SIMULATION OF AN ARTICULATED ROBOT ARM

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SIMULATION OF AN ARTICULATED ROBOT ARM

Report submitted in accordance with the partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Robotics and Automation) With Honors

By

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I hereby, declare this report entitled “Simulation of An Articulated Robot Arm” is the result of my own research except as cited in the references.

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APPROVAL

This report submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation) with Honor. The members of the supervisory committee are as follow:

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En Muhammad Hafidz Fazli Bin Md Fauadi

(PSM supervisor)

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ABSTRACT

Industrial demand on robot application is increasing steadily. Robot has effectively assisted in improving the productivity of a company. Application of robot not only use in manufacturing industrial only, it also been use in medical, chemical, and can also be used in daily life. The purpose of this project is to design and develop one of the robots that have been various used in industry, the articulated robot. The project includes design and fabrication of the mechanical structure, create the human-robot interfacing program and execute the robot according to a specific job.

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ABSTRAK

Permintaan aplikasi robot dalam bidang industri sedang meningkat dengan stabil. Robot telah menjadi salah satu pembantu yang sangat berkesan dalam meningkatkan produktiviti sesebuah syarikat. Aplikasi robot tidak terhad kepada industri sahaja, malah robot juga di gunakan dalam bidang perubatan, kimia, dan juga boleh di gunakan dalam kehidupan harian manusia juga. Tujuan projek ini ada untuk membangunkan salah satu robot yang telah digunakan secara meluas dalam bidang industri iaitu robot bersendi putar. Projek ini termasuklah reka bentuk dan pembuatan struktur mekanikal, membangunkan kod-kod untuk perisian interaksi antara manusia dan robot dan menjalankan tugas yang telah dispesifikasikan.

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DEDICATION

To my mother and father, thank you for your undying love and support. To all my friend and lectures, thank you for your support

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TABLE OF CONTENTS

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CHAPTER 1
INTRODUCTION

1.1 Background

Nowadays in the industry, we can see a lot of robots are used to replace the man power. The use of the robot can increased the production as well as lowering the labor requirement. Robot had been created for almost 90 years ago. In the year of 1920, a Czechoslovakian name Karel Capek introduced the word robot in the play of R.U.R. - Rossum's Universal Robots. The word comes from the Czech *robota*, which means tedious labor. [1],[2].

A robot is a mechanical or virtual, artificial agent. It is usually an electromechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own. [1]. However, there is no one definition of robot which satisfies everyone, and many people have their own. For example, Joseph Engelberger, a pioneer in industrial robotics, once remarked, ‘I can't define a robot, but I know one when I see one.’ The Cambridge Advanced Learner's Dictionary defines "robot" as, ‘A machine used to perform jobs automatically, which is controlled by a computer.’ For this reason, the International Standards Organization gives one definition to be used when counting the number of robots in each country. International standard ISO 8373 defines a "robot" as:

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> ‘An automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either, fixed in place or mobile for use in industrial automation applications.’

Then, it follows by the first programmable paint-spraying mechanism which is designed by Americans Willard Pollard and Harold Roselund for the DeVilbiss Company. In 1942, Isaac Asimov publishes Runaround, in which he defines the Three Laws of Robotics as follows:

1. A robot may not injure humanity or, through inaction, allow humanity to come to harm. (This was added after the initial three laws.)
2. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
3. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
4. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

A typical robot will have several, though not necessarily all of the following properties [20]:

- Is not 'natural' in which it has been artificially created.
- Can sense its environment.
- Can manipulate things in its environment.
- Has some degree of intelligence or ability to make choices based on the environment or automatic control / preprogrammed sequence.
- Is programmable.
- Can move with one or more axes of rotation or translation.
- Can make dexterous coordinated movements.
- Appears to have intent or agency.

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Even countries have different definitions of what it means to be a robot. For example the Japanese Industrial Robot Association (JIRA) defines six classes of robot [20]:

- Manual - Handling Devices actuated by an operator.
- Fixed Sequence Robot.
- Variable-Sequence Robot with easily modified sequence of control.
- Playback Robot, which can record a motion for later playback.
- Numerical Control Robots with a movement program to teach it tasks manually.
- Intelligent robot: that can understand its environment and able to complete the task despite changes in the operation conditions.

