INTERNATIONAL RESEARCH JOURNAL OF MULTIDISCIPLINARY TECHNOVATION (IRJMT)

http://www.mapletreejournals.com/index.php/irjmt
Received 05 January 2020 ISSN 2582-1040
Accepted 14 March 2020 2020; 2(2);1-8
Published online 30 March 2020

Design of Pneumatic Gripper for Pick and Place Operation (Four Jaw)

Poornesh Velineni [1,*], Jayasuriya Suresh [1], C. Naveen Kumar [1], M. Suresh [1]

[1] *Department of Robotics and Automation, PSG College of Technology, Coimbatore, Tamil Nadu, India.*

**Corresponding author E-Mail ID: v.poornesh0502@gmail.com Mobile: +91-9789988747*

DOI: https://doi.org/10.34256/irjmt2021

ABSTRACT

Grippers are attached at the end of an industrial arm robot for material handling purpose. Grippers plays a major role in all pick and place application industries. Those are connected as end effectors to realize and develop a task in an industrial work floor. Pneumatic gripper works with the principle of compressed air. The gripper is connected to a compressed air supply. When air pressure is applied on the piston, the gripper gets opened while the air gets exist from the piston it gets closed. It is possible to control the force acting on the gripper by controlling the air pressure with the help of the valve. The objective is to design an effective, simple, and economic gripper for pick and place application.

Keywords: Pneumatic System, Direction control valve (DCV), Compressor, Gripper, Modeling.

1. Introduction

A pick and place robot are the one which is used to pick up an object and place it in the desired location. A pick and place robot use a gripper as an end effector. There are some ISO standards for designing and modelling the gripper. The main standard is **ISO 14539:2000** which deals with the Manipulating industrial robots Object handling with grasp-type grippers. Pneumatic gripper is a mechanical gripper, they are cost effective and reliable option for many standard pick and place application. A research was carried out, on which type of gripper is more effectively used in pick and place application and it is concluded with a pneumatic gripper.

The pneumatic system uses compressed air to transmit and control energy. It is widely used for industrial automation and automobiles, which requires fast response and low load applications. The medium used is air, which is easy to compress and store. Air is abundantly available and in case of leakage, it doesn’t harm the environment.

In the existing technology, most of the pneumatic gripper uses two or three fingers gripper, which will be not have much sufficient gripped for picking a large object. To increase the effective of grasping power we redesigned a structure of the gripper from two-finger or three-finger gripper with the four-finger gripper.

2. Scope

The scope of this work is to design a Pneumatic gripper for industrial applications. This work is focused on selecting different features that gives more functionality and flexibility to the gripper. Grippers may be varying from one application to another application, based on an application the gripper dimensions, material used to manufacture the gripper, design of the gripper may vary. To overcome those challenges, we designed a sample model of the four-finger pneumatic gripper for soda can automation application.

3. Related Works

The Design of pneumatic gripper arose due to the difficulties faced by the pick and place industries. The idea of pneumatic gripper has existed for quite a while after there have been advancements in technology.

Khadeeruddin, et al. [1] stated that approach of handling of materials and mechanisms to pick and place found widely in factory automation and industrial manufacturing they approach is to designing of two jaw gripper which is different from the conventional cam and follower gripper to control the movement of the jaws. The design, analysis and fabrication of the gripper model are explained with comparison of existing pneumatic gripper. They calculated the force and torque for the two jaw gripper based the application and different sets of conditions. Pneumatic grippers are very easy to handle and are generally cost-effective because air hoses, valves and other pneumatic devices are easy to maintain

Swapnil Gurav et al. [2] deals with design and fabrications of end effectors of a robot which need to perform the activity of a pick place operation for handling materials in industrial automachine and manufacturing industries. They designed a gripper which need to perform a grasping of sheet metal parts in stamping and folding industry. The design is majorly focused on the kinematic and dexterousness similar to human hand (humanoid). Kinematic analysis of gripper is made to support this novice design using an Ansys software.it is tested for varies loads and shapes.

