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**Lab 2 Writeup – Forward Kinematics**

**Part 1**

A graph with a red line and blue line

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The relationship between commanded effort level and linear speed seems to be generally non-linear through the 75% command. From 50% to 100%, the relationship seems to straighten out slightly into linearity, but it is hard to tell conclusively without data from 0% to 25%.

**Part 2**

Video link to maneuver 1: <https://youtu.be/YuSoHposGy4>

Video link to maneuver 2: <https://youtu.be/IFM7d57Ceo0>

**Kinematic Calculations**

See code in ZIP for math – coordinate convention is +x forwards, +y left, positive theta CCW

Sequence 1: (x, y, theta) = (2.60, 4.59, -14.79)

Sequence 2: (x, y, theta) = (40.27, 35.85, 66.54)

**Measurements of Actual Final Pose**

Sequence 1: 6 cm forwards, 0 degrees angle

* (x, y, theta) = (6,0,0)

Sequence 2: 53.3 cm forwards, 55.5 degrees angle

* (x, y, theta) = (30.19, 43.93, 55.5)

**Comparison Table**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Predicted | Actual | Error Vector |
| Sequence 1 | (2.60, 4.59, -14.79) | (6, 0, 0) | (-131.12%, 100%, 100%) |
| Sequence 2 | (40.27, 35.85, 66.54) | (30.19, 43.93, 55.5) | (25.04%, -22.56%, 16.59%) |

**Error Analysis and Discussion**

It was evident that the low cm/s speed commands exhibit a significant degree of error compared to expectation. Both the speeds tested in Part 2 are much slower than the observed speeds in Part 1. A significant source of error could be tolerances within the motors (e.g. internal friction, wire resistance) causing the same commanded voltage/RPM to result in different output torques at the wheel treads. One may also hypothesize that there are nonlinearities in the motor/speed mapping at low speeds. During the turn move in Maneuver 1, the wheels barely turned. It may be the case that the microcontroller is translating commanded speeds to efforts on a linear scale while the true curve breaks from linear at low speeds. This hypothesis is hard to prove or disprove from the Part 1 curve because no data points were collected below 25% commanded effort. However, one may observe the relatively linear relationship at higher speeds in Part 1 and draw parallels to the much lower Part 2 error percentages for the higher-speed Maneuver 2 compared to Maneuver 1.

Terminal output of kinematic predictor code:

A screenshot of a computer program

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