Design and Implementation of Simple Controllers for Ollies and Sparks

Swarm robotics is the study of robotic systems consisting of large numbers of relatively simple agents whose local interactions with each other and with their environment lead to a collectively intelligent behavior. In this project, we are interested in navigation behaviors of the swarm and we would like to build an interface that allows a user to control navigation of robots in a swarm in an abstract manner and by providing a sequence of points each robot must reach during its execution.

The goal of this project is to design and implement controllers for Ollies and Sparks that allow the users to specify a sequence of destination points for the robots to follow and the control inputs that drive the robots from one point to the next one are automatically generated. This involves: 1) an interface that allows a user to specify the number of robots and a sequence of points for each robot, 2) controllers that derive each robot from one point to the next one in their corresponding sequence, 3) simulation of the scenario and validating correct execution of the controllers.

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Robot Manufacturing Task Design

You will design and build all necessary hardware to model an assembly task that a robot would be required to perform in a low-production flexible manufacturing environment. The robot will be placed in front of a conveyor belt and have access to bins containing parts. New parts may come on the conveyor belt or be delivered into the bins by assistants. The robot will use these parts to assemble a product in a separate work surface, and deliver it via the conveyor belt when it is ready.

The focus of this project is designing the task, parts, conveyor belt, and all necessary electronics to operate it. This includes actuating the conveyor belt and implementing sensors in the environment, for example to signal to assistants that a bin is empty and needs more parts. Programming a Kuka Youbot to perform the task is available for larger teams that have significant experience in object manipulation.

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Build a Localization Module for the Orbitix Spheros

In this project, you will design a localization module that can always stay on top of a Sphero (as shown in Fig. 1) for localization purpose when using the robot with the Vicon motion capture system. To use the motion capture system with a Sphero, first you need to build a distinct rigid model for the robot by placing some reflective Vicon markers (Fig. 2) on the robot. Yet, the Spheros rotate like spheres and thus we cannot place the markers permanently onto the robots. You will need to design an outer shell that can hold some Vicon markers and remain upright when the robot is rotating below it.

Fig. 1 Two Types of Spheros: (a) Sphero SPRK+ on the left; (b) Sphero 2.0 on the right

Fig. 2 Vicon reflective markers

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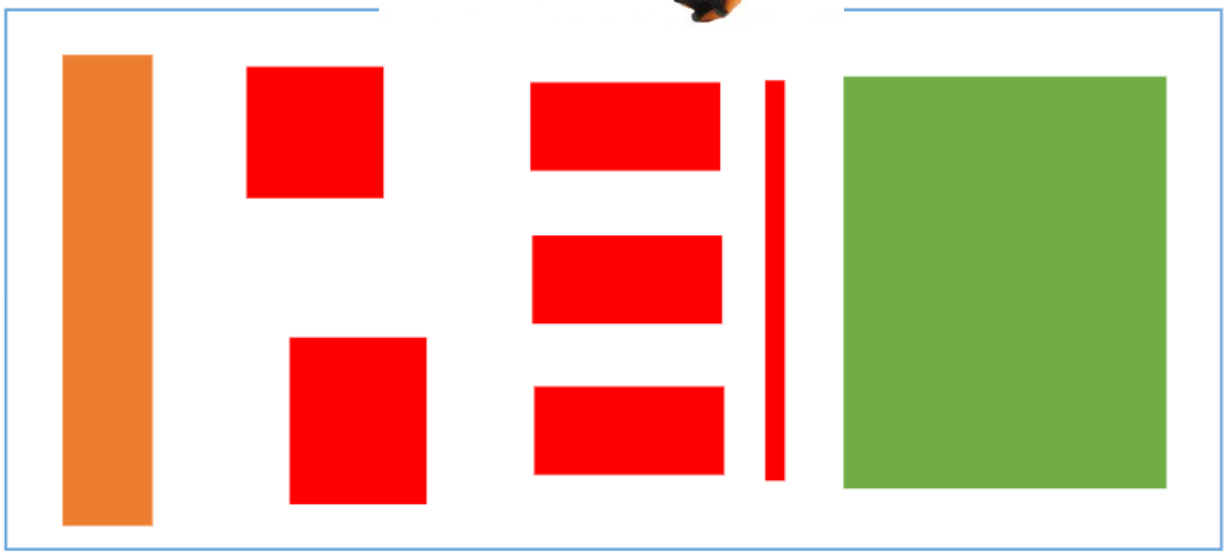
Write a Program to Control a Youbot with a Joystick

KUKA Youbot is a holonomic mobile robot that is able to move on a flat surface. The diagram below shows a simplified map of our lab. The orange region represents the area where the Youbot will be stored. The red regions are potential obstacles on the floor. The green region is where we do experiment with the Youbot. The student will need to write a program (preferably a Robot Operating System package) that allows any user to remotely drive the Youbot with a provided joystick to navigate around our lab. In addition, the program will also serve as a safety guarantee to allow the user to fully stop the Youbot at any time by pressing a button on the joystick.



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Design and construction of a gripper

Due to its evolution and development of opposable thumb, human hands can grasp and manipulate a variety of objects with strength and control. Gripping is such a trivial task that we do not even think much. However, this function is not as easy for a robot to perform because of some objects' complex geometry, the torque need it to manipulate it and the fixed design of the gripper. Thus, a gripper is usually designed to manipulate a determined shape and size of an object and that is why there is a variety of gripper designs nowadays. This project will involve (a) designing an adaptive gripper to manipulate small objects with a variety of shapes (b) choosing the best manufacturing process, actuators, and sensors and (c) finally, assembly of the gripper and testing it with common objects.

Some directions with which you could start this project:

- Design a compliant mechanism for the gripper
- Use 3D printer to manufacture it

Requirements: CAD software knowledge

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