Using social networking to develop advanced control strategies for soft robots

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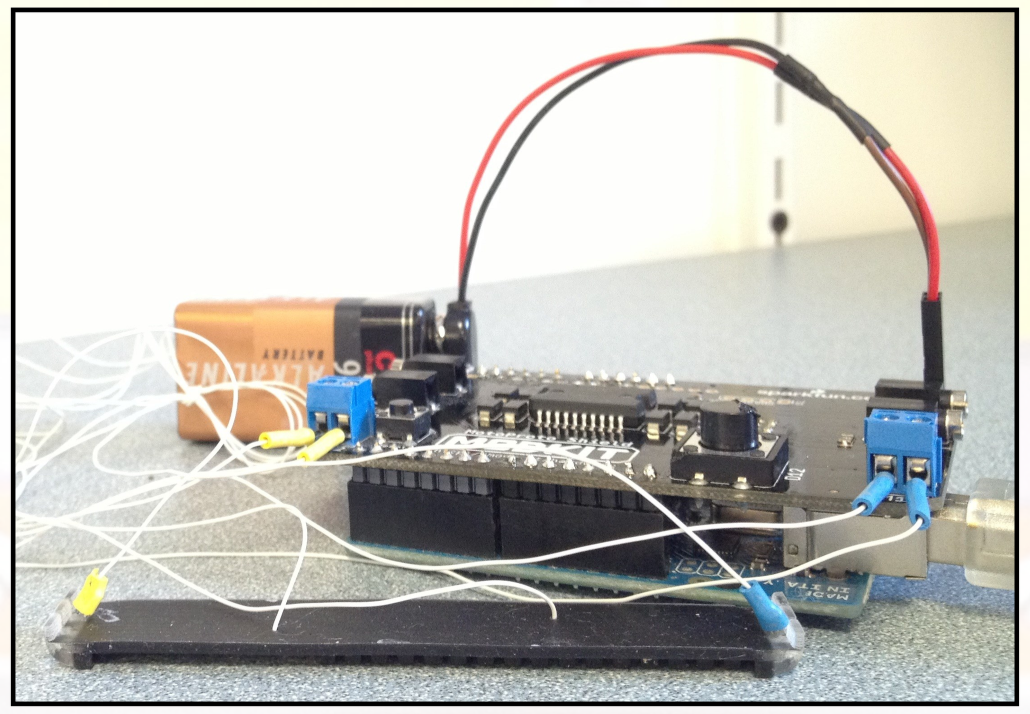
In a world where robots are becoming increasingly rooted in our lives, it is important that we are able to interact with them safely. Thus, robots must incorporate soft components into their design. Soft materials offer numerous benefits, such as the ability to act as a sensor and a limiting the chance of a human being harmed. However, in order to be able to use soft materials in these ways, we need to learn more about how to control them and how to utilize their non-linear elastic properties to the fullest extent. Our goal is to develop a platform that can be applied to many different robotic systems using soft components in their design.

The Worm

The Softworm is a 3D printed soft-bodied robot actuated by two shape memory alloy (SMA) coils. A computer running LabVIEW communicates to the Softworm through an Arduino and MotoProto shield.



Softworm connected to an Arduino R3 with a MotoProto Shield and a 9V

The SMA coils are activated by resistive heating using current pulses timed to produce a wave-like crawling motion seen in caterpillars. Our first round of testing will call on users to select the time gap and the duration of actuation of the two SMAs to determine the best gait for a Softworm moving in a straight line.

