

# IG CS Chapter 6.1-6.3 Automation and Robotics

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created by HardyWen

## Automated Systems

- an **automated system** performs actions **without human interactions**
- it is used in **small systems**
  - such as controlling the street light

## Features of automated systems

### 1. Sensors

- a type of **input device** that is used to **capture data from its immediate environment**
- used in automated systems **to measure the environment**
- sensors read **analogue data** (real-world data such as 23.5 °C)
  - continuous data that can be any value within a range
  - so we need an ADC when transferring the data to the microprocessor

### 2. Microprocessors

- an **integrated circuit** that **can perform many functions of a CPU**
- used in automated systems **to process the data from the sensors and determine if an action needs to be taken**
- microprocessors can only understand **binary data** (such as 01001011)
  - discrete data that is stored as 1s and 0s

### 3. Actuators

- a **mechanical part** that **causes another device or part to move**
- actuators understand **analogue data**
  - so we need an DAC when transferring the data from the microprocessor

### 4. ADCs and DACs

- **Analogue-to-Digital Converters (ADCs)**
  - transforms **analogue data** into **digital data**
  - used in an automated system to **transform the analogue data from the sensor to digital data that the microprocessor can understand and process**
- **Digital-to-Analogue Converters (DACs)**
  - transforms **digital data** into **analogue data**
  - used in an automated system to **transform the digital data from the microprocessor to analogue data that actuators can understand and execute**

## Classic Question

A cold store is kept at a constant low temperature using a sensor, a microprocessor, and a cooling unit. explain how the sensor and microprocessor will maintain a constant low temperature. [6]

### First thoughts

- what sensors are needed in this system?
- what outputs are needed in this system?
- what is the condition of this system?
- remember to include sensors -> ADC -> microprocessor -> comparison -> DAC -> output

### Detailed explanation

1. the temperature sensor **constantly** reads the temperature in the cold store
  - sensors input
2. the **analogue data from the sensor** is sent to the **ADC**, which converts the analogue data into digital data
  - ADC converts
3. the **digital data** is sent to the **microprocessor**
  - microprocessor receives
4. the microprocessor **compares** the incoming data with the stored or **pre-set value**
  - comparing the condition set
5. if the data is within the range or matches the stored value then, no action is taken, and the process continues
  - if not met, nothing happens
6. if the data is outside the range, then the microprocessor will send a signal to the **actuator** via a **DAC**, which converts digital data into analogue data, to activate the actuator to turn on the cooling unit
  - if the condition is met, send a signal to the actuator via DAC
7. the whole process **continues** to ensure that the cold store is kept at a constant low temperature
  - looping

## Evaluating an automated system

- just like an *economics* question...
- **The evaluation includes**
  - **initial cost**
    - the price for setting up the machines is always high
  - **running cost**
    - would be high because systems need maintenance
    - but more efficient than humans
    - save money in the long-run
      - just as *capital intensive v.s. labour intensive*

- **safety**
  - an automated system can monitor the surroundings and stop then there is a danger
  - but human labours may be distracted
- **replacing people's jobs**
  - jobs that the system now performs will be lost
    - primarily those stream-lined workers
  - more jobs are made to maintain the system
    - so high-skilled workers are benefited
- **continuous work all day every day**
  - so more can be produced
- **precision**
  - human errors will be avoided

## Robotics

- a **robot** is a **mechanical device** that **performs an action**, usually an action that **a human would perform**
  - a machine that replicates human actions or movement
- **robotics** is n area that looks at the **creation and use of robots**

## Features of robots

- **A mechanical structure or framework**
  - this is the body of a robot
- **Electrical components**
  - **sensors**
    - to record its environment
  - **microprocessors**
    - to take the reading from the sensor and decide the action to perform
  - **actuators**
    - to make the robot move
- **Programmable**
  - a program that can be written for the robot to follow

## Robots in context

### 1. Robots in medicine

- robot nurses that can move around a hospital to visit and interact with patients 护士机器人
- to perform procedures such as operations 手术机器人

- **potential harm**

- if any errors occur or the robots are hacked -> 被黑了之后做手术直接给病人开错刀了 (。

## 2. Robots in agriculture

- automated tractors 自动除草机、耕地机、blablabla
  - they can make use of satellites and satellite navigation to guide their movements
- robots that plant seeds remove weeds...
  - just **any repetitive tasks** that you can think of can be done by robots in agriculture
  - 一切你能想到重复化的工作机器人都能做

## 3. Robots in transport

- self-driving car 自动驾驶汽车
  - yes, it is a robot...
- robots that transport items in factories 传输机器人

## 4. Robots in industry

- industry is the **manufacture of goods from raw materials**
- robots can be used to
  - produce items (like cars) 机械臂 (可以看看特斯拉的工厂)
  - manage the packing of items
    - just **any repetitive tasks** that you can think of can be done by robots in a factory
  - test products
    - such as checking the temperature of each product produced
  - perform tasks that are **minute in size** and require **exact precision**
    - such as the building of circuits

## 5. Robots in entertainment

- robot dogs 机械狗
- drones 无人机
- educational robots 教育机器人 (e.g. 乐高EV3)
  - children can build a robot and then program it to perform a specific action

## 6. Robots in domestic

- domestic robots are those that **perform tasks around a home**
- vacuum cleaner 扫地机
- robot lawnmower 割草机