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Performance Testing on Pneumatic Arm Control

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ABSTRACT: HYUNDAI-TRANSYS is part of the Hyundai Motor Group. Hyundai Motor Group is South Korea's largest Automation manufacturer and the second-largest automaker in Asia. The group was formed through the purchase of South Korea's second-largest car company KIA motors by Hyundai Motors Company in 1998. HYUNDAI TRANSYS is a parts partner of Hyundai-Kia motors, supplying World-class power train and seating components. HYUNDAI TRANSYS is a global Company with manufacturing and development in Asia, Europe, and America. Now-a-days Robots are flourishing in many industries. In the olden day robots are only used for complex operations, but today it finds a wide range of applications in most industries, companies, Hospitals, etc. for automation purposes. In industries robots are used for many operations like machining, joining, assembly, and more, among that material handling, is primarily where the loading and unloading of jobs are done. In this project, analysis is done on the robot within several aspects like working time, breakdown period, the accuracy of the robot, and productivity obtained by the robot. After analysis of the robot the defects and problems in the robot due to continuous working like sensors problems, clamping & unclamping and position errors, and lower accuracy are rectified by adopting methods like Anti-unlocking system to the robot. This robot is attached to an anti-unlocking system which makes the end effector unclamp at a certain position. Where it avoids damage to the end effector as previously robots without an anti-unlocking systems will unclamp at any place due to some technical issues like air fluctuations and manual error. This anti-unlocking system as stated above unclamps the end effector at a particular place which prevents all the damage.

I. INTRODUCTION

The first usage of the word "Robot" was in a 1921 Czech science fiction play – Rossum's Universal Robots – by Karel Capek. The robots were artificial people or androids and the word was derived from the word "Robot", a Czech word for slave. A question of perpetual interest is to define a robot. Since the beginning of the study of robotics, there has been some controversy in the definition of a robot.



Robotic manipulators resembling the human arm are known as robotic arms. They are constructed by a structure consisting of structurally robust links coupled by either rotational joints or translating joints. A robotic arm is thus a type of mechanically coupled or joined arm, run by programmable commands, with similar functions to a human arm. It may be the total of the mechanism links or may be part of a more complex size. A typical robotic arm has the following components: 1. Links and joints 2. Actuators 3. Controller 4. End-effector



Grippers: Grippers are the most commonly used type of end-effectors. They can use different gripping methods (such as vacuum or use of fingers).

Material removal tools: These include cutting, drilling, and debarring tools installed as robot tools.

Welding torches: Welding is a widely used operation in robotic applications. Welding torches have become very efficient end-effectors that can be controlled in a sophisticated way for optimized welding.

Tool changers: Tool changers are used when many different end effectors need to be used in sequence by one robot. They are used to standardize the interface between the robot flange and the base of the tool. They can be manual or automatic.

1.1 Automated handling - Whenever technically and economically feasible, the equipment can be used to reduce and sometimes replace the need to manually handle material. Most existing material handling equipment is Semi-automated because a human operator is needed for tasks like loading/unloading and driving that are Difficult and/or too costly to fully automate, although ongoing advances insensing, machine intelligence, and Robotic have made it possible to fully automate an increasing number of handling task

Robotic Material Handling Robotization



Robotics is the branch of mechanical engineering, electrical engineering, electronic engineering, and computer science that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and/or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics.

The necessity of robot: Robot is an integral part of automating the flexible manufacturing system that one greatly in demand these days. Robots are now more than a machine, as robots have become the solution of the future as cost labor wages and customers' demand. Even though the cost of acquiring a robotic system is quite expensive but with today's rapid

Construction of robots: There are many types of robots; they are used in many different environments and for many different uses, although being very diverse in application and form they all share three basic similarities when it comes to their construction: Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud might use caterpillar tracks.

