# University of New Hampshire

# Design of Robotic Swarm for Indoor Testing of Cooperative Control Systems

Team Members: Michael Steed, Justin Wang          Faculty Advisor: Se Young Yoon

## Abstract

Swarm technologies have many valuable uses ranging from surveying to search and rescue, because large groups of small robots can cover wide areas to gather and share information. The objective of this project is to program multiple robots to work together via a single control scheme to form a basic swarm, utilizing a system of motion tracking cameras to provide movement information to the system. The swarm behaviors desired are aggregation, dispersion, and collective movement. Four robots were constructed to implement the desired swarm functions. Each robot utilizes an Arduino Mega, which is able to receive input commands from a central computer and determine the necessary direction of movement. Each robot can perform these actions individually, in small groups, or as a whole. The four robots are placed in a test space with 8 motion tracking cameras that live stream the coordinates of each robot. The coordinates of each robot are interpreted in real time by the control scheme to determine the next location for each agent.

## Design Goal and Objectives

- Goal is to create a robotic swarm consisting of 4 robots
- Swarm determines which behavior to perform based on commands sent from central computer
- Desired swarm behaviors include aggregation, dispersion, and collective movement
- Coordinate of each robot are live streamed and interpreted in the control model to implement desired behaviors
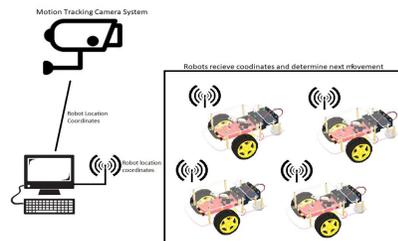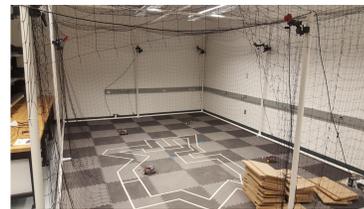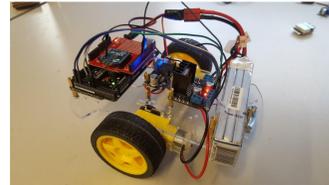


## Conclusion

- Robots respond to input commands and move in desired direction
- Simulink model live streams coordinates of one robot
- Simulation of model forces robot travel to a desired location
- Swarm functionality to be implemented in future improvements
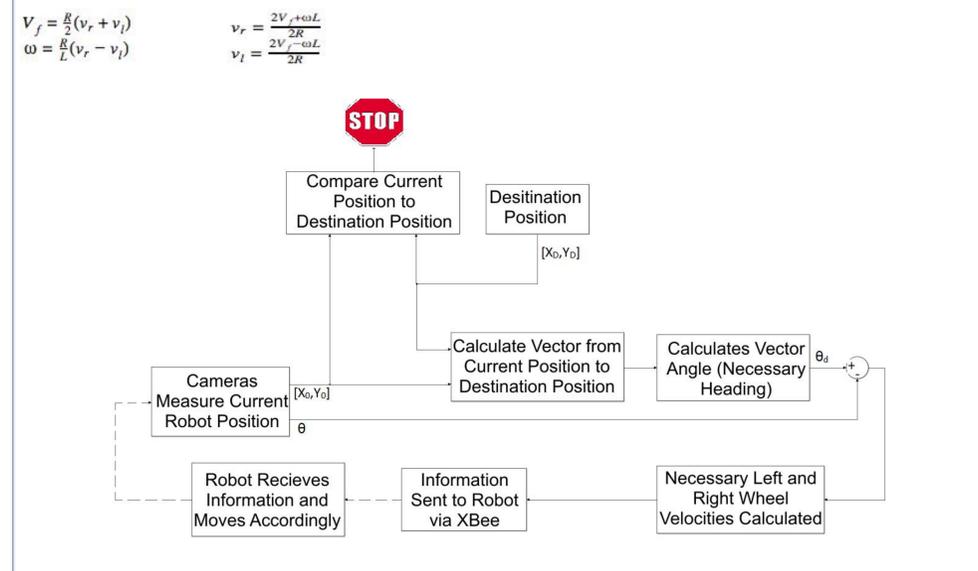
## Hardware

- Robot Chassis
- Motor Driver
- Arduino Mega
- Xbee
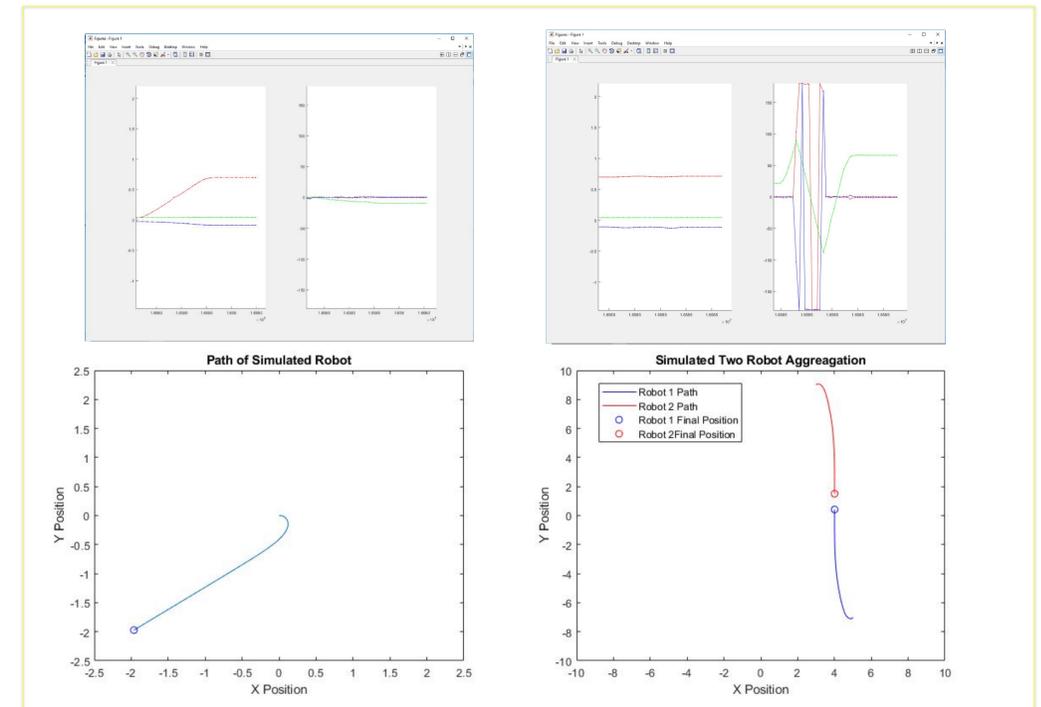- 2S/3S LiPO Battery
- OptiTrack Flex 13 Camera



## Software

- Arduino C/C++ for programming movement of robots
- Matlab for GUI, Simulink for Control Model
- OptiTrack Motive for streaming coordinates of each robot
- NatNet SDK for interfacing between Matlab and OptiTrack

## Control Model

$$V_f = \frac{R}{2}(v_r + v_l) \qquad v_r = \frac{2V_f + \omega L}{2R}$$
$$\omega = \frac{R}{L}(v_r - v_l) \qquad v_l = \frac{2V_f - \omega L}{2R}$$



## Simulation Results



## Test Results