Controlling of SCARA Robot Using Mapp Technology

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***Abstract*— The project's goal is to use B&R Automation Studio, a software platform that offers a variety of tools and features for easily integrating robotics applications into machine control systems, to control a SCARA robot. Standard automation gear is used by the system, and a single PLC can operate several robots. The machine control system incorporates all robotics functions, including microsecond precise synchronization. The concept makes use of MAPP technology, a software framework that makes using robots in manufacturing easier. The system has all the features required to operate robots, including axes that may be combined into axis groups and operated in unison using interpolated route control. The robotics features are accessible through a user-friendly interface that allows for simple coding .Programs created in C/C++, IEC61131 languages, G-code, and user-defined commands can all be integrated with the system. MAPP Robotics' preset components make robotics implementation simpler than ever. Integrating a robot into an application is now simpler than ever thanks to the MpRobotics library. Without ever writing a single line of code, users can construct robotics programs or begin point-to-point, linear, and jog movements directly.Jogging for simple manual operation, coordinate systems for running programs at various locations, workspace monitoring to prevent accidents, jerk-limited movement profiles to lessen oscillations, and tools for organizing and utilizing tools are just a few of the features that the system offers. Additionally, the system has an easy-to-use interface for programming that is intuitive.In conclusion, B&R Automation Studio's project of employing MAPP technology to drive a SCARA robot offers a simple platform for quickly and easily integrating robotics applications into machine power systems. With axes that can be combined into axis groups and manipulated together using interpolated path-controlled movements, the system has all the features required to operate robots. Robot commissioning and maintenance are facilitated by an intuitive programming interface that makes the robotics operations accessible.**

Keywords—Mapp Technology, GUI(Graphical User Interface),SCARA,

I. INTRODUCTION

This study explores the use of Modular Application Programming Platform (MAPP) technology within B&R Automation Studio to control SCARA (Selective Compliance Articulated Robot Arm) robots [1].By incorporating robotics control into the automation system, B&R Automation Studio's introduction of MAPP technology to operate a SCARA robot allows for high-precision pickand-place applications that can boost output and dependability in manufacturing lines. [2].It is now simpler to incorporate robotics functionalities into PLC programs without the requirement for separate robot controllers or specialized training thanks to mapp Technology and open ROBOTICS from B&R [3]. With up to four path-controlled axes—which can be combined into axis groups and moved in unison using interpolated path-controlled movements— the system enables the control of robots, including SCARA robots. It also includes all the features required for controlling robots [4]. Robot commissioning and maintenance are made simpler by the intuitive programming made possible by the user-friendly interface that provides access to the robotics functionalities [5]. Additionally, the system makes it easier to develop control, HMI, and safety applications, allowing for more precise positioning and lower hardware costs because it does not require a separate robot controller and display [6]. The system also permits the synchronization of sensor and robot motion and the integration of machine vision cameras for quality inspection, allowing the elimination of defective workpieces from the production process without the need for user intervention or process slowdown [7]. The efficiency and adaptability of robotic systems can only be improved by integrating cuttingedge technologies, given how quickly industrial automation is developing. One such innovative advancement is the integration of Mapp-Technology into the Scara (Selective Compliance Assembly

Robot Arm) robots' control systems. Scara robots are essential to contemporary production processes because of their exceptional accuracy in pick-andplace and assembly tasks [8]. Mapp Technology simplifies programming and opens it up to a wider range of operators with its user-friendly interface. By combining this technology with the naturally adaptive Scara robot, new opportunities for increased productivity and efficiency in a range of production applications are presented.From the early days of stiff, single-task robots to the present era of agile and adaptable robotic systems, industrial automation has seen revolutionary advancements throughout history [9]. The system has all the features required to operate robots, including axes that may be combined into axis groups and operated in unison using interpolated route control [10]. Robots called SCARA (Selective Compliance Assembly Robot Arm) are essential to industrial automation because of their remarkable flexibility, speed, and precision. They are frequently used in activities like material handling, assembly, and pick-and-place operations, greatly enhancing the productivity and efficiency of manufacturing processes [11].

