Tishk International University
Science Faculty
IT Department

Introduction to IoT

Lecture 02: IoT Hardware and Devices

4th Grade - Spring Semester

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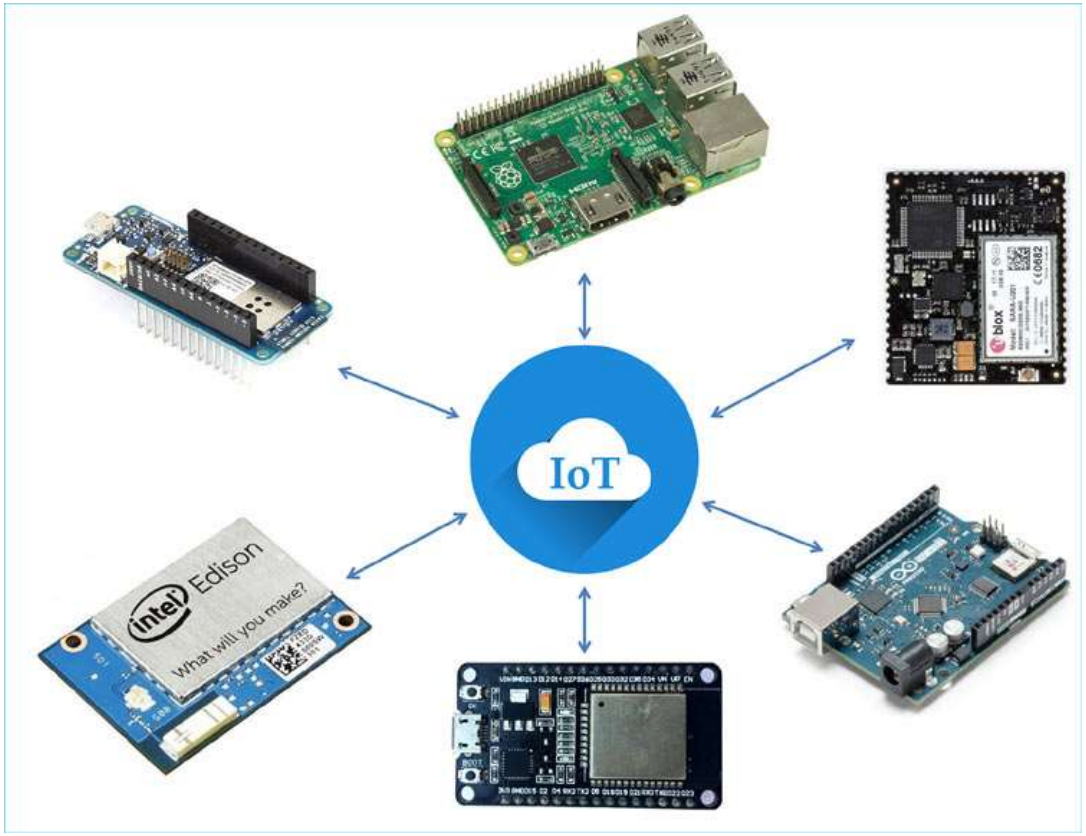
Lecture 2
IoT Hardware and Devices



Lecture Topics

1. IoT Hardware Overview
2. Sensors
3. Actuators
4. IoT Power Sources
5. Microcontrollers/Embedded Systems

1. IoT Hardware Overview

- **IoT Hardware:** are the actual physical things that make IoT possible. We'll discover the different types of devices, sensors, and other components that collect information and make things happen in the IoT world.

Why Learn About IoT Hardware?

Understanding the different devices and components will help you in:

- Build Basic Knowledge: Knowing what tools are available lets us design and create our own IoT gadgets.
- Solve Problems: We can use our knowledge to find clever ways to use IoT to make our lives easier and better.
- Become an IoT Expert: Understanding the hardware is the first step to acquire knowledge about one of the main hot topics in IT world
- Think like an Inventor: Knowing what's possible to integrate as hardware component inspires you to come up with new and exciting IoT inventions."

