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Controlling A 4 Axis Delta Robot using MAPP Cockpit

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Abstract: *Delta Robot holds high importance in industries worldwide and is used for various purposes. Delta Robot is a type of parallel manipulator robot which provides very fast and accurate object manipulation capabilities. 4 Axis Delta Robot 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. Delta robots are robots with a base connected to jointed parallelograms. These parallelograms perform motions in a solitary End of Arm Tooling (EOAT), within a workspace that is dome- shaped. This type of robot is well-known in the industrial field for its ability to execute minute, precise motions. 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. Each of them was designed to be tailored to industrial applications. These structures consist of fast pick-and-place robots as well as high stiffness machines for insertion and tool machining operations. To deal with this, each robot will be emphasized through its specifications and the application it has been developed for. The delta does have its drawbacks. All that speed typically carries some weaknesses in other areas. For the delta, this tradeoff is the speed for reach and payload. The mechanical design doesn't allow the delta to move very heavy loads.*

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. 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 on 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. These machines can achieve similar cycle times to the SCAR As 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.

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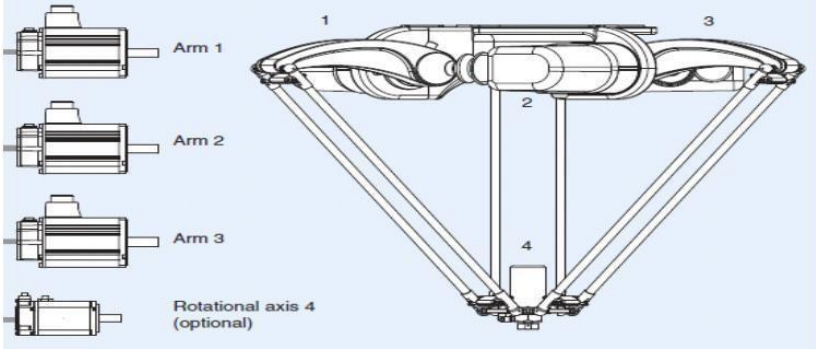

Figure 1: 4 Axis Delta Robot

II. BRIEF LITERATURE SURVEY

In 1942, Willard L. V. Polard designed and patented the first industrial parallel robot. The development of parallel manipulators can be dated back to the early 1960s, when Gough and Whitehall first devised a six-linear jack system for use as a universal tire testing machine. Later in1965, Stewart developed a platform manipulator for use as a flightsimulator. Since 1980, there has been an increasing interest in the development of parallel manipulators. The potential applications of parallel manipulators include mining machines, walking machines, both terrestrial and spaceapplications including areas such as high-speed manipulation, material handling, motion platforms, machine tools, medical fields, planetary exploration, satellite antennas, haptic devices, vehicle suspensions, variable-geometry trusses, cable-actuated cameras, and telescope positioning systems and pointing devices.

More recently, they have been used in the development of high precision machine tools by many companies such as Giddings & Lewis, Ingersoll, Hexel, Geodetic and Toyoda, and others. The Hexapod machine tool is one of the widely used parallel manipulators forvarious industries. It is in the early 1980's when Reymond Clavel comes up with the brilliant idea of using parallelograms to build a parallel robot with three translational and one rotational degree of freedom. In 1987,commercializing of parallel robots for packaging industry. In 1999, Dr.Clavel is presented with the Golden Robot Award, sponsored by ABB Flexible Automation, for his innovative work on the Delta robot. The patent on the Delta robot was bought by the brothers Demaurex in 1996. ABB Flexible Automation launched its Delta robot in 1999 underthe name IRB 340 Flex Picker. Three industry sectors were aimed: the food, pharmaceutical, and electronics industries.

The Flex Picker is equipped with an integrated vacuum system capable of rapid pick and release of objects weighing up to 1 kg. The robot is guided with a machine vision system by Cognex and an ABB S4C controller. After nearly ten years research and experience in the field of packaging technology came Flex Picker IBR 360 with the second generation of Delta ABB robots. This second generation is even more efficient. In 2004, the German company Bosch Group purchased the SIG and SIG Pack Division Demaurex and included it in their packaging technologies. Many Delta robot models have been developed by BOSCH, for example: XR31: higher performance and higher reliability, XR22: a combination of compact design and high accuracy, Paloma D2 built in stainless steel in order to meet hygiene standards and regulations for food industry.

These robots have been placed in the following production lines:

1. Mono Packer
2. LDM: A very flexible system used to place large volumes of products in containers directly from the manufacturing process.
3. Feed Placer: A system with a vision-guided highspeed Delta robot that accepts aligned or randomly oriented incoming product flow on a wide belt conveyor and it places the product directly into the moving flights of wrapper.

