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DESIGN AND FABRICATION OF PLC AND SCADA BASED ROBOTIC ARM FOR MATERIAL HANDLING

Veena C D[1], Sharath H K[2], Sree Rajendra[3] ,Shivashankara B S[4]

[1]PG scholar Dept. of Mech. Engg. Malnad college of Engineering, Karnataka, India
[2,3,4]Assisstant professor, Dept.of Mech. Engg., Malnad college of Engineering, Karnataka, India

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Abstract - *Picking and placing the object from the conveyor belt is the important task in the packing section of an industry. Pick and place manually, needs manual power and time.*

This is an attempt to design efficient mechanism for picking and placing by automating them by constructing the 3-directional robotic arm using Pneumatic cylinders which are controlled by the PLC. The system consists of a PLC which controls the movements of the pneumatic cylinders based on the inputs coming from the sensors placed on the conveyor belt. The robotic arm is having the capability to move along the three axis (X, Y and Z). A mechanical gripper is placed at the end of the robotic arm which is used for holding the objects on the conveyor belt.

Key words*:* PLC, SCADA, etc

1. INTRODUCTION

Nowadays, robots are increasingly being integrated into working tasks to replace humans especially to perform the repetitive task. In general, robotics can be divided into two areas, industrial and service robotics. International Federation of Robotics (IFR) defines a service robot as a robot which operates semi or fully autonomously to perform services useful to the well-being of humans and equipment, excluding manufacturing operations. These mobile robots are currently used in many fields of applications including office, military tasks, hospital operations, hazardous environment and agriculture.

A robotic arm is a robot manipulator, usually programmable, with similar functions to a human arm. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement.

The links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is called the end effectors and it is analogous to the human hand. The end effectors can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application.

1.1 Problem Study

Human labor for the loading and unloading of the goods within an industry and also for packing purpose will consume more time. In today industries, most of the factories run by automated robots in order to deal with their daily production activities especially in the automation field which uses robotic arms from welding, material handling, spraying, painting and drilling.

The existing robotic arm was designed based on specific purpose and function. This means that its input and output is fixed cannot be reprogrammed for any other application or use. This is to prevent for any modifications and alterations to their products. Moreover the work can be done easily using a single pick and place robot, which is used for both loading and unloading and palletizing purpose.

1.2 Objectives

To understand the structure and operation of PLC and SCADA. To study the ladder logic design and their programming technique. To understand how to make the interfacing to the PLC.

To design a program that works together with a model of 3dimensional axis with pneumatic cylinders with pick and place grippers.

1.3 Methodology

The robotic arm comprises of integration of Supervisory Control and Data Acquisition (SCADA), Programmable Logic Controllers (PLC), pneumatic gripper and solenoid valves. In the robotic arm, SCADA will be the central system that control and monitors all the data in the system. The 3 axis robot consists of three independent pneumatic cylinders which are the base for the 3 axis movements, and the pneumatic cylinders motion is controlled by DCV's which are in turn governed by PLC .

Figure 1 represents theblock diagram of the system, whenever the PLC gets the input for picking or any other operation such as placing, packing based on the end-effectors used, the PLC generates the output based on the time duration required. Once the output is triggered then the DCV activate and the action is carried out.

If any process is not happening in the way it is planned, there is a safety switch for resetting which resets the program and puts the robot in home position.

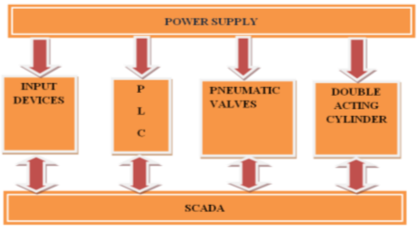

Fig -1: Block diagram of the system

2. LITERATURE REVIEW

Wan Muhamad Hanif Wan Kadira, et…al; describes the development of an internet controlled robotic arm. The movement of the robot arm can be controlled by a computer via the internet. The robot can be used to demonstrate that a robot can be used inside a home for daily human chores. The robotics controlled by Arduino Uno that interfaced with the internet using Arduino Ethernet Shield. Two type of analysis were done for the project that is servo motor analysis and accuracy test. The accuracy test shows that the results of the actual output of the servo motor as compared to the input send to Arduino Uno via internet is between 97% to 99%.[1]

MohdAshiqKamarilYusoffa, et…al; explained the development of a wireless mobile robot arm. A mobile robot that functional to do pick and place operation and be controlled by using wireless PS2 controller. It can move forward, reverse, turn right and left for a specific distance according to the controller specification. The development of the robot is based on Arduino Mega platform that will be interfaced with the wireless controller to the mobile robotic arm. Analysis such as speed, distance, load that can be lifted of the robot has been done in order to know its performance. [2]

Enrique Hortal,et…al; shows a multimodal Human–Machine Interface system that combines an Electrooculography Interface and a Brain–Machine Interface. The multimodal interface has been used to control a robotic arm to perform pick and place tasks in a three dimensional environment. Five volunteers were asked to pick two boxes and place them in different positions. The results prove the feasibility of the system in the performance of pick and place tasks. By using the multimodal interface, all the volunteers were able to successfully move two objects within a satisfactory period of time with the help of the robotic arm. [3]

