ROBOTICS

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A robot can be defined as a self-controlled device, which consists of electrical or mechanical units. A robot comes to mind, and has been fictionally known as a mobile device that is humanoid in appearance and has a metallic structure. At present robots are not very humanoid, instead they are machines that run continuously and respond automatically to a users respond, and can be controlled by a human operator even from a great distance. The word robot comes from the Czech story/play and means 'worker'. Most scientists define a robot being a machine that is operated by a computer and is able to many different jobs. Like many other machines robots are there to make our work easier, which they can do by moving materials, tools or other objects through programmed actions. A robot can be programmed to perform certain tasks, that can receive inputs, compute it, and then act out a desired behaviour or task as directed. It is a machine designed to execute one or more tasks repeatedly, with speed and precision.

There are many different types of robots used to do many different types of tasks, but all these robots are narrowed down to their bare minimum and all have the same principal behind them.

There are four main parts to a robot: the power supply, this provides all the electricity for the robot motors. There is the computer, which can also be known as the brain of the robot, and this controls what the robot does. There is the interface that links everything together.

Many automated machines are often referred to as having hard automation and this is due to the fact of the machine having a fixed configuration that cannot easily be changed. If the task was to be changed then the hard automation often becomes redundant and then may result in having to be changed physically by the operator to adapt its modification to suit the new task that has been set, or sometimes the components are used again on other applications, if this was to happen then the robot is cannibalised.

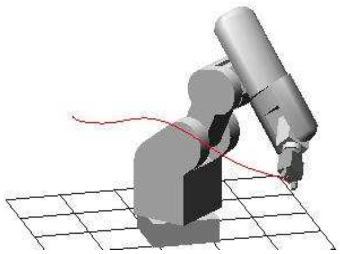
Industrial robots have many objectives: they are programming, have multiples movements and interchangeable grippers.

An operator determines the initial movements and actions of an industrial robot. This can result in a sequence of movements, which is stored within a control system, with the robot being programmed to perform the task with great accuracy as and when required. If the task is to be changed then the robot will be programmed and taught a new sequence of movements and will easily adapt to the new task. Robots can be thought to having soft automation because of its operation being largely under software control for example the control of a computer program.

Industrial robots have in-chargeable grippers, which involve gripping items of various sizes, and shape, which furthermore involve transporting or manipulating tools, components or applicators to perform various manufacturing activities.

There are many types of robot which consist of different types of control:

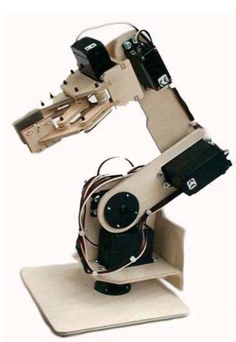
The limited sequence controller is used on the limited sequence control, which can also be described as the bang-bang control. The programming application is done mechanically, which can be done by placing a mechanical stop at the end of each of its axis. This operation may be purely mechanical, because it may use a motor to run its timing.



If a robot is able to move from one specified point to another, but is unable to stop at arbinary points that have not been previously designated, then this is called a point-to-point robot. Point-to-point robots that are driven by servos are often controlled by potentiometers and/or limit switches, which is set to stop the robot arm at a specific point.
Point-to-point robots are usually non pneumatic, they are either hydraulic or mechanical. Because hydraulics and mechanical systems do not compress like pneumatics they are able to lift much higher loads than pneumatic robots. Point-to-point robots are able to lift much higher loads than pneumatic robots. Point-to-point robots pick up heavy raw materials and are able to load them into a machine centre for it to be shaped into useful products.

A continuous path robot is able to stop at as many points, which have been specified. However a continuous-path robot is unable to pause on a straight line or constant curved path between specified points, if no stop has been specified. This type of robot is very special to manufacturing. A continuous path robot does not move in straight lines like a point-to-point robot. Instead these robots are programmed by using sensors on each of its axis motor that feeds back movement into its memory bank, which is in the machines computer. An example of a continuous path robot will be the painting of cars and other items.

Controlled path (computer trajectory) robots are robots that are used for generating straight lines, circles, interpolated curves and other paths with high accuracy. For some of these robots, paths can be specified in geometric or algebraic terms. Most of the robot is able to obtain accuracy, however start and finish co-ordinated, and also path definitions require control.



Servo controlled robots are used for sensing their own positions and feeding back the sensed position to the control, and they do this in a way in which the control causes a particular path to be followed. A non servo robot has no way of determining if they have or have not reached a specific point and acts out a task blindly.