II. Related Details

Controller Implementation: The position and motion of a SCARA robot are controlled by a PID controller that is implemented in visual C# in this work. The purpose of this controller is to effectively regulate the robot's movements.

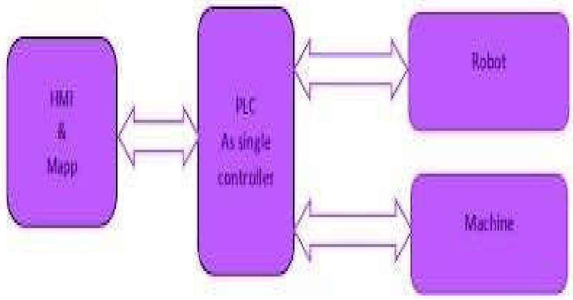
Hardware and Software Solutions: Using hardware and software solutions to implement the PID controller for the SCARA robot while minimizing costs is the main goal of the research. This strategy seeks to offer a cheap control mechanism for SCARA robot manipulators.

Graphical User Interface (GUI): A GUI is intended to provide real-time monitoring and control of the SCARA robot arm. With the help of this GUI, users may communicate with the robot, keep an eye on its parameters, and possibly change them online at any time.

Control System Design: The goal of this project is to create end-user software and a straightforward, yet effective control mechanism for SCARA robot manipulators. A digital PID controller and a C# Graphical user interfaces are included in the design.Net program to manage and keep an eye on the SCARA robot's online settings.

Adaptability and Flexibility: The goal of the visual C# controller implementation is to offer an affordable and adaptable software environment for SCARA robot control. Other SCARA robots should be able to adopt the design, which provides a popular, easy-to-use controller with a visual end-user program.

III. BLOCK DIAGRAM



The following describes the block diagram that uses Mapp Technology, a PLC, a robot, and a machine to control a SCARA robot:

Technology Mapp: The central software platform that unifies several functionalities for SCARA robot control is Mapp Technology. It has functions for quickly developing applications, configuring the robot, and facilitating smooth communication between the PLC and other parts.

Programmable Logic Controller, or PLC: The Mapp Technology software is interfaced with the PLC, which serves as the central control unit. It offers the hardware platform needed to manage inputs and outputs, carry out control logic, and interact with the SCARA robot and other system components.

Robot (SCARA Robot): The physical robotic arm that carries out the required system functions is the SCARA robot. Through the Mapp Technology software, it gets commands and instructions from the PLC, allowing for accurate motions and actions depending on the logic that has been programmed.

Machine: The SCARA robot works in a manufacturing environment that is representative of the larger system. It comprises the physical configuration, the workpieces, and any other devices or machinery that communicates with the robot. The machine component might also include sensors to keep an eye on the robot's performance and safety measures.

IV.WORKING

Robot kinematics functionalities, including both serial and parallel robot kinematics, such as SCARA and delta robots1, must be included into the mapp technology portfolio in order to operate a SCARA robot. Because the mapp technology is built on IEC 61131 programming techniques, customers may commission robots more quickly and perform significant improvements to maintenance and diagnostics.

Robot implementation is made simpler by the mapp Robotics, notably SCARA robot control, which is only available for four path-controlled axes 2. The mapp technology can be used with programs written in C/C++, IEC 61131 languages, G-code, and user-defined commands. It offers preset components that enable implementing robots easier than ever before.

With the help of the MpRobotics library, integrating a robot into an application is now simpler than ever. Users can start point-to-point, linear, and jog movements straight away without ever writing a line of code 4. There are ready-to-use configurations for many robot types that can be applied using drag & drop, and mechatronic templates for other robot models that only require configuration

Other characteristics of the mapp Robotics include feedforward torque control, which increases route precision during extremely dynamic movements, and workspace monitoring, which allows one to define zones in which the robot is allowed or prohibited to travel.With the mapp Robotics, customers may operate numerous robots with a single PLC and utilize conventional automation hardware.

