Abstract

Our objective is to develop a robotic arm that can play air hockey against a human player. The arm will be two tracks mounted at right angles. One track will be able to move vertically along the length of the table and the other track will be able to move horizontally across the table's width. An overhead camera will tell the arm where the puck is at any given time. The arm then responds by making a decision whether to protect the goal or to hit the puck. In the course of this project, we will be applying several existing technologies such as robotic manipulation, image recognition algorithms, and basic artificial intelligence to create a robotic air hockey table. This phase of the project deals only with building the robotic arm.

Introduction

In the mid-1980s, the CMU Robotics Club built a robotic air hockey table. It was quite limited in design. The arm had but one degree of freedom – left and right, and its logic was not very good. A picture of the air hockey table is available at CMU Robotics Club website at http://www.roboticsclub.org/pics/hockey-robot.gif. Our plan is to utilize existing technologies to build a more sophisticated robotic arm with better artificial intelligence to play air hockey. In this we will be developing new feedback-control algorithms for use with motion-planning systems, useful for many applications. These include mobile robotics, coordination tasks, and other similar problems.

Proposal

Our goal is to build a robotic arm with three degrees of freedom that can play air hockey. In this first phase of the project, we focus on developing the robotic arm and its control board. The arm will consist of two tracks mounted at right angles, one track that can move vertically and the other can move horizontally. This design will allow the arm to reach any location on its half of the table. A vertical pole holding the paddle will be attached to the crossed tracks. The pole will be able to move up and down through the use of a solenoid (the third degree of freedom) so that the arm can catch the puck and not worry about friction while moving. By the end of this phase, we should have a working arm that can smoothly move through half of the air hockey table. A joystick controller will be used to test the motion of the arm.

The following semester we will apply for another Small Undergraduate Research Grant (SURG) to develop a vision system for the air hockey table. The vision system will send input to the control board which in turn directs the arm to move to a particular location. By the end of this second phase of the project, we will have a working robotic arm that can play a decent game of air hockey against a human player.
Since this project is sponsored by the CMU Robotics Club, we will have the opportunity to discuss our project with several senior officers with vast experience in robotics. We also have access to all the resources that the Robotics Club can provide. After the project is finished, if further improvements can be made to the project, the air hockey table will remain with the Robotics Club. Otherwise, an air hockey table with an intelligent robotic arm will be donated to Carnegie Mellon University.

Applicants

Chris Atwood is a sophomore in Mechanical Engineering. He is the President of the Robotics Club and has worked on several robotic projects including Urban Search and Rescue and a vertical take off and landing vehicle. Fabien A. Heitz is a freshman in Mechanical Engineering. He has taken Physics I and Introduction to Mechanical Engineering. In his spare time, he enjoys building model cars, boats, and airplanes. Richard Juchniewicz is a freshman in Mechanical Engineering. Currently he is a member of the Robotics Club working on building a hexapod with a CMUCam for Mobot. Arun Penmetsa is a freshman in Electrical and Computer Engineering. He has taken Physics I and Introduction to Mechanical Engineering which are particularly relevant to this project. Currently he is a member of the Robotics Club working on developing a robot for the Trinity Firebot Competition. Steven Shamlian is a freshman in Electrical and Computer Engineering. He has over two years of experience working with robotics. Last summer he worked for iRobot on the mechanical design of the Roomba, an autonomous floor vacuum cleaner robot. Currently Steve is the treasurer of the Robotics Club working on robots for Urban Search and Rescue and developing accessories for the Cerebellum microcontroller. Andy Shen is a freshman in Electrical and Computer Engineering. Currently he is a member of the Robotics Club working on the Trinity Firebot project and on implementing Simultaneous Localization and Mapping algorithms on a mobile robot. Ramarao Yalamanchili is a freshman in Electrical and Computer Engineering. He is currently working on the Autonomous Helicopter project.

For this project, the mechanical engineers Chris Atwood, Fabien A. Heitz, Richard Juchniewicz will be responsible for building the robotic arm. Electrical engineers Arun Penmetsa and Steven Shamlian will be implementing the circuitry, control board, joystick controller with the robotic arm. Electrical engineers Andy Shen and Ramarao Yalamanchili will be programming the control board to move the robotic arm.

Dissemination of Knowledge

We will be submitting our findings to Momentum and any industries that would find our work interesting. After completion the robotic air hockey table will also be open to the public.

Presentation and Evaluation

We will present our final results at the Undergraduate Research Symposium. In addition, we will exchange weekly emails with our advisor Matthew Mason to ensure that we stay on track.
# Proposed Budget

<table>
<thead>
<tr>
<th>Components</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Hockey Table</td>
<td>$500</td>
</tr>
<tr>
<td>Robotic Arm Components</td>
<td>$350</td>
</tr>
<tr>
<td>Control Board</td>
<td>$100</td>
</tr>
<tr>
<td>Controller</td>
<td>$50</td>
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</tbody>
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Total $1,000