ME 5250 – Project Report

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KEY CHALLENGES AND SOLUTIONS:

Being ecstatic about the project given to us, we started our project by downloading the boilerplate code given to us. We faced a lot of challenges initially in understanding what's happening in the code but the lab_tutorial.m file helped me understand how the robot works.

MAJOR CHALLENGES FACED:

1. Numerical Inverse Kinematics: The built-in function in MATLAB did not produce the expected results for our project. While the visual simulator provided useful insights, we found it challenging to solve the pick-and-place problem efficiently. To address this issue, we developed our **own inverse kinematics solution**, implemented in the **`ikpincher.m`** function. We derived the inverse kinematics for the robot **using geometric methods,** which enabled us to successfully solve the pick-and-place problem.

2. Implementing Functions Step by Step on a Real Robot: Implementing functions on the visual simulator was much simpler compared to working with the real robot. We needed to clarify our input and output requirements to ensure the robot operated correctly. Additionally, we learned that we had to convert our joint angles into encoder values (until December 2, 2024, when TAs resolved this issue for everyone). As a result, we completely rewrote the **`pick_place.m`** file to better suit our problem and executed the task more efficiently..

MAIN CONTRIBUTION:

1. Rewriting the **pick_place.m and Visual_env.m** with respect to the custom functions we built.
2. Testing the entire project on pincherx100.
3. Rewriting the **set_joint_pos.m** to convert encoder values to angle values (we also removed the conversion pa rt since it was redundant for our files to run).

TEAM SYNERGY:

I would like to express my gratitude to my friend, **Unni Aditya Mohan**, for his assistance in solving the inverse kinematic equation using a geometric approach. We divided our work into two phases: Phase 1 involved solving the trajectory generation function and the inverse kinematic function, while Phase 2 focused on system integration using the functions we developed in Phase 1.

During Phase 1, Aditya took the lead in solving most of the tasks, while I was responsible for integrating and testing both the visual simulator and the pick-and-place operations on the actual robot.

LEARNING OUTCOMES:

1. I had no prior experience using MATLAB for programming before enrolling in this course. The assignments provided during the course facilitated my learning of MATLAB, which served as a significant catalyst for my understanding of the software. In comparison to Python and C++, MATLAB offers advantages in terms of faster integration and testing. Although the PincherX100 is available in C++ through the ROS2 MoveIt package, I found problem-solving with MATLAB to be more intuitive.

2. I possess expertise in addressing mobile robotics challenges, and acquiring knowledge about manipulators has always been a priority for me. This project enabled me to appreciate the complexities involved in constructing a robotic arm and enhanced my comprehension of the course's core concepts.

   The skills I have developed will be instrumental in my career, particularly with regard to understanding complex manipulators and operating Dynamixel servos or similar motors. As I advance, I intend to engage with the PincherX100 through the ROS2 MoveIt interface and subsequently explore various manipulators.