Robolympics Final Competition

EGR 345 F23

Introduction

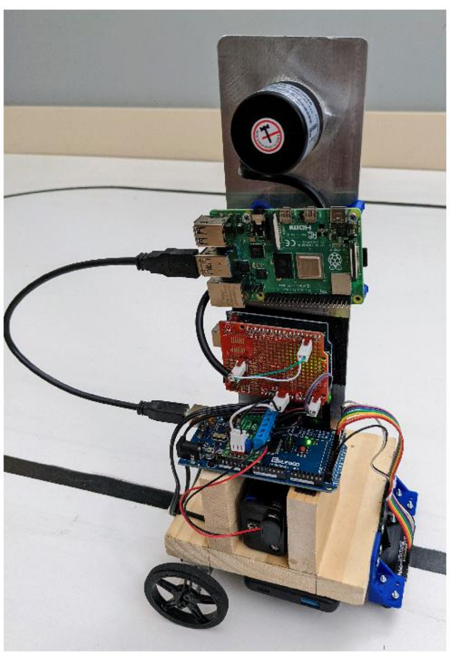
For the final project in EGR 345 you will program a pendulum/cart system to compete in a series of three events:

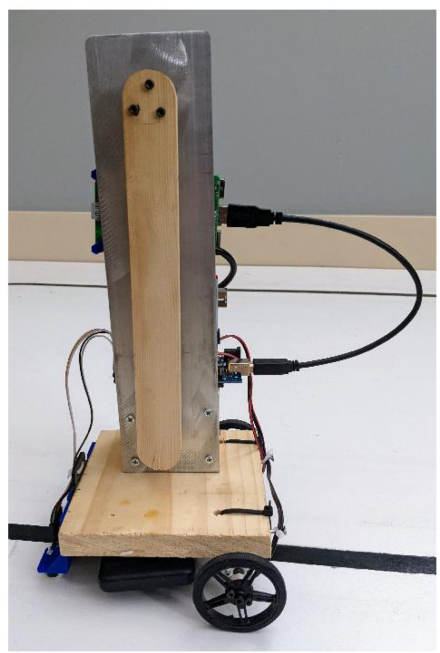
1. vibration suppression of the pendulum on the cart
2. completing three laps around the oval track while suppressing vibration of the pendulum
3. completing as many laps as possible (no time limit) while balancing the pendulum in the vertically up position

Your team's score for the final project competition will depend on how your robot performs in the three separate events.

System Description

The robot has two DC motors powered by an H-bridge. The sensors include an encoder to sense the pendulum position, and two line sensor arrays (one in the front and one in the back). An Arduino Uno is dedicated to reading the pendulum encoder. An Arduino Mega handles the H-bridge that accuates the motors and the line sensor. The main control is done by a Raspberry Pi that communicates with the Uno and Mega via i2c.



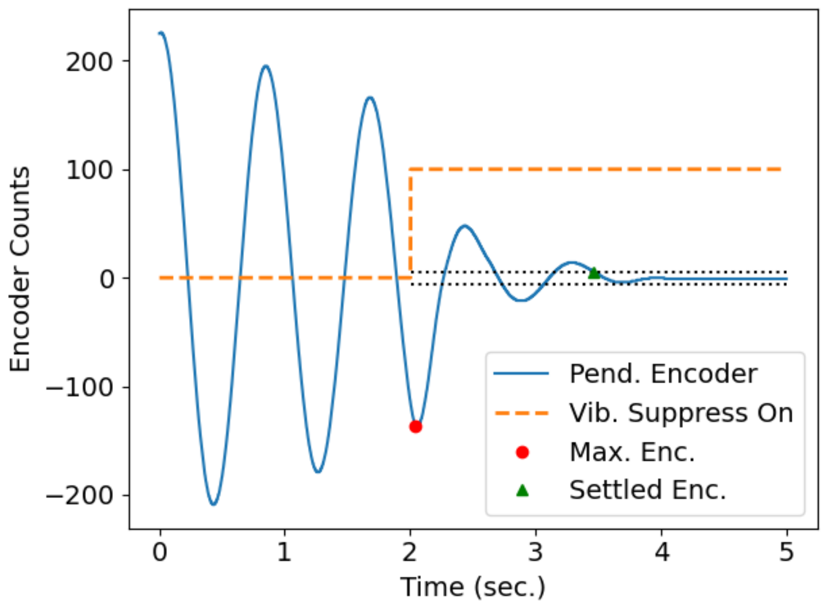


Event 1: Vibration Suppression

For the vibration suppression event, your instructor will flick the pendulum and start it swinging. Your team will then start the test by giving a command to the Raspberry Pi at the terminal. Your code must collect at least one second of data before switching on the vibration suppression control. Additionally, your vibration suppression must switch on before the encoder peaks fall below 75 counts.

Note: the cart cannot move until the vibration suppression control turns on. Your block diagram must print a variable that indicates when the vibration suppression control kicks on, in addition to the encoder data. Your score for this event will depend on the settling time that will be measured from when the vibration suppression control turns on. Settling time will be determined by finding the largest encoder value after the vibrations suppression control turns on. Your pendulum has settled when it stays within ±4% of that largest encoder value. Note: For this event, your cart must come to rest within ±4 in of where it started the event.

Example Vibration Suppression Settling Time Graph



Recommended steps:

- Perform a swept sign test to determine the transfer function between voltage to the motors and the pendulum encoder output
- Use root locus to design the vibration suppression controller

Event 2: Vibration Suppression + Line Following

For the second event, the robot will follow the line and complete three laps as quickly as possible while also suppressing pendulum vibrations. The pendulum encoder counts must remain with +/- 30 counts for the entire event (all 3 laps). If either wheel touches the line, your run is disqualified.

Event 3: Balancing the Pendulum in the Vertically Up Position

The goal of this event is to keep the pendulum balanced in the vertically upward position for as long as possible. One problem encountered in the past is that the robot may tend to "wander off" while it is balancing the pendulum. The purpose of having line sensors on the front and back of the robot is so that your robot can go around the oval indefiniltey and not wander off. Your score will be based on how long the pendulum remains vertical. Your robot does not need to make progress around the oval - your score is based solely on time, not distance.

The event ends when your pendulum falls below horizontal.

The robots may behave somewhat differently going forward versus going backwards. The idea behind following the oval while balancing is that the robot can go one direction indefinitely.

Final Report Expectations

- For event 1:
  - Discuss your control design approach and implementation
  - how did you use the root locus to guide your control design?
  - what steps did you take to tune the design?
  - what were the key challenges for getting a fast settling time on event 1?
  - what steps would you take if you were trying to improve your settling time?
  - or why do you believe your settling time cannot be improved?
- For event 2:
  - describe your overall approach
  - describe how you blended together the line following, forward velocity, and vibration supperssion
  - what could you do to improve your lap times on event 2?
- For event 3:
  - describe your root locus design approach
  - what steps did you take to tune the design?
  - what efforts did you take to keep the robot from wandering off?
  - what suggestions do you have for redesigning the competition to make it possible to keep the robots from wandering off or running into things without blowing on the pendulum?
- General Questions:
  - Discuss anything noteworthy in your control design for any of the events
  - Discuss any novel aspects of your code