Implementing Kinematic Control of Open ManipulatorX

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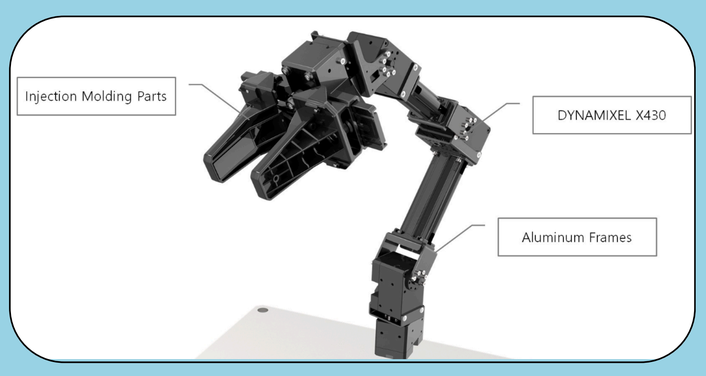
ABSTRACT

This project is centred around robotic control, specifically using Processing and ROS with the Open Manipulator-X arm. To improve control precision, unique forward and inverse kinematics algorithms are created. In order to demonstrate the arm's capabilities, handwritten text must be reproduced. To this end, the letters "CIC" must be inscribed precisely. The research highlights the significance of customised algorithms and interfaces for boosting robotic systems' efficacy and goes into detail about the methodology, implementation process, and results. This work lays the foundation for future advancements in automation and robotics and advances robotics for real-world applications.

INTRODUCTION

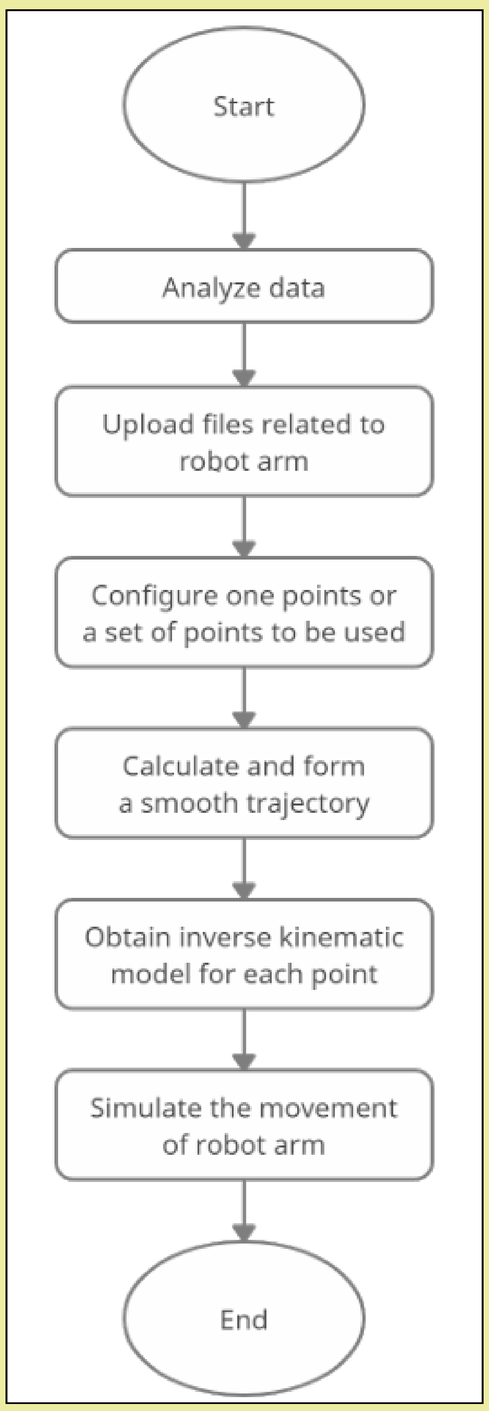


Developed by ROBOTIS, the OpenManipulatorX is an open-source robotic manipulator with several joints for diverse movements, intended for use in research and education. It is managed by a microcontroller with many communication interfaces, under the direction of a kinematic system and dynamics considerations. To ensure that the algorithm is validated before being physically implemented, the manipulator is tested in the Gazebo simulation environment.

Forward Kinematics: Using joint angles or joint displacements to determine the end-effector's position and orientation in a robotic manipulator.

Inverse Kinematics: Calculating the joint angles or displacements necessary to install the end-effector at a particular location and orientation.

