COURSE 10

IoT FOR AI

Co-funded by the European Union

Study load: 6 credits
Total studytime: 150 hours

EU-Partner(s): HOWEST, AP
TC-Partner(s): MUK, MUNI, ARU, KIST

PREREQUISITES

- Basic knowledge on
  - datacommunication,
  - databases,
  - electronics (current, voltage, resistance, power),
  - Linux,
  - C++

STUDY MATERIALS

- Course material
  - Presentations
  - Lab assignments
- Moodle learning management system
- Knowledge clips

TECHNICAL REQUIREMENTS / LAB EQUIPMENT

For the sensor nodes

- ESP32 modules for WiFi communication

- Arduino MKR 1300 for LoRaWAN communication
- Rich sensor kits
- Rich actuator kits
    - including MOSFET, relay, optocoupler for heavy loads

For the backend

- Server
    - RPi as server
    - Private cloud @ RENU
    - Local server
- MicroTik WiFi router
- MicroTik WiFi router with SIM for 3G/4G
- LoRaWAN gateway

LEARNING OUTCOMES

This course will allow IT students to gain an insight in how an IoT infrastructure can be built, and how to deploy IoT sensors in the field to gather data on a central database. This data can then be used for Data Science and AI purposes.

The IoT infrastructure is built gradually from setting up sensor nodes in the field to setting up the cloud back-end, to transferring the data in the cloud, and visualising the captured data with some standard tools, without going too deep into electronic hardware or microcontrollers.

For communication with the cloud we use WiFi for indoor and LoRaWAN for outdoor captruing of sensor data.

This course starts by getting the student some experience in interfacing with a microcontroller and in creating embedded applications that have a hardware and software component.

This is achieved by using an Arduino or ESP32 microcontroller module with some IoT sensors and actuators. The students will learn to do basic interfacing with the microcontroller module, to use UART for communication, to read and write analog values, to communicate with sensors through I^2C, SPI and to drive heavy loads.

A final part is on how to communicate over WiFi or over LoRaWAN to send data to the cloud.

The second part of the course is about Devops for IoT. This part will discuss the needed elements, what they are and why they are used. The usage of Docker is also explained, as a means for professional, straightforward and standardized deployment of the IoT backend. Finally the different software tools in the backend are explained and operationalized:

- MQTT-server
- Node-Red
- InfluxDB database
- Grafana visualization

The embedded applications communicate using the MQTT protocol, a broker protocol for sending its data to an local broker (on premises). The Mosquitto broker is installed on a Raspberry Pi. The student is able to debug his/her app by using some standard MQTT client tools. The student is also capable of sending a message to the Mosquitto broker and activate e.g. a LED connected to the Arduino or ESP32. Two-way communication should be available.

The students also learn storing the captured IoT data and visualizing it. On the central broker machine, InfluxDB is installed as a Docker container. InfluxDB is a timeseries database, which can take a heavy load of transactions, storing and representing data in a timely way.

The student installs the Grafana software next to InfluxDB, sharing the same Docker network. Grafana offers much more visualization features and supports a lot of other databases to collect and show data by installing extra plugins.

The last step is getting the whole system together in a small IoT project, with a use-case from the local context.

After finishing this course students are able to:

- explain how an IoT infrastructure is built
    - IoT client devices
    - Interfacing with various sensors
    - Interfacing with various communication protocols
    - MQTT as communication protocol
    - Securing MQTT

        - Debugging MQTT
        - Timeseries database
        - Visualization tools

    - interface with sensors
    - interface with actuators
    - deploy standard software as a Docker container

    - deploy an IoT application as a Docker container
    - explain the purpose and criteria of choosing a communication technology
    - build an IoT application from sensor to cloud and visualization of life data

ACTIVITIES

- Activating lectures
- Labs

CONTENT

- Interfacing in the Arduino ecosystem (6 weeks)
    - Read button / write led
        - Basic / interrupt
    - UART
        - User feedback / debugging
        - Sensors – devices on UART
        - Soft serial
    - Read / write analog
    - Read / write I2C
    - Read /write SPI
    - Drive heavy loads (home installation – motors - …)
- Devops for IoT (5 weeks)
    - Setting up the IoT back end
    - Elements
        - What is each element?
        - How to deploy / operationalize?
            - Docker

    - Server
    - MQTT-server
    - Node-Red
    - Database
    - Visualization
- IoT project – local context (4 weeks)

EVALUATION

First exam chance

FORM	%	REMARK
Exam	40.00	Theory
Exam	60.00	Lab exercises & project

Second exam chance (re-sit exam)

FORM	%	REMARK
Exam	40.00	Theory
Exam	60.00	Lab exercises & project