5-DOF ROBOTIC ARM MANIPULATOR

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Abstract - Every invention in the field of robotics has been done taking into account the extra work and effort for tasks that are monotonous and unrelieved. Robotic arm has been one such invention which has replaced humans in these tasks and promisingly provided more efficient productivity. This project is one such implementation of robotic arm motion path planning software for a 5 DOF robotic arm manipulator. It includes the inverse kinematic equations for 5DOF robotic arm and custom designed path planning algorithm which is designed keeping in mind the constraints of the obstacles.

I.INTRODUCTION

Robotic arms are constructed using revolute and prismatic joints. For a mechanism to be classified as the robotic arm it needs to be able to transfer the object from a certain starting point to a preset location. The development in the field of robotics has led to development of robotic arms which resemble the human arm. Industries have adjusted themselves with the use of robotic arm and have utilised them on large scale for various applications where humans fall short on the efficiency and the tasks that are mundane and this has saved the companies a huge cost for labour.Various other fields such as computer vision, machine learning signal processing, image processing have helped develop the sector of robotic arms expanding its applications.

II.OBJECTIVE

Our project focuses on the software for optimal implementation of robotic arm, with 5 DOF robotic arm equipped with an IK solver and custom designed path planner to simulate its actions and movement in capabilities similar to a human arm for a pick and place application. This software will be developed keeping in mind the inverse kinematics and the path planning, taking into account the obstacles and complexities faced by robotic arm with any dimensions.

III.APPROACH

Inverse Kinematic Solver: Inverse kinematics uses kinematics equation to get the joint parameters which then can be used to calculate the desired position and rotation of our robotic arm end-effectors.[2] We use this method as it is much faster compared to the forward kinematics. There are three methods to solve inverse kinematics:

a. Algebraic: Basically solving using matrices
b. Geometric:Using robotic arm's geometry with trigonometric equations[2]
c. Numeric:Take random movements and look how close we are to the target then move one or more segments to locally minimize the error. Repeat the same process till you reach the final point

In this project we will be using the geometric method as it is comparatively less complex and efficient.

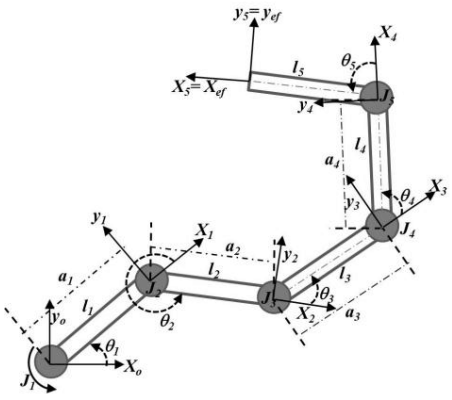

Fig 1. Inverse Kinematics of 5DOF Robotic Arm [1]

Path Planning Algorithm: Using an appropriate path planning algorithm makes sure that our point-to-point navigation is safe and effective. The robot geometry and the computing constraints decide the optimal path planning algorithm. For this project we will be using a custom path planning algorithm for our 5DOF robotic

arm as we are taking variable arm lengths into consideration.

IV.IMPORTANCE

Industry creates a lot of jobs which are repetitive, mundane and tedious. A human can work efficiently for 8 hours and more if trained properly but still lacks efficiency when compared to a robot.[3] Industry has realised this and is replacing humans with robotic arms for these highly mundane jobs to increase productivity. Today at every scale of manufacturing from minutely detailed VLSI board assembly to heavy industry such as automobile production as well as in warehouses for pick and place application, robotic arms are being used. In each of these cases selection of the right robotic arm with the right inverse kinematics and path planning algorithm should be used. The software designed by us is a dynamic IK solver and path planner for a 5 DOF robotic arm with variable arm length as per the users requirements.

V. DEVELOPMENT PROCESS

The design and development process will be followed by the AIP (Agile Iterative process) model. Here programmers Yash and Sameep will write the initial code using TDD (Test driven development) format where Sameep will be the driver and Yash will be the Navigator for the initial phase of code development. In the phase 2 of the process the driver and navigator roles will be swapped. The role of process manager will be observed by the person in the role of navigator. Iteration meetings will be conducted and parallel code changes will be made. The product backlog will be created and it will be iterated as the project progresses. This will also ensure the quality of the project.

VI. TECHNOLOGIES USED

Programming language : C++.
Build system : Ubuntu 18.04, 20.04 .
Softwares used : Eclipse, OpenGL.
Libraries: Math library, Standard C++ Libraries.

VII. RISK AND MITIGATION

Mechanical failures may result in unexpected behaviour of the arm and such failures can cause potential damage to the system. To avoid this regular maintenance of the robot should be performed. Human errors can cause a wide range of mistakes like faulty interfacing or incorrect activation of software. To avoid these we can use exceptions while programming so that such mistakes are ignored and rectified and the program doesn't crash while running.

VIII. FINAL DELIVERABLE

A complete software design to control 5 degrees of freedom robotic arm with variable arm lengths as per the users requirement, with a dynamic inverse kinematics solver and motion path planner for the same, for applications such as pick and place objects.

IX. REFERENCES

[1] CHAP Ramanathan, Kuppan Chetty S.G, Ponnambalam 2012/01/01, A Heuristic Approach towards Path Planning and Obstacle Avoidance Control of Planar Manipulator, 33010.1007/978-3-642-35197-6, _1, Communications in Computer and Information Science**.**

[2] https://automaticaddison.com/the-ultimate-guide-to-inverse-kinematics-for-6dof-robot-arms/

[3] https://sciencing.com/robots-used-in-everyday-Life-12084150.html