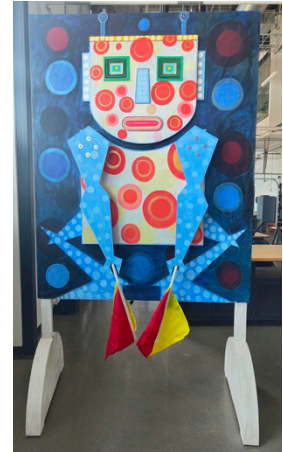


Interactive Semaphore FlagBots

Project manager and client: Prof. Iris Bahar (ribahar@mines.edu)

The Flag Bots:

[Eva Goetz](#) explored the theme of robots in her artwork several years ago. This exploration led to her *Think A Bot It* installation in December 2019 of robots of different shapes and sizes, several with moving arms and lighted digital messaging using communication methods of bygone eras. The installation provided a space for discussion and wonder and was also meant as a platform to discuss deep questions on technology and its impact on society. Of particular interest are her large 'Flag Bots' that move their arms in Semaphore language, signaling visitors to HELP, STOP, LISTEN and THINK. While from afar these are beautiful moving sculptures, at closer inspection they are robots with hardware and software and mechanical and electronic components that require sophisticated design and coordination. The robot art pieces have been donated to Mines by the artist, who has given permission for student to modify their programs to implement new features.



Modifying the Flag Bots:

Two years ago, a team of Mines CS students extended the two Flag Bot robots with new software features, allowing for more human interaction. More specifically, they implemented pose estimation algorithms in software that would capture semaphore messages from humans, and in response, the Flag Bots would signal an appropriate message in semaphore language by moving their arms. Two still frames are shown below, capturing the semaphore pose of the student and the Flag Bot.



Project Summary:

The goal of this project is to modify the software within the Flag Bots, such that the interaction between human and robot is further expanded. This should include an expanded vocabulary of semaphore (or other) messages that can be captured by the pose estimation algorithms as well as an expanded range of responses possible from the FlagBot. Note that the student team from two years ago interacted with only one FlagBot robot at a time, but there are two FlagBots available for modification. Ideally, once completed, this project would be a permanent art installation at Mines.

Work on this project will require learning different software communication protocols, controlling stepper motors, RF sensor control, pose estimation and other computer vision algorithms. Students may also optionally learn about human motion tracking, audio/music integration, and other signal processing algorithms, depending on what enhancements they choose to build into the FlagBots. Software is programmed on both Arduino and RaspberryPi boards.

The students will be involved in every phase of the project from design through implementation. During the design phase the students will interact with Prof. Bahar (and occasionally the robot artist, Eva Goetz) to better understand the current operation of the robots and their hardware and software components. The students are expected to research other robot art installations and propose their own ideas for adding motion, sounds, music, light, etc. to the robots to create a fun and interactive experience between humans and Flag Bots. There will be a modest allowance for purchase of some hardware components needed for the redesign of the Flag Bots.

Desired Skills:

- C++, Java, Python
- Embedded system design
- Prior experience with robot motor control
- Prior experience with motion tracking and computer vision algorithms.

We understand not all the students in the group may have all the technical skills listed above. This is fine, as it is expected that each student will bring unique skills and perspectives that will contribute to the project. All students are expected to work together to design, debug, and problem solve. Students pursuing the CS+computer engineering or CS+robotics tracks may find this project especially complements their coursework.

Workspace location:

The Flag Bots are currently located the atrium area on the first floor of CTLM. While some software development can be completed offsite, students are expected to spend significant time in CTLM working directly on the Flag Bots.