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Converting Manually Operated Die Into Automation Mode By Using Robotic Vacuum Gripper

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ABSTRACT

Robot gripper design is an active research area due to its wide spread applicability in automation, especially for high-precision micro-machining. The main aim of our work is to collaborate the gripper mechanism and vacuum sucker mechanism working in a single pick and place robotic arm. This robot can be self operational in controlling, stating with simple tasks such as gripping, sucking, lifting, placing and releasing in a single robotic arm. The main focus of our work is to design the robotic arm for the above mentioned purpose. Recently robotic gripper is widely used for different tasks in various fields. Variety of robotic grippers is developed in high flexibility and multi function. By comparison to the human hand, a robot's gripper is very limited in terms of its mechanical complexity, practical utility and general applications. In order to realize the full potential of future robotics technology, grippers must be designed more like human hand, both in their sensory and control capabilities as well as their anatomical configuration. The design of the end-effectors is a critical consideration in the applications of robotics to industrial operations. The end-effectors must typically be designed for the specific application.

Key Words*: *End Effectors, Mechanical Hand, Pick And Place, Proximity Sensor, Robot Arm Sensor Gauge.

I. INTRODUCTION

A robotic gripper is an essential component of a robotic manipulator. It serves as the robot's hand and allows the robot to manipulate objects. Recently robotic gripper is widely used for different tasks in various fields. The robot's use determines the type of end effectors needed. Robotic end effectors can be used in many applications. NASA has used end effectors on the robotic arms on the Space Shuttle and the International Space Station[1]. A vacuum cup gripper is an essential end-effectors tool of a robotic system. It serves as the robot's hand and allows the robot to manipulate objects for proper safely gripping [2]. Even though the cost of acquiring robotic system is quite expensive but as today's rapid development and a very high demand in quality with IS0 standards, human are no longer capable of such demands. Research and development of future robots is moving at a very rapid pace due to the constantly improving and upgrading of the quality standards of products. Material handling equipment is generally separated into four main categories: storage and handling equipment, engineering systems, industrial trucks, and bulk material handling[3].Pneumatic and electro -pneumatic

components find several applications in the industrial environment, mainly to solve problems of product automation. a great development of the electro-pneumatics has been due to the development of the electronics, which has given many other solutions in terms of sensors, controllers and mechatronic devices. This paper deals with the teaching activity on the design and test of pneumatic and electro -pneumatic systems, which has been carried out within the course of "Regulation and Control of Mechanical Systems[4,5]. Manual operation takes more time for higher production rate there for industry not reaches towards daily production and also due to harsh work zone and heavy physical demand. Small/medium production volumes, robotic production yields the best cost per unit performance when compared to manual and hard automation. Automation operation technology has to reduce worker input and automatic control over the operation. It helps to correct the path, control the quality and fault correction and fault detection. Starting cost of automation is high but for long term operation automation is necessary compare to manual operation[6].

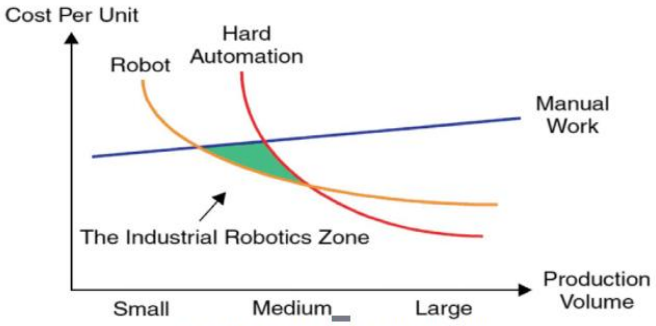

Figure 1 Industrial Robotic Zone. (Kah et al. 2015)

Vacuum grippers have a different working principle, another set of parameters, such as vacuum force and suction cups localization, should be consider. Based on this study, we define the minimum contact pressure and the most suitable position of the vacuum gripper that guarantee a reliable grasp [7]. Objects positioned on the shelves can be placed anywhere within the shelves and in any orientation. The competition robot in this project has two swiveling robot extension arms on the base of the device that incorporate the Spiral Zipper Mechanism in order to extend upward. [8]. The key design and developing a robotic arm with a gripper capable of handling soft objects without damaging the object. Some techniques that can be used for this purpose are vacuum grippers, Adhesive gripper mechanisms or magnetic devices [9].