Whereas the Robotics Institute of America (RIA) defines only four [20]:

- Handling devices with manual control.
- Automated handling devices with predetermined cycles.
- Programmable, servo-controlled robots with continuous of point-to-point trajectories.
- Capable of Type C specifications, and also acquires information from the environment for intelligent motion.

Among the robot that been used in the industrial is the robotic arm. A robotic arm is an electronic arm, usually controlled by a remote control, with similar functions to a human arm. It can be classified between articulated or non-articulated. An articulated robot is a robot with rotary joints (e.g. a legged robot). Articulated robots can range from simple two-jointed structures to systems with 10 or more interacting joints. They are powered by a variety of means, including electric motors. The articulated robot are been used widely in the industrial. The purpose of this study is to develop an articulated arm robot that use in the manufacturing industry.

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1.2 Problem statement

Nowadays robotic arm are variously use in the industrial. Thus the robotic arms become more complex but still a very useful device to replace human in executing industrial task. But the more complex courses difficult problem to deal or to settle it. For this project, the problem is the mechanism of articulated robot arm itself. Beside, the project also looks into the complexity of the serial servo controller circuit board that will be developed. The part also play an important role in the movement of the robot arm, example are the motor that will be use to drive the arm, the material to build the arm, and what kind of the movement that the robot arm capability of. After finish the robot, it comes to create the programming the robot. What will the software that will be use to create the program and can it integrate with the computer systems.

1.3 Project objective

The main objectives for this project are;

- To design and develop an articulated robotic arm
  - To make a prototype of an articulated robot that is similar to the articulated robot that been use in the industry
- To integrate the robot arm with the computer system.
  - To make a connection between the articulated robot with the computer to make the movement of the robot.
- To execute a task that the robot arm can perform.
  - The task for this articulated robot is pick and place. The articulated robot should be able to pick a certain object and place it at a different point.

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1.4 Scope of the project

In order to carry out a meaningful project, certain scopes had been define

- The task is to pick a certain object and place it at different point.
- Workspace program is used to simulated the robot

1.5 Conclusion

In conclusion, this product will contribute an excellent job in robotic application. It also will be very helpful to the users. The design and simulation is one steps for the future. Thus, the next chapter to be developed is literature review and project methodology.

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CHAPTER 2
LITERATURE REVIEW

2.1 Types of Robot

In the industrial field, robot has been use to do several of work that human cannot do. There are few type of robot that been use in industrial. Below are listed robot type that been use in industrial. Refer Figure 2.1 for Type of robots and 2.2 for Robot arm and possible workspace [4].

- **Cartesian robot or Gantry robot:**

  A robot that has three prismatic (PPP) joint. It widely used for pick and place work, application of sealant, assembly operations, handling machine tools and arc welding.

- **Cylindrical robot:**

  Combine from a rotary joint and two prismatic joint (RPP) to form a cylindrical coordinate system. This kind of robots used for assembly operations, handling at machine tools, spot welding, and handling at die-casting machines.

- **Spherical or Polar robot:**

  The position of wrist is determined by two rotations of rotary joints and one translation of prismatic joint (RRP). Therefore, it is widely used for task such as handling at machine tools, spot welding, die casting, fettling machines, gas welding and arc welding.

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- **SCARA robot:**

It’s has two parallel rotary joints to provide compliance in a plane. Most used for task such as pick and place work, application of sealant, assembly operations and handling machine tools.

- **Parallel robot:**

It's a robot whose arms have concurrent prismatic or rotary joints. One use is a mobile platform handling cockpit flight simulators.

