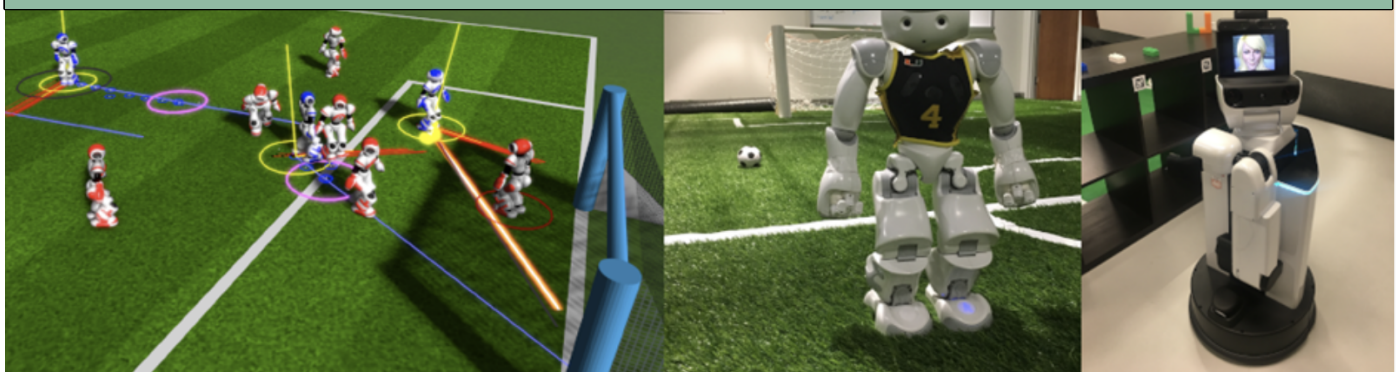
Fall 2024 - CSC398 Autonomous Robots - Assignment 1



Due date: 08/29/2024, 12:30 PM, before class starts. There will be mandatory assignments based on topics discussed in class. Problems will be either theoretical or implementation-based. The programming exercises will include Python/C++ and maybe also Matlab. The due dates will be available on the course web page and the assignment itself.

Exercise 1.1 (5 points)

Reading material: Recent advances in AI technology led to new markets and opportunities in important areas such as health, education, transportation, the environment etcetera. Machines have outperformed humans in the past decade concerning specific tasks such as some facets of image recognition or the ability to win against humans in games like Jeopardy or Go. AI researchers expect further, even accelerated progress in some areas of artificial intelligence, e.g. in self-driving car technology. All this progress has been made in areas known to AI researchers as weak or narrow AI. Significant progress in General AI where machines will demonstrate broadly applicable intelligence comparable to humans in the coming years or even decades is unlikely according to a recent AI study.

Renowned AI researchers composed a recent study on artificial intelligence, published first in September 2016 (the latest report is from 2021). The study was produced by a panel of 18 mostly American scholars and experts. The authors looked at how specialized applications of AI might affect life in a typical North American city by the year 2030. It is called "Artificial Intelligence and Life in 2030" and may be seen as a new landmark report as it is the first of a series of reports that will be produced every five years as part of the "One 100 year study on artificial intelligence (AI100)". A second report is the outcome of a panel commissioned by the White House, entitled "Preparing for the future of Artificial Intelligence".

Read the following two reports for a discussion in class:

1. AI 100 report: https://tinyurl.com/csc398-ai100-report
2. White house report: https://tinyurl.com/mrbx6twa

Exercise 1.2 (5 points)

Study the material about linear algebra for robotics given in class. This exercise has the following objective: To understand the concept of rotation matrices and apply them to transform coordinates in a robotic system. You need to submit a .py file that contains the implementation.

Remember, a rotation matrix is used to rotate a vector in a coordinate space. In robotics, rotation matrices are essential for transforming the coordinates of points from one frame of reference to another.

Review the basic rotation matrices for rotations around the X, Y, and Z axes:

$$R_x(\theta) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & \sin\theta \\ 0 & -\sin\theta & \cos\theta \end{pmatrix}$$

$$R_y(\theta) = \begin{pmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{pmatrix}$$

$$R_z(\theta) = \begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Calculation: Combine rotations around multiple axes. Use a rotation of 30 degrees around the X-axis followed by a rotation of 45 degrees around the Y-axis:

$$R = R_y(45°) \cdot R_x(30°)$$

Given a point $P^T = \begin{pmatrix} 1 & 2 & 3 \end{pmatrix}$[1] in the original coordinate frame, calculate its new coordinates after applying the combined rotation matrix from above.

Implementation: Write a Python function to compute the rotation matrix for a given set of angles and apply it to a point. Print out the new point. Hint: use `numpy` functions for efficiency.

Submission instructions: We are using Google classroom for this class. Please use the following link https://classroom.github.com/a/TntFdDvp to link your github account to this class and to this assignment. Follow instructions given in the `README.md` file.

[1] $P = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$