PRACTICAL-10

AIM

AICTE Project Demo and hardware study of Waspmote, Libellium Gateway, Zigbee module and various water sensors.

THEORY

Waspmote:

- Waspmote hardware architecture has been specially designed to work with extremely low consumption. Digital switches allow to turn on and off any of the sensor interfaces as well as the radio modules. Three different sleep modes make Waspmote the lowest consumption IoT platform in the market (7 µA).

- Features
  - Ultra low power (7µA)
  - 120+ sensors integrated on 8 Sensor Boards
  - 15 radio technologies:
  - Long range: 4G/NB-IoT/Cat-M/LoRaWAN/LoRa/Sigfox/ 868 MHz / 900 MHz
  - Medium range: ZigBee 3 / 802.15.4 / DigiMesh / WiFi
  - Short range: RFID-NFC / Bluetooth 2.1 / BLE
  - Over the Air Programming (OTA)
  - Open source SDK and API
  - Encryption libraries (AES, RSA, MD5, SHA Hash)
  - Certified encapsulated line (Plug & Sense!)
  - Industrial Protocols: RS-485, Modbus, CAN Bus, 4-20 mA

Libellium gateway:

- Meshlium is the IoT Gateway to connect any sensor to any cloud platform.

- Meshlium is the most recommended option for outdoor networks since it is encased in a rugged, waterproof enclosure which protects it from the harshest conditions.

- It can receive, parse and store frames in its local database. Meshlium can also forward sensor data directly to the Internet via Ethernet or GPRS/4G protocols, depending on the connectivity options available in the area.
- Meshlium is the best Internet Gateway for Waspmote and Plug&Sense devices. It is a Linux-based router, totally modular and specially designed for harsh conditions without compromising flexibility in the installation. Meshlium can directly send sensor data from Waspmote to many 3rd party Cloud platforms.

- Any scenario
- Fast configuration
- Easy installation
- Easy maintenance
- Fully certified

ZigBee module:

- Zigbee is a low-cost, low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications.
- Zigbee delivers low-latency communication.
- Zigbee chips are typically integrated with radios and with microcontrollers.
- Zigbee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; though some devices also use 784 MHz in China, 868 MHz in Europe and 915 MHz in the US and Australia, however even those regions and countries still use 2.4 GHz for most commercial Zigbee devices for home use.
- Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).
- Zigbee builds on the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate wireless personal area networks (WPANs).
- The specification includes four additional key components: network layer, application layer, Zigbee Device Objects (ZDOs) and manufacturer-defined application objects.
- ZDOs are responsible for some tasks, including keeping track of device roles, managing requests to join a network, as well as device discovery and security.
- The Zigbee network layer natively supports both star and tree networks, and generic mesh networking.
- Every network must have one coordinator device. Within star networks, the coordinator must be the central node.
- Both trees and meshes allow the use of Zigbee routers to extend communication at the network level.
- It builds on the basic security framework defined in IEEE 802.15.4.
- Zigbee protocols are intended for embedded applications requiring low power consumption and tolerating low data rates.

- The resulting network will use very little power—individual devices must have a battery life of at least two years to pass certification.

- Typical application areas include:

    - Home automation
    - Wireless sensor networks
    - Industrial control systems
    - Embedded sensing
    - Medical data collection
    - Smoke and intruder warning
    - Building automation
    - Remote wireless microphone configuration

- Zigbee is not for situations with high mobility among nodes. Hence, it is not suitable for tactical ad hoc radio networks in the battlefield, where high data rate and high mobility is present and needed.

Water Sensors:

A water sensor is a device used in the detection of the water level for various applications. Water sensors can come in several variations that include ultrasonic sensors, pressure transducers, bubblers, and float sensors.

- **Chlorine residual sensor:**

    - Free chlorine is the most important disinfectant in water treatment due to its easy handling and strong disinfecting effect. Free chlorine sensors are applied in:

        - Drinking water - to ensure sufficient disinfection
        - Food - to provide hygienic bottling and packaging
        - Pool water - to dose disinfectant efficiently

    - Chlorine dioxide is more and more becoming a disinfectant of choice since it is less corrosive and independent from the pH value. Chlorine dioxide sensors are applied in:

        - Cooling systems or towers
        - Drinking water
        - Wash water for packed vegetables
        - Desalination plants to prevent ClO2 from disturbing reverse osmosis

    - Total chlorine is a good indicator of residual disinfectants in discharge water. The sensors are used in WWTPs:

        - To measure the effluent water's disinfection status
        - To control reuse of water

- Sensors for chlorine dioxide measurement feature a working electrode, which is separated from the medium by a thin membrane.
- Chlorine dioxide coming from the medium diffuses through this membrane and is reduced at the working electrode.
- The circuit is completed by means of the counter electrode and the electrolyte.
- The electron reduction at the working electrode is proportional to the concentration of chlorine dioxide in the medium.
- This process works in a wide pH and temperature range.

