Swarm Robotics

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Background

- Inspired by swarms in nature, specifically ant and bee colonies.
- Implements an algorithm to locate a simulated forest fire using swarm ideology.
- Multiple robots work together to achieve a solution faster than a single robot

Design Points

- Each robot is able to orient itself on a common X-Y coordinate system.
- Each robot has the ability to send and receive local sensor data to/from other robots.
- The central hub passively monitors each robot, transmits data and does not direct robots in any manner. Each robot independently determines its own behavior.
- Modular design to allow for easy expansion to the full firefighting system

Software Subsystem Datapath

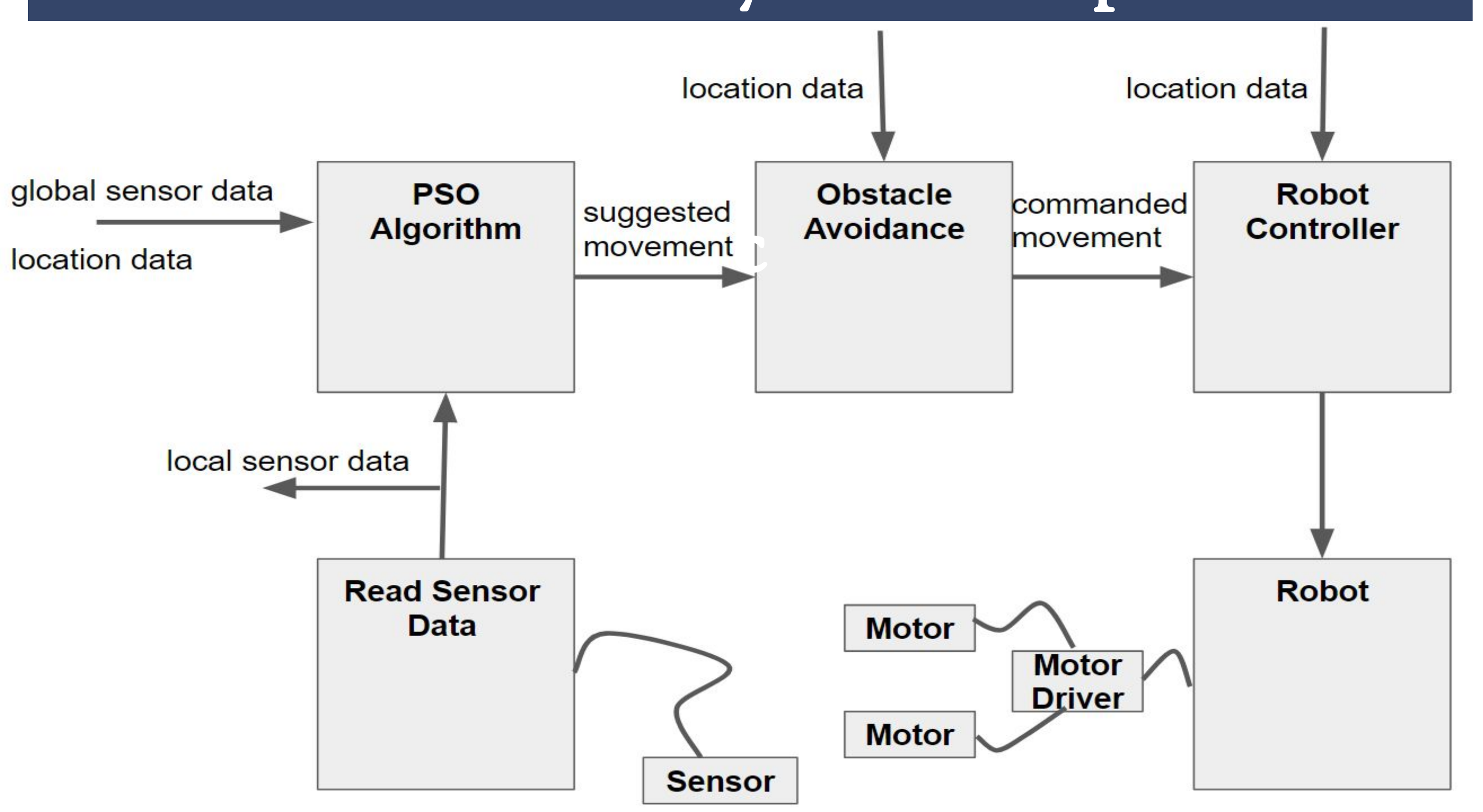

Figure 1. Software datapath for each robot

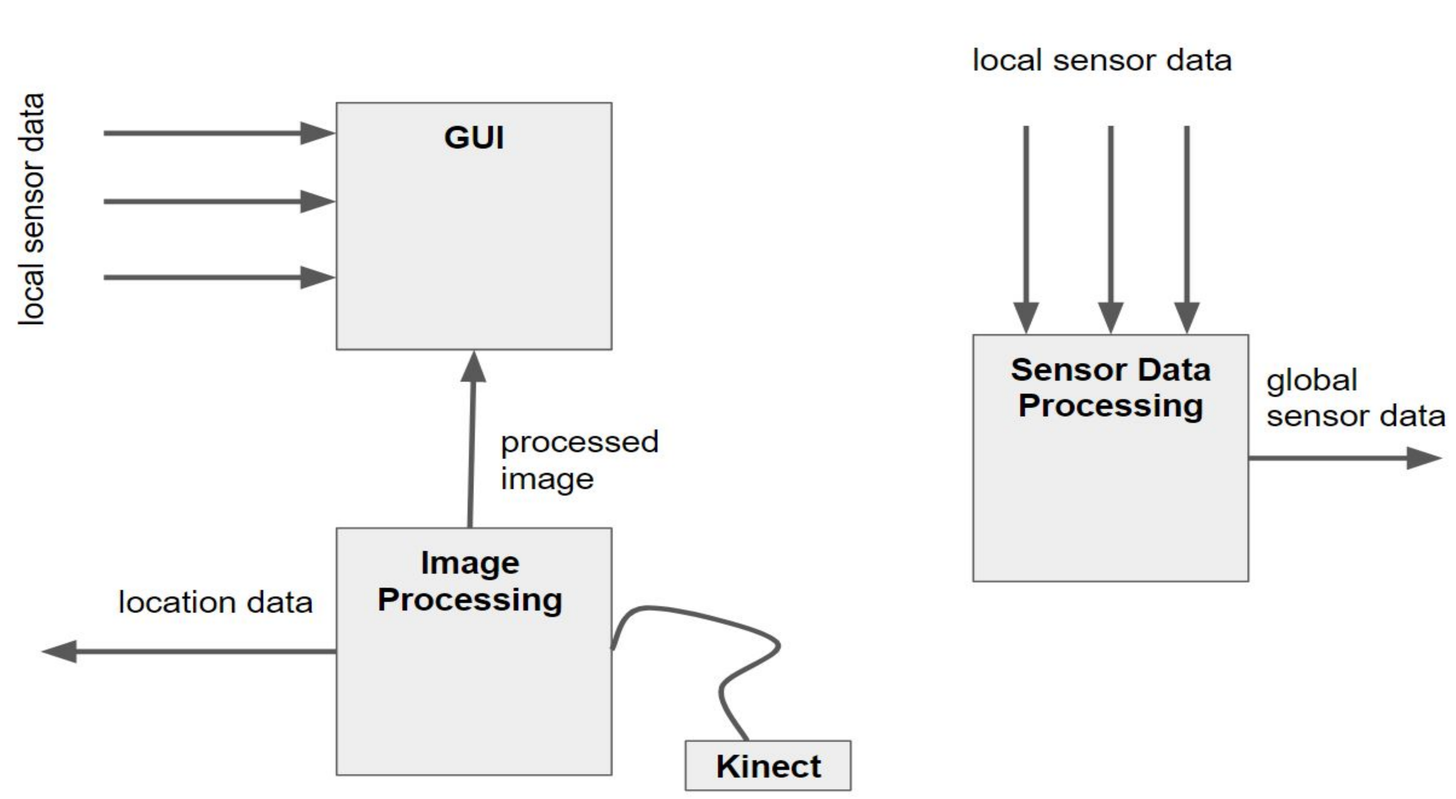

Figure 2. Software datapath for centralHub

Algorithm

- Each robot will execute an optimized random 2D search, while trending towards the global max
- This results in a swarming behavior, with all robots individually finding the stimulus faster than if they were each following their own random search path

$$
\begin{aligned}
vx[\,][\,] = {} & vx[\,][\,] + \\
& 2 * rand() * (pbestx[\,][\,] - presentx[\,][\,]) + \\
& 2 * rand() * (pbestx[\,][gbest] - presentx[\,][\,])
\end{aligned}
$$