Anna Maria Gil Fuster et al. [3] The designed and building the gripper with the help injection modeling in order to reducing the cost when serial production, the prototype of the gripper is made by a 3D printing. They did a testing on the home hold products with irregular shapes and weight. The final prototype of a four-finger gripper is designed with the reference of the SCARA robot.

Maheshwari et al [4] designed of pneumatic pick and place automation for groove grinding machine, they design is customized based on their problem statement. They took some analysis on the existing systems and found the problems to overcome those problems they designed a pneumatic pick and place automation machine. They analysis the force needs to applied on the metal is calculated, based on that the selected the pneumatic cylinder to actuate the operation in the groove grinding machine industry.

Ciprian Rizescu [5] deals with the pneumatic gripper used to manipulate cylindrical. The gripper is implemented to an automatic machine dedicated to a molding process. The gripper is attached to a mechanical arm which belongs to the automatic machine. It is designed based on the planner slider crank mechanism; the author developed the mathematical model of the gripper which is attached in the mechanical arm. It used in 3D simulation of an assembly operation. Analysis of data such as force, the gripper is designed.

4. Prototype Design

4.1. Design Calculation

Based on different automation industry, the types of material used for manufacturing and coefficient of friction μ also gets vary view below table 5.1.1. Each manufacture should follow some safety factors while designing a product. Some of the materials charts are shown in below table 5.1.2.

Fig 5.1.1 coefficient of friction

Workpiese Material	Jaw Material	Coefficient of Friction μ
Steel	Steel	0.20
Steel	Aluminium	0.35
Steel	Plastic	0.50
Aluminium	Aluminium	0.49
Aluminium	Plastic	0.70
Plastic	Plastic	1

Fig 5.1.2 Safety factor

Safety Factor, So	Type of Use
2	Normal use
3	Movement in several directions slow acceleration or deceleration
4	Shocks, fast acceleration and deceleration

Model design calculation

Assumption:

- Jaw plastic
- Aluminum Cans = 14.9g ~15g
- rate of acceleration of gripper = 0.1m/s
- weight of gripper = 60gms

1. F_G =Minimum gripping force required (N)
2. n= number of fingers
3. μ= Friction coefficient between surfaces
4. g= gravity constant 9,81 (m/s^2)
5. m= total mass; object plus gripper (Kg)
6. a= acceleration of the gripper (m/s^2)
7. S_0=Safety factor.

To calculate the minimum gripping force required we need the below formula,

$$F_G = \frac{m(g+a)S_0}{\mu \times n}$$

$$F_G = \frac{(60+15)*(9.81+0.1)*2}{0.70*4} = 0.53\text{N}$$

The assumption was made for soda can manufacturing industry and did a model calculation which is shown above for design of four (4) finger gripper.

4.2 CAD Model

Using above assumption and data we designed a four-jaw gripper with less weight. Major Parts of the gripper are shown below.

