IGCSE 06 Automated and emerging technologies(1)

Advantage and disadvantage of automated systems

Application	Advantages of using robots in the application	Disadvantages of using robots in the application
Industry		
1. **Welding car bodies** and spray painting body panels. 2. Manufacturing **microchips** or **electrical goods.** 3. Makes use of end-effectors to do many **different tasks**. 4. Used in many **production facilities** (car manufacturing, bottling/ canning, testing circuit boards and so on).	1. Robots can work in **conditions that may be hazardous** to humans (noisy, dusty, chemicals and so on). 2. Robots can **work 24/7 with no breaks** except for occasional maintenance. 3. Using robots is **less expensive in the long run**. 4. Robots are usually **more productive** than humans. 5. In manufacturing, using robotics usually produces a **more consistent product**. 6. Robots are better suited to **boring and repetitive tasks**.	1. It can be difficult to get the robot to handle '**non-standard' tasks** without some human intervention. 2. Using robots can lead to **higher unemployment**. 3. **Risk of deskilling** since the robots take over tasks previously done by humans. 4. Factories can be moved overseas (advantage to company but a **disadvantage to the workforce**); it is relatively easy to dismantle robots and reassemble them in another country. 5. Robots are **expensive to buy** and set up initially.
Transport		
Autonomous cars, vans, buses, trams and trains.	1. **Safer** since human error is removed when operating vehicles. 2. **Better for the environment** since vehicles will operate more efficiently and energy consumption is minimised. 3. Leads to **less traffic congestion** as autonomous road vehicles can move more efficiently in cities and on motorways at busy times (due to increased lane capacity). 4. **Stress-free environment** for drivers and passengers. 5. Improves **punctuality and frequency of public transport**, such as buses, trams and trains. 6. **Reduction in running costs** (due to more efficient operation). 7. Easier to **alter** the bus, tram or train **schedule** at short notice (if some event makes this necessary).	1. Very **expensive to set up** in the first place (high technology requirements). 2. Needs **constant maintenance** to work effectively, securely and safely (cleaning of sensors and cameras). 3. Ensuring the **good behaviour of passengers** (especially at peak times) can lead to problems (for example, jamming doors, too many people trying to board at once and so on). 4. Need a good, reliable control system (for example, CCTV); this can be **expensive to maintain**. 5. **Emergency situations** may be difficult to deal with. 6. Driver and passenger **reluctance to use the new technology**.
Agriculture		
1. Harvesting. 2. Weed control (AI can distinguish between weed and crop). 3. Phenotyping – observing plant growth/health. 4. Seed planting and fertiliser spraying using drones. 5. Automatic fruit picking, grass mowing, pruning.	1. **More accurate** and less likely to damage crops/fruit. 2. Potentially higher yields since seeding, fertiliser application and so on is more efficient; leads to **optimum conditions for growth and health**. 3. **Less labour needed** (for example, automatic weeding, fruit picking and so on). 4. **Plant health monitored better**, and problems can be identified earlier and rectified. 5. **Less waste** of seeds, fertilisers and so on.	1. Expensive systems to set up initially and to maintain. 2. Risk of cybercriminal activity (such as hacking, viruses and so on). 3. Risk of deskilling, since key farming skills could be lost (over-reliance on technology).
Medicine		
1. Surgical procedures. 2. Monitoring patients. 3. Disinfecting rooms and operating theatres. 4. Taking blood samples. 5. Micro bots used in target therapy. 6. Prosthetic limbs are minirobots.	1. Operations can be **quicker and safer** to carry out (fewer errors will be made). 2. Leaves doctors/surgeons available to **do more complex surgery** and leaves nurses to do more skilled work. 3. Taking blood samples is **less painful** to the patient; nurses and doctors are not subjected to potentially hazardous blood samples (for example, some viruses are very contagious). 4. Target therapy causes **less damage to surrounding tissues**. 5. Prosthetic limbs can now mimic human limb movement **more precisely**.	1. Robotic surgery is very **expensive to set up and maintain**. 2. **Difficult to make sure robots are fully disinfected** before doing surgical work. 3. **Risk of cybercriminal activity** (for example, hacking and viruses). 4. **Reluctance by the general population** to robotic surgery. 5. The all-important **human factor is missing**.
Domestic robots		
1. Autonomous vacuum cleaners. 2. Autonomous grass cutters. 3. Personal assistants.	1. Leave people **free to do other** (more interesting) tasks. 2. **More than one** task can be completed at the same time. 3. Can be programmed to **work at a specific time** of the day. 4. Can be **operated remotely** (for example, using mobile phone app). 5. Can automatically empty the dust bag/grass bag and **automatically park** and connect to the mains supply to recharge internal batteries. 6. Allow **linking together of several devices** in the home and can also carry out certain useful tasks (for example, get flight information or weather forecasts for the next day). 7. Can be programmed to **turn on lights at random times** at night if a house is unoccupied thus helping with security (there are many such tasks).	1. **Expensive devices to buy** initially and require regular expert servicing (sensors and cameras need specialist technicians). 2. Unable to deal with **unusual circumstances** as well as a human (for example, a tree has fallen on the grass). 3. **Battery life can be short**. 4. Sometimes **can't reach into corners** where dust/long grass accumulates and requires human action. 5. **Takes much longer** to do the tasks (up to three times longer than doing hoovering or grass cutting manually). 6. Personal assistants could **make people lazy** rather than looking up for information themselves. 7. Personal assistants can be **annoying** if used frequently. 8. Digital assistants can be **hacked into remotely**; this can result in a breach of the user's privacy. 9. Digital assistants can **collect and process user's personal data** without their knowledge.
Entertainment		
1. Theme parks and arenas/ large venues (robotic characters are used to interact with visitors). 2. Film and TV industry (operate cameras, stunt actions, special effects).	1. Greater realism to theme park characters, **increasing entertainment factor**. 2. Music festivals can be **more immersive** (robot-controlled lighting and animation); effects can be synchronised with music. 3. **Control of cameras leads to better results** (smoother action and always correctly focused). 4. **Better and more realistic animation** and more effective cross-over with animation and actual actors.	1. **Very expensive system to set up** initially and to maintain. 2. **Risk of deskilling** since many of the tasks done by skilled humans are now done by robots (for example, camera work).

