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The Novel of Six axes Robotic Arm for Industrial Applications

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Article Info	ABSTRACT
	Automation technology is widely accepted and rapidly growing technology in the field of core and many other industries. Anyone can observe that due to these problems many industries are turning towards automaton. When searching for problem of labor manpower in middle-case industries, we came to know about many other things like production, speed of manufacturing and quality of the product are necessary in the current scenario. These parameters are not being well maintained in incorporate industries with manual manufacturing processes instead of using automatic system. Our objective is to solve these problems by efficient use of different technologies for making an industry fully or partially automated. By using technologies we can try to solve or reduce the effects of above problems.

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1. INTRODUCTION

This Project is based on an Automation Technology. An automation or automatic control system is a system which is made up of different controlling and physical parts. These all the things are discussed in following sections [1]

Introduction to Automation Technology: -Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories. The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision. The term automation, inspired by the earlier word automatic (coming from automaton), was not widely used before 1947, when General Motors established the automation department. It was during this time that industry was rapidly adopting feedback controllers, which were introduced in the 1930s. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, and electronic and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques [2].

Introduction to Robot:-A robot is a mechanical intelligent agent which can perform tasks on its own, or with guidance. In practice a robot is usually an electro-mechanical machine which is guided by computer and electronic programming. Robots can be autonomous or semi-autonomous [1]-[2].

Field of Robotics [1]:-Robotics is the branch of technology that deals with the design, construction, operation, structural disposition, manufacture and application of robots. Robotics is related to the sciences of electronics, engineering, mechanics, and software.

Robotic Arm [1]-[2]:-A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm. The links of such a manipulator are connected by joints allowing either rotational motion (such as in an articulated robot) or translational (linear) displacement. The links of the manipulator can be considered to form a kinematic chain. The business end of the kinematic chain of the manipulator is

called the end effectors and it is analogous to the human hand. The end effectors can be designed to perform any desired task such as welding, gripping, spinning etc., depending on the application. For example robot arms in automotive assembly perform a variety of tasks such as welding and parts rotation and placement during assemblyMultifunctional Robot: The Multifunctional Robotic Arm is similar to that of robotic arm. We have added robotic car at base so our project can also work as transportation device. And also we are adding an application of conveyer belt.

2.   TERMS BEING USED IN ROBOTICS

Numbers of axes – two axes are required to reach any point in a plane; three axes are required to reach any point in space. To fully control the orientation of the end of the arm (i.e. the wrist) three more axes (yaw, pitch, and roll) are required. Some designs (e.g. the SCARA robot) trade limitations in motion possibilities for cost, speed, and accuracy [2].

Degrees of freedom which is usually the same as the number of axes, *Working envelope* – the region of space a robot can reach, *Kinematics* – the actual arrangement of rigid members and joints in the robot, which determines the robot's possible motions. Classes of robot kinematics include articulated, Cartesian, parallel and SCARA. Carrying capacity or payload – how much weight a robot can lift [1]-[2].

Speed – how fast the robot can position the end of its arm. This may be defined in terms of the angular or linear speed of each axis or as a compound speed i.e. the speed of the end of the arm when all axes are moving [2].

Acceleration - how quickly an axis can accelerate. Since this is a limiting factor a robot may not be able to reach its specified maximum speed for movements over a short distance or a complex path requiring frequent changes of direction [2].

Accuracy – how closely a robot can reach a commanded position. When the absolute position of the robot is measured and compared to the commanded position the error is a measure of accuracy. Accuracy can be improved with external sensing for example a vision system or Infra-Red. See robot calibration. Accuracy can vary with speed and position within the working envelope and with payload (see compliance) [3].

Repeatability - how well the robot will return to a programmed position. This is not the same as accuracy. It may be that when told to go to a certain X-Y-Z position that it gets only to within 1 mm of that position. This would be its accuracy which may be improved by calibration. But if that position is taught into controller memory and each time it is sent there it returns to within 0.1mm of the taught position then the repeatability will be within 0.1mm [3].