- **Articulated robot:**

Articulated robots, often called jointed arm, revolute, or anthropomorphic machine. Articulated robots typically contain at least three rotary joints (RRR). It is widely used for performing task such as line assembly operations, die-casting, gas welding, and arc welding and spray painting. The advantages of articulated robot are robot still can achieve deep horizontal reach although articulated robots uses a minimum of floor space and high positioning mobility of the arm allows the robot to reach into enclosures. Besides that, the articulated robot required a higher cost. [7]

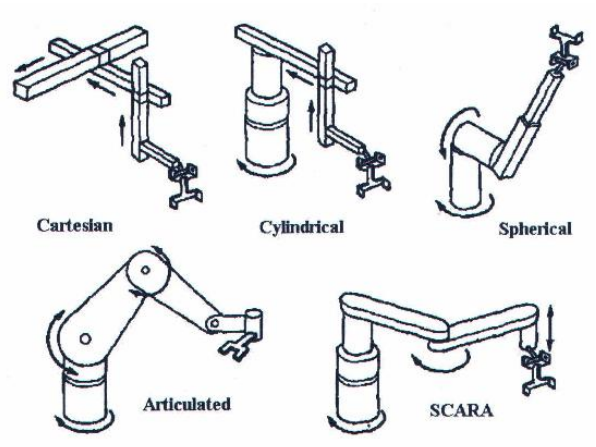

Figure 2.1 : Type of robots [4]

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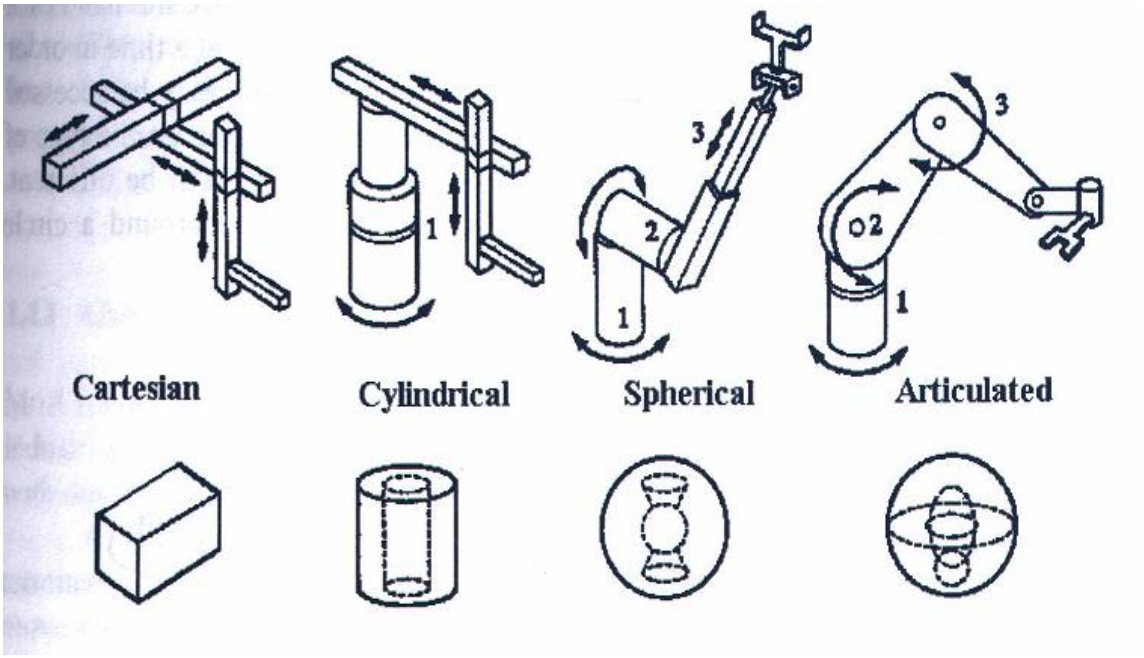

Figure 2.2 : Robot arm and possible workspace [3]