Using Brain-Computer Interface (BCI) technology, a SCARA robot can be controlled by interpreting brain impulses and translating them into orders for the robot. The BCI system is made up of a number of sensors that measure brain activity, including magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), and electroencephalography (EEG).

These sensors provide noisy raw data, thus in order to analyze it further, a number of signal processing procedures must be performed, such as filtering, amplification, feature extraction, and selection. The extracted feature set is then subjected to machine learning methods, such as recurrent neural networks (RNNs), convolutional neural networks (CNNs), and artificial neural networks (ANNs), to identify certain pattern representations and translate them to the intended output.

When operating a SCARA robot, the BCI system uses several types of sensors, such as EEG, fMRI, or MEG, to gather input signals from the targeted regions of brain tissues. These sensors gather raw data, which is then processed and filtered to get rid of artifacts and noise. Prior to additional calculation, the processed data is subjected to feature extraction and selection. A machine learning model is then trained using the extracted feature set to identify particular patterns associated with directing the motions of the SCARA robot.

The way Automation Studio 4.0's mapp technology functions to operate SCARA robots, we can learn from the following sources:

Mapp Integration of Robotics: Mapp Robotics provides tools and functionalities for several robot kinematic systems, such as SCARA and delta robots, 0making the deployment of robots in production processes easier.

The mapp components, or "mapps," are simple to use and don't require a lot of technical knowledge to configure. These maps expedite the creation of application software by an average of 67% and simplify the process of creating new software.

Functionality: All features required to operate robots are included in the mapp Robotics licensing. This enables axes to be connected into axis groups and moved collectively using interpolated path-controlled movements.

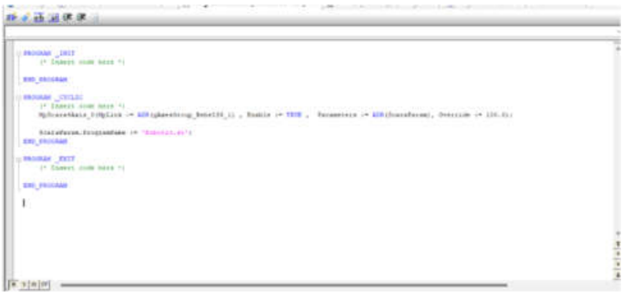
Additional features offered by mapp technology for managing SCARA robots include workspace monitoring to prevent collisions, jerk-limited movement profiles to lessen oscillations, intuitive manual operation through jogging, and executing programs at various positions using coordinate systems.

User Interface and Configuration: The mapp technology user interface is simple to use and straightforward to work with because it is built on wellknown IEC 61131 programming techniques 2.

Robot kinematics can be set up visually through an online interface, doing away with the requirement for conventional programming. This configuration in graphical form makes robot setup and maintenance easier.

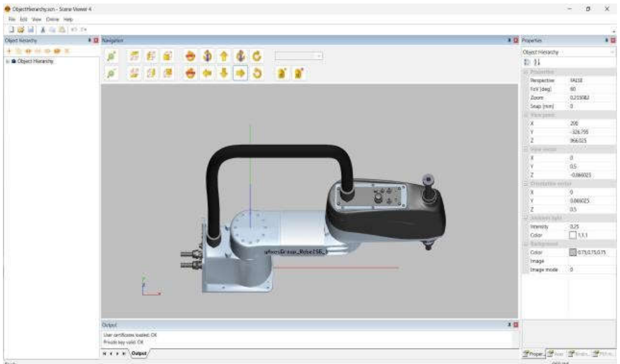
V. IMPLEMENTATION

Programmers and managers of SCARA robots in manufacturing systems will find it easier to program and manage these robots thanks to the MpRobotics library in mapp technology. The library offers ready-to-use configurations that can be applied via drag-and-drop, and the robot kinematics are configured graphically in a web interface.



