Preparing the Segway for Autonomous Navigation

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Goals

- Integrate the Segway with the existing robots in the GRASP lab
- Find the optimal method of mounting sensors on the Segway platform
- Enable the Segway to complete autonomous navigational tasks
Why the Segway?

- Very maneuverable:
  - small foot-print
  - zero turning radius
- Carries over 100 lbs on its platform
Problem: Mounting Sensors

- When undergoing acceleration the Segway’s platform pitches.
- This decreases the usefulness of the data collected from sensors.
Solution: Dynamic Sensor Platform

- The platform that carries the sensors acts as a pendulum
- The sensors will always have a horizontal orientation

Constant Velocity  Forward Acceleration
The Software Platform

- Robots in the GRASP Lab are run on the Remote Objects Control Interface (ROCI)
- Basic Building Blocks of ROCI:
  - Modules: processes that take an input and give an output (C#)
  - Pins: connect modules together (C#)
  - Tasks: specifications of how modules are attached together via pins to create applications (XML)
Basic Segway Software

- Segway module: sends commands to the Segway
- Segway Dashboard module: provides a user interface for Segway control

Example Screenshot of the User Interface
Autonomous Navigation: Obstacle Avoidance (1)

- Uses the laser range-finder for obstacle avoidance

Using the equation for \( r \), one can filter the laser’s readings (if the actual reading is shorter than the calculated \( r \) then there is an obstacle/if it is longer then there is a hole)

**Flaws:**
1) Assumes that the ground is a horizontal plane (no hills/ramps)
2) Only recognizes obstructions that intersect with the plane of the laser’s view (defined by the red and orange lines)
Obstacle Avoidance (2)

- Current Obstacle Avoider: Passive (no planning)

**SegwayObstacle Module**
- Filter laser data
- Check laser data for obstacles
- If no obstacles then passes on drive commands unchanged else turns on obstacle avoidance

**Obstacle avoidance:**
1. Stop then turn until path for the Segway is clear
2. Choose an angle that still “sees” the obstacle
3. Drive straight ahead while checking the chosen angle
4. When the distance to the obstacle has been receding for some time turn off the obstacle avoider
Obstacle Avoider (3)

Original Course
- Turns off obstacle avoider
- Line of Observation
- Projected Course

Course if the obstacle were to extend further outwards

Goal
Obstacle
Robot

11/12/2004
Autonomous Navigation (Future Plans)

- Active Obstacle Avoider: maps the obstacles, knows the location of the robot and the location of its goal and attempts to plan a route

  -need to be able to locate the robot on an absolute grid with a fair degree of accuracy. Indoors (hard problem) could use encoders (error-accumulating). Outside could use Global Positioning System (GPS)

- Combine the Obstacle Avoider with other autonomous navigational applications (i.e. way-point following or blob following)
Conclusion:

- Segway technology has potential for robotic applications especially as a platform for an indoor autonomously navigated robot.
- The dynamic sensor platform and the work with the laser range finder lays the groundwork for using the Segway as an autonomously navigated robot.
- Future work should focus on improving the obstacle avoiders and on combining them with other robotic applications using other sensors.

For more information:

http://www.cis.upenn.edu/marsteams/Segway/Segway%20site.htm
http://www.grasp.upenn.edu/research/