METHODOLOGY ADOPTED



CUSTOM TRAJECTORY

- FINDING CIC COORDINATES
- CORRESPONDING JOINT ANGLES (ROS)
- MOVE ANGLES TO PROCESSING GUI
- ARM MOVE TO END EFFECTOR

CUSTOM SHAPES

- MAKING CIRCLE
- MAKING STRAIGHT LINES

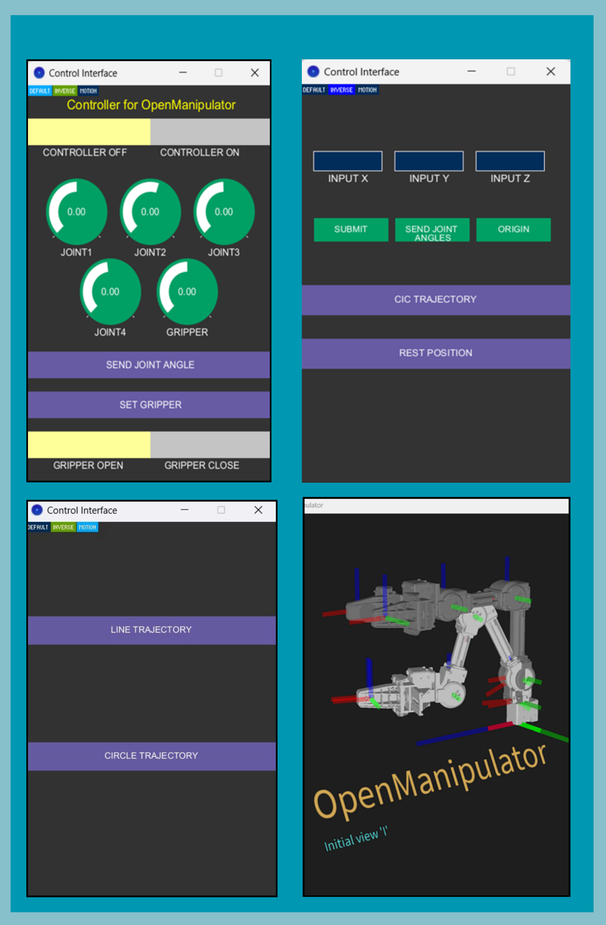
SOFTWARES USED

ARDUINO, ROS

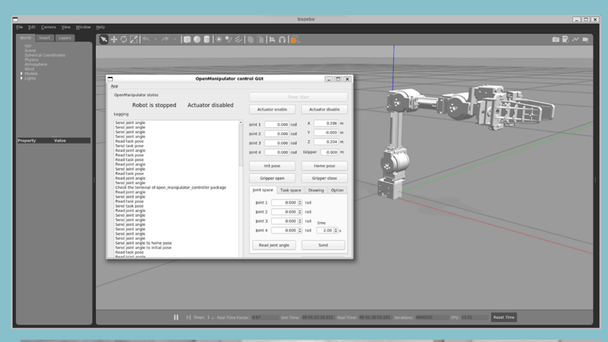
RESULTS

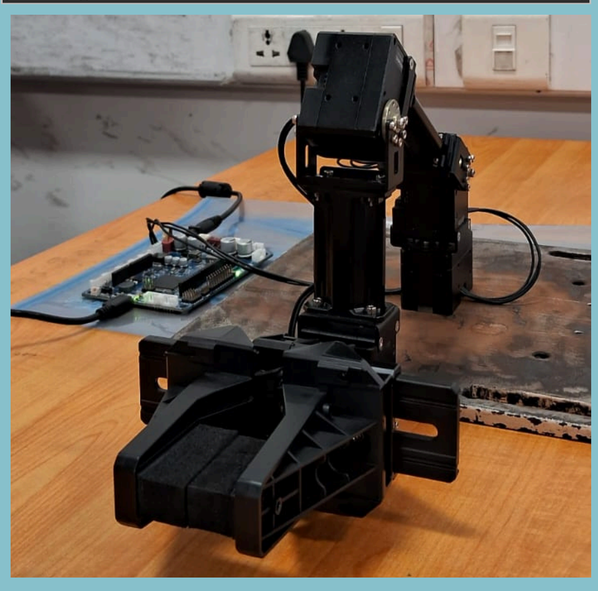
Improved forward and inverse kinematics functions are now integrated into the new, user-friendly GUI. Additionally, we are able to create custom trajectories.

CUSTOM GUI



PHYSICAL IMPLEMENTATION





CONCLUSION

The successful implementation of forward and inverse kinematics algorithms, along with the integration of Dynamixel actuators and trajectory planning techniques, enabled precise control and versatile movements of the Open Manipulator-X robotic arm. The development of a user-friendly graphical interface enhanced accessibility, while comparing ROS simulation and Processing software provided insights for future research. Achieving the goal of writing "CIC" coordinates demonstrated practical applications, showcasing the arm's capabilities and the seamless integration of hardware and software components for robotic control systems.

FUTURE ASPECTS

Enhancing the GUI Functionalities: Integrating advanced features into the Processing GUI to mirror the ROS interface enables seamless user interaction and standardized control capabilities across platforms.

Mapping Cursor Movement to Real Arm Position: Implementing algorithms to translate cursor movements in the Processing GUI directly to the physical arm's end effector enhances intuitive control and simplifies arm manipulation for users.

Exploring Complex Trajectories: Experimenting with non-linear paths and dynamic obstacles advances the arm's adaptability and precision, fostering innovation and the development of sophisticated control strategies tailored for complex tasks.

REFERENCES

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- A. Dadbin, A. Kalhor and M. T. Masouleh, "A comparison study on the dynamic control of OpenMANIPULATOR-X by PD with gravity compensation tuned by oscillation damping based on the phase-trajectory-length concept," 2022 8th International Conference on Control, Instrumentation and Automation (ICCIA), Tehran, Iran, Islamic Republic of, 2022, pp. 1-7, doi: 10.1109/ICCIA54998.2022.9737207