Figure 3. Formula for weighted velocity with PSO algorithm

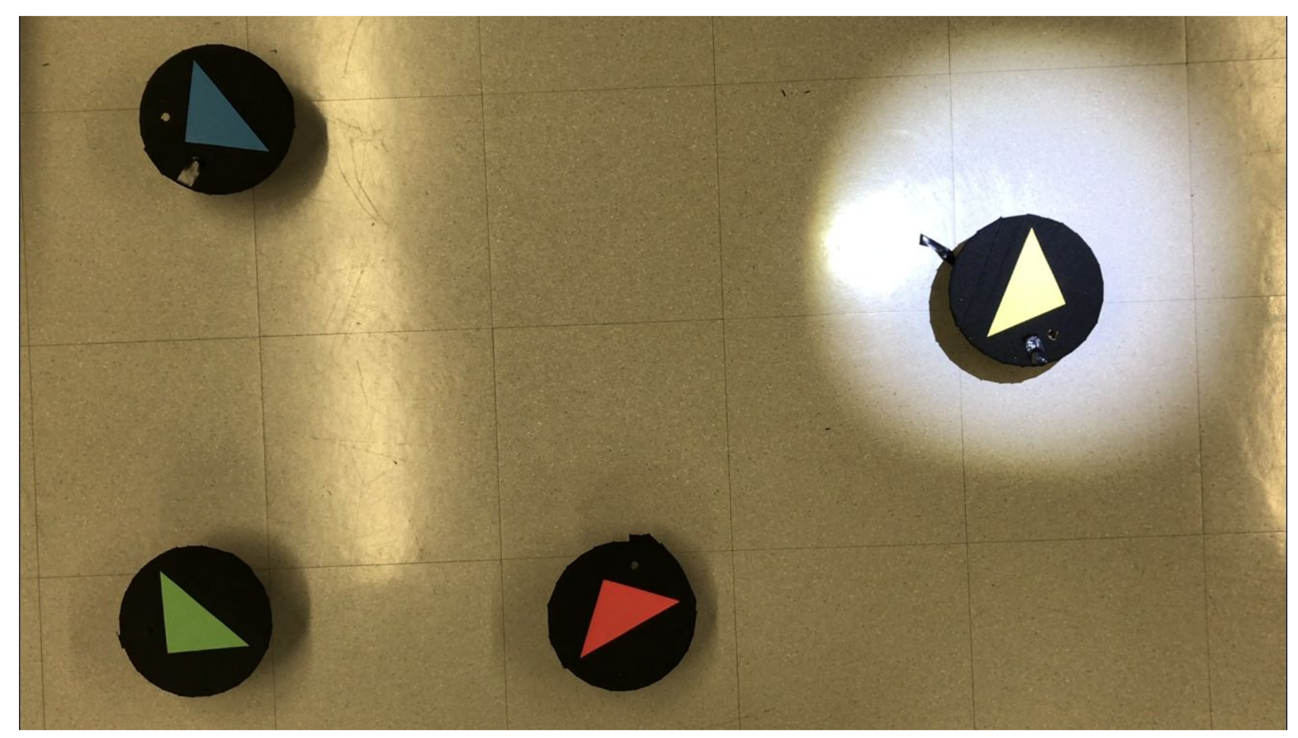

Figure 4. Swarm PSO Step 1: 1 robot has found the stimulus

