Pick and Place Robotic ARM using PLC

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Abstract— **This paper outlines the various stages of operations involved in the pick and place robotic arm. It is an automated material handling system is synchronizing the movement of robotic arm to pick the object moving on a conveyor belt. Nowadays various advanced robots are used in industries but still controlling is done manually or using processors likewise Arduino, microcontroller. But microprocessors have several disadvantages so these disadvantages can be overcome by PLC. Here Programmable logic and controller is used for controlling and operating robotic arm. All the various problems of this process have been analyzed properly and have been taken into consideration while programming and designing the pick and place robotic arm.**

Keywords – Automation, PLC, Pick and Place Robotic Arm.

I. INTRODUCTION

"To design, build, and test a Pick and Place Robotic Arm System using Programmable Logic Controller (PLC)." The present system provides an automated solution for industry requirements for pick and place operation. Robotic pick and place automation speed up the process of picking parts up and placing them in new location, increasing production rate. In this project we are designing complete model of pick and place robotic arm. The process variables that are to be controlled in this project are movement of arm, position of arm, etc. The project includes creating a model. The complete process is controlled by using Programmable Logic Controller (PLC). In this model the object is picked by arm automatically from conveyor belt and place it to desired position.

Robotics-Robotics is an interdisciplinary branch of engineering and science. It includes –

1. Mechanical engineering,
2. Electronic engineering,
3. Information engineering,
4. Computer science
5. Instrumentation and others

Robotic Arm -
An artificial developed structure to ease complex tasks used to pick up heavy loads to do complex tasks with perfection and speed. Robotic manipulator, usually programmable, with similar functions to a human arm.

PLC–
Programmable Logic Controller. A programmable logic controller (PLC) is an electronic device used in many industries to monitor and control building systems and production processes. A PLC operating cycle, or scan, consists of: Reading and storing the current value of each input. It receives information from connected sensors or input devices, processes the data and triggers the output based on pre-programmed parameters. Depending on inputs and outputs, a PLC can record and monitor run-time data such as machine productivity or operating temperature, automatically start and stop the processes, etc. PLC are flexible and robust control solution, adaptable to almost any application. A PLC program is usually written on a computer and then is downloaded to the controller. Most PLC programming software offers ladder logic programs. Ladder logic is the traditional programming language.

Grippers-
Sometimes called hand grippers, are primarily used for testing and increasing the strength of the hands; this specific form of grip strength has been called crushing grip, which has been defined as meaning the prime movers are the four fingers, rather than thumb. Robot grippers are the physical interface between a robot arm and work piece. Material handling is one of the benefits So it is important to choose the right type of gripper for your application.

Spur Gear-
Spur gears are the most common type of gears. They have straight teeth and are mounted on parallel shaft.
Many spur gears are used to create very large gear reduction. Spur gears can be made from metals such as steel and brass or from plastic such as nylon or polycarbonate. Gears made from plastic produce less noise but expense of strength and loading capacity.

Spur gears best for applications that require speed reduction and torque multiplication such as ball mills and crushing equipment's.

Conveyor Belt –
Conveyor belt is the medium of transport of materials on it. A belt conveyor system consists of two or more pulleys with an endless loop of carrying medium the conveyor belt

that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.

In our project conveyor belt is used for carrying object from one place towards the arm position.

DC Motors-

In our project we have used 4 D.C motors for gripper movement, arm up down movement, rotation of arm and conveyor belt movement. The specifications of this are as follows: -

10RPM 12VDC motors with Metal Gear box, Shaft diameter: 6mm

Shaft Length: 15mm Stall Torque: 49kgcm

No-load current: 800mA (max) Stall current: up to 9.5A (max)

II.   LITERTURE REVIEW

Robotics has become most common course in higher education or industries most of them are for industry purpose [8]. In industries there are many robots are available but most of them are costly. There is need to develop a low-cost system for students or small-scale industries. For students it will be useful for learning the elements of robotics such as kinematics, dynamics, sensing, and control. The aim of the project is to develop and design a mechanical structure of a robotic arm that can perform various operations like pick and place the object, material handling, welding, etc. the main objective is to control the robotic arm automatically and manually.[7] This project focuses upon to create more useful, and build more compact, cheaper robotic arm to perform various dangerous tasks and to eliminate human error to get more precise result [9].

History – Conceived from a design for a mechanical arm patented in 1954(granted in 1961) by American inventor George Devol.