2.2 Articulated robot arm

There are several types of robotics arm. Some of the types of the robot arm include Cartesian robot/ gantry robot, cylindrical robot, spherical / polar robot and an articulated robot. The articulated robot has three rotary joints (RRR) [1].This feature allows the articulated robot to have a relative large work-space. The articulated robot arm also known as pure spherical or anthropomorphic robot [1]. In this, the most common of jointed configurations, all of the links of the articulated robot are pivoted and hence can move in a rotary or revolute manner. They are perhaps the most common configuration for industrial robots. The major advantage of this design is that it is possible to reach close to the base of the robot and over any obstacles that within its workspace [7],[4]. As shown in Figure 1.7, the upper portion of the arm is connected to the lower portion or the forearm. The pivot point is often referred to as an elbow joint and permits rotation of the forearm in α direction. The upper arm is connected to a base or sometime a trunk. Motion in a plane perpendicular to the base is possible at this shoulder point in the β direction. The base or trunk is also free to rotate, thereby permitting the entire assembly to move in a plane parallel to the base (in the direction γ). The work envelope of a spherical-jointed robot is a portion of a

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sphere. Any linear movement requires the coordinated motion of all three revolute joints [7]. Refer Figure 2.3 for work space of an articulated robot.

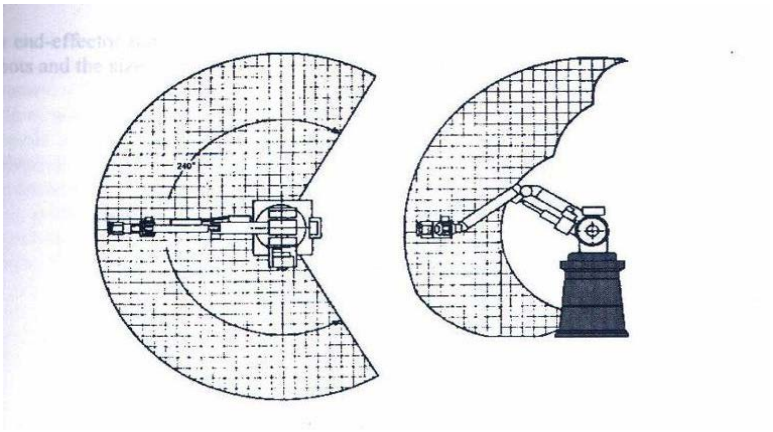

Figure 2.3: Work space of an articulated robot [3].

2.2.1 Control of the articulated robot

These articulated robots have method to control it. There are two general classes of controller; non-servo controlled and servo controller.

2.2.1.1Non- servo-controlled robots

The non-servo-controlled or limited-sequence robot is the simplest type. It also describe such a manipulator are end point robot, pick and place robot or bang-bang robot. The major characteristic of such devices is that their axes remain in motion until the limit of travel (or “end stop”) for each is reached [3]. Thus only two positions for the individual axes are assumed. The non-servo nature of the control implies that once the manipulator has begun to move, it will continue to do so until the appropriate end stop reached. The controller is operating in open-lop mode, where there is no monitoring of the motion, the position or the velocity, via external sensors, at any intermediate points [3]. The robot motion is then controlled by limit switches and mechanical stop. The simple control method enables this type of robots

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to provide relatively high-speed operation with high degree of reliability and accuracy, but they are limited to performing only simple pick and place operations. Refer Figure 2.4 [3].

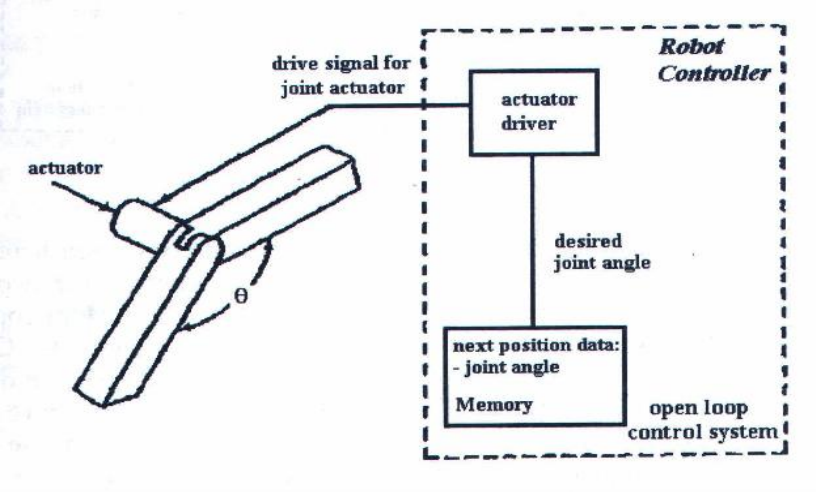

Figure 2.4 : Non-servo controlled arm [3]