Accuracy and repeatability are different measures. Repeatability is usually the most important criterion for a robot and is similar to the concept of 'precision' in measurement - see Accuracy and precision. ISO 9283 sets out a method whereby both accuracy and repeatability can be measured. Typically a robot is sent to a taught position a number of times and the error is measured at each return to the position after visiting 4 other positions. Repeatability is then quantified using the standard deviation of those samples in all three dimensions. A typical robot can, of course make a positional error exceeding that and that could be a problem for the process. Moreover the repeatability is different in different parts of the working envelope and also changes with speed and payload. ISO 9283 specifies that accuracy and repeatability should be measured at maximum speed and at maximum payload. But this results in pessimistic values whereas the robot could be much more accurate and repeatable at light loads and speeds. Repeatability in an industrial process is also subject to the accuracy of the end effector, for example a gripper, and even to the design of the 'fingers' that match the gripper to the object being grasped. For example if a robot picks a screw by its head the screw could be at a random angle. A subsequent attempt to insert the screw into a hole could easily fail. These and similar scenarios can be improved with 'lead-ins' e.g. by making the entrance to the hole tapered [2], [4].

Motion control – for some applications, such as simple pick-and-place assembly, the robot need merely return repeatability to a limited number of pre-taught positions. For more sophisticated applications, such as welding and finishing (spray painting), motion must be continuously controlled to follow a path in space, with controlled orientation and velocity [5].

Power source – some robots use electric motors, others use hydraulic actuators. The former are faster, the latter are stronger and advantageous in applications such as spray painting, where a spark could set off an explosion; however, low internal air-pressurization of the arm can prevent ingress of flammable vapors as well as other contaminants [6].

Drive – some robots connect electric motors to the joints via gears; others connect the motor to the joint directly (direct drive). Using gears results in measurable 'backlash' which is free movement in an axis. Smaller robot arms frequently employ high speed, low torque DC motors, which generally require high gearing ratios; this has the disadvantage of backlash. In such cases the harmonic drive is often used [6].

Compliance - this is a measure of the amount in angle or distance that a robot axis will move when a force is applied to it. Because of compliance when a robot goes to a position carrying its maximum payload it will be at a position slightly lower than when it is carrying no payload. Compliance can also be responsible for overshoot when carrying high payloads in which case acceleration would need to be reduced.

3. PROPOSED ARCHITECTURE OF PROJECT

Block Diagram:- The Industrial multi axis Robot Consist of Manipulator Or mechanical Structure and Another System is Controller [7].
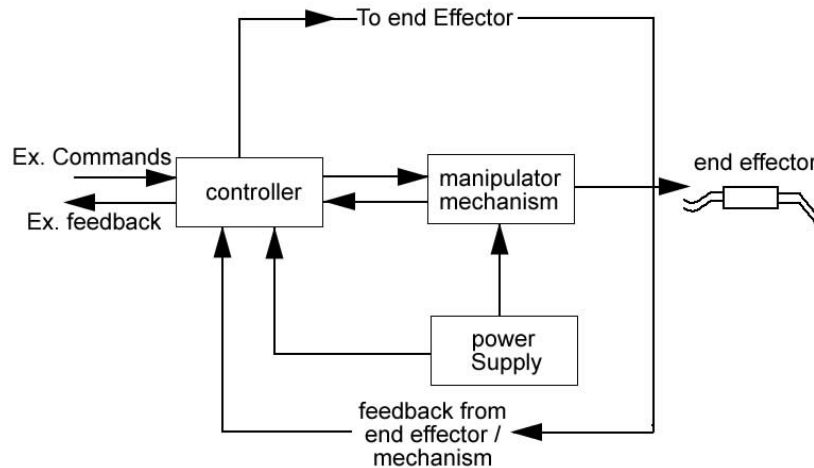

Figure 1. Proposed Block Diagram

The block diagram of industrial multi axis robot that is shown in above figure that consist of manipulator with end effecter, controller as commander, power supply and feedback mechanism or sensor feedback [7]. When these whole systems combine together then it works as automatic industrial multi axis robot which is needed in many industries to do such kind of process.

Mechanical Part:- 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 [3].

Mechanical Consideration for robots [3]:

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 effector which is a gripper tool, a special devices, or fixture attached to the robot's arm, actually performs the work.

