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Controlling 4 Axis Delta Robot Using Mapp Technology & Developing HMI

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Abstract: *Chapter 1 is an overview of robotics, and its brief history, in which we come to know how it was initialized and who are the pioneers of robotics. Further, on which basis they are classified and at the end of this chapter there are some implemented and future applications of robotics all around the world. A literature review is in Chapter 2 and it is about the mechanics and motions of robotics further, there are brief theories on positioning, orientation, degree of freedom, and geometry involved in robotics. At the end of this chapter, servo motors are discussed in greater depth. Research methodologies are placed.in Chapter 3 where design and material selection are the main concern of mechanical design of robotic arm and what sort of hardware selection is carried out which suites best the servo drive.in Chapter 4 these mechanical and electronic hardware selections are implemented along with the best suitable power supply unit and microcontroller. Last but not least Chapter 5 is the summarized version of our achievements, limitations facing in the project, robotics in the future, cost analysis, and conclusion. We mention point-to-point references for every student who wants to ripe this fruit and enhance their curiosity.*

I. INTRODUCTION

Moving 4 axis Robot with predefine sequentially is critical task existing industrial robot are giving same facility with predefine motion pattern .so our project is helpful to provide runtime input from the user to change the axis pattern using touch screen. That consists of three arms connected to universal joints at the base. The key design feature is the use of parallelograms in the arms, which maintains the orientation of the end effector, by contrast to Stewart platform that can change the orientation of its end effector.

II. BACKGROUND

Moving 4-axis Robot with predefine sequentially is a critical task existing industrial robots are giving the same facility with predefine motion pattern .so our project is helpful to provide runtime input from the user to change the axis pattern using a touch screen.

That consists of three arms connected to universal joints at the base. The key design feature is the use of parallelograms in the arms, which maintains the orientation of the end effector, in contrast to the Stewart platform that can change the orientation of its end effector.

Delta robots have popular usage in picking and packaging in factories because they can be quite fast, some executing up to 300 picks per minute.

It consists of multiple kinematic chains connecting the base with the end-effector. The robot can also be seen as a spatial generalization of a four-bar linkage with the help of B&R Scene Viewer, models of the robot mechanics can be created easily and the robot movements can be displayed and recorded without any actual hardware. This allows the robotics application to be tested in advance and reduces the amount of time required for commissioning the machine.

The parallel or delta robot configuration is one of the most recent configuration developments. This includes machines whose arms have concurrent prismatic or rotary joints. These were developed as overhead mounted machines with the motors contained in the base structure driving linked arms below. The benefit of this approach is that it reduces the weight within the arms and therefore provides very high acceleration and speed capability. However, they do have a low payload capacity Therefore, the main application is picking, particularly on packing lines for the food industry, and also assembly applications.

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These machines can achieve similar cycle times to the SCARAs with the fastest achieving the goalpost test (25, 300, 25 mm) in 0.3 s. This type of robot is sold in relatively small numbers, achieving only about 1% of the global market.

III. OBJECTIVES

The objective of the proposed system is given below:

- The select and design parallel manipulator robot for a required workspace
- To configure and monitor 4-axis delta robot features on automation studio.
- To control the movement of the end of the effector using a control unit.
- To connect scene viewer with automation studio to visualize 4 axis delta robots.
- Write a G - code to define a particular movement example to draw an image of the hexagon.
- To develop an application based on Human Machine Interface (HMI).
- To obtain good repeatability and accuracy with the high-speed movement of the robot.
- To use MAPP Technology to integrate additive on the MAPP Motion features.
- To implement OPA UA communication protocol.

IV. PROBLEM STATEMENT

To define and execute an algorithm to control 4-axis delta robots with consumption from a user in runtime. In this project, a machine-centric robot will be controlled for a certain process using Mapp Robotics and an HMI screen will be developed for the robot. A 4-axis robot is controlled for the desired application. It has 2 drives connected to 4 motors, by controlling the drives and motors, a synchronized motion of the manipulator is performed which results in a robotic application, for example, the manipulator of the robotic arm will trace 'B&R'. The operator can control the robot automatically and manually by giving commands through HMI as well. This robot will perform tasks on the basics of g-code, m-code, and n-code (type of CNC programming) written on the program.

