Preparing the Segway for Autonomous Navigation

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Goals

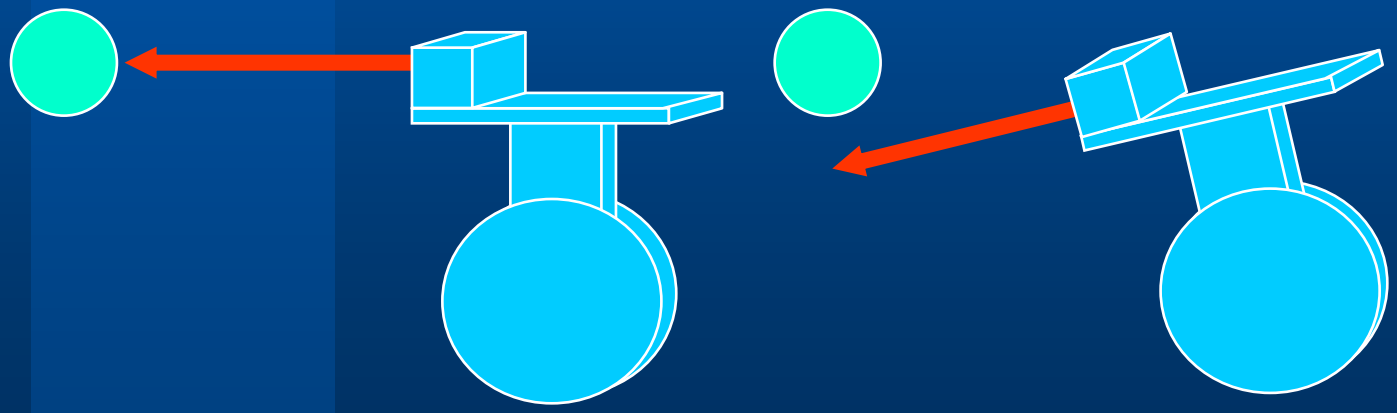
- Integrate the Segway with the existing robots in the GRASP lab
- Find the optimal method of mounting sensors on the Segway platform
- Enable the Segway to complete autonomous navigational tasks