Manipulator is amechanical unit that provides motion similar to that of a human arm. Its primary function is to provide the specific motion that will enable the tooling at the end of the arm to do the required work. A robot movement can be divided into two general categories: Arm and body (shoulder and elbow) motion and wrist motions. The Individual joint motions associated with these categories are referred to as degree of freedom. Each axis is equal to one degree of freedom. Typically industrial robots are equipped with 4 – 6 degrees of freedom. The points that manipulator bends, slides, or rotates are called joints or position axes. Manipulator is carried out using mechanical devices, such as linkage, gears, actuators, and feedback

devices. Position axes are called as world coordinates, is identified as Being fixed location within the manipulator that serves as Absolute frame of reference [8].

The x-axis travel moves the manipulator in an in-and-out Motion. The y-axis motion causes the manipulator to move side-to-side. The z axis motion causes the manipulator to move in and up and-Down motion. The mechanical design of a robot manipulator relates directly. To its work envelope and motion Characteristics. End effecter is the device that is mechanically opened and closed. Act as the tool- mounting plate. Depending on the type of operation, conventional end Effectors are equipped with various devices and tool Attachments, as follows:
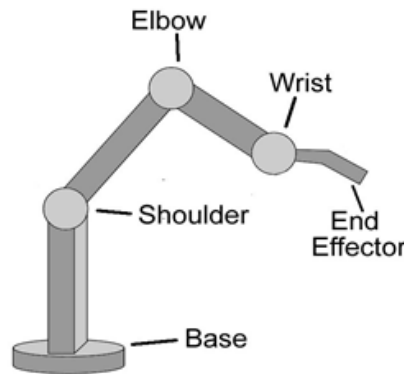

Figure 2. Degrees of freedom

Grippers, hooks, scoops, electromagnets, vacuum cups, and Adhesive fingers for material handling, Spray gun for painting. Attachments for spot and arc welding and arc cutting, Power tools such as drills, nut drivers, and burrs. Special devices and fixtures for machining and assembly. Measuring instruments, such as dial indicators, depth gauges [9].

Electronics Control: -The controller is a communication and information processing Device that initiates, terminates and coordinates the motions and sequences of a robot. It accepts necessary inputs to the robot and provides the Output drive signals to a controlling motor or actuator to Correspond with the robot movements and outside world. Shown in figure 3 block diagram illustrates the many different parts of robot Controller. The heart of the controller is the computer and its solid-state Memory. The input and output section of a control system must provide a communication interface between the robot controller Computer and following parts:

- Feedback sensors
- Production sensors
- Production machine tools
- Teaching device
- Program storage devices
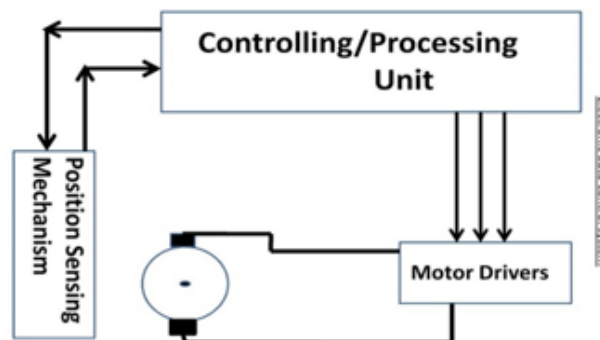- Hard copy devices

Figure 3. Electronics Control Block

The computer controls the motion of the robot arm by Means of drive signals that pass through the drive Interface to the actuators on the arm. Robots are often classified under the three major Categories, according to the type of control system used, Non servo – open loop system. Servo – closed loop system, Servo-controlled – closed loop systems with continuously Controlled path. Either auxiliary computers or embedded microprocessors are used for practically all control of industrial robots today. These perform all of the required computational functions as well as interface with and control associated sensors, grippers, tooling, and other associated peripheral equipment. The control system performs the necessary sequencing and memory functions for on-line sensing, branching, and integration of other equipment. Programming of the controllers can be done on-line or at remote off-line control stations with electronic data transfer of programs by cassette, floppy disc, or telephone modem. Self-diagnostic capability for troubleshooting and maintenance greatly reduces robot system downtime. Some robot controllers have sufficient capacity, in terms of computational ability, memory capacity, and input-output capability to serve also as system controllers and handle many other machines and processes. Programming of robot controllers and systems has not been standardized by the robotics industry; therefore, the manufacturers use their own proprietary programming languages which require special training of personnel.