A. Hosovsky, et...al; explained a Pneumatic artificial muscles (PAMs) belong to the group of nonconventional actuators with remarkable force/weight ratio that can be used for the construction of soft mechanisms safe in contact with humans. In order to be able to design an effective control of 2-link soft robot arm actuated with PAMs, a dynamic model of the system needs to be derived. We use a PAM dynamic model derived using first principles modeling (for contraction, pressure, and air flow dynamics) and ANFIS-based approximation based on the experimental data for the muscle force function. To derive the dynamics of the robot arm, use Lagrangian mechanics approach for planar arm with the inertial and mass data based on the 3D CAD model. To validate the complete dynamic model of the soft robot arm, used a gravity test (without PAM actuation) and pulse excitation for PAM control. The results confirm good validity of the dynamic model for all relevant variables (joint angles, muscle contractions, and pressures) as well as the dynamic coupling between the joints. [4]

S.C. Gutierrez, et… al; describes the manufacture a prototype of a lightweight robot arm with a low cost budget, fully functional. The prototype is used to test and fix the elements for driving and controlling. During the development process, several tests and studies were performed, such as, strength simulations, dimensional effects after a post-process treatment with acetone, adjustment of control parameters to improve the accuracy, testing of behavior of transmissions, etc. The prototype must have a low weight overall and a right operation. [5]

Hsien-I Lin,et…al; the study proposed a learning system for the machines that incorporates image characteristics into the insertion motions performed by a robot arm to solve problems related to transformer insertion. The proposed system operates in three layers: vision, motion, and decision. The vision layer involves preprocessing image data, extracting pin image features by locally linear embedding (LLE), and setting parameters for teaching insertion motions to the robot arm. In the motion layer, motions qualified for inserting the transformers were collected and the weighted Fuzzy C-means was used to converge the insertion motions and create target markers for the decision layer. The decision layer uses one-against-rest support vector machines (SVMs) to establish classifiers for applying the collected image characteristics to the calculation of insertion motions. [6]

3. WORKING PRINCIPLE

The main objective of the system is to design a robotic arm which is controlled from PLC and SCADA and used Pneumatics as its working source.

The design has been implemented and fabricated with two pneumatic cylinders for horizontal and vertical motion and attached with a gripper at the end.

The gripper is made using electrical motor with gear systems for converting rotary motion to open/close action. The PLC is used as a controller which controls the amount of motor open and close action and the traverse of pneumatic cylinder. The PLC activates the relay which in turn activates the DCV. Here 5/2 DCV are used so that a single valve can be used to connect single cylinders up and down motion.

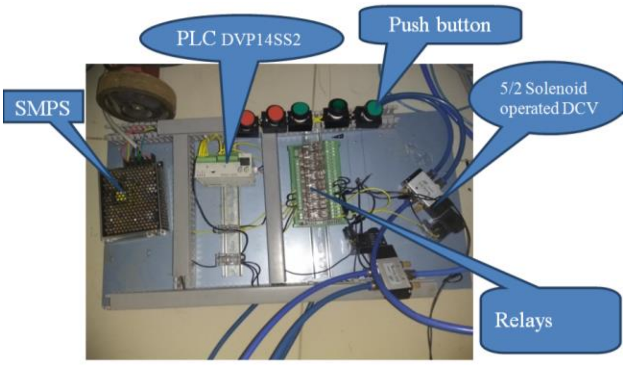

Fig -2: Components of the robotic arm

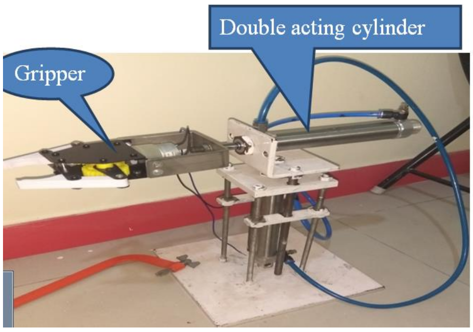

Fig -3: Robotic arm

This overall progress is governed by the SCADA system. SCADA stands for Supervisory control and data acquisition. Which means it can be used for application control and monitor. So here it monitors the process happening in the PLC and sends response to the SCADA system.

The controller has been programmed in such a way that auto and manual selection has been carried out.

Auto mode

In auto mode the actuator moves up and horizontal and picks the object with time delay given as default. This happen for one full cycle automatically.

Manual mode

In manual mode the robot motion is controlled by individual switches. It acts like Joint co – ordinate of a robot. Each and every axis is governed by individual inputs.

For interfacing the SCADA and the PLC we are using a 3rd party intermediate driver called KEPSERVER. So this kepserver will create a virtual server in which PLC and SCADA will be added. So that each can communicate to one other. The communication medium used for this is RS232. This means point to point communication.

3.1 Specification of Component

Components	Ratings
Delta PLC	24VDC,8-inputs,6-Outputs
In touch	SCADA Software by Schneider
Delta Digital Output Module	24V DC
DCV	230V
SMPS	24V, 2.1Amps
Double Acting Cylinder	2No's
RELAY	8Nors 24V
PUSH BUTTON	5 No's
Pick and Place Gripper	24V

Chart -1: Components Specification

4. CONCLUSIONS

The concepts for programming the PLC has been studied and implemented successfully for the logic of the robotic arm. The purpose of SCADA and Importance has been learnt and Animations has been created for the robotic arm. The SCADA has been designed in such a way that the Process can be controlled from SCADA also. The main aim is to develop a 2D robot that can be used for material handling, and the same has been fabricated. All the objectives has been verified and achieved full fledge. The robotic arm has been checked and verified for two operations of auto pick and place function and also manual control.

4.1 Future Scope

- Can be used in all material handling applications.
- Can be interfaced with extra axis for achieving more efficiency.
- Even by changing end effectors it can use it for general welding purposes.
- Using PLC we can establish communication to even HMI and Drives for interfacing with conveyors.

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