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References

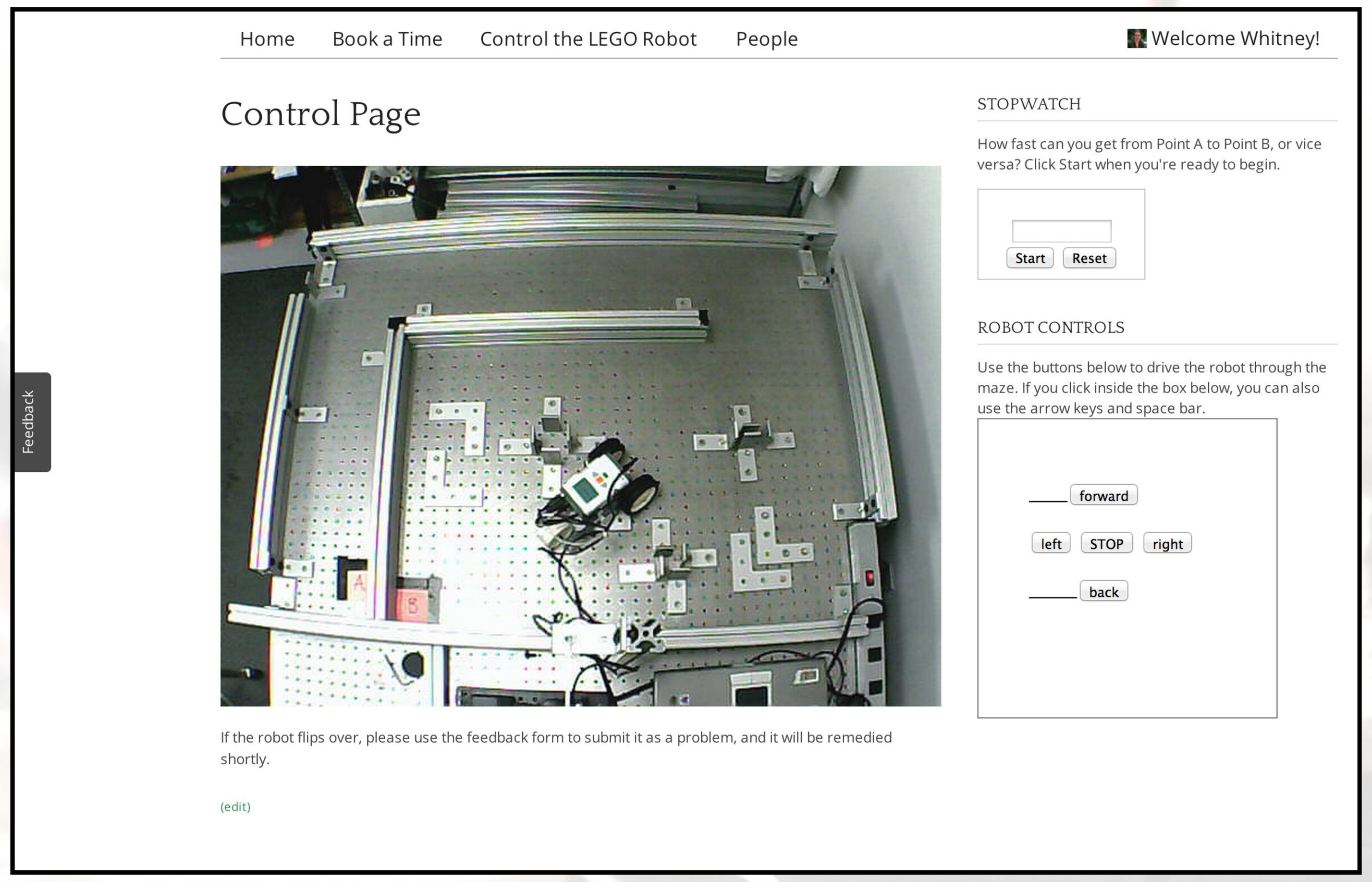
[1] Von Ahn, L. "Games with a Purpose." *Computer* 39.6 (2006): 92–94.

[2] Cooper, Seth et al. "Predicting Protein Structures with a Multiplayer Online Game." *Nature* 466.7307 (2010): 756–760.