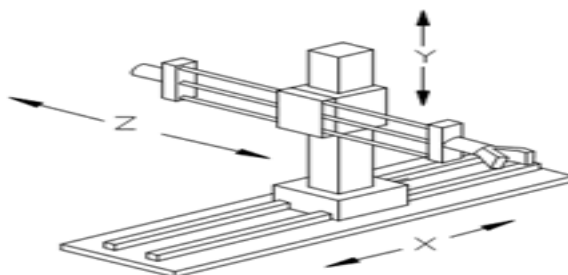
Laws of robotics:

- Law Zero: A robot may not injure humanity, or, through inaction, allow humanity to come to harm.



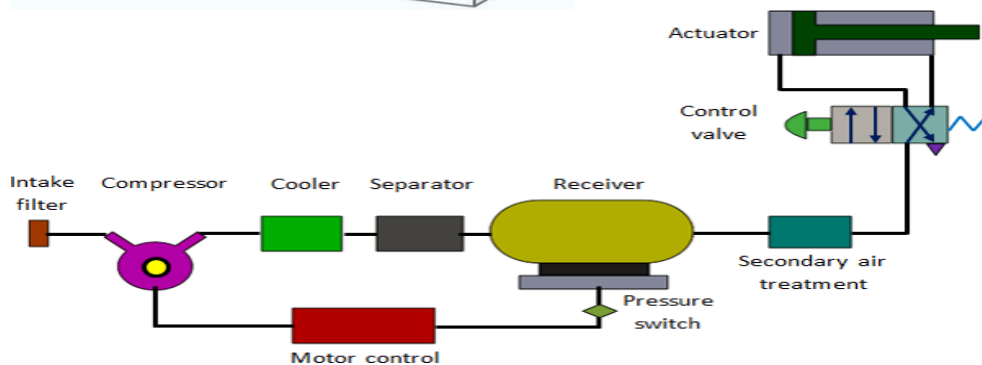
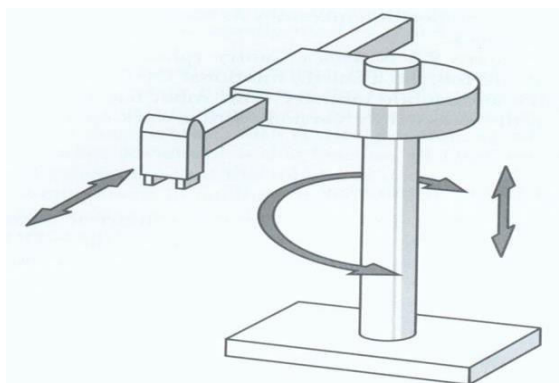
- Law One: A robot may not injure a human being, or, through inaction, allow a human being to come to harm unless this would violate a higher-order law.
- Law Two: A robot must obey orders given to it by human beings, except where such order would conflict with a higher order law.
- Law Three: A robot must protect its existence as long as such protection does not conflict with a high-order.

1. Robot-based configuration



Cartesian Configuration: A robot that is constructed around this configuration consists of three orthogonal slides, as shown in fig. the three slides are parallel to the x, y, and z axes of the Cartesian coordinate system. By appropriate movements of these slides, the robot is capable of moving its arm at any point within its three-dimensional rectangular-spaced workspace

Cylindrical configuration: In this configuration, the robot body is a vertical column that swivels about a vertical axis. The arm consists of several orthogonal slides which allow the arm to be move up or down and in and out concerning body.





