Design and Fabrication of Robotic Arm for the assembly of Phase Selector Switch

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Abstract. This paper explores the robot arm where the ability of human to do a project is restrained however now not with the aid of his mental electricity however through his bodily energy. A humanoid mechanical technology is another difficult field. To co-work with people, humanoid robots not just need to include human like structure and structure, yet more significantly, they should arrange human like conduct with respect to the movement, correspondence and intelligence. In environmental factors where human exchange can't be conceivable to do a specific errand, the robots can do. Robots are used for lean industrial processes and have diversified their contributions to meeting lines inside the production international. The main focus of this project is to design and develop the mechanism for robotic arm for lifting. It is a type of mechanical arm, usually programmable, with similar functions to a human arm. The arm might be a unit system or might be an aspect of a more unpredictable mechanical cycle. The end effectors or mechanical hand can be intended to play out any ideal undertaking, for example, welding, holding, turning etc., depending on the application. The mechanical arm is planned and designed with four degrees of freedom and modified to achieve precisely basic light material lifting undertaking to aid the creation line in any industry. 3D printing strategy is utilized in this undertaking to create the parts of the automated arm. Hence, it gave more exact measurements and gigantic time and cost expensive in creation. The automated arm is furnished with 4 servo engines to interface the parts and bring arm development. A sequential construction mechanical system can improve its efficiency through developing the assembling pace and its consistency. They additionally spare individuals from dreary and tedious mechanical production system employments. Many industries are yet to implement such automation in their assembly lines, as they do not have the technical knowhow of the changeover, or the fear of failure of investment. To proceed in this direction, a case study was conducted at a phase selector switch making company. Presently the company does manual assembly of the switches, which is a hindrance to the growth of the company. This process required a pilot study to explore the possibility as well as the implementations issues of robots in the assembly. The present system uses a belt conveyor system which has no feedback signals and the speed of the conveyor is not synchronized with the rate of assembly. It is generally not advised to transfer small size components in a conveyor since picking, orienting and inserting the components will be cumbersome. When the size of the component is considerably small, manual assembly is not recommended as per the guidelines of DFMA (Design for manufacture and assembly). Manual error is more prone to assembly of the part in a wrong orientation, especially for those components that are symmetrical.
The parts to be assembled are both axi-symmetric as well as prismatic in shape. Constraints in loading and unloading of casing were also reported. In this work, the design and development of a low cost assembly robot is done which can overcome the above drawbacks.

1 Introduction

Robots are used for lean business strategies and have diversified their contributions to meeting lines within the production world. An assembly line robotic can improve its productivity through growing the manufacturing pace and its consistency. They also keep employees from tedious and monotonous meeting line jobs. End of arm tooling or End effectors can be custom designed for every meeting robotic to cater to the producing necessities. Additional alternatives, like robot imaginative and prescient, can also be incorporated to enhance performance and accuracy of part orientation or sorting identifiers.

Many industries are but to implement such automation of their meeting traces, as they do not have the technical knowhow of the changeover, or the fear of failure of investment. To continue on this path, a case examine changed into conducted at a segment selector switch making agency in Coimbatore. Presently the enterprise does guide meeting of the switches, which is a difficulty to the boom of the agency. This manner required a pilot take a look at to explore the possibility in addition to the implementations problems of robots in the assembly.

The following inconsistencies were discovered by means of the initial have a look at.
1. The present system uses a belt conveyor machine which has no comments indicators and the velocity of the conveyor is not synchronized with the price of assembly.
2. It is normally now not counseled to transfer small length additives in a conveyor considering the fact that picking and orienting and putting the additives might be cumbersome. When the scale of the element is considerably small manual assembly isn't recommended as in keeping with the tips of DFMA (Design for manufacture and meeting).
3. Manual errors is greater liable to assembly of the part in an incorrect orientation, particularly for those additives which might be symmetrical.
4. The parts to be assembled are each axi-symmetric as well as prismatic in shape
5. Constraints in loading and unloading of casing have been additionally suggested.