- Jaw or finger
- Secondary joint
- Bridge link.
- Bottom connector

Slider link

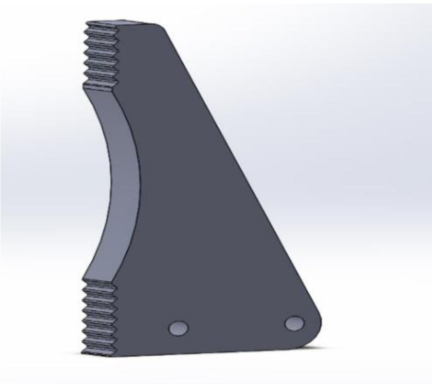


Fig 5.2.1 finger or a jaw

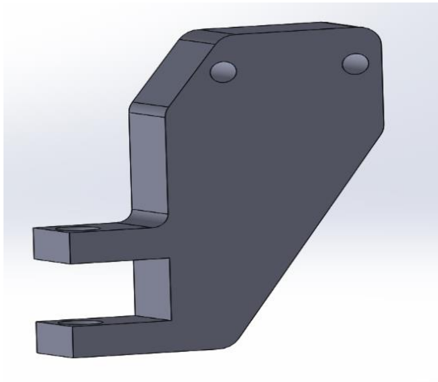


Fig 5.2.2 secondary link

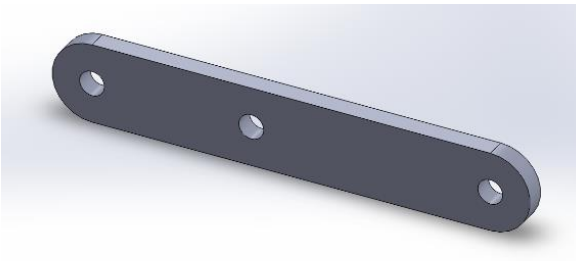


Fig 5.2.3 bridge link to connect the jaw and the secondary link

Fig 5.2.4 Bottom connector to the piston rod

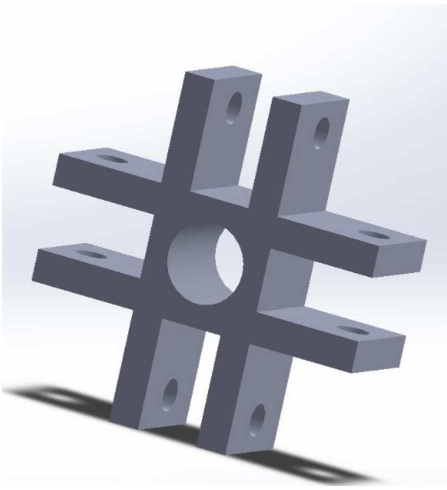
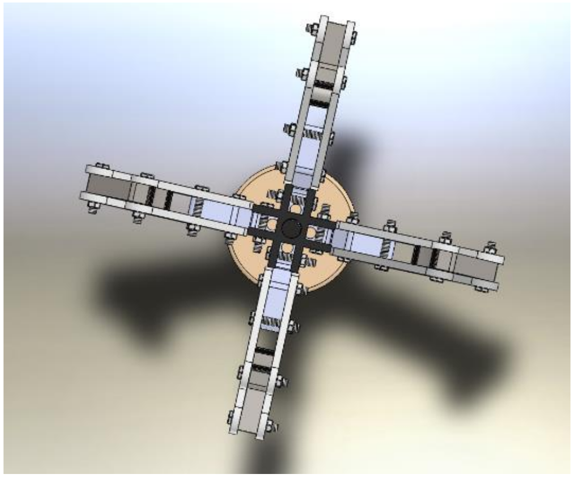


Fig 5.2.5 slider link



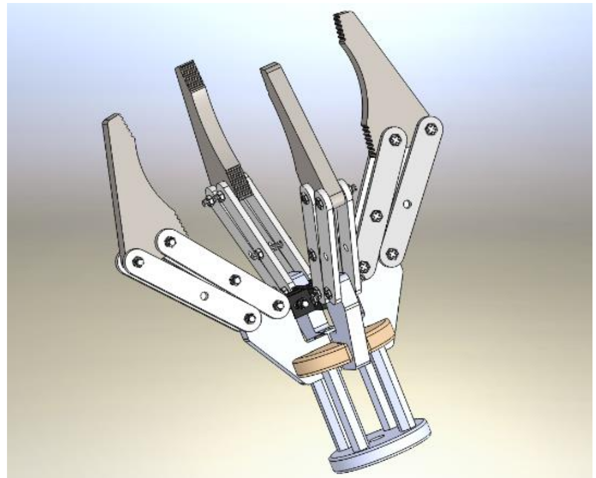


Fig 5.2.6 Assembly model of the complete pneumatic four jaw gripper

Fig 5.2.7 Fabricated Model

The fabricated model fig 5.2.7 is designed using a CAD software called a "SOLIDWORKS" each parts of the gripper are designed individually and save it as a separate file. Finally, all the parts are imported into an assembly model window of Solidworks software and assemble the parts in a sequence by the using some of the important tools available in the software.