- **Toc sensor:**
  - TOC refers to a Total Organic Carbon analyzer, which utilizes a catalytic oxidation combustion technique at high temperature (the temperature raises up to 720 ºC), to convert organic carbon into CO2.
  - The CO2 generated by oxidation is measured with a Non-dispersive Infra-Red (NDIR) sensor.
  - By using special kits and (dilution) methods the device can be applied to determine the carbon concentration over an extremely broad range (theoretically from 4µg/L to 30 000mg/L), from pure drinking water to sea water with sludge.
  - In addition, it is possible to indirectly determine the fraction of IC (= "inorganic carbon") arising from dissolved CO2 and acid salts containing carbon.
- **Turbidity Sensor:**
  - Global Water's Turbidity Sensor is a highly accurate submersible instrument for in-situ environmental or process monitoring.
  - Applications for the turbidity sensors include: water quality testing and management, river monitoring, stream measurement, reservoir water quality testing, groundwater testing, water and wastewater treatment, and effluent and industrial control.
  - In accordance with USEPA Method 180.1 for turbidity measurement, the Turbidity Sensors are a 90 degree scatter nephelometer.
  - The turbidity sensor directs a focused beam into the monitored water. The light beam reflects off particles in the water, and the resultant light intensity is measured by the turbidity sensor's photodetector positioned at 90 degrees to the light beam.

- The light intensity detected by the turbidity sensor is directly proportional to the turbidity of the water.
- The turbidity sensors utilize a second light detector to correct for light intensity variations, color changes, and minor lens fouling.
- For environmental or process monitoring, simply place the turbidity sensor directly in the water and position it where the turbidity is to be monitored.
- Since the turbidity sensor uses light to detect the water's turbidity ensure that the minimum amount of external light possible is exposed to the monitoring site.

- **Conductivity Sensor:**

  There are two basic sensor styles used for measuring Conductivity: Contacting and Inductive (Toroidal, Electrodeless).

  - When Contacting Sensors are used, the conductivity is measured by applying an alternating electrical current to the sensor electrodes (that together make up the cell constant) immersed in a solution and measuring the resulting voltage. The solution acts as the electrical conductor between the sensor electrodes.
  - With Inductive (also called Toroidal or Electrodeless), the sensing elements (electrode colis) of an inductive sensro do not come in direct contact with the process. These two matched (identical coils) are encapsulated in PEEK (or Teflon) protecting them from the adverse effects of the process.

- **PH sensor:**

  - A pH sensor is one of the most essential tools that’s typically used for water measurements.
  - This type of sensor is able to measure the amount of alkalinity and acidity in water and other solutions.
  - When used correctly, pH sensors are able to ensure the safety and quality of a product and the processes that occur within a wastewater or manufacturing plant.
  - In most cases, the standard pH scale is represented by a value that can range from 0-14.
  - When a substance has a pH value of seven, this is considered to be neutral.

- Substances with a pH value above seven represent higher amounts of alkalinity whereas substances with a pH value that's lower than seven are believed to be more acidic.

- For instance, toothpaste typically comes with a pH value of 8-9. On the other hand, stomach acid has a pH value of two.

- The difference between an alkaline substance and an acidic substance is very important for any company that uses a cooling tower, boiler, manufacturing processes, swimming pool control, and various types of environmental monitoring.

- The human body has a standard pH level of 7.4, which is essential for the body to run effectively. If the composition of the body every becomes too acidic or overly alkaline, it will look to return to the neutral state.

- **Orp sensor:**
  - Oxidation-Reduction Potential (ORP) sensors measure the ability of a solution to act as an oxidizing or reducing agent.

  - To achieve accurate results, the correct combination of reference system, junction and shape are important. METTLER TOLEDO offers ORP sensors with smooth metal surfaces and unique reference junctions to ensure dependable measurements, even in dirty samples.

CONCLUSION

In this practical, we learned about different hardware like Waspmote, Libellium module and for communication Zigbee module. We also learned about various water sensors.