These processes are then analyzed and one or multiple processes are chosen to be automated through RPA. This takes up a lot of time and is prone to errors. Therefore, the following two problems are identified:

1. It is difficult to find and pick the right candidate process for a Robotics Process Automation project.
2. Finding potential candidate processes is time-consuming and often a manual process that could be improved upon.

V. BLOCK DIAGRAM

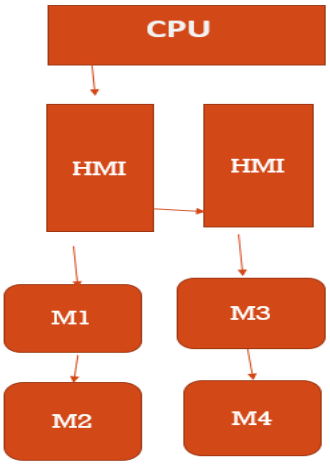

Figure: Block Diagram of delta robot

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VI. HARDWARE SPECIFICATION

Table 1: Specification PLC 80VD100PD.C000-01

Name of Property		Details	
Application	:	can be used as trigger inputs	
Operating Conditions	:	**Temperature**	
		Operation	0 to 45°C
		Storage	-25 to 55°C
		Transport	-25 to 55°C
Power Supply	:	Input voltage	24 to 64 VDC ±25%
		Inrush current	Max. 10 A
		Power consumption	
		Idle (no motor powered)	0.5 W
		Continuous power consumption	1.31 kW
Switching threshold	:	Low	<5 VDC
		High	>15 VDC
Switching delay	:	Rising edge	[Instant recording] Typ. 52 µs
		Falling edge	[Instant recording] Typ. 53 µs
Motor Connection	:	Quantity	2
		Nominal current	Up to 20 kHz: 8 ARMS / 11.3 APeak At 40 kHz and greater than 45°C: ARMS / 9.2 APeak
		Max. current/motor	10.6 ARMS / 15 APeak
		Max. current/module	30 APeak
		Nominal switching frequency	5 kHz
		Possible switching frequencies	5 / 10 / 20 / 40 kHz
		Max. motor cable length	25 m
		Controller frequency	20 kHz
		DC bus capacitance	940 µF

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VII. SOFTWARE SPECIFICATION

Table 2: Specification of B&R Automation Software

Name of Property		Details
Application	:	A single uniform programming tool for every aspect of an automation project minimizes training needs, solidifies overall integration and eliminates communication problems between engineering disciplines.
Software version	:	B&R Automation Studio 4.10.2.38
Ram	:	Min 4 GB recomn

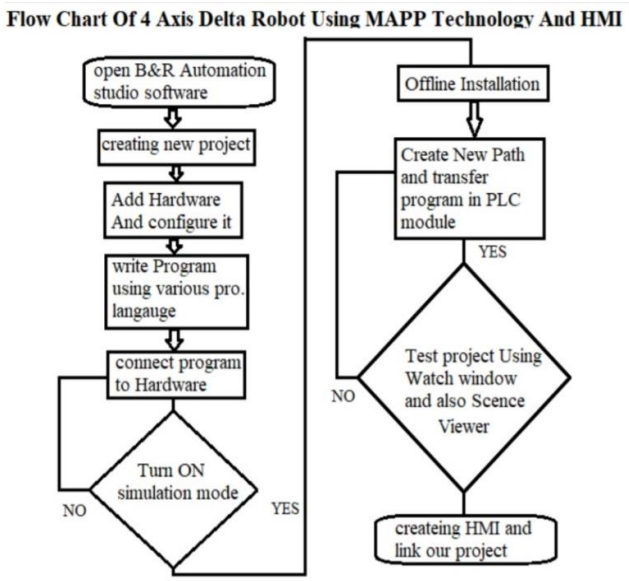
VIII. HARDWARE IMPLEMENTATION

Introduction:

The DELTA robot has attracted much attention in both academia and industry. The literature contains much information on the history and types of parallel robots. In general, the DELTA robot consists of an equilateral triangular base, with one arm (actuated via a revolute joint) extending from each side. The small, triangular travelling plate is connected to each arm by a pair of parallelogram-shaped forearms. The result is three translational degrees of freedom, with one additional uncoupled rotational degree of freedom at the end-effector, resulting in one motor being fixed to the base and connected to the end-effector by a telescopic arm with two universal joints.

Performance evaluation is an important issue for optimal robot positioning within work cells. The literature has proposed several performance analyses for parallel robots.

