Lab3 CSCE-892

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1 Lab3: PID Controller

Documentation of the tasks implemented:

The code implements three tasks: 'TaskEdge', 'RightTaskCorner', and 'LeftTaskCorner', which together allow Ringo to navigate a right and then left square path. Each task represents a specific behavior or action that Ringo needs to perform.

1.1 Control Law Implemented:

The control law implemented in the 'TaskEdge' task is a PID controller to maintain a specific heading (the heading at the start of the task- to move in a straight line) while moving forward. The same exact control loop is applied in the turning tasks to turn towards a specific heading (resulting in a 90-degree turn). The equation for the control law is:

$$\text{delta} = K_p \times \text{error} + K_i \times \text{error\_total} + K_d \times (\text{error} - \text{error\_last})$$

Where:

1. delta is the speed correction value for the motors.
2. K_p, K_i, and K_d are the proportional, integral, and derivative gains respectively
3. error is the difference between the target heading and the current heading
4. error_total is the sum of all errors
5. error_last is the error in the previous iteration.

1.2 Implemented Tasks and Justifications:

1. "TaskEdge": This task is responsible for moving Ringo forward while maintaining a specific heading(the heading at the start of the task- to move in a straight line). The task ends when the robot has moved for 2

seconds and is an open loop control task. It is sporadic, as the start of this task is determined by the ending of the turn task which is not regular and not predictable. The frequency of the control loop itself is determined by the duration and interval variables in the PID loop, which in turn affects the rate of correction for the heading. Inside TaskEdge, there is a conditional statement that determines which direction the next turn needs to be (to produce the right and then left squares). The corresponding task is unlocked and then the task edge blocks itself.

2. "RightTaskCorner" and "LeftTaskCorner": These tasks are responsible for making 90-degree right and left turns respectively. They are also sporadic, as they only run when the other edge task is complete. There is an artificial limit on the number of times a task can be called because of the design of the tasks–they only switch when they have been completed. The Corner tasks are closed-loop control. Bingo continues to perform the Corner task until the goal is met and does not switch otherwise. In this way, if the robot was stuck, it would theoretically hang. When the turn is completed, whichever corner task is running will unblock the TaskEdge, and then block itself.

1.3 Task Breakdown:

The tasks are broken down based on the specific actions Ringo needs to perform: - 'TaskEdge' handles forward movement and heading correction. - 'RightTaskCorner' and 'LeftTaskCorner' handle turning right and left respectively. This breakdown of tasks was selected based on their applicability to the problem at hand: drawing squares. Conceptually, it was easiest to design the system as a series of exclusive actions. This fit the goal task because a square path requires that Bingo the Ringo be either turning in place or making a straight line, the combination of these actions in a loop produces the squares.

1.4 Frequency Justification:

The frequency of each task is determined by the interval variable in the PID loop, which is set to 0.075 seconds. This interval allows for smooth and continuous correction of the heading, ensuring that Ringo stays on course.

1.5 Link for video:

Check out this link to watch Ringo being professional.

1.6 Acknowledgment:

This task has been made possible by equal contributions from the group members: Jett Durante, Apala Pramanik, and Darryl York.