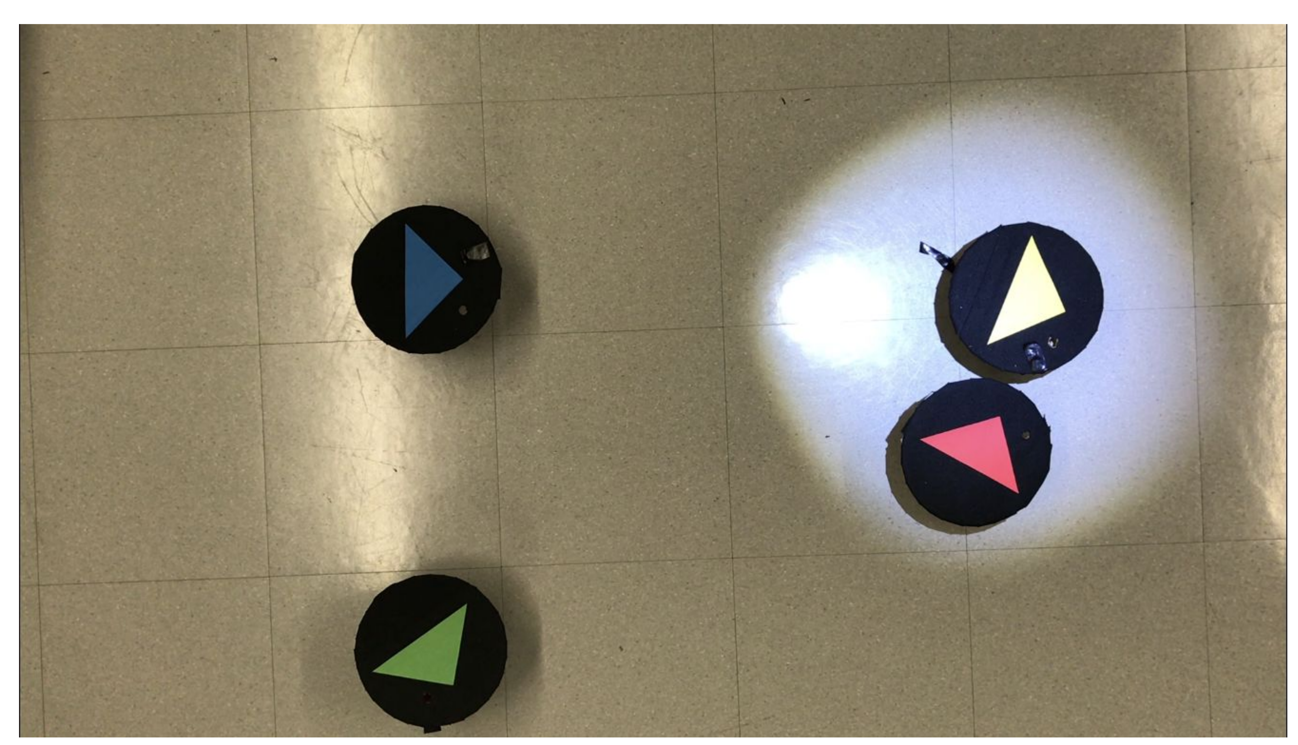

Figure 5. Swarm PSO step 2: robots are beginning to converge on the stimulus while others continue searching the grid for higher intensity stimulus