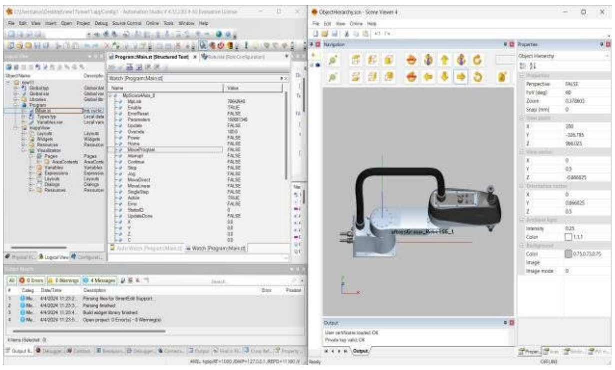
We used Scene Viewer, VNC Viewer, and Automation Studio version 4 for this project's HMI design and development. Automation Studio, which offers a number of features such programming languages, troubleshooting tools, and HMI design, was used to perform the programming. Ladder diagram, mcode, g-code, and structured text were the programming languages used.

The SCARA robot, which possesses parallel robotic kinematics, was simulated using the Scene Viewer. The SCARA robot's user interface is built on wellknown IEC 61131 programming techniques, which allow it to be smoothly integrated into the entire system without requiring a separate robotics controller. The kinematics of the robot are set up visually through a web interface, negating the need for traditional programming.



Using and managing tools is now simpler than ever thanks to the tools function. When switching tools, the dimensions and orientation of the tool can be saved and retrieved. Even at runtime, this data can be added. It is employed in kinematic tool center point (TCP) transformation as well as path planning. For each tool, mass and inertia values can be configured to be considered during feed-forward operation

In Cartesian space, coordinate systems orientation and location are specified by frames.



Real-time adjustments to these limitations are made possible by workspace monitoring in mapp technology, which permits dynamic modifications to the robot's operational bounds as needed during runtime. This feature helps to prevent collisions between the robot and other robots in the workspace as well as keeping it from leaving defined zones, which improves safety. Users may guarantee exact control over the motions of the SCARA robot by putting workspace monitoring into practice, which improves operational efficiency and safety in industrial applications.

VI. SOFTWARE : **Automation Studio 4.0:**

Software for circuit design, simulation, and project documentation is called Automation Studio.Programming languages like ladder diagram, structured text, functional block diagram, etc. are available in the automation studio. It offers diagnostic and troubleshooting tools **Scene Viewer 4:**

Robot kinematics functions for serial and parallel systems, such SCARA and delta robots, are included in the mapp technology from B&R. Without the need for a separate robotics controller, the robotic functions integrate smoothly into the overall system and are based on well-known IEC 61131 programming techniques for the user interface.

There is no need for traditional programming because the robot kinematics are set up graphically through a web interface.

Mapp Technologies:

There are a lot of procedures and activities carried out in industry. Because there is a chance that every operation or procedure will go wrong, security features like alarms, user logins, and management are essential. In order to audit, some functions are used to record data.

These kinds of tasks are required in every industry. Therefore, some software blocks are used instead of investing time building these capabilities for every application. As a result, less time is spent constructing a function that isn't worthy of high-caliber work.

For those purposes, Mapp offers pre-made widgets and layouts.

Languages used in programming

Structured Text : The IEC 61131-3 standard supports this language. This language is advanced.

Ladder Diagram : Programming language called Ladder Diagram uses graphical diagrams based on relay logic hardware circuit schematics to express programs.

M and G codes : These devices move thanks to the G code, which is written in an alphanumeric manner. When constructing a part, it instructs the machine on where to begin, how to proceed, and when to stop.