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

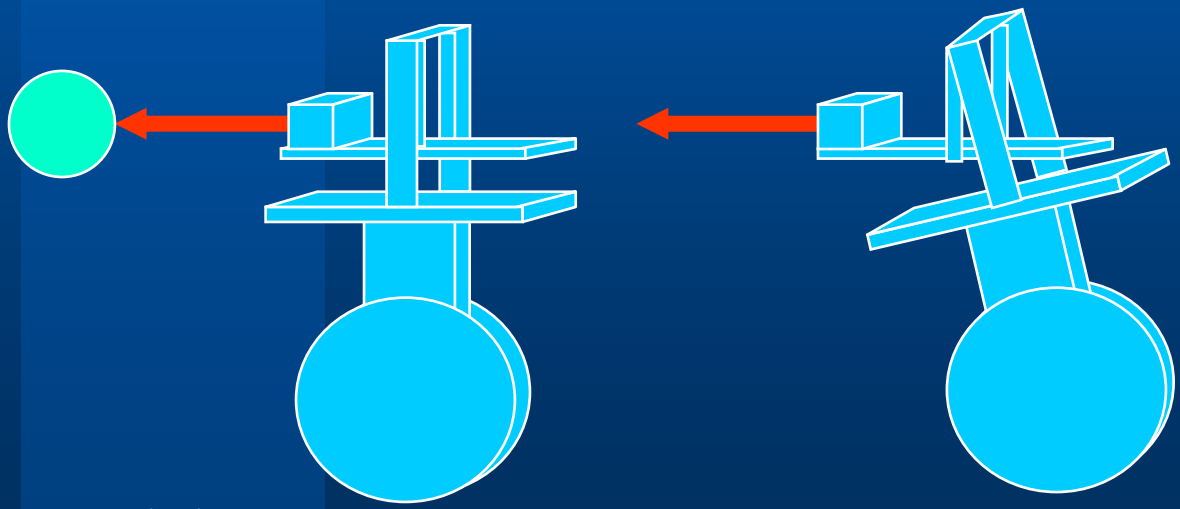


Constant Velocity

Forward Acceleration

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:**

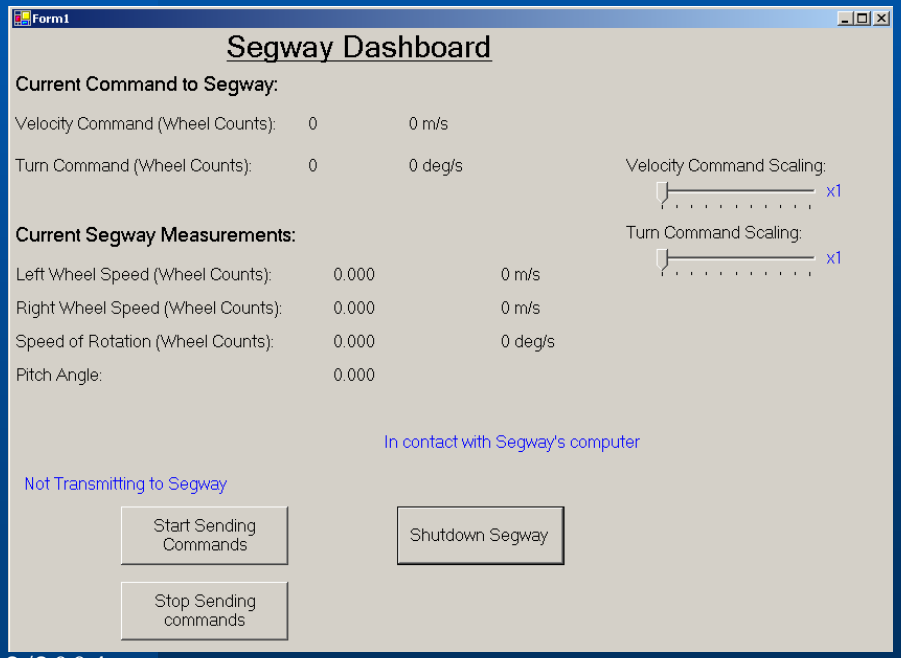
  -Modules: processes that take an input and give an output (C#)

  -Pins: connect modules together (C#)

  -Tasks: specifications of how modules are attached together via pins to create applications (XML)

Basic Segway Software

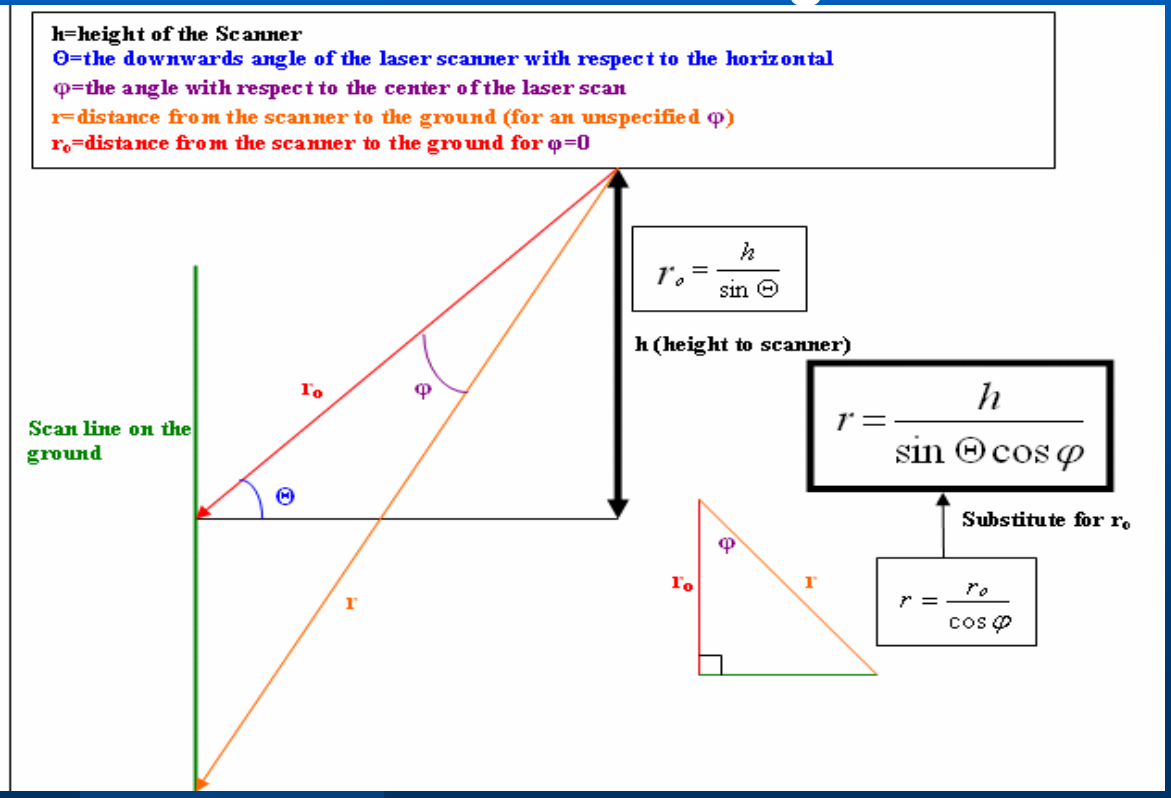
- **Segway module: sends commands to the Segway**
- **Segway Dashboard module: provides a user interface for Segway control**



