FACTFILE:
GCE DIGITAL TECHNOLOGY

UNIT A2 1:INFORMATION SYSTEMS

Rewarding Learning

Robotics

Learning Outcomes

Students should be able to:

- Describe the technology involved in the use of robotics.
- Evaluate the use of robotics in a range of commercial situations.

Content in Robotics

- What do we mean by the term robotics?
- Components parts of an industrial robot.
- Evaluating the use of robotics in commercial situations.

What do we mean by the term robotics?

Robotics is the combination of a range of disciplines, including computer science and mechanical and electronic engineering to support the design, production operation and application of robots. It also incorporates the use of computer control systems in their processing of information and their application of feedback from sensors used as input elements.

An alternative view is that robotics is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialisation, automation is a step beyond mechanisation.

Robotics involves the design, construction, programming and testing of machines using a combination of physics, mechanical engineering, electrical engineering, structural engineering, mathematics and computing to produce robots which can solve problems. In some cases biology, medicine and chemistry might also be involved.

A good working definition of a robot is that it is a machine that imitates a human. While it has proved impossible so far to give a robot sufficient common sense to reliably interact with a dynamic world, humanoid robots have been developed to do work that is too dangerous, boring, onerous, or just plain nasty for humans. Most of the robots in the world are of this type. They can be found in auto, medical, manufacturing and space industries.

An industrial robot is an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes.

Robots

There is no standard definition for a robot. However, there are some essential characteristics that a robot must have.

Sensing
A robot should be able to sense its surroundings in ways not dissimilar to the ways that humans sense their surroundings. Providing a robot with sensors - light sensors (eyes), touch and pressure sensors (hands), chemical sensors (nose), hearing and sonar sensors (ears), and taste sensors (tongue) gives the robot awareness of its environment.

Movement
A robot needs to be able to move around its environment. Whether rolling on wheels, walking on legs or propelling by thrusters a robot needs to be able to move.

Energy
A robot needs to be able to power itself whether solar powered, electrically powered, battery powered.

Intelligence
A robot needs to be 'smart'. It requires programming so that it 'knows' what it is required to do.

In summary, a robot is a system that contains sensors, control systems, manipulators, power supplies and software all working together to perform a range of tasks.

Components parts of an industrial robot

Industrial robot arms include the following main parts.

1. **Controller** – the controller represents the 'brain' of the robot arm and it co-ordinates the operation of all of the other parts. It is controlled using a specially written computer program and can be used to allow the robot to connect to external systems. The program used to control the robot is often input using a teach pendant which is a specially designed hand held device used to instruct he robot by specifying the movements it is expected to take in order to complete a given task.

2. **Arm** – robot arms can vary in shape and size (in accordance with the task they are designed to facilitate). The robot arm is the part of the robot that will position a device called the end effector. The robot arm can move and rotate the end effector into place using a range of joints. Each joint will add an additional 3 degrees of freedom to the robot's range of motion. For example, the robot arm will have 3 degrees of freedom if it has 3 joints. It will be able to move up and down, left and right and forward and backward. It would be more normal today for robot arms in a commercial environment to have six degrees of freedom however.

3. **End effector** – The end effector is an item of hardware which connects to the robot arm and performs a specific function. End effectors can be in the form of grippers, vacuum pumps, magnets, welding torches, paint sprays for example. Often the end effector can be changed to support the completion of different tasks by the robot arm.

4. **Drive** – The drive is the engine or motor used to move the various robot parts into an appropriate position when completing a programmed task. Drives may be hydraulic, electric or pneumatic.

5. **Sensors** – Sensors provide feedback to the controller about the environment the robotic arm is interacting with. As is expected the sensor will collect data regarding the environment. This is processed by the controller to help determine any further actions the robot arm needs to take to help complete the programmed task.

Programming

Robots are not just machines. A robot, like a machine, can perform different tasks efficiently, accurately and effectively but, once programmed, a robot can perform the required tasks repeatedly and consistently in exactly the same way. Through the use of re-programming, moreover, the same robot can perform a completely different task to exactly the same consistent and accurate standard.

On-line programming
For basic tasks such as paint spraying or simple pick and place operations, robot programming can be on-line. This means that the robot moves in unison with commands used by programmer. On line programming incorporates record play-back where the robot performs a sequence of moves.

There are two types of on-line teaching:-

Lead through
This method is used to teach robots to carry out such tasks as paint spraying or applying adhesive to an irregular surface. The robot arms using this

teaching method are typically ones with wrist motion plus three degrees of freedom and having revolute joints. The robot is taken through its operating cycle manually and the movements of each axis are logged automatically at frequent intervals. Joint position sensors provide position information as the robot is moved through its cycle. The positional information is sampled periodically and stored in the computer memory.