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III. PROPOSED METHODOLOGY

The main question that arises is what challenges do we encounter in today's industrial robotics field? As technology is progressing at exponential rates, so are the possibilities and applications of industrial robots. industrial robots are more successful than mobile and/or service robots because they work in a controlled environment. Without vision systems and sensory interfaces, robots have really no perception of their environment, reducing them to programmable machines but with poor added value. So, a controlled environment is a prerequisite. By giving robots perceptual systemsand tools they can advance in working under un-certain and undetermined environments.

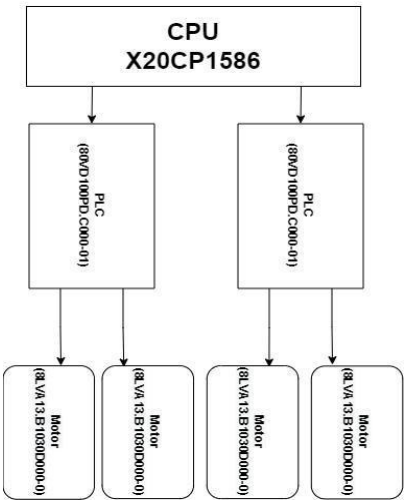

Figure 2: Block Diagram of Delta Robot

Figure 2 represents the block diagram of 4 Axis Delta Robot. This 4 Axis Delta Robot Automation Done in B&R Automation Studio 4.10 and Simulation done in Scene Viewer 4. In this block diagram we have used 1 CPU(X20CP1586),2 Plc Drives (80VD100PD.C000-01) and 4 synchronous motors (8LVA13.B1030D000-0).

The X20CP1586 is a powerful X20 system CPU. This CPU is especially useful for applications which 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.2 PLC Drives Connected to CPU which is used as trigger inputs, Its A PLC an Industrial Computer Control system that continuously monitors the state of input devices and make the decisions based upon a custon program to control the state of synchronous motors connected to the PLC. Industries that take advantages of the high speed of delta robots are the packaging industry, medical industry and manufacturing. Motor are the primary mechanisms by which robotic arm or Axes move. When PLC gives input to synchronous motors its started moving all axes according to the CPU Program input.

IV. HARDWARE IMPLEMENTATION

In this project, a machine centric robot will be controlled for a certain process using Mapp Robotics and 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'. Operator can control the robot automatically and manually by giving commands through HMI as well. This robot will perform tasks on the basic of g- code, m-code and n-code (type of CNC programming) written on the program.

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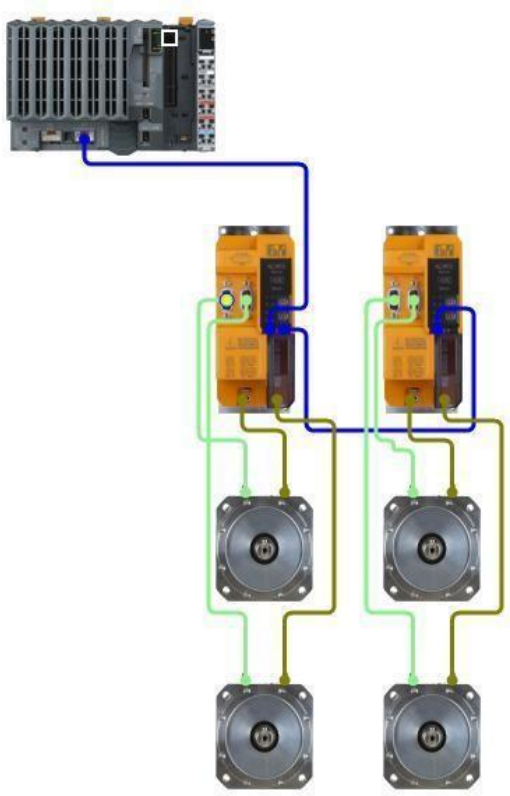

Figure 3: Architecture of $ axis Delta Robot

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 which 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 Connected to CPU which is used as trigger inputs, Its A PLC an Industrial Computer Control system thatcontinuously monitors the state of input devices and make the decisions based upon a custom program to control the state of synchronous motors connected to the PLC.
3. Synchronous Motor 8LVA13.B1030D000-0, Industries that take advantages of the high speed of delta robots are the packaging industry, medical industry and manufacturing. Motor are the primary mechanisms by which robotic arm or Axes move. When PLC gives input to synchronous motors its started moving all axes according to the CPU Program input.

