FACTFILE:
GCSE
Technology and Design
OPTION B: MECHANICAL AND PNEUMATIC CONTROL SYSTEMS

Rewarding Learning

2.35 Robotics

Learning Outcomes

You should be able to:

- give examples of where robots are used in society;
- describe and analyse the reasons for using robots to assist humans; and
- identify and explain the basic control systems used to produce robotic movement.

Course Content

Robots can be described as machines controlled by a computer to work in a set way to complete a specified task or tasks.

In real life robots are very different from those portrayed in films and science fiction.

The study of robots is called robotics.

There are many examples of where robots are used in society. They are used widely in industry, space, underwater exploration, surgery, dangerous environments and military manoeuvres to name but a few.

Robots in industry

Robots are used extensively in car production and other industries where companies manufacture different parts of products at different stages. They are preferred over automatic machinery as robots can be reprogrammed to do many different jobs such as installation, painting and welding. The robots generally perform on assembly lines where the programmers take full advantage of the mechanical arms, motors and sensors to complete various jobs. The main advantage of robots is that they can perform mundane tasks at a very fast pace. They have a very high level of accuracy in the tasks they are programmed to do and can work continuously without breaks. Robots can work in very dangerous environments involving heat/paint fumes without adverse effects.

Robots in the home

Robotic vacuum cleaners are now being rapidly seen in use in many homes. The price of these 'affordable' robots is such that they could become a luxury commodity. Many people control their heating systems, tv/music systems from 'smart' boxes and the increasing development of 'apps' will soon enable us to turn on heating/ovens and many other appliances in our homes remotely.

Robot vacuum cleaners use cameras and lasers to navigate around the home.

Robots in Farming

Throughout the years, robots have been introduced to the world of commercial agriculture. Robots have the ability to work faster, longer and more efficiently than humans in agriculture. They have the ability to remove the human factor from some of the labour intensive and difficult work on a farm such as planting and harvesting. They can be taught to navigate through farmland and harvest crops on their own. Robots can also be used for horticulture needs, such as pruning, weeding, spraying pesticide and monitoring the growth of plants.

Robots in space

Robots are the ideal equipment to complete space missions. They are able to work in atmospheres of extreme and fluctuating temperature as well as exposure to radiation without any lasting side effects. The robotic arm on the space shuttle has many pre-programmed movements that enable it to perform many tasks and has the ability to be self-fixing. The Viking I and II probes were sent to Mars to collect data such as weather, soil and pictures and relay them back to earth. Commonly used space robots are the Remotely Operated Vehicle (ROV) and the Remote Manipulator System (RMS).

Both are unmanned robots that collect and feedback data to a central server usually on earth.

Underwater Exploration

Underwater robots are often used in marine missions, shipwreck explorations and in association with oil rigs. ROV's (Remotely Operated Vehicle) are extensively used underwater often in deep and dimly lit environments. They are controlled by the command centre often on ships above the water to collect information such as pictures and marine life samples that can be analysed remotely. Underwater robots are extremely complicated to design as it is difficult to send signals over long distances under the water. ROV's are often connected by cables to the ships so that the data can be transmitted.

Robots in Surgery

The use of robots in surgical procedures has revolutionised medicine. Surgical robots are operated via consoles by human surgeons. In this way they use a computer to control robotics arms holding surgical instruments in a very precise manner.

This type of surgery is less invasive to the human and operations can take less time. Some surgery is able to take place in different countries. This is particularly optimal where the patient is too weak to travel or the surgery is very specialised. In medicine clinical condition hygiene is of immense importance and this can be maximised by the use of robotics.

Military Manoeuvres/ Dangerous Environments

Military Robot

There is extensive use of robotics in military manoeuvres and other dangerous environments. In war zones robots are sent to complete an initial assessment of a suspected dangerous situation such as a car bomb or a land mine. These robots are remotely controlled by a skilled engineer who can control the robots to complete certain actions and in many cases to safely diffuse the bomb or move it to a safer location to be examined. Many of the robots are fitted with sensors for combustible and toxic gases and are also being used by the fire brigade in industrial and commercial fire incidents if there is a suspected hazardous substance present.

Other Resources

https://mic.com/articles/118712/9-awesome-robots-that-are-helping-to-save-the-world#.ESO9oO2CL

Summary

Advantages of Robotics

They produce very fast, automated procedures accurately.