1.1 PROBLEM STATEMENT

Any firm, any company is identified by the best optimized techniques they have chosen for manufacturing. Best optimization can be achieved by minimizing manual interference reducing wages require over worker and achieving maximum production with minimum time. Presently production line of (Tractor) Bonnet requires about 28 workers which affects overall cost and time for production.The best feasible solution to solve this problem is by using automation technology and redesigning the dies for mechanism and sensors. This will increase production rate, human safety and decreases number of workers.

1.2 OBJECTIVE

Objectives of this project are as follows:-

1. To study the design of tool and die in metal stamping.
2. To design the tool mechanism for sheet metal stamping dies.
3. To increase the productivity of manufacturing process using automation.
4. To implement the control system in the motion of gripper.
5. To integrate control system with sensor.
6. To study about the robotic gripper and automation thoroughly.
7. Reduce man power in production line.

1.3 SCOPE

1. Design tool mechanism that capable of detecting sheets inside die.
2. Sensors attached to the gripper, sensors will send data through the electrical circuit and a parallel port to the computer.
3. Gripper performance based on the type and thickness of the object.
4. Reducing the cost, manpower and increasing the production rate.
5. Increasing the production rate.
6. Design and development of conveyor line for material handling.

II.METHODOLOGY

The time allotted to analyze and zero down the solution is Four Months. To understand the overall stamping process & the whole manufacturing process of metal sheet stamping took around 3 weeks by visiting the plant. After the complete understanding conceptualization was done by studying the basics like tried to fulfill the requirement by suggesting some ideas for the new process for stamping& grippers studying about the various methods used for stamping process, study on various types of grippers. Afterwards the ideas were discussed before the company and with the proper validations some of them were rejected due to resulting failure in optimization of the process in the company.

When the suggested designs were not considered, the work is been preceded with involvement of mechanisms used in the ongoing manufacturing machines of the company. This will result into the final design model of pick and place mechanism. The conceptualization is to be done for the redesigning sensing mechanism for die and also study of various grippers and finalizing the one which is most feasible for the process. The basic 3D detailed drawing of the whole system of redesigning die & robotic pick and place mechanism will be studied to the fullest.

III.DIES

- Die Operations

1. OP10 (Draw).

2. OP20 (Trim Pierce).
3. OP30 (Cam Pierce)
4. OP40 (Part Off).

3.3.1 Requirement Of Input Detector

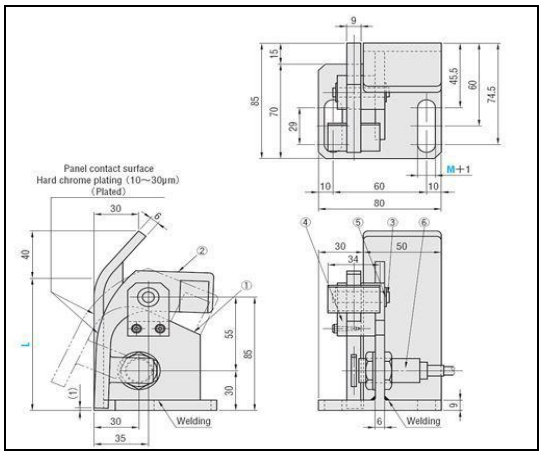

Figure. Drafting of input detector.