All of the non-geometric activities of the machine are managed by a set of auxiliary directives called the M code. It is used in conjunction with G-code to turn on and off certain machine functions.

VII . PROGRAMMING

Main ST :

```
PROGRAM _CYCLIC
        MpScara4Axis_0(MpLink :=
ADR(gAxesGroup_RebelS6_1) , Enable := TRUE , Parameters
:= ADR(ScaraParam), Override := 100.0);

   ScaraParam.ProgramName := 'Robotic.st';
END_PROGRAM
```

MpScara4Axis_0: A four-axis SCARA robot is controlled with this function call. It outlines the specifications required to operate the robot.

The parameter **MpLink** :=

ADR (gAxesGroup_RebelS6_1) connects the SCARA robot to the designated axis group within the program.

Enable:= TRUE: This setting makes it possible for the SCARA robot to function.

Settings := ADR(ScaraParam): This parameter provides the SCARA robot control settings. ScaraParam probably holds robot-specific configurations or parameters.

Override:= 100.0: This parameter sets the override value to 100.0, which could have an impact on the robot's movement speed or characteristics.

ScaraParam.ProgramName:= 'Robotic.st': This line sets the ScaraParam structure's ProgramName field to the program name 'Robotic.st'. This can be a reference to a particular script or program connected to the SCARA robot.

Robotics.st:

```
VAR CONSTANT
P1 : McPointType := (Pos:=(X:=135, Y:=-336, Z:=0));
P2 : McPointType := (Pos:=(X:=326, Y:=-381,
Z:=63));
P0 : McPointType := (Pos:=(X:=547,Y:=-164,
Z:=100));
END_VAR
PROGRAM _MAIN
WHILE TRUE DO
Feedrate(10000);
MoveJ(P1);
MoveJ(P2);
WaitTime(3);
MoveJ(P0);
END_WHILE;
END_PROGRAM
```

VAR CONSTANT:

Three constant of type

McPointType are defined in this section on variable declaration. Using the Pos field, each constant represents a distinct location in three dimensions.

The coordinate system for P1 is (X:=135, Y:=-336, Z:=0), signifying a point in three dimensions having X coordinates of 135, Y coordinates of -336, and Z coordinates of 0.

The coordinate system for P2 is (X:=326, Y:=-381, Z:=63), signifying a point in three dimensions having X coordinates of 326, Y coordinates of -381, and Z coordinates of 63.

The coordinate system for P0 is (X:=547, Y:=-164, Z:=100), signifying a point in three dimensions having X coordinates of 547, Y coordinates of -164, and Z coordinates of 100.

PROGRAM_MAIN: This is the main program, which has an endless WHILE loop running in it.

FeedRate(10000): 10000 units per minute is the feed rate that is set by this function.

MoveJ(P1): This function uses a joint-based movement to move the robot to position P1.

MoveJ(P2): This function uses a joint-based movement to move the robot to position P2.

WaitTime(3): Before processing the subsequent instruction, this function waits three time units.

MoveJ(P0): This function uses a joint-based movement to move the robot to position P0.

VIII. CONCLUSION

The use of Mapp technology in our project to control a 3-axis robot, like a SCARA robot, with a single controller PLC is in line with the idea of a Machine Centric Robot (MCR), especially in light of the current industry scenario where robots typically have their independent controllers and control cabinets. By combining the robotic and machine controllers, this method simplifies control and allows operators to simply manage servo motors, I/O, and visualization using a single industrial PC.

The project's usage of Mapp technology allows for a user-friendly HMI interface to enable control and command execution for the 3-axis robot, much like a SCARA robot.Without the need for hardware, the project's simulation format enables a thorough testing and debugging environment where all of the robot's capabilities can be simulated and confirmed. The SCARA robot is controlled safely and smoothly thanks to this simulation-based method, which also improves operational effectiveness and lowers the requirement for physical hardware during the development and testing stages.

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