

IG CS Chapter 6.1-6.3 Automation and Robotics

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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