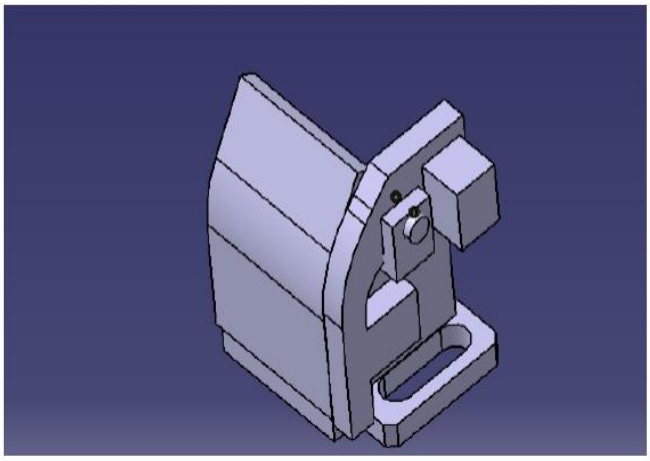

Figure. Input detector 3-d Drawing.

3.3.2 Input Detector specification

Part No	Name	Quantity	Material
1	Body of front gauge	1	SS400
2	Panel detection lever	1	SS400
3	Lever pin	1	S45C
4	Support plate	1	SS400
5	Snap Ring(C type)	1	-
6	Proximity Sensor	1	Product of SICK wire type)

IV. SENSORS

SENSOR NAME-SICK IME18-08BPSZC0K

4.1 Sensor Specification

Housing	Cylindrical thread design
Housing	Short – body
Thread Size Diameter	M18*1
Diameter	Φ18 mm
Sensing Range	mm

V.DESIGN AND ACTUAL ASSEMBLEY OF GRIPPER.

5.1 PARTS OF GRIPPER

Various parts of gripper

1) Swivel Arm - The swivel arm is the part which allows for unlimited positioning of the suction cup.

2) Clamp- A clamp is a fastening device used to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure.

3) Suction Pad Attacher- We need to attach suction pad to clamp at different angles to grip arbitrary shaped objects.

4) Bayonet -It is a type of connector which attaches special purpose arm with the robot, so that the whole assemble moves with the robot.

VI.CALCULATIONS FOR DESIGN OF GRIPPER

A. Load case I – Suction cup horizontal, direction of force vertical

The work piece (in this case the steel sheet with the dimensions **910*0.7*450 mm**) is lifted from a pallet. The work piece is lifted with an acceleration of 2 m/s2.

Illustration of load case I the suction caps land on a workpiece vertically that is to be lifted up.

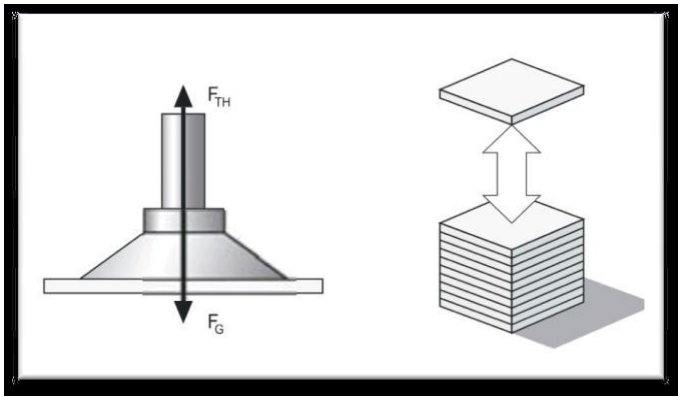

Figure.Suction cup horizontal, direction of force vertical

F_{TH} = m × (g + a) × S

F_{TH} = theoretical holding force [N]

m = Weight [kg]

g = Gravity [9.81 m/s^2]

a = Acceleration [m/s^2] of the system

S = Safety factor

Our example:

F_{TH} = 2.30 kg × (9.81 m/s^2 + 2 m/s^2) × 1.5

F_{TH} = 35.8445 N

B. Load case II – Suction cup horizontal, direction of force horizontal

The work piece (in this case the steel sheet with the dimensions **910*0.7*450 mm**) is lifted up vertically and transported horizontally. The acceleration is 2 m/s^2

The suction caps land on a work piece horizontally that is to be moved to the side