Drive through
This programming method is used for industrial tasks such as spot welding and machine loading and unloading. The robot movements are controlled by inputs from a keypad - the programmer can specify the movement and speed of each robot limb. The robot cycle is a sequence of such movements which can be observed during the programming. In the play-back period the programmer can modify the sequence to get optimum cycle time and accuracy. When programming the operator may need to be very close to the driven robot which can create potential safety problems.

Off-Line Programming
In off-line programming the program uses a high level computer language such as VAL which gives the robot decision making power. This method needs a large amount of computing power and incorporates the use of sensors on the robot or within its environment to provide system status information. Typical input sensors could be of the position, vision and tactile types. Information from the sensors can allow the robot to take alternative action within its overall task cycle. Using off line programming the robot can make decisions such as counting a number of operations or perform one task until another is ready to be started. Robots which are off-line programmable are more useful in a production situation since they can be reprogrammed with a minimum of interference to the production process.

Evaluating the use of robotics in commercial situations

There are a wide range of uses of robotics in commercial industries today. Some of these uses include: -

Welding – robots can complete welding tasks to a standardised quality and at high speed, for example in the car industry.

Spray painting – the use of robot arms to complete painting tasks means there is standardised quality of work at a high speed. Often at a reduced cost. This can be particularly useful in situations where fumes can prove hazardous to humans.

Product Assembly – robots were first used to aid with the assembly of products which required repetitive actions due to their fast speed of operation and ability to work continually.

Product packing – robots are ideal for the packing and unpacking of large quantities onto pallets for storage or transportation due again to their high speed of operation, their ability to transport large quantities in one go and their ability to complete complex tasks to a standardised quality (folding of magazines and insertion of additional leaflets / mini magazines etc.)

Aerospace robots – robots are ideal for outer space exploration; scientists can collect the samples they require without putting themselves in danger.

Healthcare provision – robots are more currently being used to support surgery for example in remote areas, again with a high level of precision.

Robots versus humans

It has been claimed that cheaper, better robots will replace human workers in the world's factories at a faster pace over the next decade, pushing down manufacturing costs. One prediction is that that investment in industrial robots will grow 10% a year and this investment will pay off in lower costs and increased efficiency and robots are getting cheaper and they can do more things. Robots could only operate in predictable environments but newer robots can use improved sensors to react to the unexpected. Robots can be reprogrammed far faster and more efficiently than humans can be retrained when products are updated or replaced — a crucial advantage at a time when smart phones and other products quickly fade into obsolescence. However, as with any software, developing and testing a new program, or even a modification to an existing program, can be a long and complicated process. By contrast, a human operator could respond immediately to an instruction to change to a new task or way of operating, provided no additional training was required.

Advantages of Industrial Robots

1. Increased efficiency
Industrial robots are able to complete certain tasks faster and better than people, as they are designed to perform these tasks with a higher accuracy level.

This and the fact that they are used to automate processes which previously might have taken significantly more time and resources, means that you can often use industrial robots to increase the efficiency of your production line.

2. Higher quality
Due to their high accuracy levels, robots can also be used to produce higher quality products which adhere to certain standards of quality, whilst also reducing the time needed for quality control.

3. Improved working environment
Industrial robots are often used for performing tasks which are deemed as dangerous for humans, as well as being able to perform highly laborious and repetitive tasks. Overall, by using industrial robots you can improve the working conditions and safety in your factory or production plant. Robots don't get tired and make dangerous mistakes, neither do they suffer from repetitive strain injury.

4. Increased profitability
By increasing the efficiency of your production process, reducing the resource and time needed to complete it, and also achieving higher quality products, industrial robots can thus be used to achieve higher profitability levels overall, with lower cost per product.

5. Productivity
A robot can work 24/7, and keeps running at 100%. Typically if you replace one person on a key process in a production line with a robot the output increases by 40% in the same working hours.

Disadvantages of Industrial Robots

1. Capital cost
Whilst industrial robots can prove highly effective and bring you a positive Return on Investment (ROI) , implementing them might require a fairly high capital cost.

2. Expertise
Whilst industrial robots are excellent for performing many tasks, as with any other type of technology, they require more training and expertise to initially set up. The expertise of a good automation company with a support package will be very important.

3. Limitations
In recent years the number of industrial robots and the applications they can be used for has increased significantly. However, there still are some limitations in terms of the type of tasks they can perform. Often the success or failure of an industrial robotic system depends on how well the surrounding systems are integrated e.g. grippers, vision systems, conveyor systems and so on.