WHAT ONLINE HUBO CAN LEARN FROM CTU’S SYROTEK

SYROTEK MOTIVATION
The System for Robotic E-Learning (SyRoTek) at the Czech Technical University (České vysoké učení technické, CVUT) in Prague was developed to allow students of the university and also remote students access to multiple mobile robots and a testing environment. The robots can be accessed over the internet and controlled through a Stage simulator interface or by using the Robot Operating System (ROS). As is our goal at Drexel University for our full-sized humanoid, HUBO, a safe and dynamic testing environment with robust robots and communication has been built for worldwide educational use.

This document will cover, in multiple sections, the SyRoTek features relevant to the development of the Online HUBO system at Drexel. The topics discussed include:

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ACCESSIBILITY

SyRoTek was developed to be accessible worldwide to people interested in mobile robot research but lacking robots or an environment in which to test. Users who register are given the ability to reserve up to six robots at a time for half-hour or more time slots. During this time, the robots are accessible to only the one user. Registered users are also given a Subversion (SVN) account which can be used to load code onto the SyRoTek server for testing.

Considerations for HUBO

- Online user registration
- SVN (or Git) account on server
- Time slot reservation

AVAILABILITY

When a reservation is made, the user chooses how many robots he needs and what capabilities the need (i.e. laser range finder). The availability of the robots is displayed to the user through the SyRoTek website. If not all robots are charged, it will show that the robots are available at a later time slot. When a reservation is made, the necessary robots will automatically drive from the charging stations out to the main floor of the arena. At the end of the reserved time, the user is warned of their dwindling time though the console and the robot drives back to charge itself.

Considerations for HUBO

- Availability of robots displayed online
- Robot moves out to the proper workspace for reserved time
- Self docking and charging

Alex
ADAPTABILITY

Each SyRoTek robot has IR and sonar range sensors. Also, each has a compass, accelerometer, camera, and wheel encoders. Almost every robot also has a laser range finder. The SyRoTek arena has a wide open area for robot group exercises with raisable obstacles for path planning or mapping work. Also, for navigation algorithms, a maze like area of the arena is available at all times. The maze area includes raisable doors so that the maze may have many variations. The multiple types of layouts available with the SyRoTek arena, along with as many sensors as will fit on the robots, allow for use testing many types of algorithms in many situations.

Considerations for HUBO

- More sensors allow for more uses
- Dynamic environment - obstacles can be added to an otherwise empty work area
- Multiple workstations with different tasks (grasping, vision, stair climbing, etc.)
- Ability to reset environment (e.g. reset cup position for grasping task)
- Drexel must install sensors/hardware necessary per user request (user provided)

USER INTERFACE

While using the SyRoTek robots in the arena, it is not difficult to know what is happening, even from a remote location. Three web-accessible cameras are located within the arena to give the user visual feedback of their algorithms at work. A web-based arena map also shows robot graphics moving around based on location and orientation data. Also, Stage plugins have been developed to make raising and lowering obstacles in the field as simple as clicking the obstacle in the simulator.

Considerations for HUBO

- Visualization tools for sensor data, possible web-based
- Full positional feedback utilizing currently installed motion capture system
- Ability to easily add obstacles to or reset a work environment
SAFETY

The robots of SyRoTek are small, stable mobile robots. There is therefore very little to worry about except crashing into walls. When positioning the robot around the area, an automatic path planning algorithm is employed to get the robot there without collision. This obstacle avoidance is overridden by any user algorithm employed on the mobile robots.

Considerations for HUBO

- Gantry must lift and reset HUBO after failure
- Gantry and HUBO soft limit at arena extents and near static obstacles
- Gantry should lock if connection (if algorithm is running on client)
- HUBO should navigate to the different work environments autonomously
- Self- and external collision checking before motion if physically enacted.

SOFTWARE

The SyRoTek website provides the plugins necessary to use NetBeans IDE to communicate with the arena and the robots. Through this interface, the algorithms can be programmed and tested in the Stage simulation environment then easily tried in the real area. You can also use this software to raise available obstacles and make arena reservations.

ROS has also been implemented for robot control and data acquisition.

Considerations for HUBO

- Downloadable ROS package for HUBO sensors and actuators
  - ROS demo sensor visualization
  - Data logging
- Integration with a simulator (OpenRave / Gazebo) for collision detection and pre-HUBO algorithm testing
- Ability to communicate with ROS remotely (roscore on Drexel server, algorithm on client)
- Ability to download and run code locally (on HUBO) for real time applications
DOCUMENTATION

The SyRoTek website includes both a user's manual and guidelines for teachers, students, and remote users. For users, fully working Linux distributions are available to be used with VirtualBox, VMware, or as a .iso file type. Test environments and scenarios correspond to problems trying to be solved by students enrolled in different courses available.

Considerations for HUBO

- HUBO software installation guide for users
- HUBO example code for demonstrations
- Beginner problems to be solved

Presented in this outline are the high-level features of CTU’s SyRoTek that should be considered when developing the Online HUBO system and interface at Drexel University. When using robots from a remote location, the user interface plays heavily into how the system will be used and how productive the user can be. Ease of use includes straightforward methods of testing code on virtual and online HUBOs along with the availability of many types of feedback to the user. Ease of sensor data acquisition and visualization is a must for productive algorithm implementation, tuning and debugging. SyRoTek provides a very easy way to reserve robots, test your code and see what you are doing. These high level ideas of what the remote system should be will guide our design and development towards a well-used and full-featured Online HUBO.