They can be used in dangerous/unusual environments.

They can be extremely hygienic.

Disadvantage of Robotics

They can be very expensive to install/set up/replace initially.

They need highly trained professional to operate them.

They cannot make decisions for themselves.
There are many different types of robots and the mechanisms involved are endless. These include:

Wheeled Robots

Basic wheeled robots in particular multiple drive motors (one connected to each wheel) have the best degree of functionality and control. They are a low cost option for a beginner robot builder. They may lose traction and slip as each wheel has only one point of contact with the ground.

Tracked Robots

Tracked wheel robots gain advantage as they have less slippage and provide an even distribution of weight across the ground. However, they have a limited flexibility of turning movement which can reduce their speed/control of turning.

Legged robots

Legged robots are often designed to imitate 'human form' and are useful on uneven terrain. Amateur legged robots require at least six legs for stability and produce the closest type of 'natural' motion. They can be costly to build and require more complex programming.

Robotic Arms

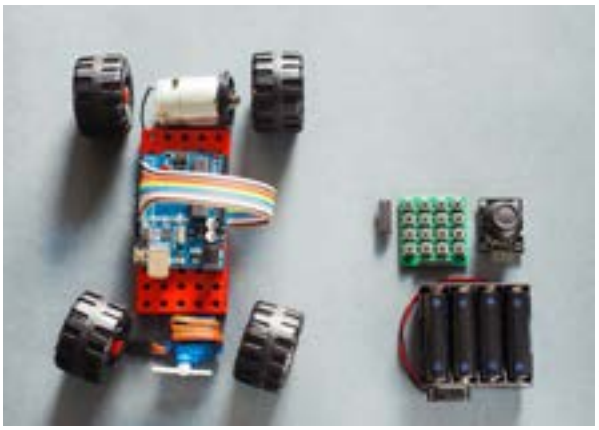
A robotic arm is designed to mimic a human arm but it only has six degrees of movement. (a human has seven). It simulates the human joints with segments and joints to be able to move in different directions to perform a task.

Actuators

Actuators are the name given for a mechanism that controls movement in a robot. Most actuators in robotics produce either rotational or linear movement. Actuators come in many different forms but a DC motor is a typical actuator to produce rotary movement. Linear Actuators come in the form of electrical and pneumatic solenoids and pneumatic cylinders.

DC Motors

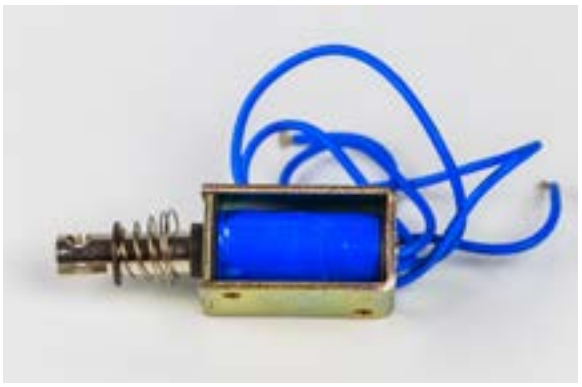
DC Motors convert electrical energy into rotary motion. DC motors tend to have very high speeds but little torque (strength). There is little positional control with a standard DC motor so it is often advantageous to purchase a geared DC motor which allows control of the speed this increases positional control of the attached wheel and also the torque (strength of turning).



Linear Actuators

Electrical Solenoid

Electrical solenoids convert electrical energy into linear movement. A solenoid is a wire wrapped around a soft iron core and when an electrical signal is received this induces a magnetic field which in turn produces the linear movement of the core. The range of linear movement can be quite small and it lacks positional control.



Pneumatic Cylinders

Pneumatic cylinders need valves to control their movement. The cylinder can produce linear motion (SAC – single acting cylinder) or reciprocating motion (DAC – double acting cylinder). They are useful for applications which require long strokes. The motion can also be strong and fast. They are

used in industrial situations especially dangerous environments or those requiring a high degree of hygiene.

Class Activity:

1. Design a robot to move around a course similar to the one below.
2. What would be the best type of actuators to use?

Revision Questions

a) What is the best actuator to use if your robot requires movement in a straight line?

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b) Discuss the main advantages and disadvantages of robotics.

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c) How has robotics improved advances in medicine, the military and farming?

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d) Discuss the advantages and disadvantages of wheeles versus tracks when used on a robot.

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