2. Sensors

- IoT sensors converts physical information about the environment into digital signals.
- Sensors are divided into two types:
  - ❖ Active. They work only if they are powered by a power source.
  - ❖ Passive. They measure changes in the environment without additional power supply (example: IoT temperature sensors)

Ultrasonic Sensor IR optical Sensor LDR Sensor Gas Sensor

Sensors

- **Temperature sensors**: collect information about the temperature of an object or environment. These sensors are common and are used everywhere in the home and industry.
- **Humidity/ Moisture sensors**: monitor measurements of moisture levels in the environment. It detects changes by sending electronic signals to the surface, which it converts into a digital signal.
- **Fire detection sensors**: are used to detect ignition or smoke in a room so this signal can be used to activate a fire extinguishing system or call for civil defense services.
- **Light sensors**: are photosensitive elements that are used to detect the source of the visible color spectrum. These sensors are used in street lighting, indoor lighting, and automatic day lighting in automobiles.

Sensors

- **Proximity sensors:** determine the distance to an object or a person. Such sensors are used in almost all spheres. For example, they activate video cameras, turn on lighting, simplify parking, and activate security systems. They are divided into infrared sensors, ultrasonic sensors, optical sensors, and Light Detection and Ranging (LIDAR).
- **Gas detection sensors:** are used to detect gas in the environment. This helps detect potentially dangerous gases for humans indoors or outdoors to prevent accidents. As an example, hydrogen sulfide, a gas that is not detected in time, causes a violent explosion when burned.
- **Patient condition monitoring sensors:** Wearable sensors are used to collect data on the patient's organizational status and use wireless (wired) technology to exchange data. The work of health care professionals is greatly simplified because they receive data on all patients from their work computer

3. Actuators

IoT Actuators convert electrical impulses into physical actions or objects.

- **Hydraulic:** converts hydraulic power to perform mechanical functions and operations.

- **Pneumatic:** are powered by a vacuum or compressed air at high pressure to implement the required type of motion.

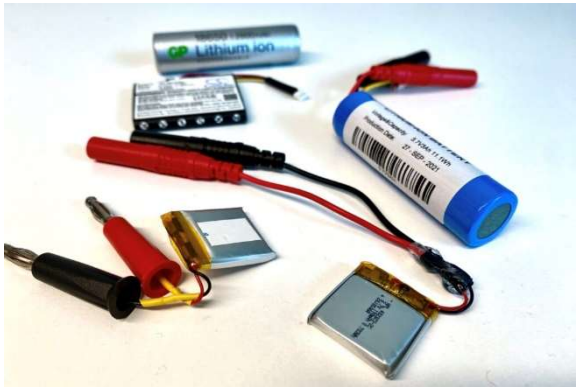
- **Electrical:** are motors that convert electrical energy into mechanical motion.

- **Thermal**: have thermal-sensitive material fitted inside, which is used to produce linear motion.

4. IoT Power Sources

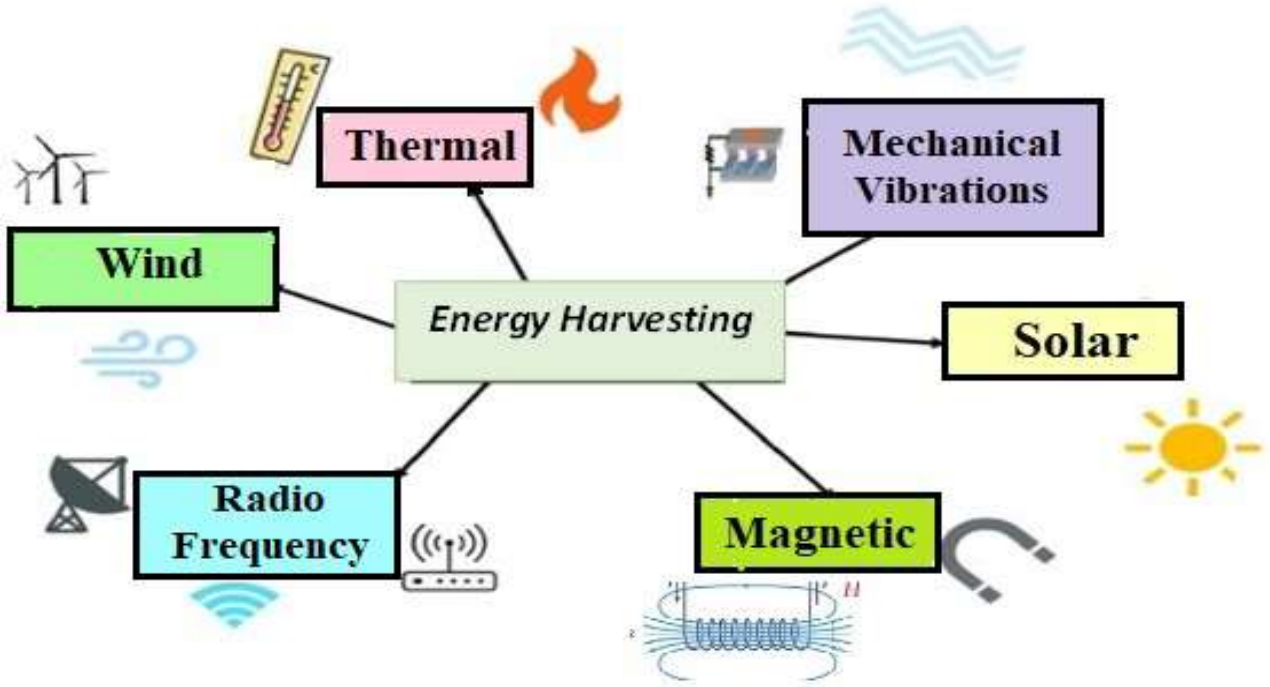
- Despite the many differences, there is one common requirement for all device systems. They must have power (energy or electricity) to operate. There are three common options to power an IoT device:

- Mains Electricity: Home automation applications, such as connected light bulbs, can draw energy from existing wiring in the home. Industrial applications are often fixed-location devices, hardwired to a power grid.
- Batteries: Found in everything from wearables to tools, batteries are a common solution for portable IoT devices. The application will determine if it makes sense to use rechargeable or one-time use (primary) batteries.



IoT Power Sources

- Harvesting (Renewable Sources): are converting energy from ambient forms into electricity.
  - Solar cells: converting light to electricity, are most common.
  - Air and fluid flow
  - Heat, motion, RF and chemical energy.



5. IoT Microcontrollers and Microcomputers

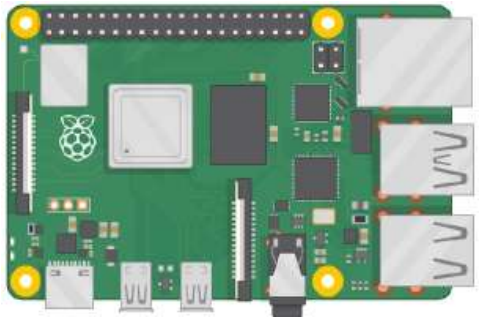
Microcontrollers and microcomputers play a crucial role in enabling IoT functionality by acting as the brains of smart devices. They collect data from sensors, process it, and communicate with other devices or cloud services. Microcontrollers are ideal for simple, low-power tasks, while microcomputers handle more complex processing and multitasking in IoT systems.

- A microcontroller is a microchip or board with a microchip for solving IoT projects' client parts. Usually, you can program microcontrollers with a high-level programming language, like C, C++, Python, etc. Some projects in IoT are easiest to solve on microcontrollers.
- A microcomputer is usually a system on a chip, including classical von Neuman architecture with a central processor(s), video card, RAM memory, WiFI/Bluetooth networks, and input-output ports. Modern microcomputers use operating systems like Linux and Windows. Usually, microcomputers have more computation power than microcontrollers, video output to HDMI, high-speed WiFi and Bluetooth, connection to flash memory cards

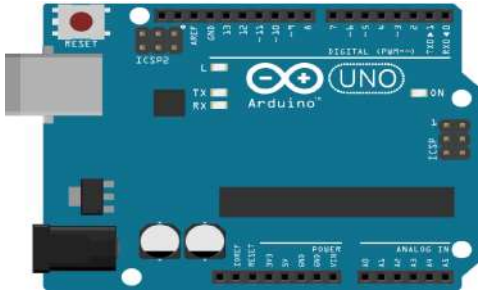
Raspberry Pi vs. Arduino

- Raspberry PI is a Microcomputer
- It has an ordinary Operating System (Linux)
- You can connect USB devices, Keyboard, Mouse, Monitors, etc.
- It has a “hard-drive“ in form of a microSD card
- It has Bluetooth, Wi-Fi, and Ethernet connection
- It has video out (HDMI)
- Ram from 1 to 8 GB
- Much more expensive than Arduino