II. LITERATURE SURVEY

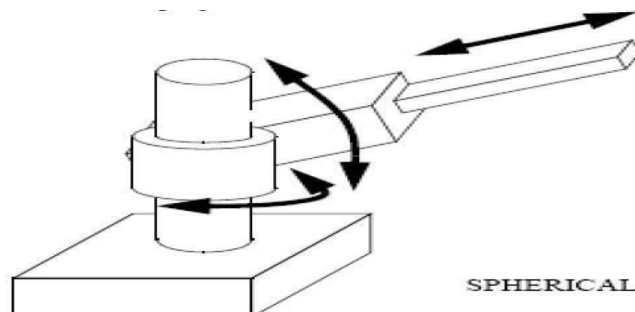
Ted hesselrod, kakali sarkar ,P. Patric van der smagt .Klaus Schulten [1] The neural map algorithm has been employed to control a five-joint pneumatic arm and gripper through feedback from two video cameras. The pneumatically driven robot arm (soft arm) employed in the investigation shares essential mechanical characteristics with the skeletal muscle systems.to control the arm 200 neurons formed a network representing a 3D workspace

Tetsuya Akagi, Shujiro Doha, Feifei Zhao, and Takahiro Fujiyama [2] a wearable actuator needs to be flexible so as not to injure the human body. The purpose of our study is to develop a flexible and lightweight actuator that can be safe enough to be attached to the human body and to apply a robot arm and rehabilitation device..

G. Carducci Mario Massimo Foglia Angelo Gentile Nicola Ivan Giannoccaro A. Messina [3] this paper shows experimental results carried out considering vision feedback obtained with a cheap cam mounted on the top of the end-effector. This vision feedback is processed to localize the plant position along the movement plane of the robotic arms end effector.

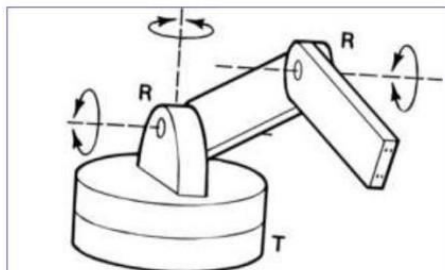
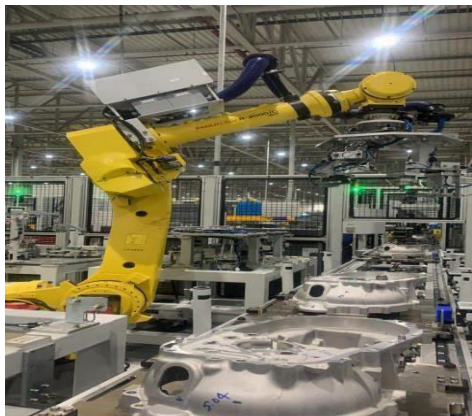
Swapnil Gurav, Chetan Bagul, Rahul Ramole, and Pukhraj Patil [4] This paper deals with the design and fabrication of end effectors of the robot to perform the pick and place activity. For material-handling industrial robots, special-purpose purpose end effectors play a great role to reduce cycle time and cost of production.

Polar Configuration: This configuration also goes by the name “spherical coordinate” because the workspace within which it can move its arm is a partial sphere as shown in the figure. The robot has a rotary base and a pivot that can be used to raise and lower a telescoping arm. **Jointed-Arm Configuration:** It is a combination of cylindrical and articulated configurations. This is similar in appearance to the human arm, as shown in fig. The arm consists of several straight members connected by joints that are analogous to the human shoulder, elbow, and wrist



The robot arm is mounted to a base that can be rotated to provide the robot with the capacity to work within a quasi-spherical space.

Pneumatics in Material Handling - Pneumatic systems usually operate at a much, lower pressure than hydraulic systems do, pneumatics holds many advantages that make it more suitable for many applications. Because pneumatic pressures are lower, components can be made of thinner and lighter-weight materials, such as aluminum and engineered plastics, whereas hydraulic components are generally made of steel and ductile or cast carries heat from them. Furthermore, because pneumatic components require no electricity, they don’t need the bulky, heavy, and expensive explosion-proof enclosures required by electric motors. Even without special enclosures, electric motors are substantially larger and heavier than pneumatic motors of equivalent power rating.



Jointed-arm body-and-arm assembly (TRR).