The typical industrial robot does jobs that are difficult, dangerous ad dull. They perhaps lift heavy objects, paint, handle chemicals or perform assembly work. They are able to perform the same task over and over again. The major categories of industrial robots by mechanical structure are:
Cartesian robot: this type of robot is used for picking and placing things, assembly operations, handling machine tools and arc welding. Cartesian robots move in three linear axes in right angles to each other. This means that it can make the human job of programming easier and also reduce the amount of computer power required. They have a rigid structure which means that they can manipulate high loads so that it is easier to pick and place operations such as: loading machine tools, stacking parts in bins and any other application that uses X, Y, Z planes. This kind of robot occupies a large space that gives a low ratio of robot size to the operating volume. There are many advantages for this type of robot:

» It can be easily programmed and controlled
» There is a simple control system used
» It has a high range of accuracy
» There is a constant speed, accuracy and payload capacity over the entire work range
» Its familiar X, Y, Z co-ordinates are easily understood
» It has an inherently stiff structure
» There is a large area coverage
» It has a large payload capacity
» It offers good reliability because of its simple structure
» Because it has a modular fashion it is easy to expand

The Cartesian robot configuration finds applications in areas that have linear movements and that need high accuracy. Some examples include: manipulation of components through apertures, like furnace doors, machine openings and similar confined spaces and also openings or similar confined spaces.

Cylindrical configuration: this type of robot combines a both vertical and horizontal linear movement that uses horizontal planes about the vertical axis. It is used for operations like spot welding and handling at die casting machines. This robot also has several advantages:

» Like the Cartesian robot it has a simple control system
» Good accuracy
» Fast operation
» Good access to front and sides
» It can be easily controlled

Because there is only one rotary movement, it is easy to visualise where the end effecter is going to be.

Polar configuration: this can also be known as the spherical configuration and it combines with rational movement in both horizontal and vertical directions with only one single linear movement of the arm. These robots can be powered by electricity or it can be hydraulically driven. This type is used for lifting large loads.

Articulated configuration: this is probably the most widely used. This is because of its flexibility in reaching any part of working envelope. The end effecter is almost impossible to visualize because of all its joints being rotary. The articulated configuration consists of several rigid arms connected together; this configuration can also be referred to as a jointed arm configuration. Some particular advantages include:

- Good manoeuvrability
- The ability to reach over obstructions
- Easy access to its sides and overhead
- Slim design
- Fast operation

SCARA configuration: this type is a combination of the cylindrical and revolute configuration. It is a three-linked arm that has two rotary joints providing movements of horizontal and vertical joints. The SCARA configuration was developed for assembly type operations. However they are now being used for welding, drilling and soldiering operations. These robots are very fast accurate.

There are many points that have to be considered in a robot and all contribute to the way it works. These points also help the motivating influences of a robot and show how a robot has more advantage than a human.

Accuracy is one of the most important terms in describing machine characteristics, which can also be referred to as precision, and is the measure of the difference between the programmed point or path, and also the actual point or path. Accuracy is also one of the most important factors of increasing product quality, the reason being that robots can be programmed with the exact accuracy for the work needed, whereas humans only have a certain amount of knowledge of accuracy and may take time to improve accuracy skills.

Repeatability, which is also another very important term when describing machine characteristics and is the measure of the ability of a robot arm, and to see whether it is able to go to a point in space or along a path, time after time, under the same conditions. The robots application determines the required repeatability. For example; if a robot is being used for assembly or welding then the required repeatability of the order of better than +/- 0.2mm. Whereas if a robot is used for loading or unloading - then this can be taken up by the gripper.

The better the accuracy and/or the repeatability of a robot arm, then this would mean the robot being more cost efficient. As a general rule: the accuracy and/or repeatability of a robot arm should usually be higher than what is required by the task, because that then allows a degree of flexibility.

Current robots with 1 metre reach can achieve accuracies of 0.2mm and repeatability of 0.1mm. A robot used for welding can produce a weld where there will be no need for grinding afterwards, and can also produce better tolerances than any other human welder would be capable of.

It is typical for the accuracy and repeatability of a robot arm be scarified to some degree when high speeds are being used when an inverse relationship is being evident.

Speed	Low →	Medium →	High
Accuracy/repeatability	Very good	Moderate	Poor

It is now easier to control accuracy and speed because of robots; it has been know that more difficult welds that were almost impossible to produce have now been made possible due to robots.

