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Introduction to Pneumatic Robotic Arm

Abhinav D. Khasale[1], Akshay S. Kolhe[2], Ajinkya A. Korde[3], A. T. Bathe[4]
[1,2,3]*Student, Dept. of Mechanical Engineering, DES'S COET, Dhamangaon Rly., India*
[4]*Professor, Dept. of Mechanical Engineering, DES'S COET, Dhamangaon Rly., India*

***Abstract*: The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. Certain characteristics of compressed air have made this medium quite suitable for used in modern manufacturing and production industries. The air is compressed in an air compressor and from the compressor plant the flow medium is transmitted to the pneumatic cylinder through a well laid pipe line system. Moving materials utilize time and space. Material handling is a necessary, but wasteful and expensive activity in manufacturing and distributing. Material handling is a specialized activity for a modern manufacturing concern. It has been estimated that about 60-70% of the cost production is spent in material handling activities. Insufficient material handling accounts for additional costs in two main ways: idle time and cost of labor. Effective material handling solutions can reduce a production or distribution cost by significant amounts.**

***Keywords*: Robot Arm, Material Handling, Pneumatic.**

1. Introduction

Material handling an integrated system involving such activities as moving, handling, storing and controlling of materials by means of gravity, manual effort or power activated machinery Material handling is an important area of concern in flexible manufacturing systems because more than 80 % of time that material spends on a shop floor is spent either in waiting or in transportation, although both these activities are non-value added activities. Comparing the source of operation hydraulic and pneumatic, Pneumatic source having good response over hydraulic and gives safe and cost effective material handling. Efficient material handling is needed for less congestion, timely delivery and reduced idle time of machines due to non-availability or accumulation of materials at workstations. Safe handling of materials is important in a plant as it reduces wastage, breakage, loss and improves the overall efficiency of plant. Hence with concern of major area in production field in order to improve the product quality, productivity, improve the personnel effort, improve the efficiency of plant and improve the safety the pneumatic based material handling system select as flexible system in manufacturing area. Robotic arm (also referred to as robotic manipulator) are mainly used to carry out highly repetitive, material handling and precision tasks such as spot welding, assembling, cutting, palletizing, spray painting etc. in manufacturing industries. It is a programmable device with similar attributes to that of a human arm and is best suited to hazardous environments where human intervention is highly undesirable. The main advantages include high quality of work, more repeatability, time saving, less material wastage and no fatigue. In recent years, major advancements in the field of robotics led its usage in numerous fields namely health care where it is used for executing complex surgical procedures, rehabilitation, prosthetics etc. Electromechanical robot arms were mainly dominant because they exhibit linear characteristics and hence easy to control. Despite of several advantages, electromechanical robot arms are still restricted to its work-cell because of its high stiffness and inability to work safely in a robot-human environment. Also it consumes a lot of power for its operation, has poor strength to weight ratio, bulky structure and requires high maintenance. This demanded robots implementing different drive technologies and hence pneumatic robot arm emerged.

System that uses compressed air as its main source of energy is termed pneumatic systems. Pneumatic driven systems are of lower cost than hydraulic and electromechanical systems and perform well in carrying out arduous work. Advantages of pneumatically actuated systems are mainly increased level of safety, cleanliness, variable load carrying capacity, simple configuration, minimum pollution, reliable, storage capability, high strength to weight ratio, ease of maintenance, high speed and fast transmission. The system is better at working in hazardous environment where explosions are likely; industries where it is highly suitable are mining, chemical, petroleum and painting industries. It has been used extensively for many years in robotics and factory automation mostly to execute simple tasks using open loop control. Nonetheless, they are often avoided because they exhibit high nonlinearity and are hence difficult to control. But the advent of sophisticated control systems and algorithm for pneumatic servo system in the recent years shifted the paradigm in pneumatic technologies. It is now possible to control pneumatic servo system just like electro servo system.

2. Overview of pneumatic arm

A. Main pneumatic components

1) Linear rod less actuator

It is the main actuating mechanism of the pneumatic system and it contains a cylinder with a movable piston in it. The cylinder has two ports from which pressurized air can enter at any one port in a given time and can drive the piston either in

the forward or in backward direction.

Fig. 1. Linear Rod less Actuator

It is called rod less because unlike other cylinder actuators, it does not have a rod attached to its piston. The model of the linear actuator used in the project is SRL2-G-LB-16B200 and has a bore diameter of 16mm with a stroke of 200mm.

2) Control valve

It is analogous to an electrical switch which directs the flow of fluid (air in this case) and in special cases, regulate the flow of air (proportional valves). A spool valve (5/3-way proportional directional control) is used in this study which moves horizontally inside the valve casing and it opens and closes or controls the flow of fluid from the pressure supply to the working lines and the exhaust. It falls under the category of infinite position valves because the spool can be displaced anywhere within the range of space available inside the valve's housing.