[3] Soft Robotics. https://softrobotics.k12engineering.com/

The Crowd

"Games with a Purpose" like Peekaboom and Foldit have successfully crowd-sourced tags for images and solutions to protein folding, respectively. [1,2] Drawing from these approaches, we have developed a website [3] users log into using social media. Once a user is logged in, they may book a time to control the robot. When it is their turn, they are granted access to the controls and are able to drive the robot through the maze. Players compete for the best time, and top players and times are featured on a leaderboard. Users may also interact with each other through chat, submit feedback, explore blog posts, and watch others control the robot. Currently testing on the website is being carried out with a LEGO robot on an optical table while development of webpage for the first phase of Softworm testing is finalized.

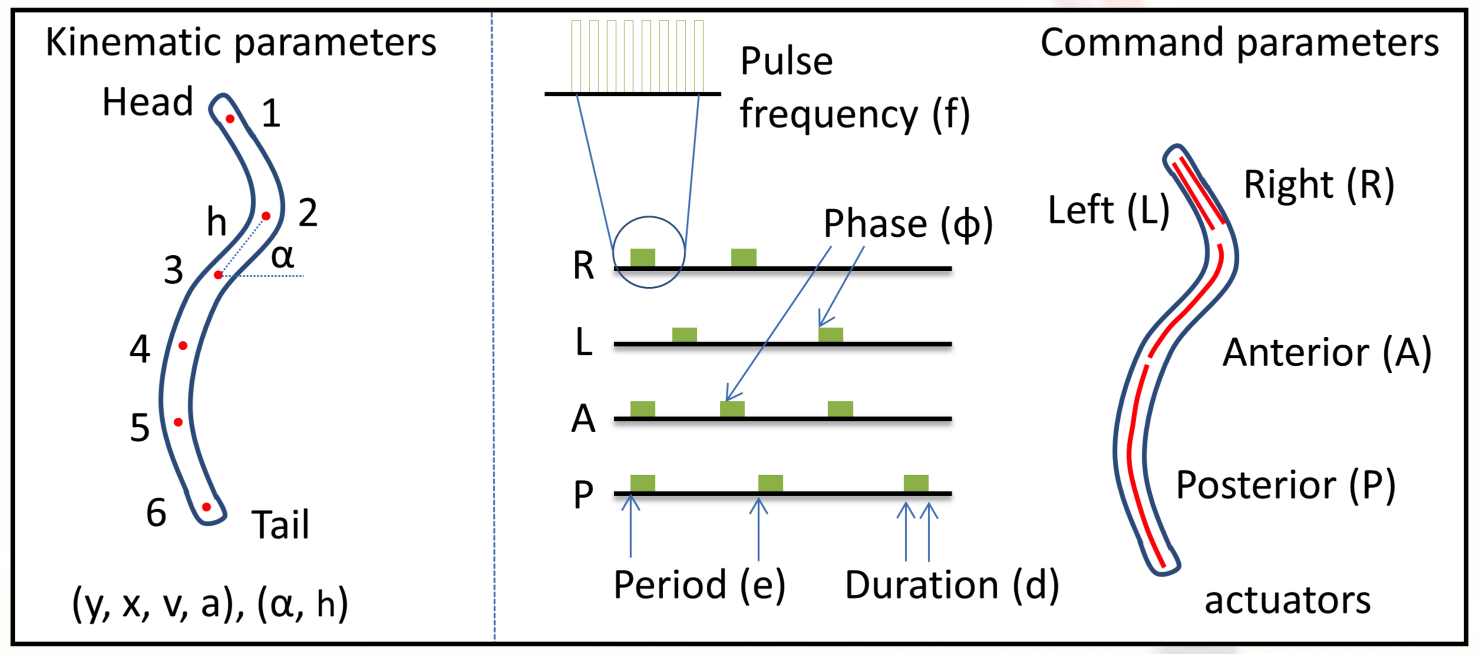


Control Page, where users are able to navigate the LEGO test robot through the test arena after they have signed up for a time