The flexibility of a robot should be enough to allow any modification of a process or a product during its lifetime. Due to change in customer demands and product technological advances, no product or process is entirely static in nature; therefore consideration needs to be taken to future developments.

It is possible that good accuracy and repeatability is attainable at moderately high speeds, however this would require the robot arm to have sophisticated sensory and also sophisticated control systems, which can be very cost effective. High payloads due to the inertial load can limit the maximum speed of a robot arm, which is placed in its structure, whilst it is being accelerated and decelerated.
The given task selected for a robot arm should be given a type and specification, should allow a certain degree of versatility, which should then be allowed for a future modification of a process, and adaptability if the model were to be placed by a newer one or similar product.
An obvious consideration would be the payload, which requires the factor of safety that allows the foreseen loads, some examples include: tight fits during assembly operations or the extra forces that are involved when there is an attempt to assemble a defective part. Also what is more important is that the robot load capability includes the weight of the end-effecter, which is sometimes considered as well as the maximum total weight of the actual work piece.

The first industrial robot was created by Unimat and was purchased by the Ford Company in 1961. Since then robots have gradually taken over human workers. The cost of robots of early produced robots were many hundreds thousands of pounds, so this meant that only the largest manufacturing companies could justify their uses with the use of a robot. Decreasing productivity and increasing labour costs meant that companies were forced to use robot. The demand of robots increases and more companies built newer and better robots so this meant that the costs of robots dropped rapidly.

One of the most used robots that have been used since some of the first robots were made is the automotive industry along with: electric machinery, electric components, plastic moulding products and much more. In the near future fast food industries are hoping to use robots to cook, prepare and serve food items as well as dispense beverages.

At this present time the number of robots that are being used are increasing at the rate of about 35% per year, and sales volumes are increasing each year about the same rate.

The motivating factors that have been influenced the introduction of the robots into the industry can be explained by the changes in modern manufacturing methods:

One of the early applications of a robot was loading and unloading of hot forging presses. Before the robot this application needed to men workers to hold ingots in place during the forging operation, but now one robot is able to hold the ingot with a steel used effecter that positions the part accurately for the forging process.

When painting is done there are extreme hazards for the paints health because some painting is done with toxic paints. In some cases men are required to work completely covered with seal garments that included wearing hoods that had an air supply piped into them. Now robots are taught to do this work and allow human workers to be freed from working under these conditions. Robots working in hazardous environments instead of humans have resulted in production rate and quality of the work that is being produced to have greatly improved.
Manufactures are finding that the use of robots can reduce the production costs, there are several reasons for this:

» Robots have no benefits that need paying, whereas humans do for example: to install and actually run a robotic system over several years is less than £5 and hour, whereas an average labour costs £15 to £20. Also robots do not get their beneficial cover: pension, holiday pay, sick leave, medical and dental benefits and social pay.
» As humans we are unable to work at continuously over a certain amount of time, we need to take brakes to eat and use the toilet, whereas robots are able to work 98% of time at their assignment task.

» Robots are able to produce a higher percentage of good parts or assemblies, whereas human workers are not, humans do not have the superior levels of accuracy and repeatability that robots have. Robots also do not make errors due to fatigue or lack of attention.

» Very often robots are able to repay their entire capital, installation and training costs within less than 18 months.

Robots are able to produce better grinding, welding and better tolerance than humans. To produce high quality parts, whether it is in grinding or welding there needs to be good speed of operation, which is also another advantage for robots. It is now easier to control accuracy and speed because of robots; it has been known that amore difficult welds that were impossible to produce have new been made possible due to robots.

Increases productivity can mean that more work is completed on schedule and that schedules can be maintained. Because of robots utilisation of space and equipment is improved and this can result in savings to cover capital investment.

Robots are able to work much faster at many tasks than humans can: for example, a human worker that does arc welding is able to maintain an average work rate of 0.50 metres per minute where as a robot arc welder is able to arc weld and maintain an average work rate of two metres per minute, under the same conditions.

Robots can be found in a variety of locations, which include the automobile and manufacturing industries. And from what is written above we know that robots are able to do many different things from loading a machine to cutting glass. Although robots are mainly used for manufacturing they can perform other important jobs. They can be found in design, prototyping, fighting fires and medical applications.

Robots can be used here on earth, under water and even in space, without the help of robots we would have very little knowledge of space and the underwater and also life would be very difficult and also very slow.

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