# EE413FZ Assignment-1


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## Objective

To complete this assignment on trajectory planning for the UR5 robot and Onrobot RG2 gripper in ROS1-Noetic, I would:

1. **Set Up Ubuntu and ROS Noetic**: I will start by setting up a stable Ubuntu environment and installing ROS Noetic to ensure a compatible workspace for robotics programming.
2. **Utilize MoveIt**: I will use the MoveIt framework in ROS for planning and executing complex trajectories for the UR5 robot arm, focusing on precise control.
3. **Write Python Scripts**: I plan to write Python scripts to define the trajectories for geometric shapes like triangles, squares, and the letters M and U, ensuring accurate coordinate calculations.
4. **Visualize in RViz**: I will use RViz in ROS for visualizing the robot's trajectories, making sure they align with the desired shapes.
5. **Integrate Shapes**: I will combine these individual trajectories to form the complete Maynooth University emblem, paying close attention to the spatial arrangement and proportions.
6. **Debug and Optimize**: Throughout the process, I will continually test and refine my code for improved accuracy and efficiency.

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## For Task-1

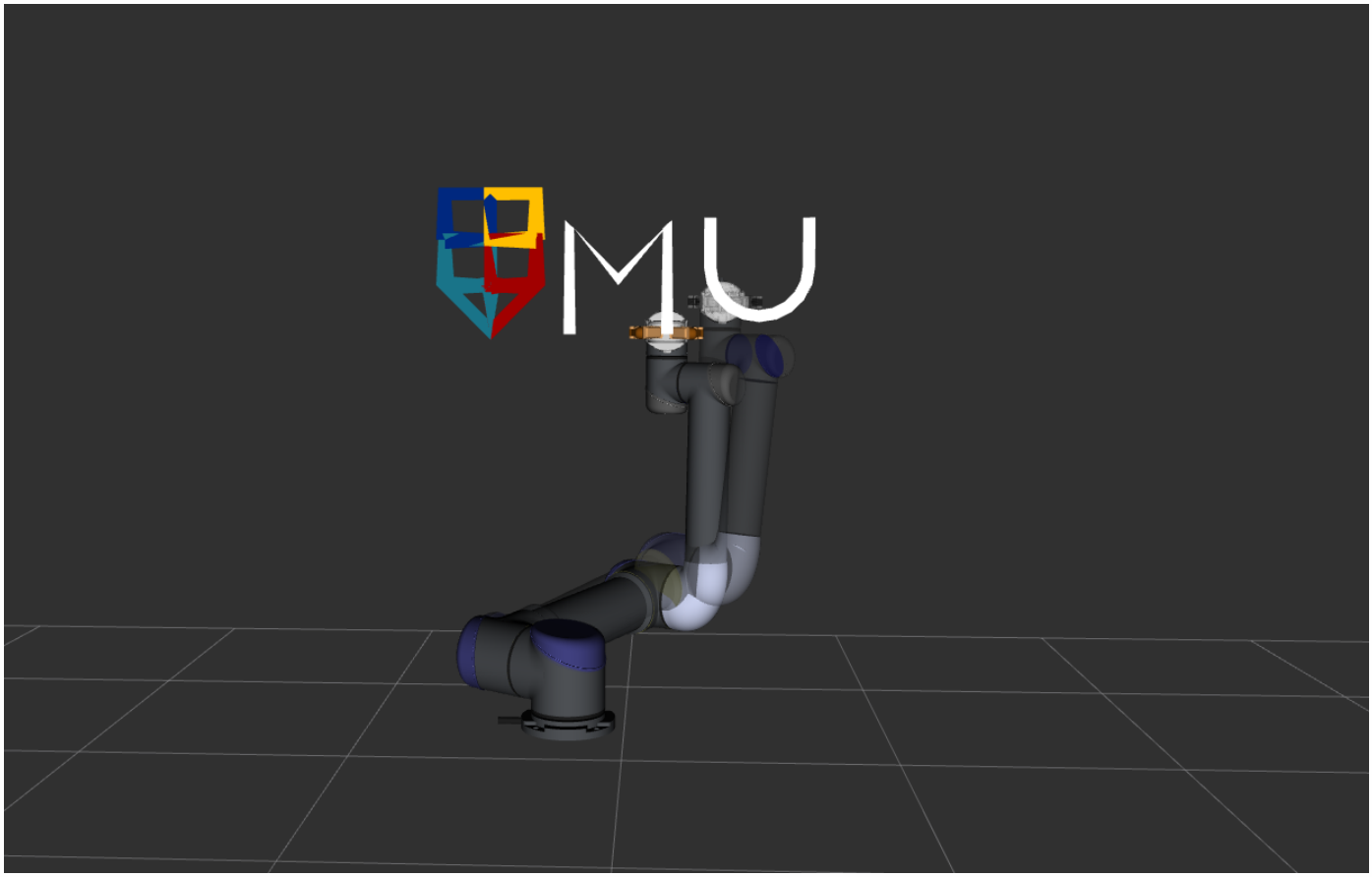
Firstly, to construct the Maynooth LOGO's triangular part, I would create a function, `square_trajectory`. This function would calculate the points of the square's corners in the robot's coordinate space. I would carefully determine these points to ensure the square's sides are of equal length and aligned correctly in the space. The function would then generate a trajectory for the robot's end effector to move sequentially through these points, effectively drawing a square. The trajectory planning would involve smooth transitions between points to maintain a steady and precise movement of the robot's arm.

