Industrial Robotic Arm: An Overview

Kshiteesh Kulkarni[1], Shreyas Limaye[2], Vishwesh Apte[3], Akshay Najan[4], Prof. Vipul Ruiwale[5]

[12345]*Department of Mechanical Engineering, MIT College of Engineering, Pune.*

Abstract

Manpower acquisition is a major hurdle for many industries, especially in manufacturing industries. With low margins and increasing cost per worker, the only option for improving profits is automation. We approached an injection moulding industry facing a similar problem. The objective of this project to automate the process of component removal and stacking using a robotic arm. Another primary purpose is optimization of the process to reduce cycle time and eliminate any damage caused by human handling. It is a crucial aspect of this project to design and build a working prototype of this robotic arm at prices significantly lower than available robots in the market.

Keywords: *Automation, End effector, venturi effect.*

1. INTRODUCTION

The term robot has the origin of the Czech word *robota*, which means as "forced labor." This is applicable to most of the robots perfectly. Almost all robots in the world are designed and developed for large heavy, repeated manufacturing work. They handle tasks which are difficult, dangerous hazardous, error prone, cumbersome or boring to mankind. [3]

The robotic arm is the most common manufacturing robot. Seven metal segments joined by six joints makes a typical robotic arm. By rotating individual stepper motors connected to each joint is reason behind a robot controlled by computer (some larger arms use hydraulics or pneumatics). Stepper motors move in exact direction unlike ordinary motors allowing the computer to move the arm very precisely. Thus exactly the same movement can be repeated over and over again. Motion sensors are used by robot to move just the right amount. [4]

A robotic arm is a type of mechanical arm, which is usually programmable. Robotic arm functions similar to a human arm. The arm may be the sum total of the mechanism or it may be a part of a more complex robot. The links of such manipulator are connected by joints which allows either rotational motion (such as in case of an articulated robot) or translational motion. The links of the manipulator form a kinematic chain. The last part kinematic chain of the manipulator is called as the end effector and is equivalent to the human hand. [2].The use of industrial robots is growing in areas such as food and beverages, consumer goods, wood, fibers and plastics and electronics, but is still widely used in the automobile industry.

When the robot is taken, a humanoid comes to the mind of many people. which often appears in sci-fi movies, exhibitions and toys. The industrial robots are very different from humanoid robots. Sometimes they are called as robotic arms which are used in performing simple up-and-down motion, pick and place components etc. But, a lot of machines can be controlled by programs to perform different jobs e.g. searching, transportation, targeting, assembly and inspection.

2. LITERATURE REVIEW

In the paper, *Design Analysis of a Remote Controlled "Pick and Place" Robotic Vehicle* by B.O. Omijeh ,the design and analysis of a Remote Controlled Robotic vehicle is discussed. The work states the fact that man would always want to stick to safety at workplace and to be able to handle some specific tasks which are very difficult for humans. A Robotic Vehicle is capable of traveling over various terrains and obstacles. The design in this work, includes a Robotic arm of five Degree of Freedom having its base resting on top of the vehicle, a body having four drive wheels coupled to the ends . The wheels are selectively powered to propel the vehicle. The design methodology involves the hardware, software specifications and implementation of designs. A prototype of the Remote Controlled "Pick and Place" Robotic vehicle was built to validate design. The results obtained were acceptable. The use of Robots is highly useful for Industries especially for safety and productivity.[2]

In the paper, Industry Based Automatic Robotic Arm by Dr. Bindu A Thomas , a 3 joint automatic robotic arm which can be used in industries to do repetitive work like picking the object from conveyor and placing it to some other place is discussed. A sensor will be used to detect the obstacles if present, while doing the task. If any obstacle is encountered, while moving the object, the arm will wait for a predefined specified time for the clearance. After the obstacle is cleared, the arm will continue to do its work. If the obstacle is still there, a buzzer will be pressed autonatically so that worker from the industry can attend the situation and remove the obstacle. [3]

In the paper *Review on Development of Industrial Robotic Arm* by *Rahul Gautam,* a prototype of robot using lightweight materials such as aluminum and carbon fiber together with a newly developed stepper motor has been developed. There is need to construct wrist for cables to run on the inside. It is very costly to change cables and therefore the design to decrease the friction on cable, is crucial to increase time duration between successive maintenance. A concept generation was carried out based on the functional analysis, the specifications of requirements had been established.

In the paper, A Review on Design and Analysis of Pick and Place Robot using Vacuum Gripper by Sanketkumar R. Patel , select kinematic configuration of robot and vacuum cup to handling object for pick and place application, how to evaluate d-h parameter, forward and inverse kinematics equations and work volume. . Kinematic analysis of robot and selection of vacuum cup for varied weight of object during pick and place application and dynamic analysis of it.

In the paper, Design, Analysis and Implementation of a Robotic Arm- The Animator by Md. Anisur Rahman , The human-like manipulation generation motions has been designed and implemented and tested for 4 degrees of freedom (DOF) arm of the humanoid. The approach doesn't consider the robot arm dynamics. This would be necessary to generate realistic velocity distribution for the manipulation motions. In this paper the review of the characteristics of the main mechanical structure and construction of a humanoid robotic arm is done. From this arm design, the next step is the exploration of full body of humanoid which is controlled by body switch. The final step of this robot is auto learner, where the robot can learn automatically. The exact position and orientation of the arm can be obtained by significantly large modifications of the joints.

3. Types of Robot

- **Cartesian robot / Gantry robot**: It is a robot having three prismatic joints in the arm, axes of whose are coincident with a Cartesian coordinator. It is Used for pick and place assignments, assembly, handling of machine tools and arc welding.