V. SOFTWARE IMPLEMENTATION

In this project, a machine centric robot will be controlled for a certain process using Mapp Robotics and 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 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'. Operator can control the robot automatically and manually by giving commands through HMI as well. This robot will perform tasks on the basic of g-code, m-code and n-code (type of CNC programming) written on the program.

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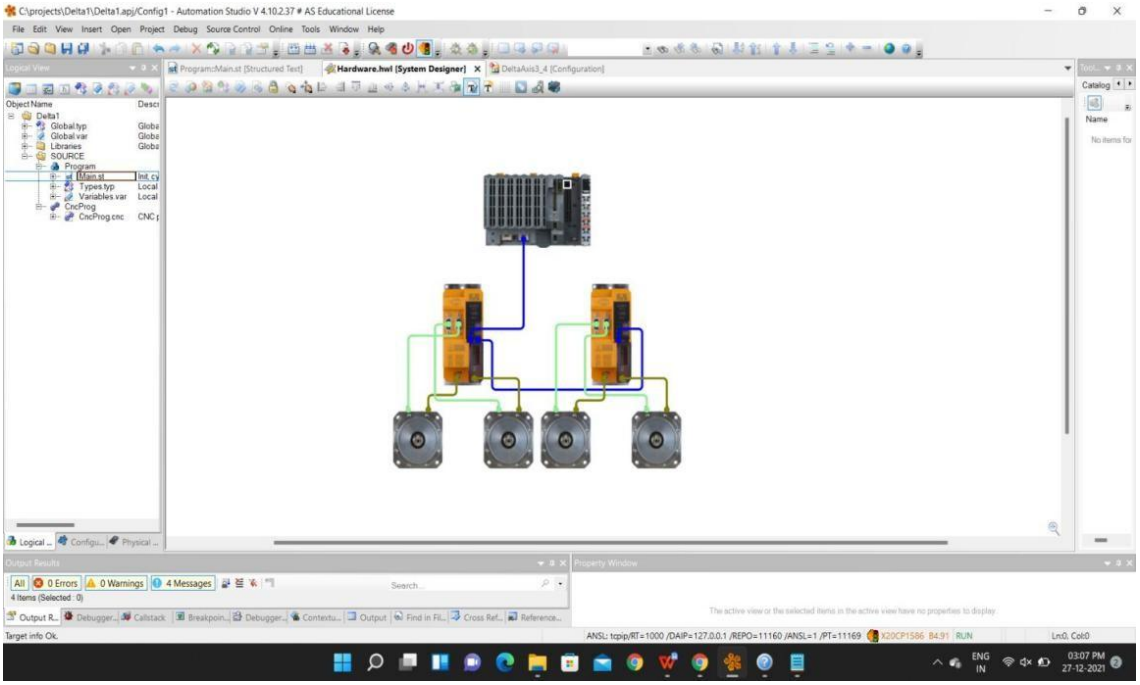

