart's motor.

The second control system using a coordinated set of general purpose input/output (GPIO) pins to control communication between the Arduino and RPi. Five GPIO pins are used as digital input flags to indicate: left movement, right movement, increasing speed, decreasing speed, and motor stop. One pin is used as a digital output to inform the Raspberry Pi of the current mode of operation (manual or auto). The two speed-related pins send a signal to increment or decrement a variable in the Arduino. This variable controls the PWM signal that is sent to the motor. If neither speed pin is activated by the RPi, then the speed of the motor is maintained constant.

There were two major physical modifications that needed to be implemented on the existing SwimView system. The newly installed Raspberry Pi required modification of the existing electrical distribution system. The Raspberry Pi requires 5VDC to operate. This was obtained by splicing the connection to the receiver for the Xbox controller. This modification did not adversely affect the overall electrical system, and the complete system has been tested with satisfactory results. The second modification was required to prevent slippage of the nylon paracord on the pulley system flywheel. During operation, the paracord slipped around the plastic flywheel, which prevented the cart from moving in one direction. Athletic tape was wrapped around the flywheel as a temporary repair measure. This increased the traction between the flywheel and the paracord, which allowed the cart to move at appropriate speeds in both directions. With the mechanical modifications in place, the system operates as expected under manual control and the automated control systems can be accurately tested. Further modification will be required during Phase Two. Specifically, Pi camera will be mounted on a PVC arm attached to the cart.

The rate of progress in Phase One has called for adjustments in the scheduling for Phase Two. Development of the automated control system and overall hardware integration are ahead of schedule; however, several setbacks have been encountered during the development of the tracking algorithm. Phase Two of the project is expected to include more work than shown in the initial estimate, and there will be an initial focus on finalizing the tracking algorithm. Table 1 summarizes the updated timeline for Phase Two of the project.

Table 1: Updated Timeline

Phase	Week No.	Wednesday Date	Objective
Phase Two	10	22-Mar	Tracking Algorithm Development
	11	29-Mar	Controls Testing
	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

The majority of the items on the initial budget have been purchased. The remaining items will be ordered upon successful implementation of image tracking and control systems. The updated budget is summarized in Table 2.

Table 2

Items Already Purchased	
Item	Price
Raspberry PiCamera	$29.99
Picamera Case	$8.49
Picamera Cable	$11.96
USB-to-Micro USB Cable	$6.95
	$57.39
Remaining Items	
Rubber	$10.00
PVC Pipe	$50.00
Raspberry Pi Camera Lens	$30.00
Colored Athletic Tape	$20.00
Overhead	$58.54
	$168.54

Overall, the project is progressing smoothly. The majority of the outstanding work is related to developing the tracking algorithm. Once the tracking algorithm is complete, the remaining time will be used for complete system testing. The project is on track to be completed before the Senior Design Fair on April 28th.