In the light of the above situation, a Project bec ome envisaged to automate the entire meeting of PS-forty phase selector transfer at M/s Salzer Electronics, positioned at Coimbatore.

It is proposed to design and develop a low cost assembly robotic which can conquer the above drawbacks. Since the no. of components to be assembled is huge multi-stage meeting is endorsed. This idea is submitted for investment the assignment for this meeting line. The knowhow and the experienced gained with the aid of this educational work may be shared with different such requirements of meeting in numerous small and medium scale industries.

2 Objective & hypothesis of work

2.1 Objective

The task is aimed at design, improvement and implementation of a totally automated the switch meeting unit for PS-forty (Phase Selector Switch) the usage of robots and allied devices. The

Predominant purpose of this proposed research work is to construct automation within the switch meeting unit. The Pick and place mechanism, Servo managed conveyor, Vibratory bowl for loading the additives is to be applied for assembling the transfer gear. The implementation of robot arm mechanism is anticipated to improve the performance inside the meeting unit of Salzer Electronics.

2.2 Hypothesis of the work

Automation has come to be a figuring out component in whether or not an organization will remain aggressive in the production industry. In the past twenty years, technology has modified the nature of manufacturing. In the vintage days, production and fabrication have been all accomplished by using hand by means of people. Now the computer systems and generation have penetrated the enterprise, automation has emerge as the competitive benefit in today’s manufacturing world. Automation has allowed corporations to produce mass products at notable speeds and with notable repeatability and nice.
3 Review of literatures
Bhavesh Kaila, (2014) used a choose and area robotic for moving components in a ceramic industry and feature efficiently applied the same.
Sushanth Kanbail Srinivas, (2013) used a select and place mechanism actuated via an electromagnetic device for picking components from a conveyor. This required the synchronisation of the conveyor movement along with the collection of the robotic operations.
Ravikumar Mourya, (2015) had proposed a four-DOF articulated pick and vicinity robot arm that does operations like gripping, lifting, placing and liberating. Articulated arm consisted of revolute joints that allowed angular movement among adjoining joints. Four servo automobiles were used on this mission to perform four diploma of freedom (four-DOF) and successfully established its usage.
Santosh C, (2016) designed and fabricated a pneumatically operated pick out and vicinity arm for moving non-cylindrical gadgets from a decrease plane to a higher plane. It consists of cylinders, a shaft with a lead screw mechanism converting the piston moves right into a rotary motion using compressed air. The pneumatic arm model can be without problems set at intermediate positions by way of regulating the pressure the use of the flow manipulate valve. It can be used in loading and unloading of goods in shipping harbors because the motion of products is achieved from decrease plane to better aircraft.
Visual Vasistha, (2014) has designed and implemented a Pick and Place operational Robot with stud mechanism for loading and unloading machines, setting components on circuit forums, moving components off conveyor belts and so forth. The disadvantage is of those sorts of robots are, they should be custom made to a particular software.

4 Scope and methodology:
The following are the scope of this take a look at which can be listed in conjunction with the method of implementation:
● Working version Automation gadget
● Prismatic joint for automation
● Stepper motor for conveyer belt
● Stack for loading of additives
● Servo motor for conveyer belts rather than stepper motor
● Vibratory bowl for loading of additives in preference to stack
● Pick and vicinity mechanisms
● Manual assembly of switchgear deliberating the assembly problems
● Minimization of Cost to make the device lean
● Timing diagram and Electronic layout to be considered
● Finalization of Bill of substances
● Prototype checking out
● Prototype testing at the industry web site
● Implementing of the device on the enterprise and analyzing the time reduction and compare with the existing guide feed of additives
● Training of enterprise employees and turning in of the challenge