Control Unit:-

The controller is a communication and information processing Device that initiates, terminates and coordinates the motions and sequences of a robot in shown figure.4. It accepts necessary inputs to the robot and provides the Output drive signals to a controlling motor or actuator to Correspond with the robot movements and outside world. As shown in bellow figure controlling of the Robotic Arm will be done. It is shown that servo motors are controlled with PWM signals and the controlling for the degree at which it will rotate or work can be performed. There are varieties of controllers are available for controlling of robotic arm and Servo motors. There are two major types of controllers [2], [8], [9]:

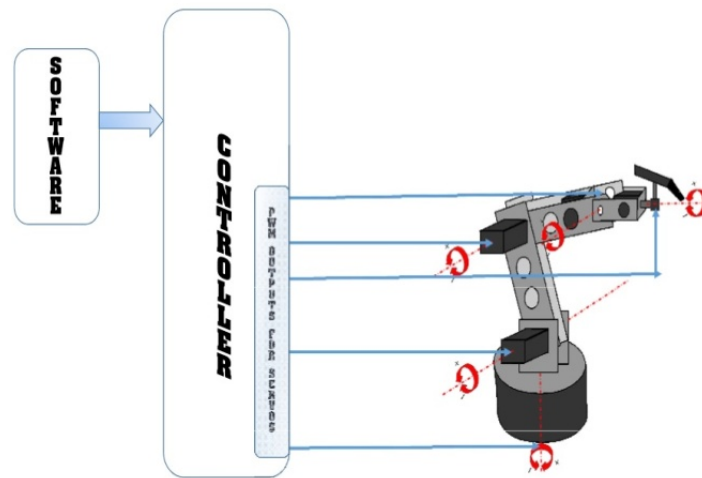- Mechanical Controllers
- Electronics (Digital) Controllers

Figure 4. Controlling Block Diagram

Mechanical Controllers:- Mechanical controllers are controller that can be treated as analog controllers. They work on mechanisms and various principals. Due to this a possibility of getting high accuracy is very low. Hence, Mechanical controllers are not preferred now a day. As compared to Mechanical controllers, Electronics (Digital) controllers are very fast and due to digital processing of information they are widely preferred. Also due to slow processing speed and data accuracy Mechanical controllers are not being preferred and they are avoided due to these reasons. The next is Electronics (Digital) Controllers.A figure Illustrated below shows the basic design and architecture of prototype. Above figure shows the basic prototype for robot arm, which consist of five degrees as named A1, A2, A3, A4, A5 respectively. Each axis has several limits for movement in particular direction like forward and reverse direction. A table shown as below indicates the total degree of freedom for each axis.

Axis	Degree*
A1	180
A2	120
A3	120
A4	90
A5	90

*indicates total degree of freedom.

By exploring our design and mechanical work we have started work for development of arm body. At first we purchased a poly carbonate sheet from local market. As per the guidance we made one drawing on paper of different part. Before preparing a hardware design model for robotic arm we have prepared each part with hard paper, which are of the same size that of robotic arm's parts.

Electronics (Digital) Controllers:- Controllers are the heart of any of the system. Controllers provide brain to the system. A controller do every task and processes the information's inside it. According to the obtained information they provide control signals to the system. And according to these signals system responds. Hence, Controller in any of the system works like a brain do in human body. It controls almost everything. According to our project requirements, we have gone through many controllers some of which are discussed below:

- 8051 Family
- PIC family
- AVR family
- ARM based cortex-xx series

All the above mentioned controllers are from market's leading manufacturers of microchips and control/processing ICs.

Application:- Now a day, every industry wants to implement technological solution, but due to higher rates many of them are not able to purchase it. So, this product is an initiative towards low cost solutions in automation technology. We will try to design industrial robot such a way that it has,

- Higher production
- Higher Quality.
- No Labor problem
- Higher Speed
- Manufacturing flexibility

4.   CONCLUSION

A research and development project in robotic assembly automation which merits special mention in this research paper stands for adaptable programmable assembly system. the analysis methods include the payback method, return on investment methods, and equivalent uniform annual cost method. Robot and the programmable automation projects present certain unique problem in the economics justification of industrial applications

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