Fig. 2. Push flow control valve

A solenoid is used to control the position of the spool from one control position to another using control signals and proportional valves contains internal microcontroller to control the position of the spool. In this study, 5/3 directional control valve was used at first and then 5/3 proportional valve was used all manufactured by FESTO.

B. Pneumatics in material handling

Pneumatic systems usually operate at 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 aluminium and engineered plastics, whereas hydraulic components are generally made of steel and ductile or cast iron. Hydraulic systems are often considered rigid, whereas pneumatic systems usually offer some cushioning, or "give." Pneumatic systems are generally simpler because air can be exhausted to the atmosphere, whereas hydraulic fluid usually is routed back to a fluid reservoir.

Fig. 3. Pneumatic in material handling system

Pneumatics also holds advantages over electromechanical power transmission methods. Electric motors are often limited by heat generation. Heat generation is usually not a concern with pneumatic motors because the stream of compressed air running through them 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. In fact, even without special enclosures, electric motors are substantially larger and heavier than pneumatic motors of equivalent power rating. Plus, if overloaded, pneumatic motors will simply stall and not use any power. Electric motors, on the other hand, can overheat and burn out if overloaded. Moreover, torque, force, and speed control with pneumatics often requires simple pressure- or flow-control valves, as opposed to more expensive and complex electrical drive controls. And as with hydraulics, pneumatic actuators can instantly reverse direction, whereas electromechanical components often rotate with high momentum, which can delay changes in direction.Here it is shown how to style a subsection and sub sub-section also

3. Working principle

A. Robotic arm

The automation plays an important role in saving human effort in most of regular and frequently carried works. The most common work is pick and place of jobs or work piece from source to desired position. Present day industry turned towards computer based program automation as it increase the productivity and delivery of end products. The inflexibility and hard automation is used in highly automated truck in the past have to led used of automated arms which is capable of performing the variety of manufacturing function in a flexible environment and at lower cost. The pick and place mechanical arm is human based controlled based system that detection of object human detect presence of object and move the machine accordingly.

The robot's manipulative arm is the mechanical unit. This mechanical unit is also comprised of a fabricated structural frame with provisions for supporting mechanical linkage and joints, guides, actuators (linear or rotary), control valves, and sensors. The physical dimensions, design, and weight carrying

ability depend on application requirements .It consist of following parameters.

- *Work Envelop:* The set of points Representing the maximum extent or reach of the robot arm or working tool in all direction.
- *Payload:* The ability to carry, continuously and satisfactorily given maximum weight at a given speed.
- *Velocity:* The maximum speed at which the tip of a robot is capable of moving at full extension, expressed in inches or millimeter per second.
- *Cycle:* Time it takes for the robot to complete one cycle of picking up a given object at a given height , moving it to a given distance lowering it, releasing it, and returning to the starting point.
- *Accuracy:* A Robot's Ability to position the end effecter at a specified point in space upon receiving.
- *Repeatability:* The ability of a robot to return consistency to a previously having attained that position.
- *Resolution:* The smallest incremental change in position that it make or its control system can measure.
- *The manipulator:* Which is the robot's, consists of segments jointed together with axes capable of motion in various direction allowing the robot to perform work. The end effectors which is a gripper tool, special devices, or fixture attached to the robot's arm actually performs the work.

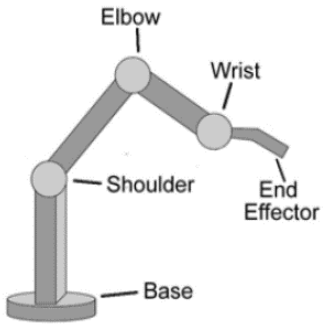

Fig. 4. Simple Robotic Arm

B. Pneumatic robotic arm

The broad overview of this arm is shown in Fig. 5. This arm is composed of a pneumatic hand and a pneumatic wrist, and we used McKibben pneumatic actuators as the drive source.

Fig. 5. Pneumatic robot arm

These actuators generate force in response to applied pressure. This pneumatic actuator has a dual structure of an internal membrane and external shell. When the internal membrane is inflated with compressed air, the pressurized gas pushes against its external shell, increasing its volume. The muscle radius increases and together with radial expansion, the muscle contracts axially and exerts a pulling force. Also, the generative force of a pneumatic actuator depends on the air pressure and shrinkage ratio, and these pneumatic actuators are driven by low pressure up to 0.2 MPa. The actuators used in this research are divided into two main groups. The first one is a regular pneumatic actuator, which is between 18-45 mm. Its maximum generative force is 14-25 N. This pneumatic actuator is smaller than the conventional one, therefore, through fitting this actuator to a set of fingers of a robot hand, it can move knuckles directly. Moreover, a robot hand consists of 13 regular pneumatic actuators and possesses five fingers, similar to a human hand. Meanwhile, fitting a spring on the back side of a finger enables the finger to expand. In this way, a pneumatic hand can grasp soft, fragile objects, such as eggs, without force sensors on the fingertips because of the compliance characteristics of the pneumatic actuators.

4. Conclusion

This paper presented an overview pneumatic robotic arm.

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