5 Tools used for implementation
The Raspberry Pi is a low price, credit-card sized laptop that plugs right into a trendy display device. To add to it, GPIO guide additionally method it has to interface and coordinate among the OS and low-level hardware. Thus, to get most effective overall performance, Raspberry Pi 3 Model B+ which has excellent computational strength amongst all of the editions. Raspberry Pi runs at the Raspbian OS, a Linux kernel essentially. Thus, any external webcam will work (Using a general USB webcam), but now not with the equal performance level as the digicam module v2 (Camera Module V2 - Raspberry Pi) provided through Raspberry Pi which has an eight MP sensor. It is ideally suited for pleasant real-time processing responsibilities the use of RPi. Also, electricity and modern-day consumption, as well as latency issues, are deterrent to the usage of a webcam with a Raspberry Pi for High-best belief tasks like pick and place.
### 6 Design Calculations

**Table 1. Specifications of the components**

| Sl. No | Items                                           | Specifications                  |
|-------|------------------------------------------------|---------------------------------|
| 1     | Pneumatic Cylinders                            | 5mm Diameter                   |
| 2     | C – Frame                                      | 10 meters                      |
| 3     | Arm Gripper                                    | 4mm displacement               |
| 4     | 5/2 Solenoid operated DCV                      |                                |
| 5     | FRL Unit                                       | Medium duty                    |
| 6     | FRL adapters                                   | Medium duty                    |
| 7     | Pneumatic Link Wires                           | 8 meters                       |
| 8     | Pneumatics @ 20,000                            | 7 sets                         |
| 9     | Conveyor Belts (Rubber/leather)                | LXW – 4 X 0.300 m              |
| 10    | Pulleys                                       | 100 mm dia                     |
| 11    | Compressor Unit                                | 1 HP                           |
| 12    | PIC-MICROCONTROLLER (interfaced with drives)   | (7 no’s)7                      |
| 13    | Servo motor for conveyor belt with feedback    | (if necessary)                 |
| 14    | Servo motor for grip.                         |                                |
| 15    | Motor controlled drive                         | (for controlling DCV)          |
| 16    | Raspberry Pi 3 Model B+ Complete kit with Accessories | Model B                  |
| 17    | Waveshare Newest Raspberry Pi IR-CUT Camera Module Kit Sensor to Support Night Vision | 5MP OV56471                   |
| 18    | Raspberry Pi 7TOUCH Touchscreen LCD Display    | 1 No                           |
| 19    | Raspberry Pi                                   | No                             |
Figure 1. Block Diagram of the proposed system

Table 2. Valve sequencing

| TIME (Sec) | DCV A | DCV B | DCV C | D     |
|------------|-------|-------|-------|-------|
| 0          | -     | -     | -     | -     |
| 1          | -     | B1    | -     | -     |
| 2          | A1    | -     | -     | -     |
| 3          | -     | -     | C1    | -     |
| 4          | -     | -     | -     | CLOSE |
| 5          | A2    | -     | -     | -     |
| 6          | -     | B2    | -     | -     |
| 7          | A1    | -     | -     | -     |
| 8          | -     | -     | -     | OPEN  |
| 9          | -     | -     | C2    | -     |
| 10         | -     | -     | -     | -     |

Table 3. Components used

| SL.No | Part Name | Quantity | Image   |
|-------|-----------|----------|---------|
| 1.    | Cam       | 3        | ![Image](Cam.png) |
| 2.    | Bush      | 2        | ![Image](Bush.png) |
## Design of Cylinders

Horizontal, vertical, rotary cylinders & arm lifting cylinder are of same design and selected from the product catalogue (Janatics pneumatic products). Cylinders are of double acting type. So double acting cylinders are preferred. This time interval cannot be achieved by single acting cylinders. According to the applications the forward and return stroke of the piston has to be controlled with some time interval.

