Lab Assignment 2: Coordinate Transformations

Goals
- To gain a better understanding of transformations within global and relative coordinate systems.
- To apply the kinematic equations and matrix manipulations discussed in class.
- To provide a basis for localization techniques which you will learn later in the semester.
- To have some fun!

Team Assignment: Design a Waypoint-Traveling Robot

1. Design and construct a robot that translates and rotates on both global and relative coordinate systems using the transformation matrices and kinematic equations described in class. Movements will be determined at run-time using a menu-driven movement command interface, which will be provided for you. At the end of each movement, the robot should display its current position relative to the origin. Each team will execute a series of 9 commands, chosen by your teaching assistant. Commands include:
   a. `rotateGlobal(θ)` rotate the robot θ degrees about the origin
   b. `rotateRelative(θ)` rotate the robot θ degrees about itself
   c. `translateGlobal(x, y)` translate the robot to coordinate (x, y) relative to the origin
   d. `translateRelative(x, y)` translate the robot to coordinate (x, y) relative to itself

2. Mount a white board pen near the center of your robot that will be used to trace your path. Pens will be provided. A white board with targets will be in place in EB 2029.

3. Using the CMUCam, search for the red soda can of the specified color. Once the can is found, report the coordinates of the soda can relative to both the robot and the origin. Then, search for the green second soda, and report its coordinates as with the red can. In addition, display the coordinates of the green can relative to the red can.

Notes and Suggestions

1. Your team will need to design a drive-train. There are numerous types of wheel configurations and drive trains. Some provide more accurate movement than others. Read Chapters 2 and 4 of “Robotics Explorations” for a simple robot design and to learn about gearing. There are also links on the course website to other drive trains.

2. IC 6 has Back EMF motor library commands that will help you complete this assignment. Additionally you could design your own encoders. Chapter 3 of “Robotics Explorations” has information about encoders.

3. Read Chapter 5 of “Robotics Explorations” to learn about PD control.

4. There are numerous sub-systems to this assignment so it will take team work to complete it. Here is a suggested division of labor for this assignment: ME’s – design and build mobile robot and drive train, design the calculations for determining global and relative coordinates. ECE’s – determine sensor suite, determine the conversion of sensor data into real-world measurements, for example ticks per inch of movement, distance to objects. CS’s – implement motor commands & search algorithm, implement coordinate calculations. After your design meetings it will be important to work concurrently.

Demonstration
- Demonstrations will be in class on February 13th.
- Your team will have three attempts; the best of the three will be counted.
- Only five human interventions are allowed.

Hand-in
- A lab report describing your team’s design. It must include pictures with labels. If you need a digital camera, one can be checked out (contact Ross or Jeff).
- Team Meeting Notes
- Due date: February 15th at 5pm. Soft copies must be placed in the class drop box.
Evaluation: 100 points

- 45 points: Robot Coordinate Transformations (5 points each; -1 point per inch error)
- 30 points: Object Coordinate Transformations (6 points each; -1 point per inch error)
- 15 points: Lab Report
- 10 points: Team Meeting Notes

Extra Credit: 20 points

- Draw a regular convex polygon up to 8 sides (triangle, rectangle, pentagon, …) : 2 points per for each point of the polygon, or draw a circle for 20 points.