Joseph Engel Berger – the Father of Robotics.[9]

Design and Performance of a robotic arm for farm use- Article in International Journal of Agricultural and Biological Engineering 12(1):146-158· January 2019[6] According to research done by Abdellatif Baba [1], human needs are growing faster so as in resemblance technology is also developing with same speed and in same direction. In this, they controlled the robotic arm by connecting a robot application via Bluetooth module connected with Arduino Nano controller. In this they used 5 servo motors with robotic arm has capability to move in 4 axes. Its main focus on industrial and medical sector.

Research conducted by Kaushik Phasale, Praveen Kumar, Akshay Raut, Ravi Ranjan Singh, Amit Nichat[2], used SCARA configuration to operate the robotic arm. They

highlighted on low cost robotic system for industrial purpose. The paper published in [3] 2014, controlling a robotic arm for application such as object sorting with the use of vision sensor would need an image processing algorithm to detect and recognize the object. The paper is directed towards the development of image processing algorithm. In this object is detected by feature extraction algorithm.

A research conducted by Rasika Yenorkar ; U. M. Chaskar [4] in 2018, they developed a GUI based, a trainable robotic arm which is being controlled automatically for various industrial applications. Here, they used MATLAB Graphical User Interface (GUI) also they used AVR controller which has been used for programming part in which central controlling station has GUI access and GUI makes robotic arm easily trainable and user friendly.

According to research paper Motion Control of Robotic Arm for Micro-Positioning in Industrial Application in [5] (2018), came up with idea of developing an automated robotic arm for industrial purpose. The paper describes the 3 degree of freedom directing by using inverse kinematics. The proposed system is expected to fulfill the requirement of reliability, accuracy, security required for threading and grinding operations.

Use of industrial robots increased in areas such as food, consumer goods, wood, plastics and electronics, but still mostly concentrated in the automotive industry.[7]

The main aim is to design and develop lightweight robotic arm using lightweight materials such as PVC material, wooden ply, etc. and also to make low cost system.[7]

OBJECTIVES

- Increase in productivity
- Reduction in running cost
- Precision in control
- Increase in speed of operation
- Efficient operation
- Early/predictive fault notification
- Reduce the start-up time for process
- Complete control of manufacturing process
- Increase in quality and consistency of the product
- Shorten the time to market
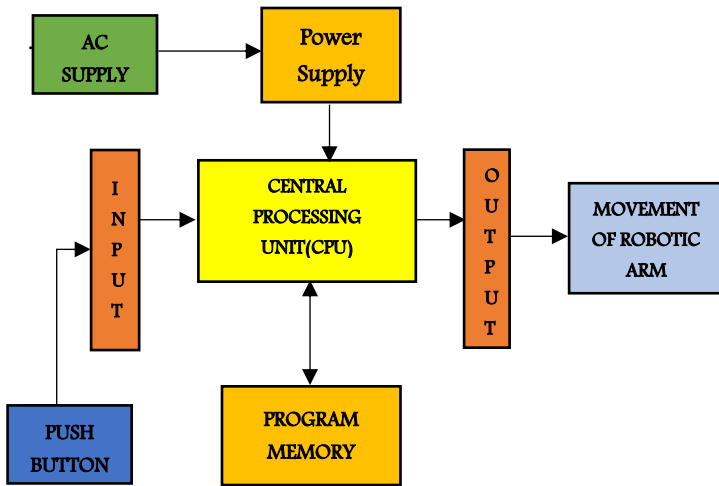- Increase in human safety from hazardous Conditions

Parameter	PLC	Microcontroller
Quality	High	Low
Efficiency	High	Low
Accuracy	High	Low
Cost	High	Low

III.   PROPOSED SYSTEM

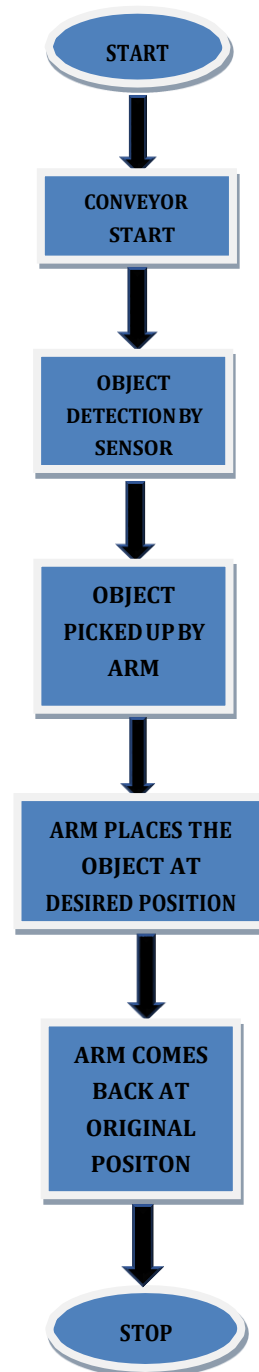We have used two push buttons to control the operation of the system. They are:

- *START:* When this push button is pressed, system will start.
- *STOP*: When this push button is pressed, system will stop.
- We have used robotic gripper for pick and place

BLOCK DIAGRAM -   FLOWCHART

```
AC SUPPLY → Power Supply
                ↓
INPUT → CENTRAL PROCESSING UNIT(CPU) → OUTPUT → MOVEMENT OF ROBOTIC ARM
                ↓
           PROGRAM MEMORY

PUSH BUTTON → INPUT
```

```
`1        START
            ↓
     CONVEYOR START
            ↓
     OBJECT DETECTION BY SENSOR
            ↓
     OBJECT PICKED UP BY ARM
            ↓
     ARM PLACES THE OBJECT AT DESIRED POSITION
            ↓
     ARM COMES BACK AT ORIGINAL POSITON
            ↓
          STOP
```

The block diagram represents the simplified principle of any project. Here, the block diagram of pick and place robotic arm is as shown in fig. which one simply example the whole working of the robotic arm. The block diagram has following parts like PLC, Power supply, Sensors, Input switch, Program memory is used to take decision according to the inputs status and then transfer it to the output devices through output channels. Given fig consists of switches, PLC and output device.

Here, the system requires 230VAC power supply which is converted into 24V through PLC. Mitsubishi FX5u PLC is used in the project. Here program is stored in program memory and according to program input and output module works. Here conveyor belt, and sensor also 2 pushbuttons are used as input while for output 3 DC motors are used.
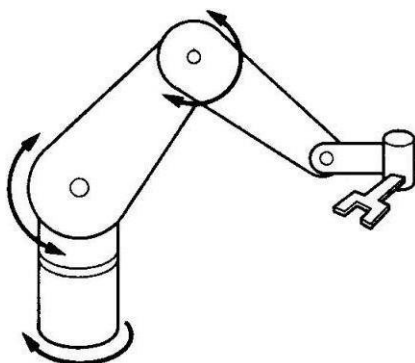
Fig. 3.1 Mechanical Design

IV.   METHODOLOGY

The proposed idea of this project is to develop and design Pick and Place Robotic Arm which can be controlled by using PLC. The idea was to design an automated system for industrial purpose so that could be able to control it from anywhere and at any time. 1st motor was situated at gripper position, 2nd motor used for up-down movement of arm, 3rd motor used for rotation of arm and 4th motor was used to operate conveyor. The implementation is shown in Fig.4.1 below.

Figure 3.1 shows the mechanical design for robotic arm. The system will start by pressing a start push button. The conveyor belt will start moving. The object is placed on the conveyor belt. As the conveyor starts moving, the sensor will detect the object. Here we can use proximity sensor for nonmetallic material, inductive sensor for metallic objects. And after detection of object, conveyor will stop automatically. The robotic arm automatically picks the object placed on conveyor and it will rotate the arm 90, 180, 270,

360 degrees according to requirement and with correspondence to timer given by PLC and placed the object at desired position.

Fig.4.1 Actual Setup

V. CONCLUSION

A robotic arm is type of a mechanical arm which function is as similar to human arm. After detailed study, it is easily programmable and to operate. It is fully automatic system but one can operate it manually also. Conclusively, this project helps to find solution for difficulties coming in industrial automation. The robotic arm is used for material handling, object sorting, welding, grinding, spray painting purposes. A successful model of Pick and Place Robotic Arm has designed using PLC.

SR. No.	Advantages	Disadvantage s	Application
1.	Higher accuracy and repeatability	Expensive	Material handling
2.	Increase productivity	Sometimes hazardous	Industrial application
3.	Easily programmable	Increase requirement of skilled technicians	For pick and place of objects.
4.	Reduces time	Maintenance	Product packing.

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