- Force to be exerted is 40N
- Pressure x area = 0.4 x 105 N/m²
- Force/pressure = 40/40000 = 0.001m²

From Janatics pneumatic products catalogue we have selected 40mm bore diameter cylinder

### For forward stroke
- For 40mm bore diameter

|   |   |   |
|---|---|---|
| 3. | Circlip | 2 |
| 4. | Hexagonal Shaft | 1 |
| 5. | Brass Plate A | 1 |
| 6. | Brass Plate B | 3 |
| 7. | Brass Plate C | 3 |
| 8. | Spring | 3 |
| 9. | Follower | 3 |
| 10. | Screw | 2 |
| 11. | Casing A & B | 1 |
Corresponding rod diameter = 16 mm
Area of the piston = \( \frac{\pi d^2}{4} = \frac{\pi \times 40^2}{4} = 1256.8 \text{ mm}^2 \)
Force (modified) to be exerted = Pressure \times\text{ area}
= 0.4 \times 10^5 \times 1256.8 = 50 \text{ N}

For return stroke
On the return stroke, when the pressure is applied to the reverse direction, the force on the piston due to the pressure is = \( P \times (A-a) \)

Where,
\( P = \) Pressure in the cylinder (N/m²) \( A = \) Area of the piston (m²)
\( A = \) Cross sectional area of the piston rod (m²)
Therefore
Area of the piston (A-a) = 1256.6 - 2011055 \text{ mm}^2
Force to be converted on the reverse direction
pressure \times\text{ area} = 0.4 \times 105 x 1055 = 42.2 \text{ N}
For working pressure of 0.4 \times 105 N/m²
Extending force = 50.3 \text{ N}
Retracting force = 42.2 \text{ N}

1. Design of Arm Lifting Cylinder of the prototype

For forward stroke
For 32 mm bore diameter Corresponding Rod Diameter = 12 mm
Area of the Piston = \( \frac{\pi \times d^2}{4} \)
= \( \frac{\pi \times 12^2}{4} = 804 \text{ mm}^2 \)
Force to be exerted = 0.4 \times 10^5 \times 804 = 32.2 \text{ N}
For return stroke
On the return stroke, when the pressure is applied to the reverse direction, The force on the piston due to the pressure is = \( P \times (A-a) \)
Therefore,
Actual area of the piston (A-a)
= \( \left\{ \frac{\pi \times d^2}{4} \right\} - \left\{ \frac{\pi \times d^1^2}{4} \right\} \)
= \( \left\{ \frac{\pi \times 40^2}{4} \right\} - \left\{ \frac{\pi \times 12^2}{4} \right\} \)
= 690 \text{ mm}^2
Force to be exerted in the reverse direction
= \( P \times\text{ area} = 0.4 \times 105 \times 390 = 27.6 \text{ N} \)
For working pressure of 0.4105 N/m²
Extending Force = 50.3 N, Retracting Force = 42.2 N

7 Conclusion
Thus, a pneumatic pick out and location robot arm is evolved which helps to recognize how to obtain low fee automation. The ability of our material coping with gadget is 35 N. The software of pneumatics produces clean operation. The paintings extent is produced within the attitude of 120°. With connection with remark made in this work, it could be concluded that employing the choose and place mechanism will carry accuracy and efficiency to the manufacturing machine. It is controlled with the aid of Arduino microcontroller. It makes use of solenoid valve and pneumatic cylinder for motion and rotation of robotic arm. Automation is the manner to bring those modifications. The gadget will lessen human attempt notably, hence lowering the price incurred by using human errors. The prototype can be used in a whole lot of industries which includes micro technology, manufacturing, packaging, canned food industry for inter transportation. The fabricated model will reduce the want for the presence of humans in industries. It will reduce the time and growth productivity.
In a comparable manner, any other 11 robot palms are deliberate to be fabricated and six arms in each transfer tools assembly line is to be carried out for assembling correctly. This will growth the Production price of the enterprise and will lessen errors which in flip will increase the income of the industry.

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