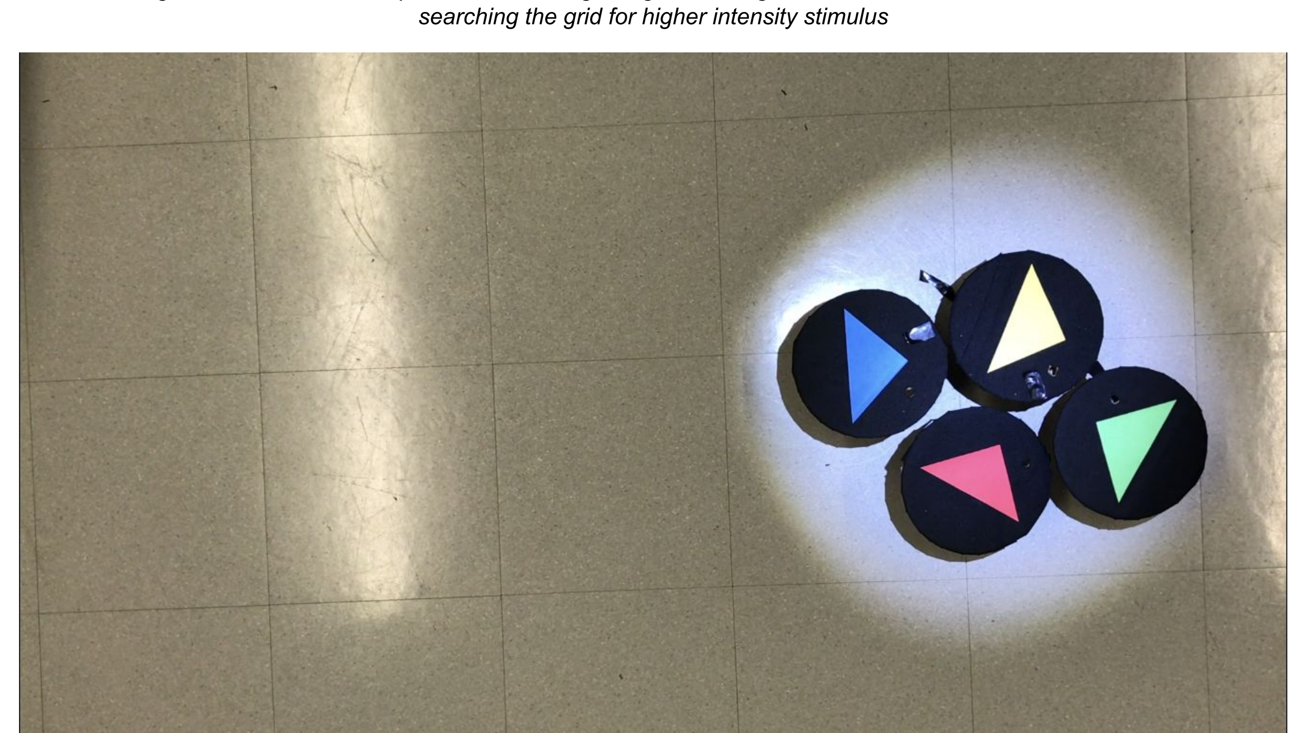

Figure 6. Swarm PSO step 3: all robots have converged on the stimulus

Computer Vision

- Used to implement robot location and obstacle avoidance.
- Robot location was achieved by setting the computer to recognize different colored triangles as different robots. It then maps their locations to a common grid.
- Obstacle avoidance was implemented by making a boundary in front of the robot and overriding the robots original movement.