Working of Blocks:



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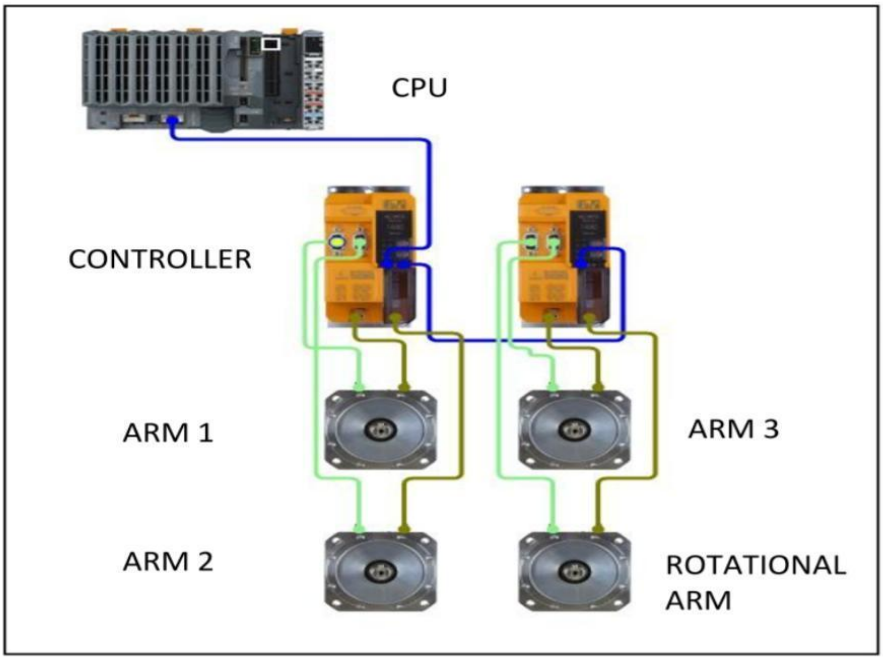

Figure 1: Hardware Implementation

X20CP1586 CPU Controller

In this Project we have used 1 CPU X20CP1586 Controller; The X20CP1586 is a powerful X20 system CPU. This CPU is especially useful for applications that require short cycle times, have to process very large amounts of data, or carry out floating-point operations. It is clocked at 1.6 GHz and has 512 MB DDR2 SDRAM It turns on when we apply Power Parameter in Automation Studio.

PLC Drives (80VD100PD.C000-01)

2 PLC Drives are Connected to the CPU which is used as trigger inputs, A PLC is an Industrial Computer Control system that continuously monitors the state of input devices and makes the decisions based upon a custom program to control the state of synchronous motors connected to the PLC.

Synchronous Motor 8LVA13.B1030D000-0

Industries that take advantage of the high speed of delta robots are the packaging industry, medical industry, and manufacturing. Motor are the primary mechanisms by which robotic arms or Axes move. When PLC gives input to synchronous motors it's started moving all axes according to the CPU Program input. Software Implementation

The Delta Robotic Automation Studio (DRA Studio) controls all of Delta's articulated robots. Select your robot type and model for further configuration (see the screenshot below). The robot types Delta Robot Automation Studio and indicate 4-axis / 3-axis / 5-axis robots respectively, while VA indicates 4-axis circulated robots.

In this project, a machine-centric robot will be controlled for a certain process using Mapp Robotics and an HMI screen will be developed for the robot. 4 Axis Delta Robot automation done in B&R Automation Studio 4.10.2.38. B&R is a Very user-friendly software for robotics automation.

Simulation for 4 Axis Delta Robot is done in B&R Scene Viewer 4. For HMI Development done in B&R HMI Software. For example, the manipulator of the robotic arm will trace 'B&R'. The operator can control the robot automatically and manually by giving commands through HMI as well. This robot will perform tasks on the basics of g-code, m-code, and n-code (type of CNC programming) written on the program.

