Lab Report: Triangular Motion Profile Mini Car Project

Objective

The aim of this project was to gain practical experience in position and velocity control of a dynamic system using a mini car, which was introduced in Lab 5. This involved assembling the mini car, modifying provided software for specific tasks, and tuning PID controller parameters for optimal performance in both position and velocity control tasks.

Methodology

The project was executed in several steps:

Velocity Control Task: Implemented a velocity control script to move the mini car at a constant velocity of 65 RPM, adjusting the MAX_RPM parameter and utilizing a serial plotter for visualizing motor velocity readings over time.

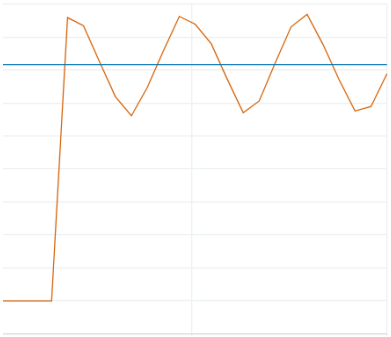
Position Control Task: Utilized a position control script to direct the mini car to a set position, calculating the encoder tick counts corresponding to the target distance.

PID Tuning: Experimented with different PID gain settings to achieve low steady-state error, and low oscillations when traversing a specified distance.

The following coefficients effected the system in different ways

Kp = 0, Ki = 3.5, Kd = 0

Goes to position and oscillates indefinitely



Kp = 3.5, Ki = 0, Kd = 0
Goes to position with slight overshoot, and oscillates to a stop at the position

Kp = 3.5, Ki = 0.005, Kd = 0

Smoother, faster to get to position, still some small oscillations to a stop, minimal SSE

Triangular Velocity Control: We experimented with different MAX_RPM, Delay time for velocity increments.

Actual vs desired speed

Implementation of Triangular Velocity Profile

For the main challenge, the mini car was required to carry five wood blocks over a distance of 50 cm using a control system. We Tried using PID, Triangular Velocity Control, and Trapezoidal Velocity Control. We decided to use a triangular velocity profile. This profile was selected for its smooth velocity variation, beneficial for carrying multiple blocks without causing instability. The triangular profile was implemented by defining appropriate MAX_RPM and cycle numbers and increment delay, ensuring the car could smoothly accelerate and decelerate over the course.

Results and Discussion

The mini car successfully completed the main challenge, demonstrating efficient position and velocity control under the constraints of carrying five blocks. The triangular motion profile allowed for smooth handling of the load, minimizing the risk of the blocks toppling over during acceleration or deceleration phases.

Conclusion

The project successfully demonstrated the application of theoretical control principles to a practical scenario, highlighting the importance of PID tuning and motion profiling in dynamic system control. The use of a triangular velocity profile proved effective for the task, showcasing the potential for similar approaches in automated transport and robotics applications.