DESIGN OF A ROBOTIC SYSTEM FOR AUTOMATIC CLUTCH DIAPHRAGM SPRING TESTING BY USING AUBO 15 ROBOT

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Abstract- *A practical approach to design a robotic system for automatic pick and place operation in clutch diaphragm spring testing system. This work aims to design a magnetic gripper which is simulated using a Delmia robot simulation. The system opens its gripper to grasp the object upon arrival and move to the position. The methodology in this work involves the determination and analysis of the salient needs of the necessary components to design the mechanical grippers, electrical system and their integration as a system. The robotic automation is done by a collaborative robot called AUBO I5 with payload of 5kg. The testing of the spring system is carried out manually which results in fatigue of the worker thereby reducing the worker's productivity. To overcome this draw back we have automated the testing process, eliminating the human intervention thereby increasing the speed and accuracy of the testing process and results.*

Keywords- AUBO I5, Electromagnetic Gripper, Delmia, Proximity Sensor

I. INTRODUCTION

Since the age of industrial revolution, the industries are moving in the direction of techniques with more efficient and faster way of production. In India, industrial revolution 4.0 is in trend which involves automation and data acquisition. Thus, numerous research on automation is in progress and one such kind is the design of a Robotic gripper for picking objects from a pre-defined position and placing them at a target destination. Such automation in production line will increase the production and avoid line accidents which frequently occurs due to the fatigue nature of the work. [6]. Now a day's robots find their application in versatile fields. In the highly competitive market industries are forced to maintain high standards in terms of quality, functional features, cost etc., which is possible only by the intervention of robots as machines replacing human labour. In spite of the high cost of robots, it has become mandatory to procure and deploy them in the industries to perform highly accurate and repetitive nature of job. [5]. Thus, the need of such automated machines has led to extensive research and development of robots for specific application. Apart from manufacturing, testing of materials also forms an integral part of product development, qualification and assessment of system performance. Hence automation in this sector too would increase the productivity of the organization. In this work the pick and place operation of a material is performed with the help of custom designed electromagnetic grippers, implemented in automatic diaphragm testing machine with 6 DOF collaborative robot named AUBO15 having a payload of 5 kg. The DELMIA simulation software is used to design simulate and develop such a system from scratch, to its operation [16]. The operation can be virtually performed and the functionality can be assessed and validated to understand the effectiveness of the design before the actual development of the system. Thus, manufacturers can virtually visualize and realize the product operation and effectiveness before the physical plant or production line is existent.

II.CUSTOM ELECTROMAGNETIC GRIPPERS

To reduce the operational cycle time and errors, it is necessary to design an innovative and efficient end effector for an automatic assembly system. The operation of the peripheral device has to do in hand with the design and function of the other parts of the system [1]. In this work the tool has been designed following the procedures developed and practiced by experts. The notion of robots as human beings has changed. They have transformed in order to perform several automated industrial operations to increase the standards and quality of products. In recent past industries are focussing their attention on utilization of robots instead of automation to increase the productivity by producing high quality products in mass at lower price to sustain in the market. The preference of robots with anthropomorphic features is not necessary for performing tasks in industries though the focus still remains on developing robots with super human capabilities. A robotic arm is one such example that is commonly used in industries. [6]. The features and functions of a human arm, waist, shoulder elbow etc., is reproduced by designing a system using links and joints that have the same degrees of freedom. [7]. The motion of all these parts are integrated to perform a task.

In our design we have designed and developed an end effector with an aluminium gripper which has a high tensile strength to weight ratio [8]. The purpose of the gripper is to pick, firmly hold and place the diaphragm clutch for testing in the machine as shown in figure 2. A voltage regulator provides the power to the electromagnets which generate magnetic field that ensure firm gripping of the clutch. The gripper has a steel pot placed at the bottom of the gripper plate to dissipate the magnetic field [5].

Figure 2. Electromagnetic Gripper

Figure 3 Support Plate

III. DIAPHRAGM TESTING PROCEDURE

In the manual testing process, the clutch spring diaphragm is placed at the centre of the testing machine and depressed. After reading the tensile strength from the LCD display, the plate is removed from the machine and the strength value is marked on the surface of the diaphragm plate. Based on the reading of the tensile value, the plates are segregated as "accepted" and "rejected plates", The same procedure is repeated continuously for all the specimens. In this work involving a robot, a customised gripper is designed to pick and place the diaphragm plate and a dot matrix printer called DOMINO printer is employed to print the stress value on the plate with the help of a pneumatic actuator [16]. The system is controlled and monitored by a robotics controller as shown in figure1.