The individual parts file is exported to extension ".STL" (Standard Triangle Language) for 3D printing. All STL files are imported in to a 3D printing software to produce a solid object

5. Circuit

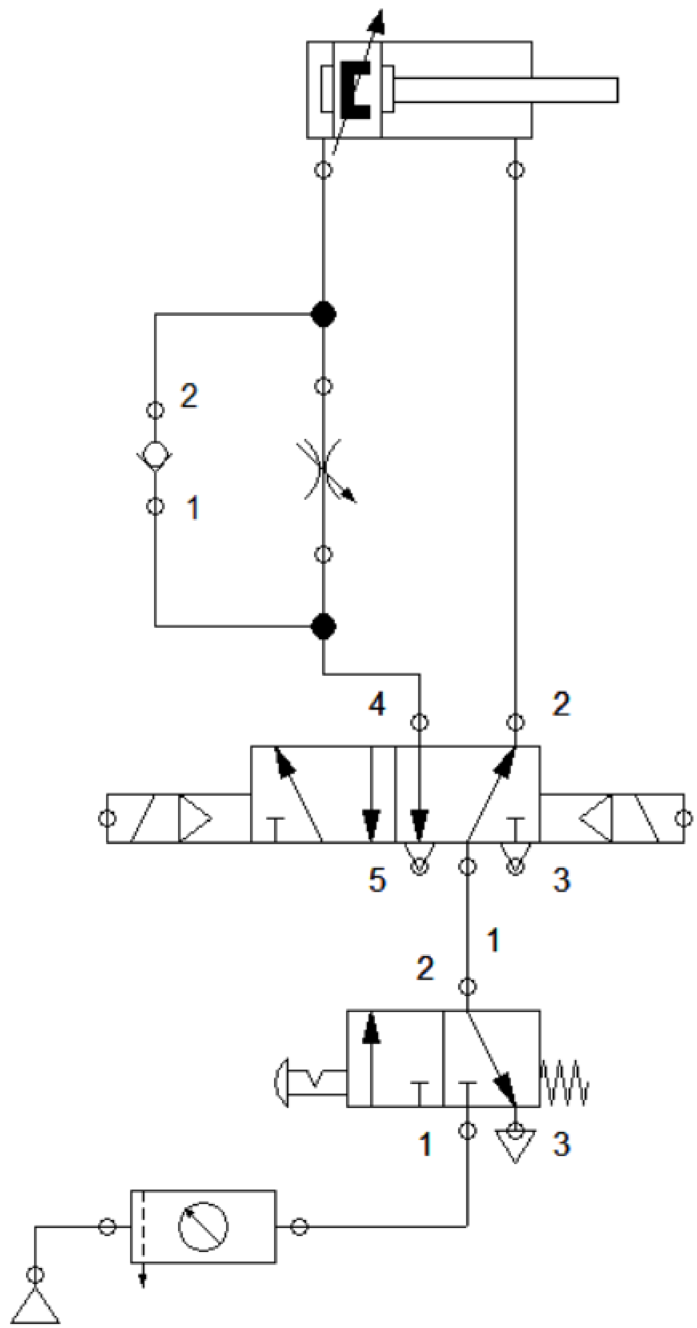


Fig 6.1 Electro-Pneumatic circuit for proposed model

The following fig 6.1 shows the pneumatic circuit for the Automatic actuation of a Pneumatic gripper in robotic arm applications. The Circuit contains the following components: Pneumatic Double acting cylinder (#1), 3/2 DCV (#2) ,5/2 DCV (#3), Throttle valve (#4), Check valve (#5), FRL (#6) and the pneumatic source (#7). Add the gripper is attached at the end of the piston (#Gripper).

The 3/2 DCV is operated by a hand lever or a push button for the safety purpose to allow the air to pass through the circuit. The robotic arm has an Accelerometer sensor to detect the rotation (#A) and a proximity sensor (#B) at the centre of the gripper to detect the objects. The signals from the sensor are used to actuate the cylinder through the 5/2 DCV.