Operation of Pneumatic System - To affect mechanical motion, pneumatics employs the compression on of gases, based on the working principles of fluid dynamics in the concept of pressure. Any equipment employing pneumatics uses an interconnecting set of components: a pneumatic circuit consisting of active components such as a gas compressor, transition lines, air tanks, hoses, open atmosphere, and passive components.

III. METHODOLOGY & WORKING PRINCIPLE

Robots may be used to perform tasks that are too dangerous or difficult for humans to implement directly or may be used to automate repetitive tasks that can be performed more cheaply by a robot than by the employment of a human or may be used to automate mindless repetitive tasks that should be performed with more precision by a robot than by a human (material handling, material transfer applications, machine loading, and unloading, processing operations, assembly, and inspection presented

CLAMPING AND UNCLAMPING OF JOINT ARM ROBOT Previous mode:

Clamping and unclamping of the end effector of a robot is done manually which has many defects such as it can clamp or unclamp the end effector at any place whenever it receives the airflow. As the robot is driven by the pneumatic system the clamp or unclamp is done by the airflow where the solenoid valve gives the air to the EOAT locker. The most occurring problem in this manually operated is that the end effector is dropped suddenly due to air fluctuations and it drops on any place

IV. DETAILS ABOUT THE BREAKDOWN OF THE ROBOT END

Table 1: End effector change M5EF2

Break down time	Defected parts	No. of defected parts	Loss of Cost
2.30 hours in 8 hours	Air cylinder	2	25000/2
	Sensors	2	10000/2
	Diff fixture	One box	9600
	Grippers	3	15000/3
		Total parts=8	Total cost=59600/-



Table 2: End effector changed M6CF1

Break down time	Defected parts	No. of defected parts	Loss of Cost
2.30 Hours in 8 hours	Sensors	3	15000/3
	Grippers	2	10000/2
	Input fixture	One box	8000
	Output fixture	One box	9600
		Total parts=7	Total cost = 42600

Table 3: End effector changed M6CF3

Break down time	Defected parts	No. of defected parts	Loss of Cost
2 HR in 8 hours	Input fixture	One box	8000
	Gripper	3	15000/3
	Air cylinder	1	12500
	Sensors	3	15000/3
		Total parts=8	Total cost=50500
Break down time	Defected parts	No. of defected parts	Loss of Cost
3 HR in 8 hours	Diff fixture	One box	9600
	Gripper	3	15000/3
	Air cylinder	1	12500
	Sensors	3	15000/3
		Total parts=8	Total cost=52100

Table 4: End effector changed M6CF-3

Break down time	Defected parts	No. of defected parts	Loss of Cost
2 HR in 8 hours	Diff fixture	One box	9600
	Input fixture	One box	8000
	Output fixture	1	10000
	Sensors	3	15000/3
		Total parts=6	Total cost=42600



Break down =total no. of parts /total no. of working hours

Table 5: Total details about the breakdown

Break down time	Loss of cost	No. of defected parts	No of parts delayed
2.30 HR	59600	8	60
2.30 HR	42600	7	75
2 HR	50500	8	60
3 HR	52100	8	90
2 HR	42600	6	60
12 HR	Total=-2,47,400	Total=37	Total=345

Part name	Specification	Cost of the part
Wiring	5C X 0.75 sq.mm (40M)	4800
Solid state relay	4-ways (1 nos)	5000
Conduit pipe	30meters	2400
Sensor	Inductive sensor (6 nos)	27000
	Total no. of parts=9	Total cost =39,200

PARTS FOR IMPROVEMENT anti-unlocking system Table 8: parts for improvement of the anti-unlocking system

TOTAL RUNNING HRA IN MONTH (PER DAY 8 HRS): 208 HR“S ROBOT BREAKDOWN: 2 HR 30 MIN

V. CALCULATIONS AND RESULT

- BEFORE ANTI-UNLOCKING SYSTEM BREAKDOWN CALCULATION:

Work efficiency

Per day working hours = 8 HR For

one hour work=30 parts

Per day total pick and place parts = 8x30 = 240 parts

20/03/2021 is the day where the breakdown occurs with a time of 2.30 HR

$$= 2 \times 30 + \frac{1}{2} (30)$$

Breakdown parts in a day =85 parts

The products prepared on breakdown day

$$= \text{total parts in a day} - \text{breakdown parts in a day}$$

$$= 240 - 85$$

$$= 155 \text{ parts prepared on day 1}$$

$$= \frac{155}{208} \times 100$$

$$= 69\%$$

The Second day 2.30 hours breakdown

We get the Work efficiency as 69%

Third day is the day 2 HR = 2 X 30 = 60 parts

The products prepared on breakdown day



= total parts in a day – breakdown parts in a day
 = 240 – 60 = 180 parts are prepared

$$\begin{aligned} \text{Work efficiency} &= \frac{\text{parts prepared on break down day}}{\text{parts prepared per day}} \\ &= \frac{180}{240} \times 100 \\ &= 75\% \end{aligned}$$

The third day (27/06/2021) is the day where the breakdown occurs with a time of 3 HR = 3 X 30 = 90

The products prepared on breakdown day

$$\begin{aligned} &= \text{total parts in a day – breakdown parts in a day} \\ &= 240 – 90 \\ &= 150 \text{ parts are prepared in a day} \\ \text{Work efficiency} &= \frac{\text{parts prepared on break down day}}{\text{total efficiency}} \\ &= \frac{150}{240} \times 100 \\ &= 63\% \end{aligned}$$

For the second (30/07/2021) day also 2 hours breakdown We get the Work efficiency as 75%

Overall Work efficiency = Work efficiency = total efficiency

Dates	Efficiency
20/03/2021	69%
15/04/2021	69%
21/05/2021	75%
27/06/2021	63%
30/07/2021	75%
No. of days = 5	Overall efficiency = 68%

AFTER ANTI-UNLOCKING SYSTEM BREAKDOWN CALCULATION:

With the anti-unlocking system breakdown time for a month, we will get one hour only
 One-hour breakdown means 30 parts have defected

$$\begin{aligned} \text{Work efficiency} &= \frac{\text{parts prepared on break down day}}{\text{total efficiency}} \\ &= \frac{210}{240} \times 100 \\ &= 88\% \end{aligned}$$

VI. SAFETY AND PREVENTIVE MAINTENANCE OF FANUC R-2000ic ROBOT

Considering safety for your robot installation - Safety is essential whenever robots are used. Keep in mind the following factors about safety:

- The safety of people and equipment
- Use of safety-enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)



- Techniques for safe automatic operation of the robot(s)
- Regularly scheduled inspection of the robot and work cell
- Proper maintenance of the robot

SAFETY PRECAUTIONS

This chapter describes the precautions which must be observed to ensure the safe use of the robot. Before attempting to use the robot, be sure to read this chapter thoroughly. Before using the functions related to robot operation, read the relevant operator's manual to become familiar with those functions. If any description in this chapter differs from that in the other part of this manual, the description given in this chapter shall take precedence.

VII. CONCLUSION

This project has concluded “performance testing of pneumatic arm control” where there are more benefits rather than manual handling. While using an anti-unlocking system there is the least chance for possible error with the help of PLC all the defects of the joint arm robot are rectified with the higher precision. The analysis shows that the robot can handle without any problem by using the anti-unlocking system.

Without an anti-unlocking system, there is a lot of damage to parts and work delays. But when with these anti-unlocking systems there are no damages and no work delay and the precision is increased. With these anti-unlocking system production rate increases and the breakdown, rate is decreased.

When the robot is manually operated for clamp or unclamps the Work efficiency is 68% and when using the anti-unlocking system the efficiency is improved to 88% which increases the production rate and reduces work delays.

The loss due to the breakdown period without an anti-unlocking system is 2, 47,400 which is recovered within 6.3 weeks when the anti-unlocking system is installed in the robot.

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