The 4th year module of Dynamics and Control contained a practical based assessment where we could demonstrate our learning and understanding upon a physical system. A 2 Degree-of-Freedom (2DoF) drawing robot was successfully designed, built, and programmed to autonomously draw geometric shapes. The robot, controlled via a Raspberry Pi Pico, implemented control strategies to operate with high accuracy and efficiency, demonstrating the practical application of engineering principles. My role within the design included developing the virtual and physical product, aiding the setup of the hardware, calculating the inverse kinematics and helping structure code within Arduino IDE.

The project began with a series of design explorations using Fusion 360, leading to the selection of a tower configuration for its simplicity and effective decoupling of movement. This design separated the motors, with one controlling an initial linkage, and the other controlling a belt connected to a second linkage, jointed at the end of the primary. This meant that the motors could move independently without affecting each other. The mechanical linkages were optimized through iterative 3D printed prototypes, culminating in a design that facilitated easy assembly and maintenance.

Control algorithms were developed using MATLAB and implemented in the Arduino IDE to drive the motors with precision. Inverse kinematics calculations were conducted to translate desired drawing paths into motor movements. A PID controller was fine-tuned to achieve a settling time of 0.25 seconds, enabling the robot to draw shapes like squares, triangles, and circles with dimensions specified to high precision, achieving accuracies between 97% and 100%.

Electrical design was robustly addressed with a detailed wiring schema and proactive troubleshooting of hardware issues, ensuring reliable operation throughout the project's duration. Programming efforts refined the motion control algorithms, enhancing the robot's ability to reproduce the input geometric figures accurately.

In conclusion, the 2DoF drawing robot project not only met its design objectives but will now also serve as an educational tool, illustrating the integration of mechanical design, electronic control, and software programming in robotic systems. The project's design success lays the ground for further innovative motor configurations for future solo projects.

Skills used:

Mechanical Design

Fusion360

Rapid Prototyping

Control Systems Engineering

MATLAB

Arduino

Hardware Design