Automated systems

An automated system is a **combination of hardware and software** that is designed and programmed to **work automatically without the need for any human** intervention.

Advantage and disadvantage of automated systems

Advantages of automated systems	Disadvantages of automated systems
1. Faster than humans taking any necessary action. 2. Safer if automated system is part of a hazardous system. 3. System is more likely to run under optimum conditions. 4. Less expensive in the long run/more energy efficient. 5. Can be a more effective use of materials and resources.	1. Often expensive to set up and purchase initially. 2. There is always the possibility for a set of conditions to occur which weren't considered during the development stage. 3. The constant fear of cyberattacks (hacking, viruses, and so on). 4. Automated systems need enhanced maintenance to operate correctly; this

Robotics

Robotics is a branch of (computer) science that **brings together the design, construction and operation of robots**.

Factories robots uses:
1. welding metal parts in a factory (car body panels)
2. spray painting panels
3. laser cutting of patterns (for example, in metal, plastic, leather) with a high precision and very little waste
4. bottling and canning in the food and drinks industry
5. warehouse logistics (for example, location of items and loading onto correct lorry).

Home robots uses:
1. autonomous **floor sweepers**
2. autonomous **lawn mowers**
3. automatic **window cleaning**
4. in **home entertainment** ('friend' robots).

Drones robots uses:
1. **reconnaissance** (for example, aerial photography)
2. **parcel deliveries** (particularly in busy cities)
3. **flying in dangerous areas** where there is a danger to human life (for example, carrying out a survey following a hazardous chemical spillage or nuclear incident).

Characteristics of a robot
1. **a mechanical structure or framework**
    1. Use sensors and cameras as input to the robot.
    2. Use sensors to recognise the immediate environment by building up a 3D picture to determine the size, shape and weight of an object, for example.
    3. All sensor data is sent to a microprocessor or computer.
2. **electrical components**, such as sensors, microprocessors and actuators
    1. Use of wheels, cogs, pistons, gears and so on, to carry out functions such as turning, twisting, moving backwards/forwards and gripping or lifting.
    2. Mechanical structures made up of motors, hydraulic pipes, actuators and circuit boards.
    3. Contain many electrical components.
    4. Able to use end-effectors – different attachments to carry out a number of tasks.
3. **programmable**
    1. Have a controller that determines the actions that need to be taken to carry out a task automatically.
    2. Controllers are programmable so that the robot can be 'trained' to do various tasks.

Artificial Intelligence(AI)

Artificial intelligence (AI) is a branch of computer science dealing with the simulation of intelligent human behaviour by a computer.

Three categories of AI
1. **Narrow AI**: a machine has superior performance to a human in one specific task.
2. **General AI**: a machine is similar, but not superior, in its performance in doing one specific task.
3. **Strong AI**: a machine has superior performance to humans in many tasks.

Examples of AI include:
1. news generation based on live news feeds
2. smart home devices/assistants (such as Amazon Alexa or Apple Siri)
3. use of chatbots that interact through instant messaging
4. autonomous vehicles
5. facial expression recognition.

Expert System:
Expert systems are a form of AI developed to **mimic human knowledge and experience**. They use knowledge and inference to solve problems by analysing responses to a series of questions thus mimicking a human expert.
Expert systems have **a knowledge base**, **a rule base**, **an inference engine** and **an interface**

Setting up an expert system
1. Information needs to be gathered from human experts or from written sources such as textbooks, research papers or the internet.
2. Information gathered is used to populate the knowledge base which needs to be first created.
3. A rules base needs to be created; this is made up of a series of inference rules so that the inference engine can draw conclusions.
4. The inference engine itself needs to be set up; it is a complex system since it is the main processing element making reasoned conclusions from data in the knowledge base.
5. The user interface needs to be developed to allow user and expert system to communicate.
6. Once the system is set up, it needs to be fully tested; this is done by running the system with known outcomes so that results can be compared and any changes to the expert system made.

Machine learning
Machine learning is a subset of AI where algorithms are **'trained' and learn from their past experiences**.
Machine learning is when a program has the ability to **automatically adapt its own processes and/or data**