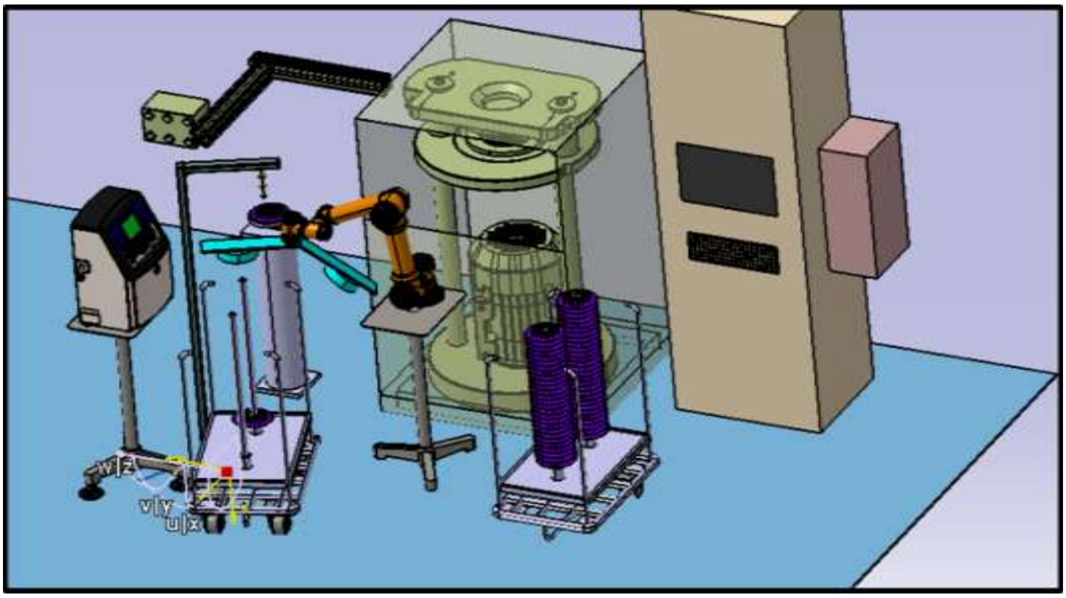

Figure 1 AUBO15 Robot with Electromagnetic Gripper in Clutch Diaphragm testing Process in DELMIA Software

IV.COLLABORATIVE ROBOT

The machine is also called as Cobot. The specification is given in Table 1. It occupies a smaller floor area and is capable to work within the existing space provided for the human labour and without the need of safety equipment. [12]. The machine is light in weight, easy to deploy and user-friendly to operate without the requirement of programming skills. As the machine operates on single phase 110 – 230 V power, it can be connected in the shop floor itself. In this project the robot is deployed to pick and place a clutch diaphragm specimen accurately in the testing machine with the help of a sensitive encoder. The robot is provided a significant feature that can access its default features and customise the robot to future needs through an API support [8]. An open source software ROS which can be interchanged among robots of different manufacturers is provided to efficiently control the motion of the machine [5]. Deploying the robots in such process will enhance the productivity of the plant

Table 1 Specification of the Robot

Name of the Robot	AUBO i5
No. of Degrees of freedom	6
Payload (kg)	5
Arm reach length (mm)	924
Voltage	110 – 230 V

V. SENSING SYSTEM

In this system, proximity and laser transducers measure the distances between the objects and providing feedback to the robot controller. In proximity series, inductive type proximity sensors are used as this type of proximity are widely used in detecting only metals components. Both cylindrical and block type industrial grade proximity sensors are used whose details are given in Table.2

Table 2 Sensor used in robotics system

S.NO	SENSORS TYPE	RANGE	PURPOSE
1	Proximity-cylindrical	16mm	Input trolley detection
2	Proximity-cylindrical	16mm	Output trolley detection
3	Proximity-block	40mm	Loading gripper
4	Proximity-block	40mm	Unloading gripper
5	Proximity-cylindrical	16mm	Printer plate detection
6	Photoelectrical	600mm	Double Plate detection

VI. INTEGRATION AND CONTROL

The sensors and robots are integrated with the robotic controller. A distribution box is used for better serviceability, maintenance and wire management. The sensors and actuators are integrated with the distribution box. A 32 pin SIBAS connector is used to connect with the controller [8]. A detailed schematic is provided in fig.7, An additional SMPS is used to reduce the load to robotic controller. A system is defined as the integration of different parts or subsystems where in each subsystem perform their prescribed function to accomplish the goal of the primary system. [4] A robot is a similar system which has different parts with each one performing their own task to finally deliver the output of the robot [5].

