Autonomous Systems Practical Assignment 2: Kick Resubmission

Sho Cremers (S3135144)
Sukhleen Kaur (S3157423)
Group 19B

March 29, 2018

Introduction

The goal was to design a left foot kick for the Nao robot such that the Nao did not fall over, and kicked the ball in a consistent direction.

Method

The programs Choregraphe and Webots were used to design the kick for the Nao. The timeline option in Choregraphe helped us make kick for the Nao where we could set the degree of movement of the joints of the robot, and Webots helped us in running the program in a life-like simulator to see whether or not it might succeed. Center of mass and support polygon functions from Webots were used to see the balance of the Nao during the kicking motion in the simulation.

Design

Program Design

Initially, the Nao bends both of its knees to add stability by lowering its center of mass. The Nao gets on one leg by tilting its right ankle to the right. Then it brings the left leg backward by increasing the left hip pitch value in Choregraphe, and at the same time it bends its left knee to bring the left foot behind. While maintaining balance, the Nao will bring the left foot forward and stretch its left knee to create a strong kick. The left knee is not completely stretched out during the kicking motion to avoid hitting the ground and losing balance. The left ankle is stretched out during the kicking motion by increasing the left ankle pitch value so that the toes or the heal do not get stuck to the ground. After the kicking motion, the left leg is brought back to the original spot slowly while maintaining balance. The right arm is raised high (about 45 degrees from its body) for increasing stability, and the left arm is raised very slightly so that the arm does not get in the way of the left leg during the kicking motion.

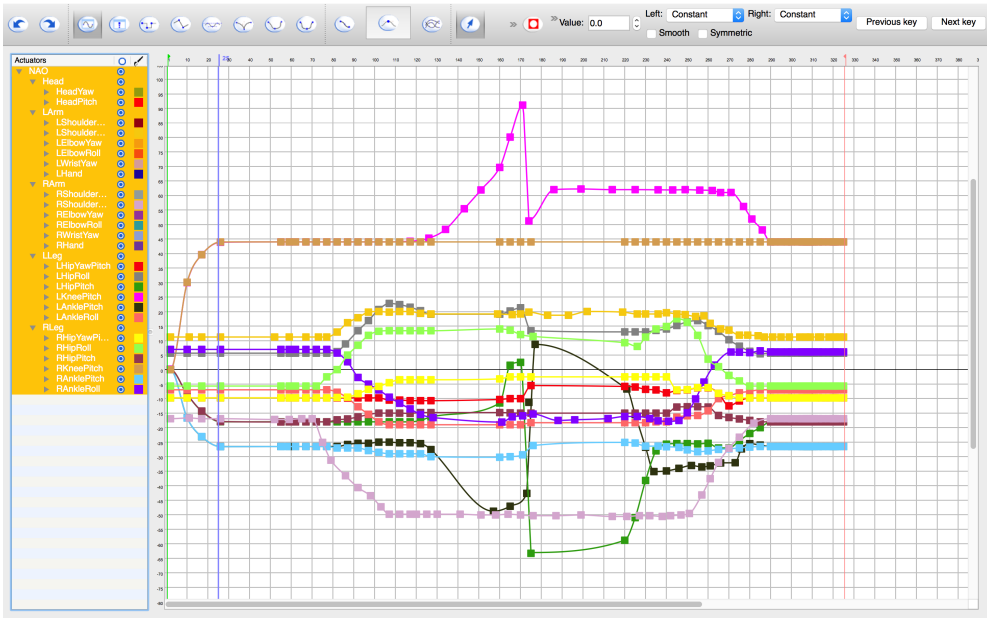

Figure 1: Timeline for the improved implementation of the kick

Experiment Design

We ran this final implementation on the robot and made it perform the kick for 10 trials and for each trial the distance from the robot to the ball was measured, the angle relative to the Nao robot was determined and also, whether or not it fell.

Results

Table 1: Results of the improved implementation on the robot for 10 kick trials.

Trial	Fall	Direction	Distance / m	Deviation / deg
1	No	Left	>4	3.70
2	No	Left	>4	2.56
3	No	Left	>4	9.18
4	No	Right	>4	7.51
5	No	Right	>4	11.12
6	No	Straight	>4	0.00
7	No	Right	>4	6.25
8	No	Right	>4	6.53
9	No	Right	>4	4.13
10	No	Right	>4	2.14

We were not able to measure the exact distance of the ball because the length of the artificial grass field at the lab was shorter than the actual travelled distance of the ball. Link to Youtube video with Nao performing the kick for 10 trials: https://www.youtube.com/watch?v=P3jJEjQHaOc

Conclusion

From the 10 trials we concluded that the Nao was able to kick the ball to a great distance (M > 4 m). The robot was in balance before, during and after the kick after each trial therefore we conclude that the stability was good. The robot kicked the ball in a straight direction, 11.12° being the largest deviation and the mean deviation of 5.31°.

Discussion

We were able to construct a kick that is powerful and stable enough to avoid falling. However, there could be an improvement in stability after the kicking motion when bringing back its left foot. The issue is that the left foot touches the ground too early and hence the two legs are too close to each other. When the right ankle rolls back to the starting place, the left foot is stuck until a certain point, and causes a wobble when the left foot slides leftward. If we get another chance, we want to keep the Nao's left foot off the ground until it starts rolling its right ankle back to the original place. Another problem is that, because it is performing a powerful kick while being stable, it takes up a lot of time. This is not an issue when merely performing a kick in the experiment, but it might be problematic during competitions since other robots might reach the ball before ours.