- Arduino is a Microcontroller
- Arduino has a Bootloader and not an ordinary operating system
- Arduino is NOT a computer, only a small controller, whose purpose is to control things
- No Bluetooth, Wi-Fi or Ethernet (but can be provided with Shields)
- Very little RAM (a few KB)
- Inexpensive
- Arduino (UNO) has also Analog Input Pins

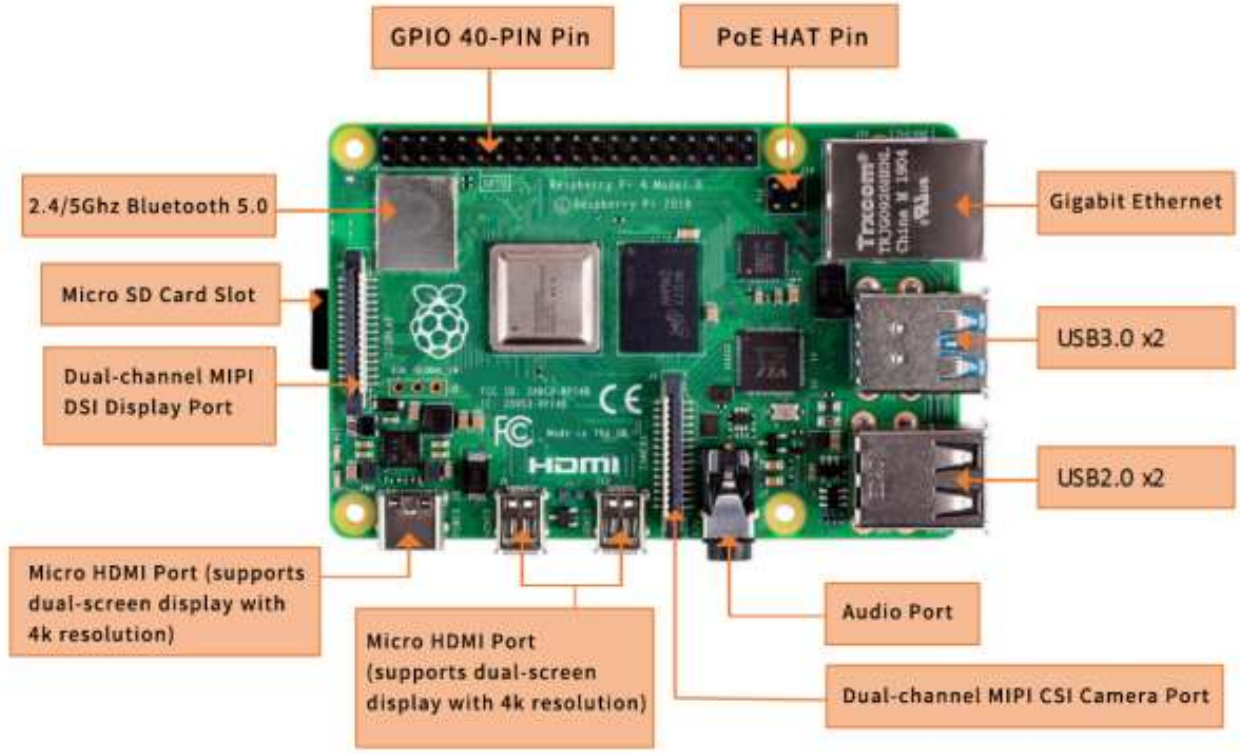


- Both have Digital Pins
- Both have SPI and I2C



Raspberry Pi Overview

- Raspberry Pi is a tiny single-board computer that supports embedded Linux operating systems
- The recommended Operating System is called Raspberry Pi OS (Linux based)