The controller is fed with the program to do the desired operation. The programming can be done in pendent of the robot or though ROS of the robot. A detailed Overall Schematic of AUBO15 Robot for pick and place operation in clutch diaphragm spring testing shown in Figure.4.

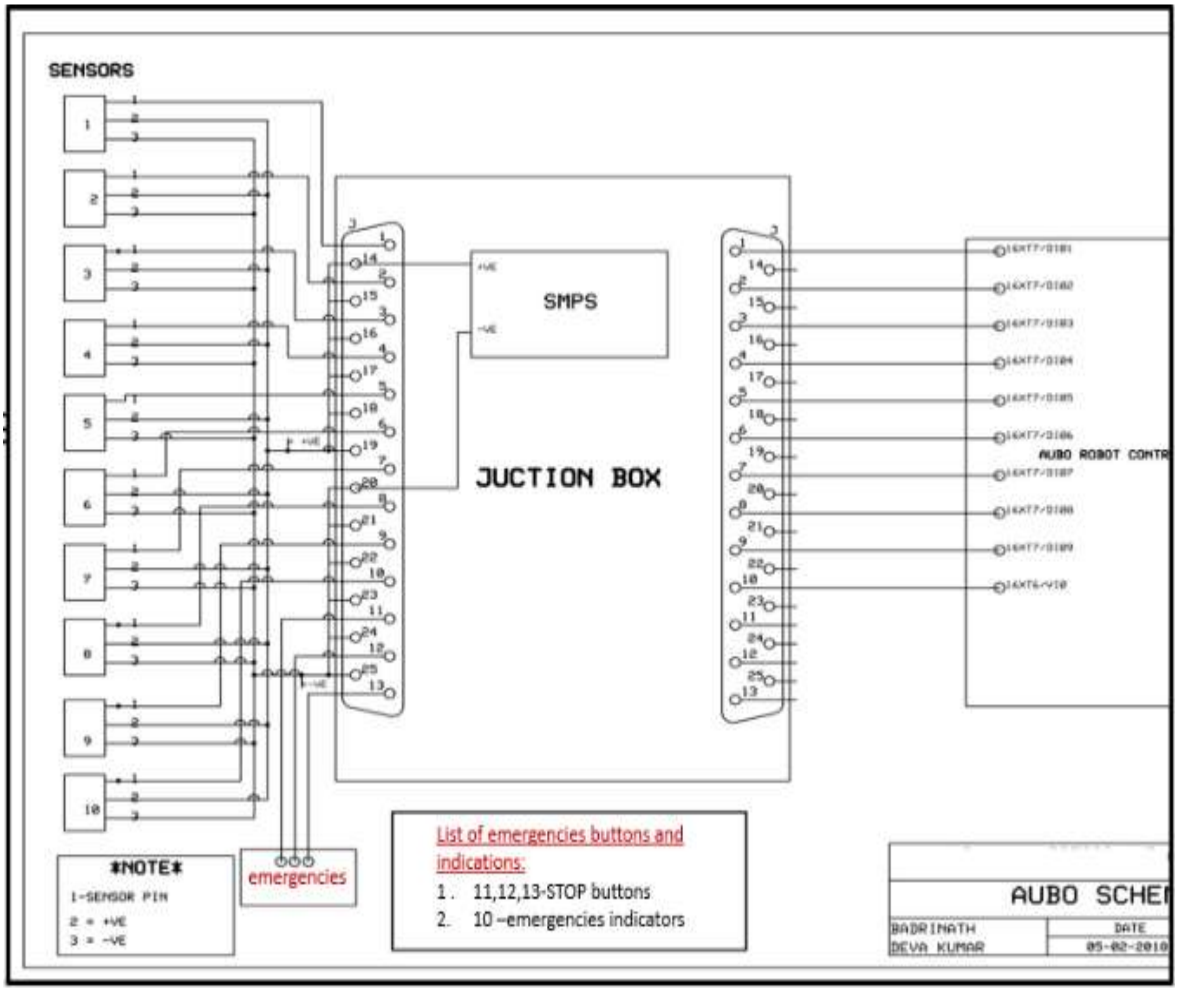

Figure.4 Overall Schematic of pick and place operation in clutch diaphragm spring testing

VII. ALGORITHM FOR AUBO15 ROBOTIC SYSTEM

Figure 5 depicts the programming flow chart of the robot motion control for the pick and place operation of the clutch diaphragm. The system runs on 230 V power supply. As and when the system is switched on, the signal provided by the user is collected and processed by the machine [5].