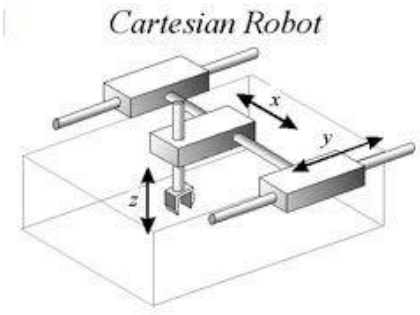

Figure 1. Cartesian Robot

- **Application:** Industrial gantry type Cartesian robot is applied on CNC lathes, continuous parts loading and unloading. It performs 3-axis linear movement (X, Y, and Z) in high speed. In addition, the robot is also able to handle heavy loads of pick and place parts with high positioning accuracy.
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- **Cylindrical robot**: In this type of robot axes form a cylindrical coordinate system. It is generally used for assembly operations, handling at machine tools, spot welding, and handling at die-casting machines.

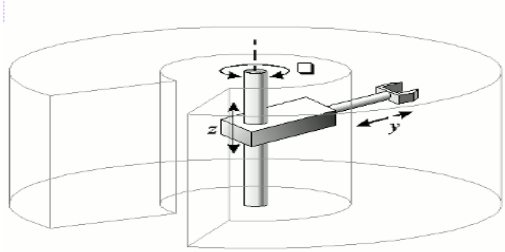

Figure 2. Cylindrical Robot

- **Spherical robot** Spherical mobile robots have applications [8] in surveillance, environmental monitoring, patrol, underwater and planetary exploration, rehabilitation, child-development,[9] and entertainment. Spherical robots can be used as amphibious robots [7] viable on land as well as on (or under) water.[10]

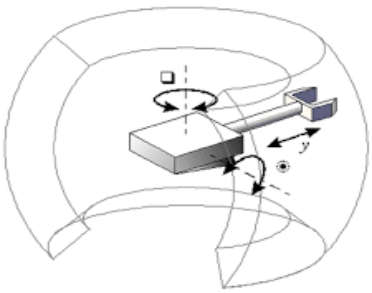

Figure 3. Spherical robot

- **Polar robot**: These are used for handling machine tools, spot welding, die casting, gas welding and arc welding. It is a robot whose axes form a polar coordinate system.

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- **SCARA robot**: It is used for pick & place operations, assembly work & handling machine tools. This robot consist of two parallel rotary joints to provide compliance in a plane.

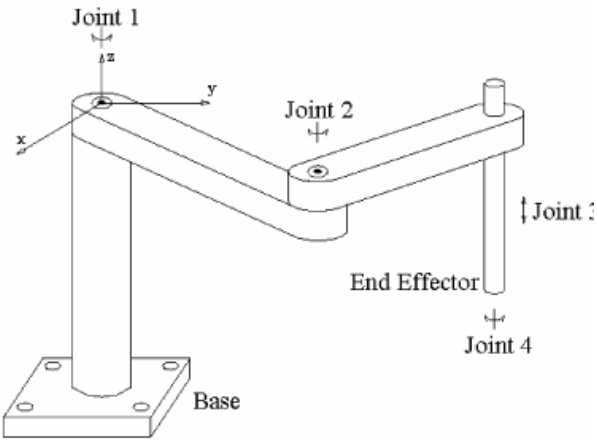

Figure 4. SCARA robot schematic

- **Articulated robot**: It is used for assembly work, die casting, fettling operations, gas welding, arc welding and spray painting. It is a robot in which arm has at least 3 rotary joints.

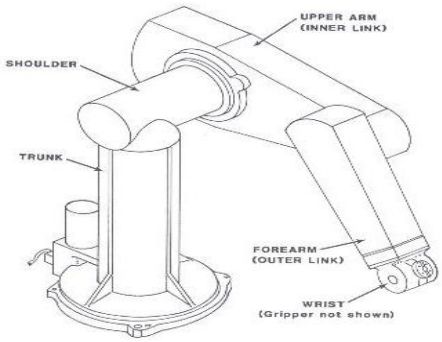

Figure 5. Articulated Robot

4. DEGREE OF FREDOM

Robot arms are described by the degrees of freedom. The degree of freedom number refers to the number of single-axis rotational joint in the arm, where higher number specifies an increased flexibility in positioning a tool.

A degree of freedom is the ability to move in a single independent direction of motion. In order to move in multiple directions need to have multiple degrees of freedom. Up & down movement is one degree of freedom, moving right & left is another; moving up/down and left/right has 2 degrees of freedom.

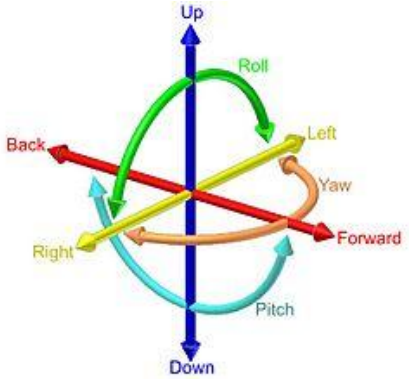

Figure 6. Degree of freedom

5. CONCLUSION

- With increase in demand for automation and quality use of robotic technology is gaining immense popularity in the manufacturing industry.
- As reviewed different designs of robotic arm are used for a wide range of applications in practically all industries.
- Depending on the cxomplexity of motion and flexibility requirements the degrees of freedom allowed for robotic arm are chosen.

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