



HASAN KALYONCU UNIVERSITY

Electrical-Electronics Engineering Department

EE 499 Project Proposal Form

Part I. Project Proposer

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Part II. Project Information

Title of the Project	6 degrees of freedom (6DoF) articulated robot arm				
Maximum Cost of implementation (TL)	10500 TL	Conceptual Design Dead Line	in 4 weeks	Prototype Production Deadline	in 14 weeks
Standards and licenses to be used in the project. example; IP65, IEEE, APACHE, MIT, etc.	ROS2, MIT/Apache 2.0				

Project Description

In this project, I will be making a 6 degrees of freedom (6DoF) robot arm, which basically means that the robot arm will have 6 joints with 6 motors that move simultaneously to change the position of the end part of the arm, which is called an End effector.

Users can control the arm by inputting the desired X, Y, and Z positions for the end effector, and using ROS2 running on a Raspberry Pi, the arm will be able to use inverse kinematics (IK) calculation methods to figure out the angles for each motor to reach the desired end effector position.

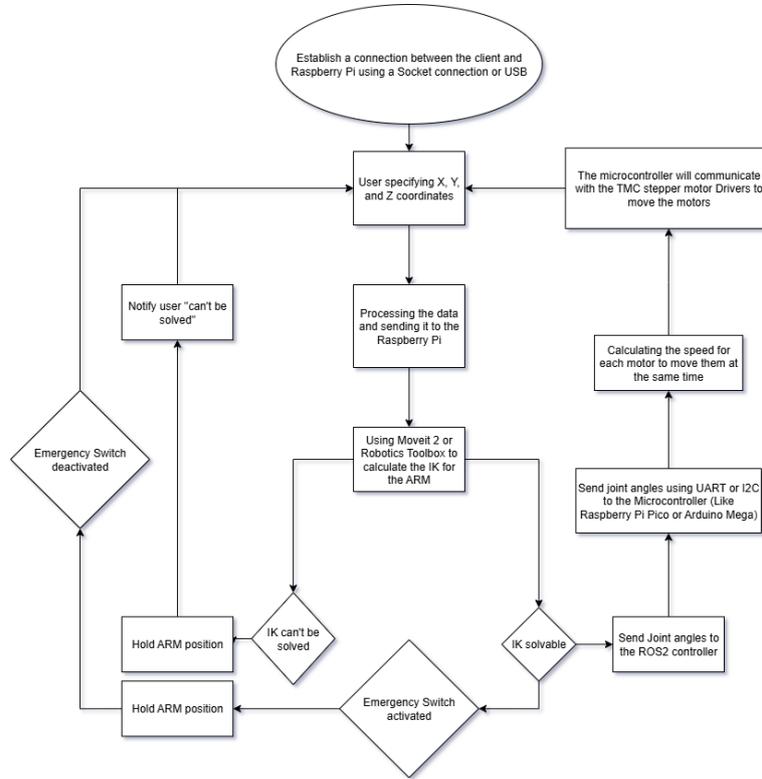
Calculated motor angles will then be sent to a custom-built controller board with 6 TMC motor drivers to rotate each motor to the calculated angles.

The motors are attached to custom 3D printed Planetary Gearboxes, like the ones seen below, that increase the output torque of the motors to allow them to carry the weight of the other part of the arm, and the weight of the load attached to the end effector.



The arm will also have a replaceable tool head, which means the tools attached to the end effector (like a gripper, for example) can be swapped for a different tool depending on the job

The steps of how the arm will work are explained in detail in the Flow diagram below



Project Justification

Novelty

New aspects

Integration of ROS2 to fully control the Robot Arm and do IK solving, custom-designed Hardware, like making a custom controller board, and custom 3D-printed mechanical components

Complexity

Challenging problem and issues

Calculating the Inverse kinematics (IK) is quite complicated, there are lots of methods to calculate it like the Analytical Method, Numerical method, and the geometric method but they are very hard to code from scratch so using open-source and custom-built tools will be easier but require more processing power, some of the most common tools that can be used are Moveit 2 and Robotics Toolbox, but which one I will go for will be apparent after further testing.

Also, designing a gearbox that can be 3D printed leaves us with a few options, like a planetary gearbox and a cycloidal gearbox. Cycloidal gearboxes are more precise, but they require a lot of bearings, making them very big and expensive. So I opted for planetary gearboxes, but I have to calibrate my printer and adjust the gear design to make them more precise.

Related electrical-electronics science fields and subfields

Robotics, Serial Communication Techniques, Control System Theory, Sensors, Actuators, Embedded Systems, Microcontrollers, PCB design, Circuit design and power management

<p>Tools</p>	<p>Microcontroller/Microprocessor: Raspberry Pi, Raspberry Pi Pico W (RP2040), Arduino Mega (ATmega2560)</p> <p>Software/Programming: ROS2, Python/C++</p> <p>Hardware Design: KiCad for PCB Design and Fusion 360 for Mechanical Design and 3D printing</p> <p>3D Printer: Elegoo Neptune 4 Pro</p>
<p style="text-align: center;">Risk involved</p>	
<p>Potential problems and alternative solutions</p>	<p>Inverse Kinematics (IK) Solver problems: if Moveit2 (which is a tool in ROS2) does not work properly or it has a hard time doing the IK calculations on the raspberry Pi, the IK calculation might be done on laptop connected to the Pi, or we could replace Moveit 2 with Robotics Toolbox.</p> <p>Mechanical Weakness of 3D-Printed Parts: we can Use higher infill density or we can increase the wall count or go with a stronger material like ASA or ABS.</p> <p>Not enough Motor Torque: we can replace the motors with more powerful ones or redesign the gearbox to have more torque</p>
<p>Minimum work required</p>	<p>3 and a half MONTHS WITH 1 DEVELOPER (ME)</p>