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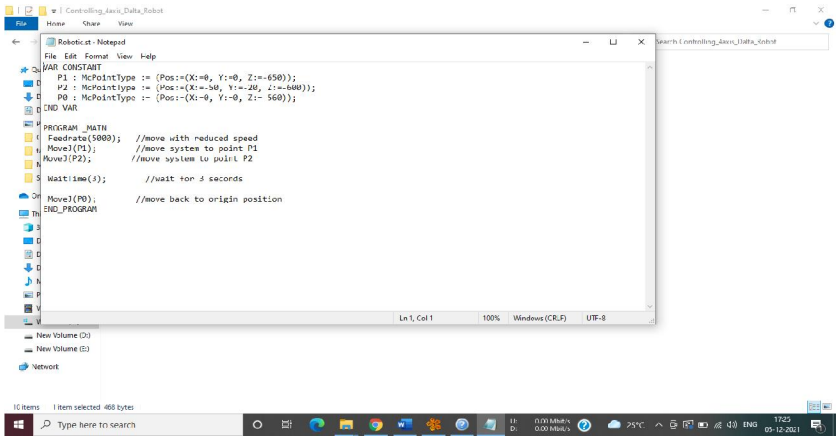

Figure 2: External C Drive Program

IX. RESULTS

Performance evaluation is important for optimal robot positioning within a workspace. To evaluate the performance of the developed DELTA robot, a measurement set-up is built. A repeatability test is carried out to ensure the accuracy of the robot system. This positioning accuracy is close to that of an equivalent commercial robot. These results reveal that the robot system is reliable. Automation studio can provide to write a program in various ways so in our project we can write a program in external source from c drive in this program in we can make program to draw a triangle and when we can give its name in our main program or is path is declared in AS Software. we can easily access this this program in our automation studio. so, when we can create simulation mode. (It is basically we Create Copy of Hardware in our Laptops or desktop. And it is worked as a runtime Hardware.) In this process we can use SCENCE VIEWER Software.

When we can create delta robot in Scence Viewer and we can give its axis values declared in our main program after declaration we Connect both Automation Studio and Scence Viewer by Using OPC UA connect Method in which We use BnR Automation runtime server name is BnR Embedded OPC -UA Server and Client. Then after We Put Automation studio in Simulation mode and when we open "Watch Window" And Set Following Value, Power -True, Home – True, Move Program – True. Our 4 axis Delta robot Starting to Move and Draw a Specific Diagram Respectively Declared in our Main program. Basically, in our program we Creates Triangle Draw Program. And we also change program directly changing axis values of Delta Robot on HMI.

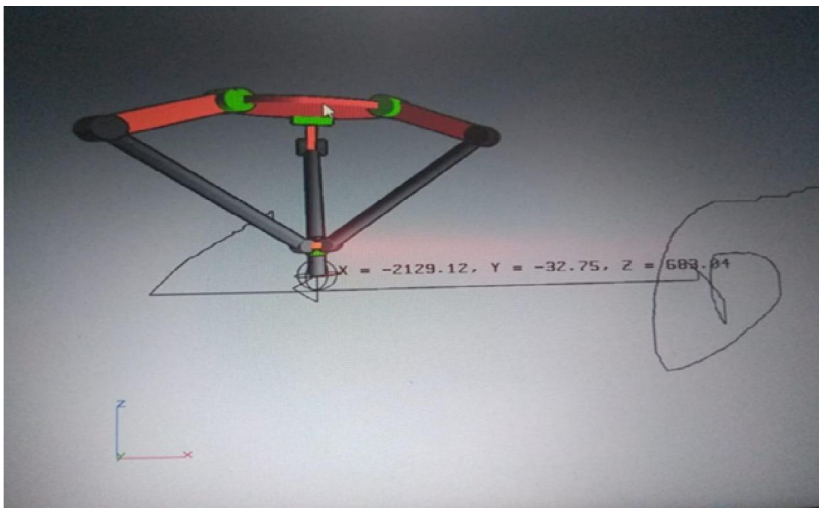

Figure 3: Simulation of Project on Scence viewer

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X. CONCLUSION AND DISCUSSION

This work introduces a design of a DELTA robot with an end-effector for performing multifunctional operations and provides insight into the way this academic innovation has been transformed into a mechatronic kit for education. The design of the proposed DELTA robot includes the 2-axis rotation of the wrist, a gripper, and a 4-axis robotic arm. The robot system's implementation involves the development of the mechanism, both its hardware and software.

XI. FUTURE SCOPE

In the future, we use mainly this 4-axis delta robot in industrial work for packaging or picking and also Designing and Developing new Designs and Cutting metals in well Shapes. it is the best investment for Upcoming companies.

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