2.2.1.2Servo-controlled robots

Servo-controlled robots are normally subdivided into either continuous path or point-to-point devices. In either case, however, information about the position and velocity (and perhaps other physical quantity is continuously monitored and fed back to the control system associated with each of the joints. In other word, each axis loop is "closed". Here the control system is based on close-loop servo, whereby the position of a robot's axis is measured by feedback devices and compare with a pre-determined point store in the controller's memory [3]. Only the extreme axis could be programmed [3]. Furthermore, it is possible to control the velocity, acceleration, deceleration, and jerk for the various joint between the end point. Manipulator vibration can, as consequence is reducing significantly. Refer Figure 2.5 [3]

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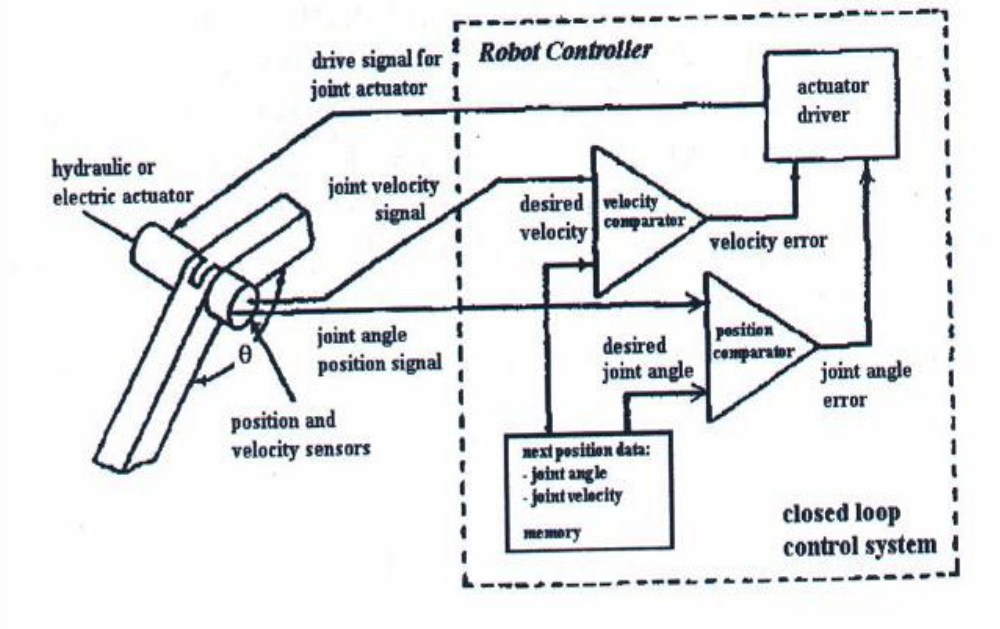

Figure 2.5 Servo-controlled arm [3]

2.2.2 Robot Application

Robot is general are designed to help people with tasks that would be difficult, unsafe, or boring for real people to do alone. Robots are now widely used in factories to perform high-precision job such as welding and riveting. They are also used in special situation that would be dangerous for human, for example in cleaning toxic waste or defusing bombs. Robots are used in underwater recover efforts, particularly in water too deep for human exploration [1],[4] .

