Marble Game - Assignment

Deadline: 23:59 18th October 2025

Introduction

The goal of this assignment is to demonstrate your ability to control the position and orientation of the hip of your leg.

You will demonstrate the control using a small fun marble game.

Challenge 1: Open-Loop Control of the Two-Dimensional Marble Game

In this challenge, we will first demonstrate the ability to control the movement of the hip.

After constructing your leg assembly, add a two dimensional maze at the hip of your robot. The size of the maze should be about 11cm by 15cm. The goal is to roll a golf or table tennis ball from the start position to the goal position.

The walls of your maze should be about 1cm tall. For a greater challenge, you can lower the height of the walls, especially the external walls. Then you have to carefully control the speed of the ball, since it will otherwise jump out of the maze.

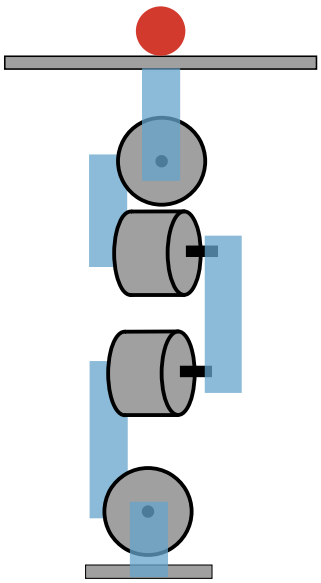

Fig. 1a: possible leg assembly with maze mounted

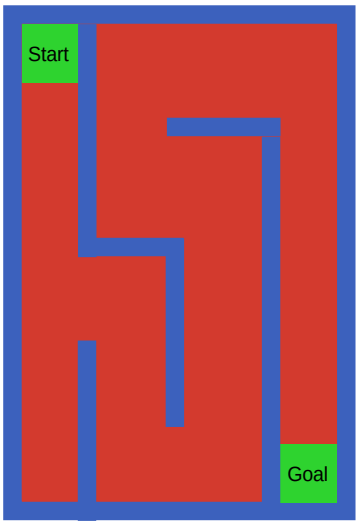

Fig. 1b: simple 2D maze for the marble game

Servo Control

First implement a program on the Raspberry Pico PI to demonstrate control of the four RC servos.

Identify the maximum angles and home positions of your servos given your leg assembly.

Make sure that you keep your leg assembly light, so that you can move the hip given the RC servos.

Remote Control

Implement an application on the Raspberry Pico PI to control the leg that you constructed.

Your application should be able to:

- change the angles of each of the four servos
- control the position and orientation of the hip of your leg

You can use a combination of keyboard, mouse, touchscreen, or joystick to control your leg.

Use manual control to move the ball from the Start position to the Goal position.

Challenge 2: Control of the One-Dimensional Marble Game

In this part of the challenge, we will simplify the maze to a single rail, which runs from the front to the back of your maze.

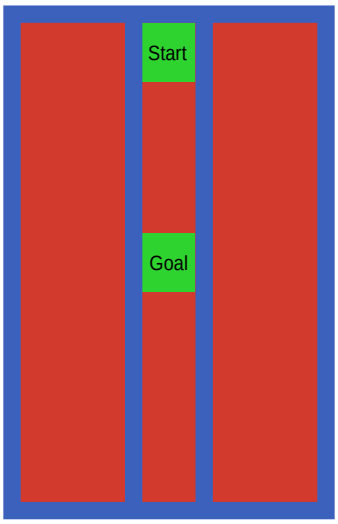

Fig 2: A maze with a single rail for experiments in feedback control.

Camera Feedback

Mount a webcam so that you can watch your leg assembly and the ball.

Implement a program for the camera. I suggest a simple blob/color detector to estimate the position of the ball and angle of the hip of your leg.

Evaluate the performance of remote controlling (i.e., use keys or joystick while looking directly at the ball and leg assembly) the servos versus tele-operation (i.e., only look at the output of the vision system on your screen).

Show the average and maximum error of the ball position for several trials of balancing the ball using remote control or tele-operation.

Challenge 3: Manual Control of the Two-Dimensional Marble Game

In the third challenge, we extend our work to control the ball to balance on a plane in two dimensions.

The maze is empty inside. The Start is at the top left and the goal is center of the playing field.

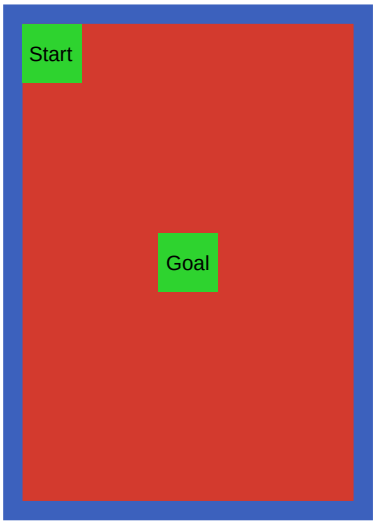

Fig 3: A maze with a single rail for experiments in feedback control.

Evaluate the performance of remote controlling (i.e., use keys or joystick while looking directly at the ball and leg assembly) the servos versus tele-operation (i.e., only look at the output of the vision system on your screen).

Show the average and maximum error of the ball position for several trials of balancing the ball using remote control or tele-operation.

Submission

Honesty Declaration

By submitting an assignment, you claim that your submission is **only your own work.** This means that you have developed the design, implemented the code, run the experiments, and all other work necessary to complete the assignment **by yourself and without the use of any AI tools**.

If you discussed your work with other students, used sources on the Internet, or used AI tools such as ChatGPT, then you **must** say so clearly at the beginning of the assignment.

Use of AI tools is permitted, but you must specify which tools were used and what prompts you entered.

You can discuss parts of the assignment with others, but these discussions must be limited sharing ideas on a whiteboard or notepad. If you exchange code/programs/designs or exchange any material via the Internet, then you must say so in your honesty declaration.

Fill out the NTNU Honesty Declaration and add any external sources that you used during the assignment.

Submission

The submission consists of three parts: honesty, code, and report.

1. First, create a directory with a name "<Student ID>_assignment_marble"
2. Download and fill out the honesty declaration. Add it to the directory you just created
3. Create a directory "code", which includes all the source code for your assignment, all build tools, and a file ReadMe.txt which includes all necessary instructions for how to build and run your code
4. Create a directory "report", which includes a pdf file "<Student_ID>_report_marble" that describes the results of your evaluation of your assignment. How well did it work. What problems did you face when implementing your assignment. Were the results expected or did they surprise you? Did the results highlight shortcomings in the system? Do you have any ideas for how to fix those?
5. Create a compressed archive of your directory, that is a zip file, of your directory. If the file is less than 10 MB, then you can email it to me directly (jacky.baltes@gmail.com), otherwise upload it to a cloud storage provider (e.g., Google drive) and send a link to my email. Make sure that you give read permissions to my email.