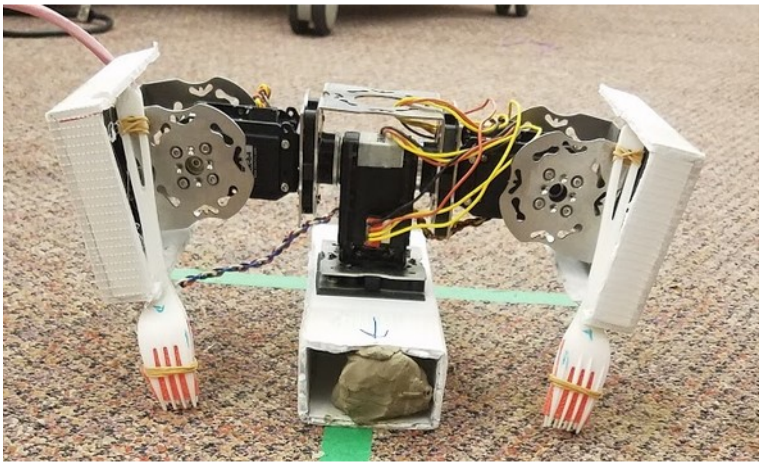
EECS 464 HANDS ON ROBOTICS
PROJECT 0 FINAL REPORT



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FEBRUARY 7, 2018

Contents

1 Background

1.1 Problem Description

The main object of this project is to build a robot that is able to navigate around a figure eight track as fast as possible without being disqualified. The basic requirements include:

1. The robot can move 1 meter forward
2. The robot can rotate 90 degrees
3. Fits in a 60 x 15 x 30 cm box.

Some of the constraints that need to be considered are:

1. Only three Dynamixel motors are allowed
2. No fully rotational parts are allowed
3. The track is carpeted
4. The robot is tethered by controller.

1.2 Brainstorming

1.3 Alternative Prototypes

1.4 Final Design

- **Mechanical Part**

- **Programming Part**
  In the code, we prepare three different motion plans: moving forward, turing left and turning right. Every plan is a cycle with a period of 1 second, and we can hold keys on the keyboard to repeat different motion plans and achieve the leaping and turning function. The three motion plans are shown below. "M" stands for middle servo, "L" stands for the servo on the left(from the rear view), and "R" stands for the servo on the right(from the rear view).

  When moving forward, the middle servo swings the two legs back by 55 degrees. This motion is completed in 1 second. Meanwhile the other two servos fold in by 10 degrees. We realize that leg angles matter after we tested the number of steps needed to leap forward by 1 m by changing the angles. In the test, the angles that we picked are 0, 10 and 20 degrees. The result is in table 4.

  We apply t-test with 4 degrees of freedom to comparing the case of 0° and 10° and comparing the case of 10° and 20°. When comparing 0° and 10°, we had a p-value of 0.001, which is much smaller than 0.05. This is sufficient to reject the null hypothesis of equality and conclude that the legs leap faster when it is folded in by 10° than 0°. When comparing 10° and 20°, we had a p-value of 0.235. This is not sufficient to reject the null hypothesis, so we should say the folding legs by 10° has the same performance as 20° in terms of speed. We pick 10° to ensure that more teeth of the fork legs are touching the ground. It can mitigate the chances that the teeth break when the robot is leaping forward.

  As to moving left, the left servo and the middle servo follow the same pattern as they are when the robot is moving forward. The right servo swings to -90 degrees to raise the right foot in the air. We do this to make sure it doesn't interfere when the left leg is dragging the body rightwards.

  Turning right follows the same philosophy as turning left. The only difference lies in that the motions of the left and right servos are swapped.

t(s)	M(°)	L(°)	R(°)
0.05	0	10	10
0.1	-5	10	10
0.15	-10	10	10
0.2	-15	10	10
0.25	-20	10	10
0.3	-25	10	10
0.35	-30	10	10
0.4	-35	10	10
0.45	-40	10	10
0.5	-45	10	10
0.55	-50	10	10
0.6	-55	10	10
0.65	-55	10	10
0.7	-55	10	10
0.75	-55	10	10
0.8	-55	10	10
0.85	-55	10	10
0.9	-55	10	10
0.95	0	10	10

Table 1: Forward

t(s)	M(°)	L(°)	R(°)
0.05	0	10	-90
0.1	-5	10	-90
0.15	-10	10	-90
0.2	-15	10	-90
0.25	-20	10	-90
0.3	-25	10	-90
0.35	-30	10	-90
0.4	-35	10	-90
0.45	-40	10	-90
0.5	-45	10	-90
0.55	-50	10	-90
0.6	-55	10	-90
0.65	-55	10	-90
0.7	-55	10	-90
0.75	-55	10	-90
0.8	-55	10	-90
0.85	-55	10	-90
0.9	-55	10	-90
0.95	0	10	-90

Table 2: Turn Left

t(s)	M(°)	L(°)	R(°)
0.05	0	-90	10
0.1	-5	-90	10
0.15	-10	-90	10
0.2	-15	-90	10
0.25	-20	-90	10
0.3	-25	-90	10
0.35	-30	-90	10
0.4	-35	-90	10
0.45	-40	-90	10
0.5	-45	-90	10
0.55	-50	-90	10
0.6	-55	-90	10
0.65	-55	-90	10
0.7	-55	-90	10
0.75	-55	-90	10
0.8	-55	-90	10
0.85	-55	-90	10
0.9	-55	-90	10
0.95	0	-90	10

Table 3: Turn Right

0°	10°	20°
11	9	9
11	9	11
11	9	10
11	10	9.5
11	9.5	10

Table 4: Number of Steps to Leap Forward by 1m

2 Result

P-day has four different events. First was the qualification round where the robot had to move from one end of the track to the other in a line ignoring the marker tape. The next event was a race around the figure eight track with inner and outer bounds. The third event was the same as the previous, but only the inner bound applied. The last event was a straight race along a 15' straightaway.

2.1 Qualification

2.2 Figure Eight Track (Inner and Outer Bounds)

	Trial 1	Trial 2	Trial3	Trial4	Trial5
Green Team	134 (DQ)	143		111(DQ)	133
Red Team		76 (DQ)	67		63
Blue Team	160 (DQ)		153 (DQ)	127	

2.3 Figure Eight Track (Only Inner Bounds)

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Green Team		140 (DQ)	110 (DQ)		83
Red Team	63		65	61	44
Blue Team	151	153 (DQ)		166 (DQ)	

2.4 15' Straightaway Race

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Green Team		DNF		38	38
Red Team	39	69	44		42
Blue Team	76		73	54	

3 Discussion

3.1 Project Day Result Analysis

- Turning was time consuming. Takes approximately 7 seconds to turn 90 degrees either right or left. Turns were primarily the reason why we got disqualified so often. Improvements can include adding features to the side of the fork, such as bamboo skewers or knives.
- Our robot slipped a lot. Localized, Friction based movements. Especially on tape. The back end of the base of our robot, ended up adding a knife at the end to help prevent the slipping. Using the leg padding from the other team, helped us realize that directional friction was needed, but ultimately using the padding prevented us from turning.
- Our robot's stride length and stride times were slow compared to other teams.

3.2 Future work