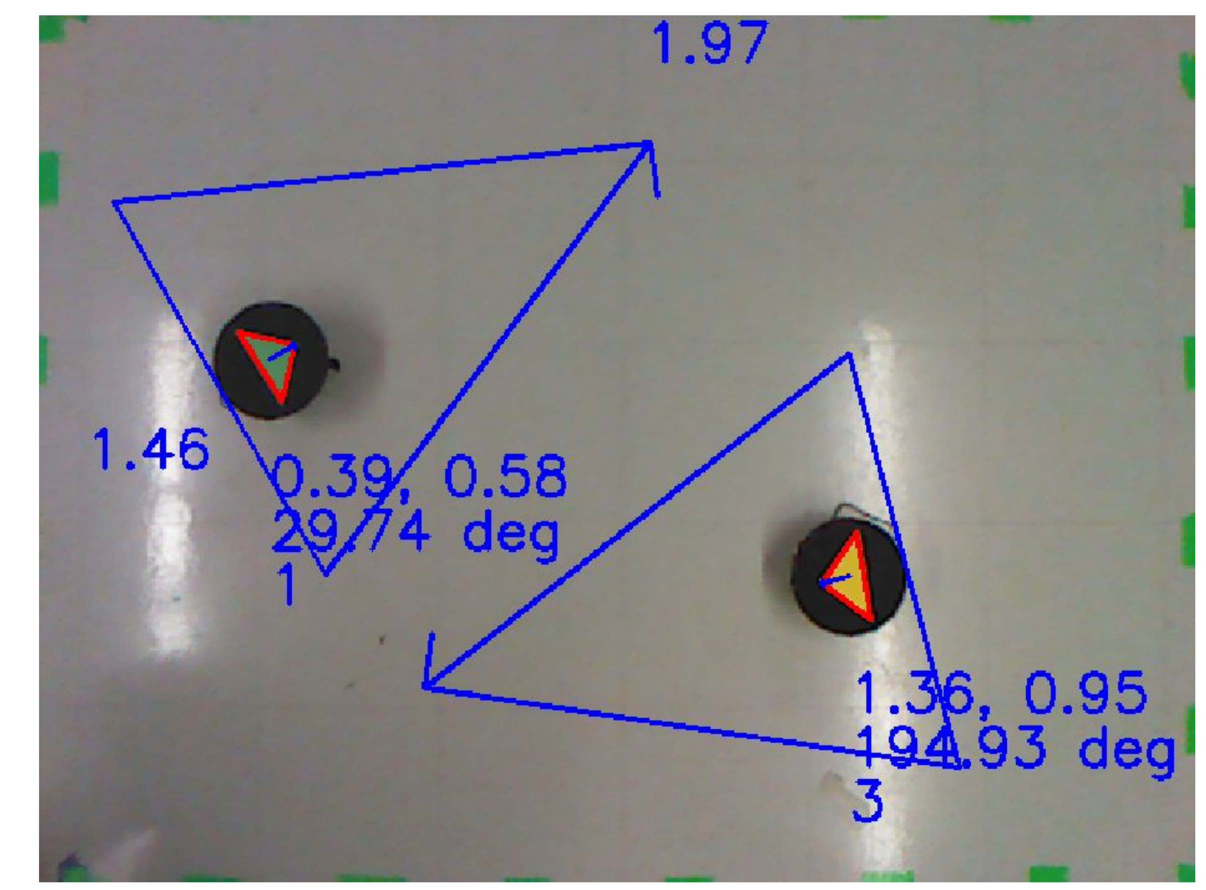

Figure 7. Output of computer vision showing collision detection and location of each robot

PCB Design

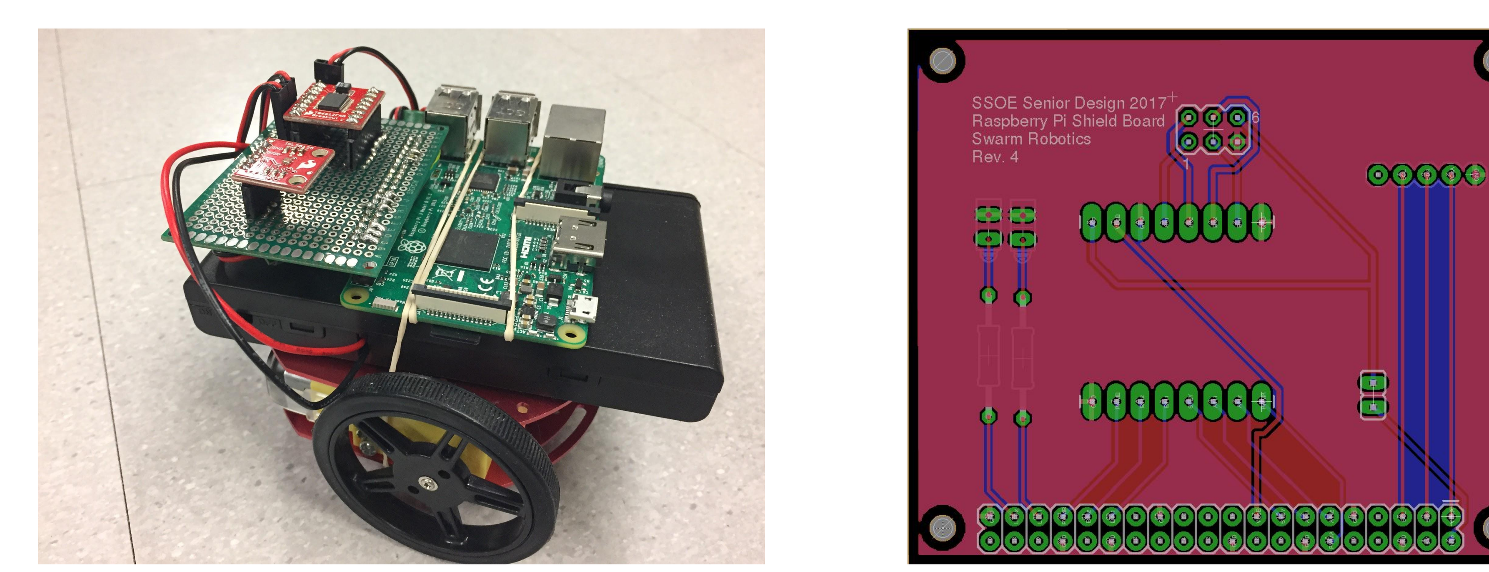

Figure 8. Custom robot electronics with PCB designed for interfacing the light sensor, and motor drivers into a small computer.

Acknowledgements

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