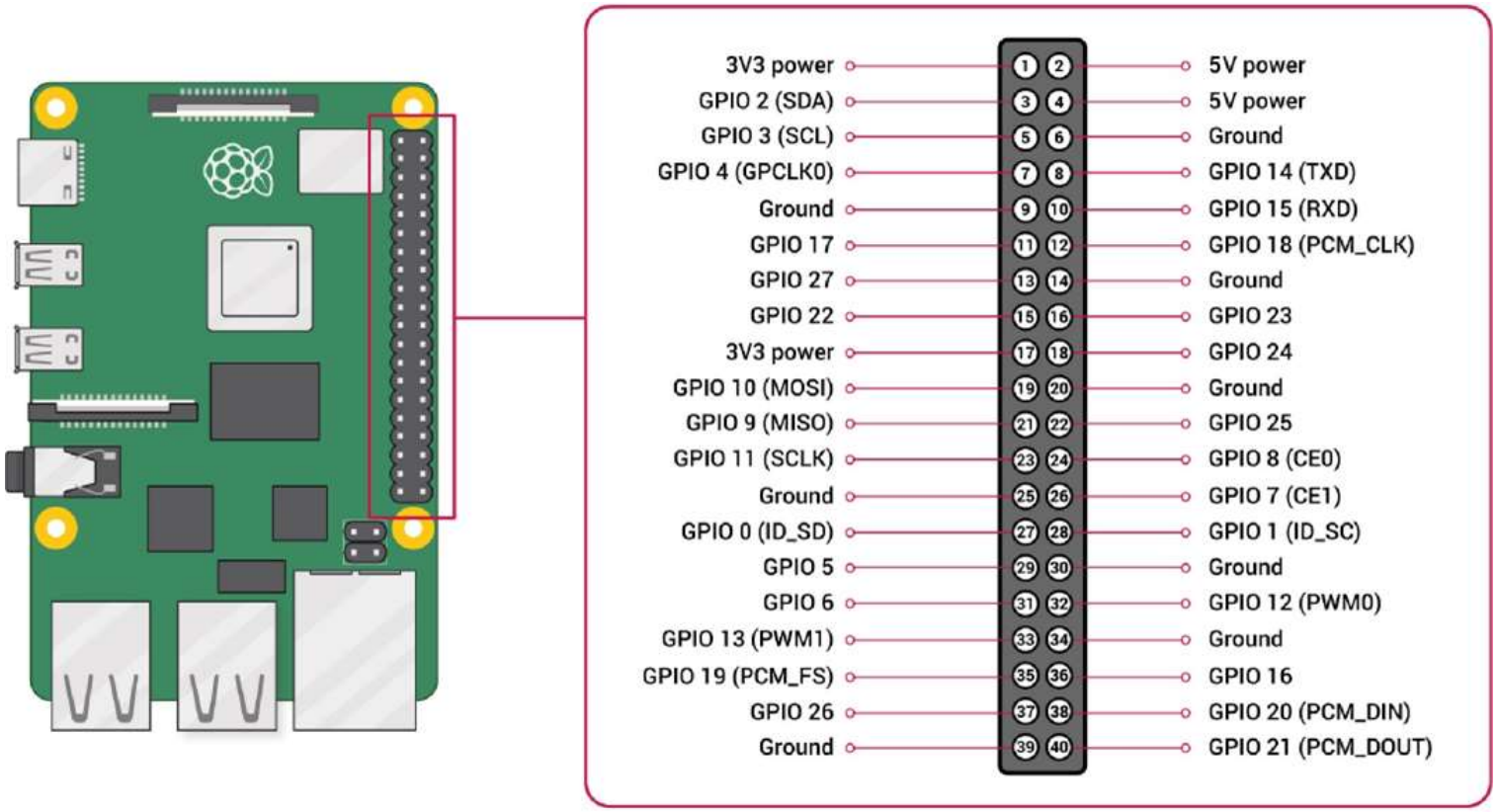
Raspberry Pi OS

The procedures to install the necessary OS are:

- Connect a microSD card to the laptop
- Use the “Raspberry Pi Imager“ in order to download the OS to the microSD card.
- Put the microSD card into the Raspberry Pi
- Connect Monitor, Mouse and Keyboard
- Connect Power Supply
- Follow the Instructions on Screen to Setup WiFi

Raspberry Pi GPIO

- A powerful feature of the Raspberry Pi is the GPIO (general-purpose input/output) pins.
- The Raspberry Pi has a 40-pin GPIO header as seen in the image



Raspberry Pi and Python

The Raspberry Pi OS comes with a basic Python Editor called Thonny

- Raspberry Pi + Python are a powerful combination!
- Below is LED Example: Python code, Setup and Wiring