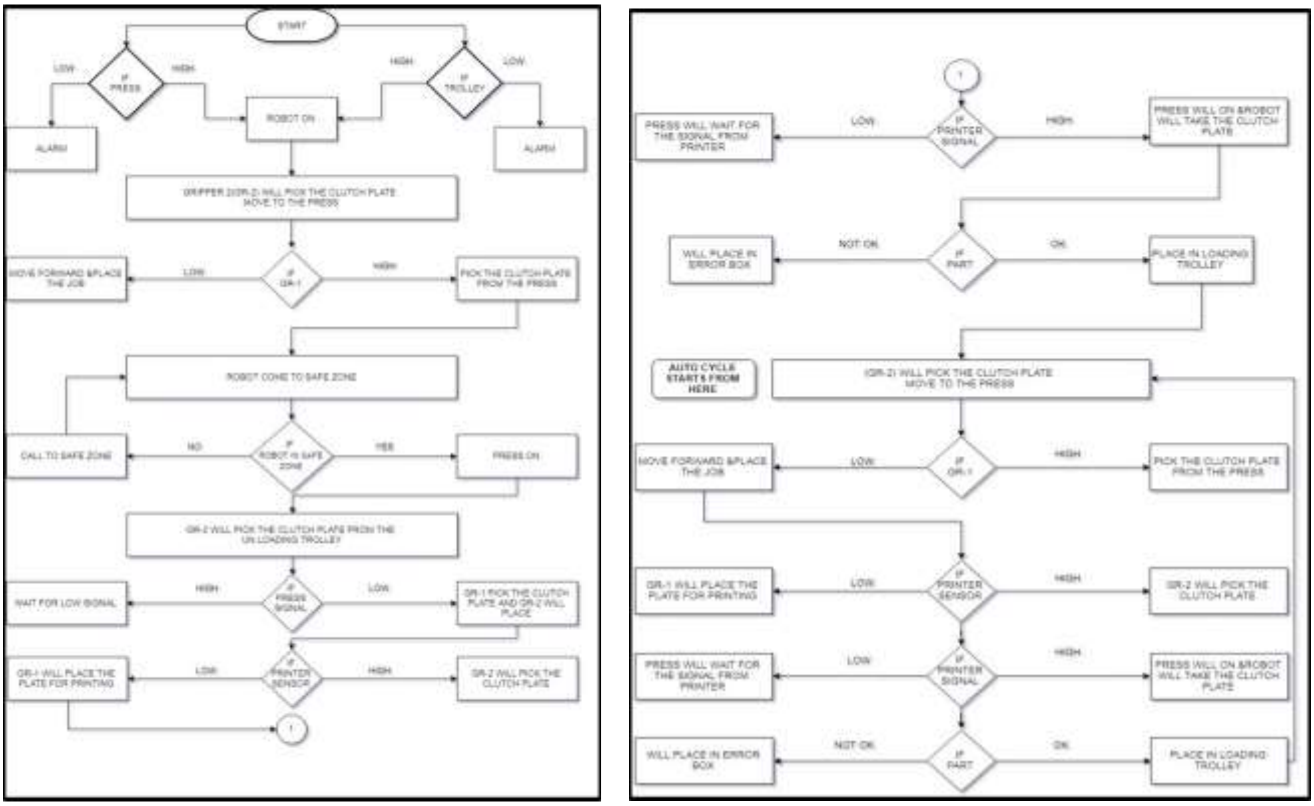

Figure.5 Flowchart for pick and place operation in clutch diaphragm spring testing robot.

VIII. CONLUSION

The customised electromagnetic gripper is designed for pick and place operation in clutch diaphragm spring testing robot. The robotic system is incorporated, with sensors, robot controller, gripper. Both the mechanical and electrical integration is done. The automation of the system is simulated in DELMIA and the trajectory planning is noted. This automation system will automate the testing procedure with more speed and accuracy. The average speed of robot for removing the component is 0.29 m/s. As the urge to improve the quality and speed of production with minimal cost is rapidly growing, many such automation systems employing robots will come into existence in the near future.

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