Besides, I have developed two python functions: `left_tri_trajectory` and `right_tri_trajectory`, to draw triangles in two different colors (green & red). The key difference between these functions lies in their selection of coordinate points, tailored to each color. I'll ensure these triangles align with the squares on the x-axis and intersect with squares along the y-axis. By merging these triangles, a "V" shape emerges. To differentiate their colors, I will initiate two marker instances, each representing a unique color, ensuring both accurate positioning and coloration for the LOGO.

## For Task-2

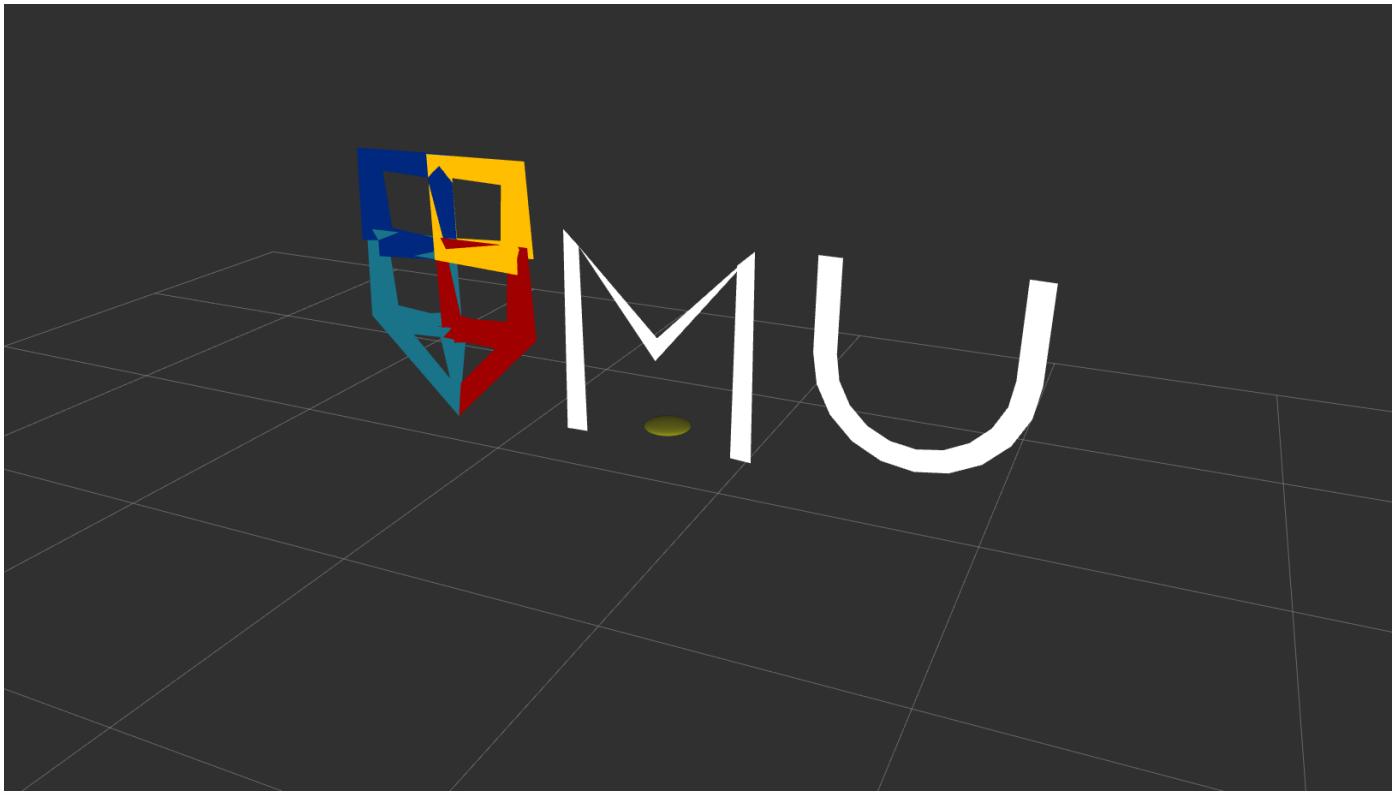
To draw the letter "M," I will use the existing `m_trajectory` function. For the letter "U," I will divide the task into three segments: the left vertical line, the curve, and the right vertical line.

Then, I will add a downward curve, forming a half-circle, to connect these two vertical lines. This approach mirrors the process of handwriting, ensuring the drawn "U" closely resembles its hand-drawn counterpart. This method provides a systematic and structured way to replicate the letters "M" and "U" with precision, as shown in the following figure 1.



## For Task-3

To create the complete Maynooth University emblem, I will integrate the designed logo with the letters "M" and "U." I'll focus on precise alignment and spacing to ensure a cohesive and visually appealing symbol. By programming the robot to sequentially draw the logo and then the letters, I can maintain a smooth and connected design flow. I'll use visualization tools like RViz for accuracy verification before the final implementation, ensuring that each element of the emblem is perfectly positioned and harmonized,  as shown in the following figure 2.

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# Overall

Through this experiment, I learned about precise robotic trajectory planning using ROS-1,MoveIt and python, including creating specific geometric shapes and letters. I also gained experience in integrating different elements to form a coherent symbol, enhancing my skills in robotic programming, visualization, and spatial alignment.

Lastly, I would like to express my heartfelt gratitude to **Dr. Lo Fook-Loong** for his invaluable guidance and support throughout this semester. His expertise and insights have significantly contributed to my learning and understanding in this field.

- **By Hanlin CAI (20122161)**
- **Christmas, 2023**