First, the cylinder has to be extended to grab the objects. When the arm rotates 180 degree, the signal is sent to the 5/2 DCV to energise the Solenoid Once it is energised, the cylinder is extended the gripper gets opened. Then, the presence of object has to be detected and grabbed.

Once the object has been detected by the Proximity sensor which is placed on the centre of the gripper, the signal is sent to the Solenoid B to be energised.

Once it's energised the cylinder is retracted so that the gripper's jaw gets closed and the object is grabbed. Now we can move it to the required place. Thus, these are the operation of the above pneumatic circuit in the Pneumatic Gripper Robotic Arm.

6. Conclusion

The concept of the pneumatic gripper with more flexible and low cost four finger gripper was designed with a required parameter was achieved. From the model, it is found that the pneumatic gripper has many advantages and is one of the modern techniques in the world of robotics which makes pick and drop work easier and much faster than the conventional techniques. The sensor used in the robotic arm and centre of the gripper provides the sensing data with which the pneumatic gripper with four jaw finger gets actuate in a more effective manner. Using the raw data of application and purpose of gripper, we can design the gripper for the required configuration. Among all other grippers, pneumatic gripper plays a safe and secured role of handling various sensitive and thin objects. In many robotic applications, pick and place operation can be done with this type of gripper to safe guard the object from damage.

REFERENCES

[1] Mohammed.Khadeeruddin, T.V.S.R.K Prasad, Raffi Mohammed, Design & Analysis of a Two-jaw parallel Pneumatic Gripper, International Journal of Computational Engineering Research, 03 (2013)41.

[2] Swapnil Gurav, Chetan Bagul, Rahul Ramole, Pukhraj Patil, Sneha Bire, Review On Design And Fabrication of Pneumatic Gripper For Material Handling, International Journal of Advance Research in Science and Engineering, 5 (2016) 42

[3] Anna Maria Gil Fuster, Gripper design and development for a modular robot, DTU Electrical Engineering Automation and Control Technical University of Denmark Bachelor thesis, June 2015.

[4] Anil S. Maheshwari, Arpana Gangurde, Sachin Kadam, Gaurav Gangurde, Shubham Rathod, Department of Mechanical Engineering Design Of Pneumatic Pick And Place Automation For Groove Grinding Machine, International Journal of Advance Research in Science and Engineering, 07 (2018) 655.

[5] Ciprian Rizescu, "Pneumatic Gripper For Cylinder Objects", Department Of Mechatronics And Precision Engineering, University “Politehnica”, 313 , Splaiul Independentei, 060042; Bucharest, Romania

[6] Ardhendu Prasad Nanda, Design & Development of a Two-jaw parallel Pneumatic Gripper for Robotic Manipulation, National Institute of Technology Rourkela, Project Thesis, Department of Mechanical Engineering.

[7] S.N.Teli, Akshay Bhalerao, Sagar Ingole, Mahesh Jagadale, Kiran Kharat, Design and Fabrication of Pneumatic Robotic Arm, International Journal of Scientific & Engineering Research, 03 (2017)126.

[8] C. Santosh, C.S. Manoj, Akshay Peddarajula, Abhishek R Shetty, Design and Fabrication of Pneumatic Arm for pick and place of Cylindrical objects, International Journal of latest Technology in Engineering Management and Applied science, 05 (2016) 111.

[9] Albert Aparisi I Escrivà, Design of a Smart Gripper for Industrial Applications, International Journal of Engineering Research & Technology (Special Issue), 07 (2019) 01.

Funding

This study was not funded by any grant

Conflict of interest

None of the authors have any conflicts of interest to declare.

Cite this Article

Poornesh Velineni, Jayasuriya Suresh, C. Naveen Kumar, M. Suresh, Design of Pneumatic Gripper for Pick and Place Operation (Four Jaw), International Research Journal of Multidisciplinary Technovation, Vol 2, Iss 2 (2020) 1-8.

DOI: https://doi.org/10.34256/irjmt2021