Figure 4: Automation View Of 4 Axis Delta Robot

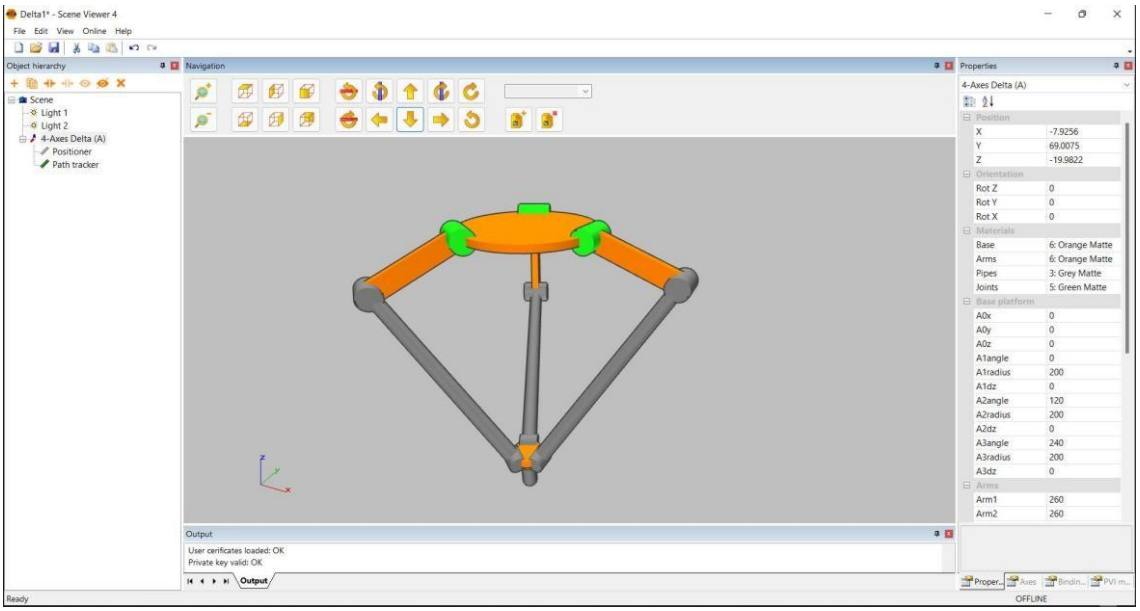

Figure 5. Simulation View Of 4 Axis Delta Robot

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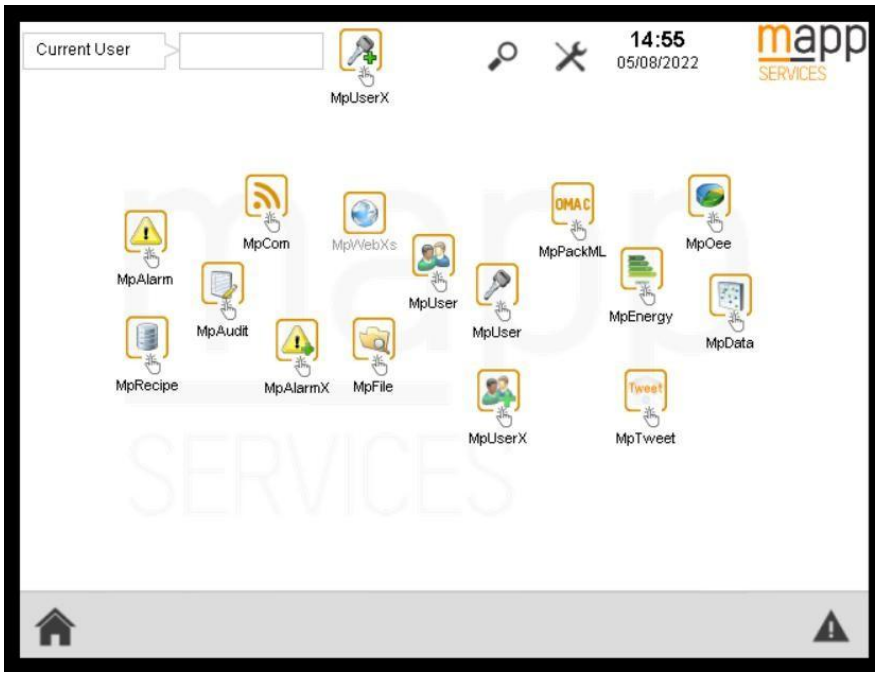

Figure 6: Human Machine Interface For 4 Axis Delta Robot

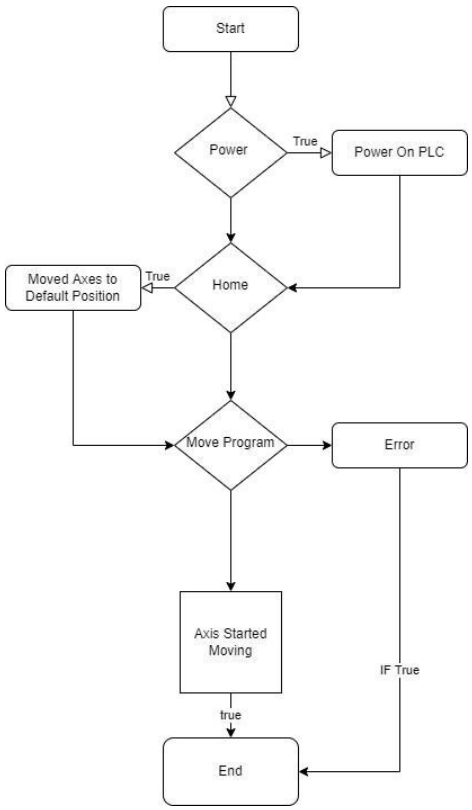

Figure 7: Working Flowchart of 4 Axis Delta Robot

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VI. RESULT AND DISCUSSION

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. Th.ese results reveal that the robot system is reliable.

VII. CONCLUSION

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 4-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.

VIII. FUTURE SCOPE

We use mainly these 4-axis delta robot in industrial work for packaging or pick and place.

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