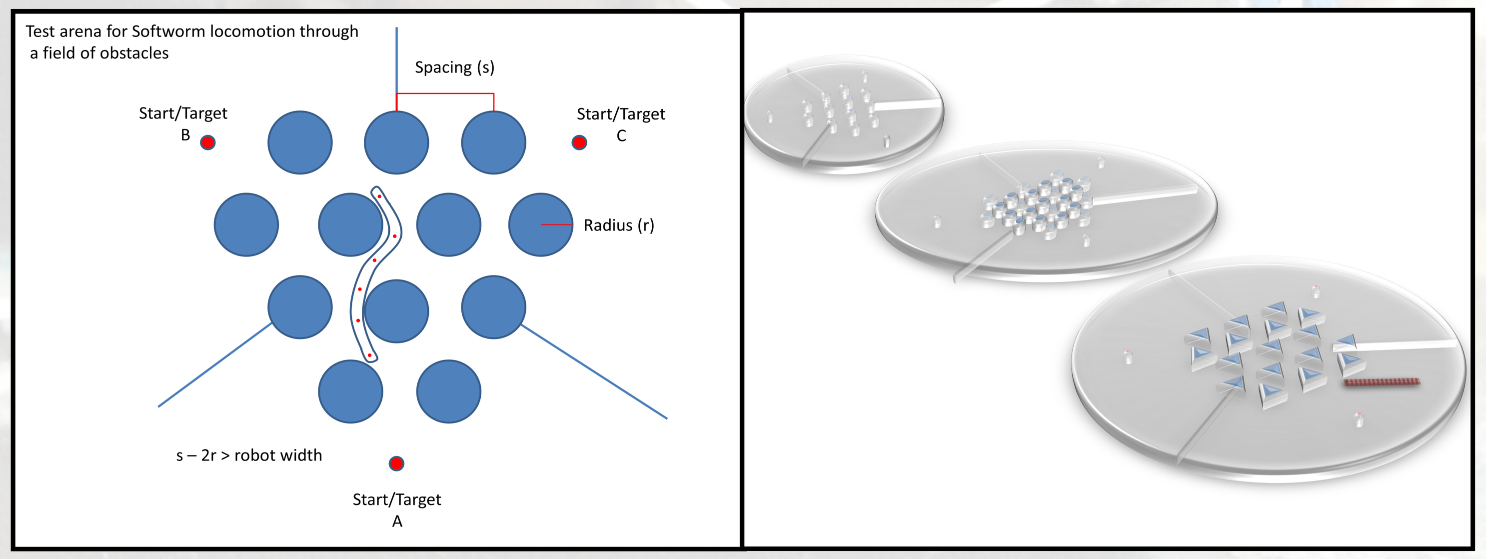
As the player navigates through the arena, we are collecting which buttons and/or keys they press and in what order. We are also using the live video feed to collect information on where the robot is at a given point in time, what shape its body is in, etc. Combining these two data sources, we will be able to create a genetic algorithm, enabling the robot to choose the appropriate control strategy for a given situation it encounters.

The Future

In the second phase of Softworm testing, the players will guide the robot from one point to another in an obstacle course, and we will collect data on the best strategy for each situation the Softworm encounters, such as going over an obstacle or turning a corner. We will then collect a variety of kinematic and command parameters to expand the robot's control strategies. We will also vary the arenas, using different materials, sizes, and shapes for pegs and place the pegs at varying distances from each other, in order to achieve a wilder range of strategies. Our long-term goal is to continue developing this platform so that it can be applied to more complex robotic systems.



Kinematic and command parameters for the Softworm. Example kinematic parameter set: (x,y) position, velocity (v), and acceleration (a) for the 6 points, and segment angle (α) and length (h). Example command set: actuator R, L, A, P (d, e, φ, f).



Proposed arenas for the Softworms will have three symmetrical sections. Players will guide the robot between targets. Obstacle size, shape, and position can be changed.