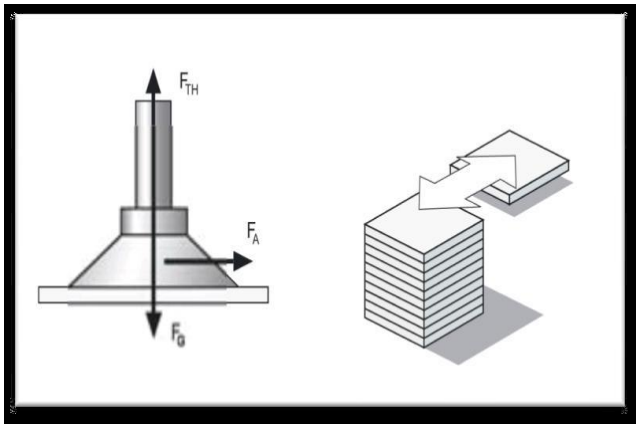

Figure. Suction cup horizontal, direction of force horizontal

$F_{TH} = m \times (g + a/\mu) \times S$

F_{TH} = theoretical holding force [N]

F_a = Acceleration force = m x a

m = Weight [kg]

g = Gravity [9.81 m/s^2]

a = Acceleration [m/s^2] of the system (keep in mind Emergency Stop situations!)

μ = Friction coefficient

S = Safety

F_{TH} = 2.30 kg × (9.81 m/s^2 + 2 m/s^2 / 0.5) x 1.5

F_{TH} = 47.6445 N

C. Comparison:

A comparison of the figures for load cases I and II results, in this example, in a maximum value for F_{TH} = 47.6445 N in load case II, and this value is therefore used for further design calculations

VII. MANPOWER COST SAVING

Manpower Required	Manual Operation		Automation Operation	
	Operator	Helper	Operator	Helper
	09	09	02	01
Salary Per Shift Per Person	Rs 833.33	Rs 555	Rs 833.33	Rs 555
Daily No. Of Shifts	02		02	
Daily Salary of Man Power	Rs 14,999.94	Rs 9,990	Rs 3,333.32	Rs 1,110
Yearly Salary (340 Days) Excluding Holidays	Rs 50,99,979.5	Rs 33,96,600	Rs 11,33,328	Rs 3,77,400
Total	Rs 84,96,579.5		Rs 15,10,728.8	
Salary Cost Saved Per Year	Rs 69,85,850.8			

VIII.TIME SAVING

Parameter	Manual operation	Automatic operation
Sheet per minute(SPM)	4	5.5
Time required per sheet(sec)	15	11
Time required for 2400 sheets	10 hrs	7 hrs 20 min
Time analysis	More than one shift (8 hrs) is required. 2 hrs is required from next shift to complete 2400 sheets	Completed in one shift (8 hrs) only. More 218 extra sheets can be stamped in one shift.

IX. ADVANTAGES

- Improved Quality.
- Material handling is reduced.
- Manufacturing speed increases due to continuous working.
- For safety purpose less man power required.
- High Accuracy.
- Automation results in virtual elimination of labor and therefore reduces number of accidents.
- Heavy works are made easier

X.DISADVANTAGES

- Initial cost is high.
- Unemployment.
- Micro porosity in the die casting products is a common problem because of faster solidification, trapped air and vaporized die lubricants.
- Not suitable for short product life cycle.
- Not economically justifiable for small scale production

XI.CONCLUSION

We have redesigned the series dies with sensors and using the sensors to operate the gripper mechanism and we conclude that, they can perform different applications such as pick and place of pallet, accurate positioning of pallet, moving of pallet with desire speed and accurate position of it on press line of any size and shape of pallet by just changing the gripper holding mechanism. They increase the productivity of process using automation. It reduces the need of man power in the industry which avoids many problems such as shortage of man power, social problems, increases human safety,etc. We need to change only the gripper holding mechanism according

to pallet for performing different operations so it reduces the time and cost of manufacturing for performing different operations.

XII.FUTURE SCOPE

This project is concerned about the redesigning of solving the press line problem for pick and place application. So this redesigned dies and gripper can be designed for different application by placing the sensors in proper place, changing the programming of robot and end effectors of robotic arm. The end effectors of the robot can designed and manufactured as per the application constrains. There are different controllers that can be used for better performance of the robotic gripper and performance parameters can be checked.

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