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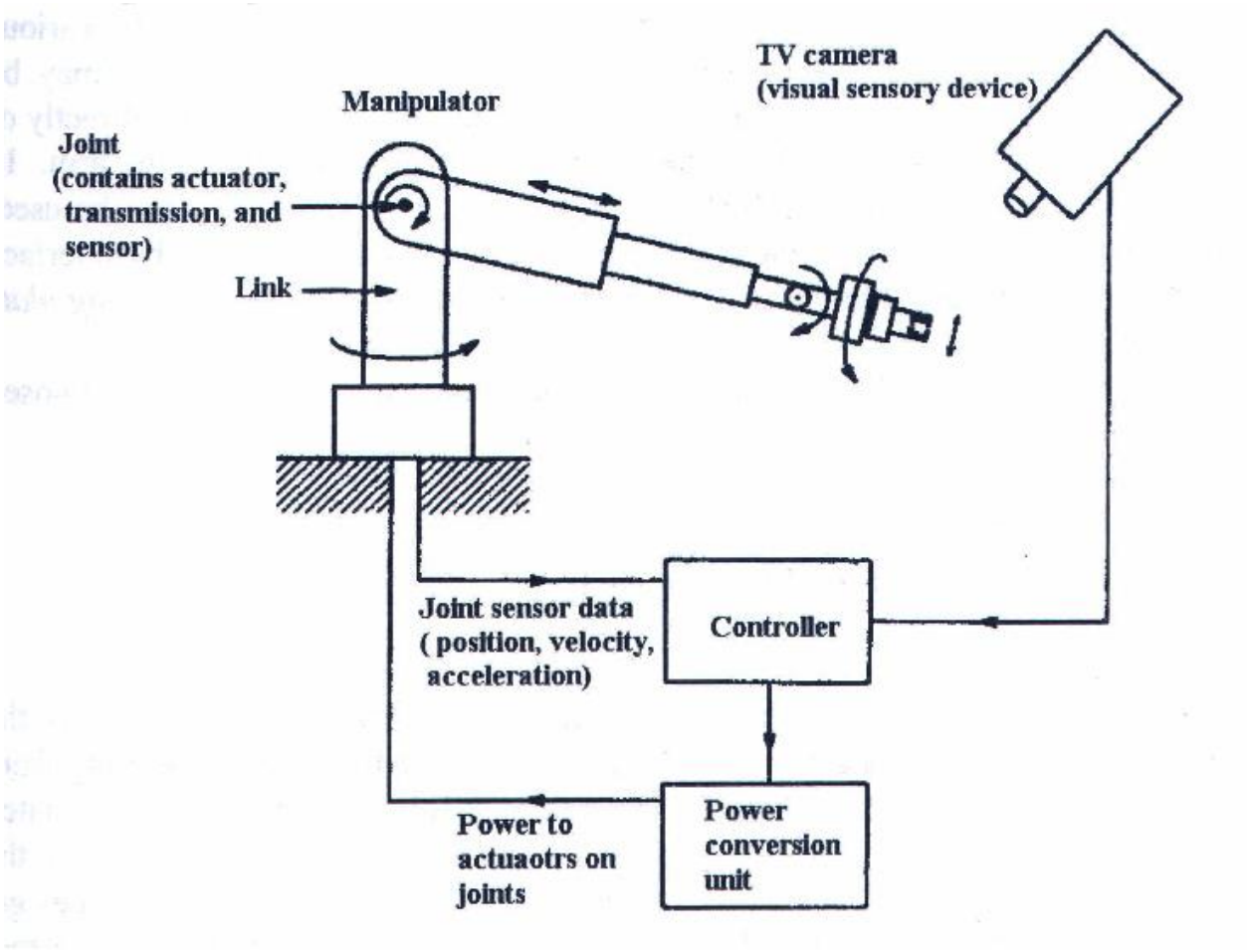

Figure 2.6 Basic Robot systems

Machine loading, where robots supply parts to or remove parts from other machines. In this type of work, the robot may not even perform any operation on the part, but only a means of handling parts within a set of operation

Pick and place, where the robot picks up parts and place them elsewhere. This may include palletizing, placing cartridges, simple assembly where two parts are put together (such as placing tablets into the bottle), placing parts in an oven and removing the treated part from the oven, or other similar routines.

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