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)

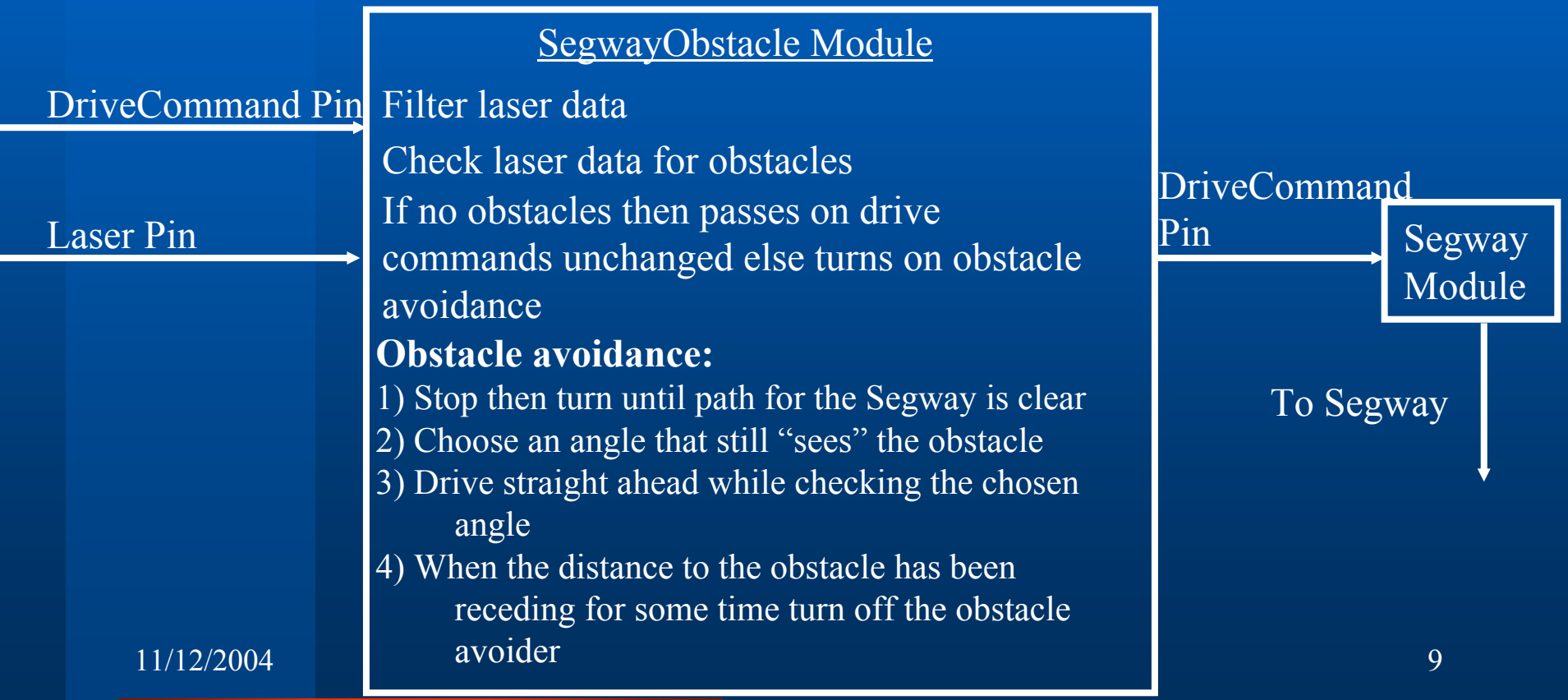
Flaws:

1) Assumes that the ground is a horizontal plane (no hills/ramps)

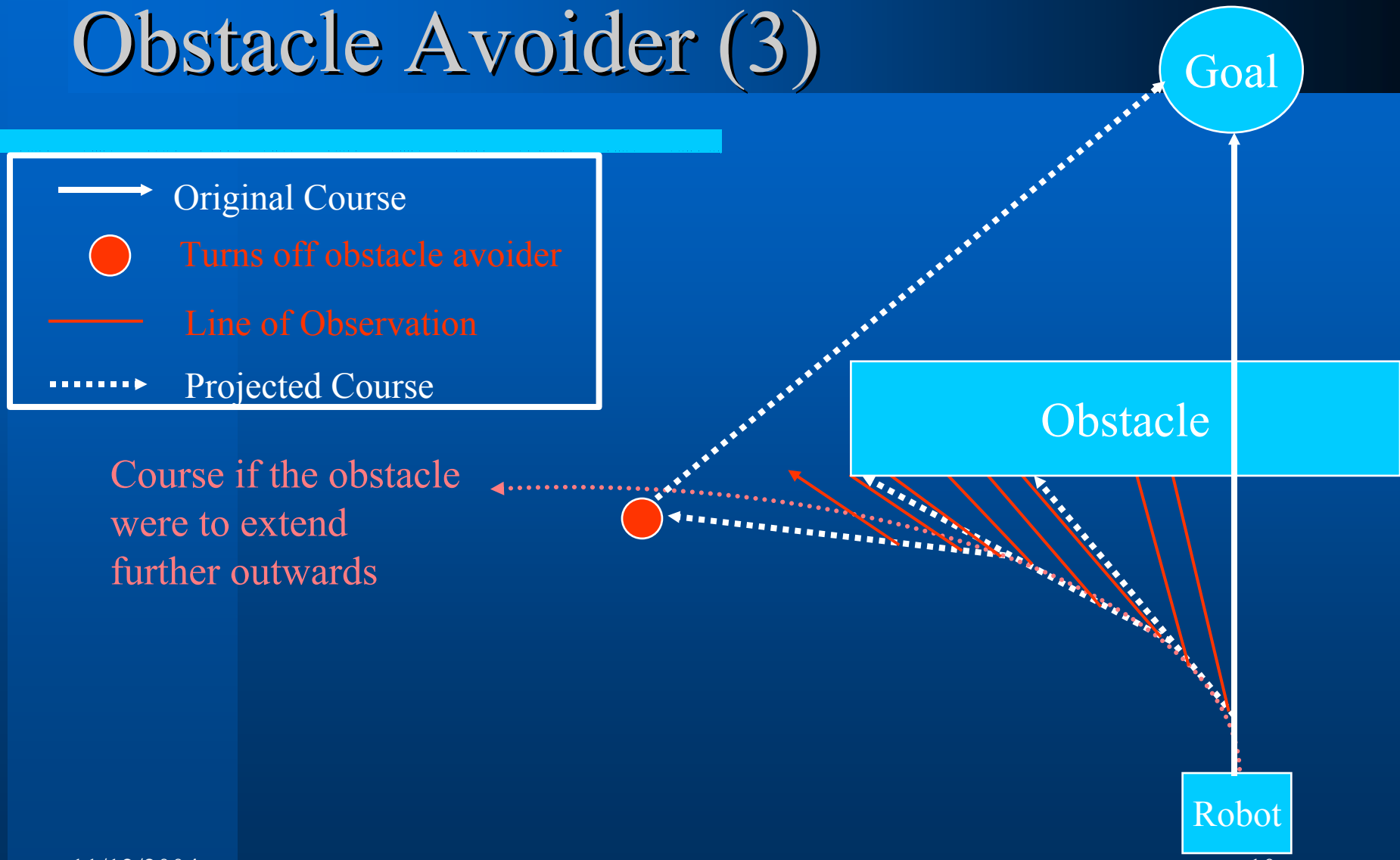
2) Only recognizes obstructions that intersect with the plane of the laser's view (defined by the red and orange lines)

Obstacle Avoidance (2)

- **Current Obstacle Avoider : Passive (no planning)**



Obstacle Avoider (3)



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.darpa.mil/ipto/programs/mars/rmp.htm

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

http://www.grasp.upenn.edu/research/