Universidad Zaragoza

Academic Year/course: 2024/25

67246 - Electronic sensor networks

Syllabus Information

Academic year: 2024/25
Subject: 67246 - Electronic sensor networks
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 622 - Master's in Electronic Engineering
ECTS: 6.0
Year: 1
Semester: Second semester
Subject type: Optional
Module:

1. General information

Interaction with the context awareness environment is key within the scope of intelligent environments and the Internet of Things. In this aspect, knowledge of the technologies used to implement embedded electronic devices as well as the fundamentals of sensor networks for application in intelligent environments is of great importance.
This knowledge will allow the student to design and develop electronic devices that can be integrated in intelligent environments and capable of monitoring the user and the environment.

The objective of the subject is to train the student in the fundamentals of electronic design of sensor networks, as well as to become familiar with the appropriate laboratory instruments and some practical applications.

- Sensor networks, their applications, relationship with ambient intelligence and Internet of Things.
- International standards and protocols for sensor networks.
- Electronic design of sensor nodes
- Design of embedded intelligence in smart sensors

2. Learning results

Smart sensor networks are key in the field of smart environments and the Internet of Things. Its usefulness focuses not only on the ability to automate and adapt to the environment, but also on improving aspects related to energy consumption. In this aspect, knowledge of the technologies used and the emerging ones in order to implement electronic devices, sensors and actuators is of great importance. Specifically, the results are:

- To know the fundamentals of sensor networks for application in intelligent environments.
- To know the main international standards and protocols used in wireless sensor networks.
- To understand the energy implications associated with sensor networks.
- To understand the implications for the design of artificial intelligence in intelligent sensors.
- To continue acquiring autonomously new technical knowledge related to sensor networks.

3. Syllabus

Theoretical program:

- Presentation of the subject and assessment
- Introduction to IoT
    - Applications and implications
    - IoT architecture and components
- How to make a critical state of the art
- Introduction to sensor networks
    - ISO-OSI layers. Physical layer. MAC Layer
    - Network topology. Synchronization. Routing. Security
    - Standard protocols in sensor networks. PAN (BLE)-LAN (ZigBee, WIFI, 6LowPAN)-LPWAN (Lora, SigFox, NBIOT)
    - Data management. Coding-Interoperability.
- Electronic design of an intelligent sensor node
    - Energy storage and management.
    - Hardware architecture and component selection.
    - Firmware architecture. Real-time operating systems.
- Design of the intelligence of a smart sensor node
    - Firmware architecture. Layers of data processing in embedded system.

- Intelligence design methodology. Experiment design, data collection and algorithm development.
- Implementation and evaluation of the algorithm.

Practical program:

- Communication, management and representation of sensor data with Python.
- ESP32 as a rapid prototyping platform for sensors. TIMER. I/Os. UART. ADC. Interruptions. Serial buses (I2C and
- SPI). Reading sensor data
- WIFI communications from microcontroller. IP Stack and data upload to the cloud.
- BLE and Bluetooth communications.
- Lora Communications and LoraWAN.

4. Academic activities

Master class and problems (25 hours): In this activity the fundamental contents of the subject will be explained and a set of representative problems will be performed. This activity will be carried out in the classroom. The materials to be presented in the master classes will be available to students through the Digital Teaching Ring (Anillo Digital Docente).

Laboratory practices (25 hours): The practices are structured in 6 tasks. The practical exercises will be available to the students in the Digital Teaching Ring (Anillo Digital Docente).

Study and independent work (94 hours): This activity includes both personal study aimed at achieving the adequate follow-up of the subject, preparing laboratory sessions, research work assignments and tutorials.

Assessment tests (6 hours): the evaluation activity comprises the presentation of the research paper and article.

5. Assessment system

The student must demonstrate achievement of the intended learning results through the following assessment activities:

E1 Attendance and evaluation of theoretical contents and practices (40%)
The practices will be used to initiate and guide the student in the realization of the practical work. The work done in the laboratory sessions will be evaluated as part of the practical work. In addition, attendance is considered mandatory as it is a fundamental part of learning. Students will have to complete the theoretical questions and submit the corresponding reports for each of the practical blocks.

E2 Subject project: Design of an intelligent sensor (30%)
A practical group work activity will be proposed to apply the different concepts and contents seen in the theoretical classes. This learning method is an approach to professional activity and a more autonomous, more efficient learning style that allows the student to acquire those professional competencies that will be most useful in their professional practice.
The work will be carried out in groups of students. An initial work specification will be proposed. This specification is provided in a document together with an index of chapters to be completed by the group. In the initial phase, the group has to decide how to carry it out and distribute the tasks. This will be included in the working document and must be approved by the teacher to continue the work. The final deliverable will include:
- Presentation of the prototype.
- Oral presentation of the work done.
- Workbook with a complete description of the work performed, distribution of tasks, calculations performed, work diary and any documentation deemed necessary to document the work.

E3 Research article (30%)
The student must write an article on one of the topics related to the theoretical contents of the subject (to be agreed with the teacher). They must also read and evaluate the work of their classmates and make a presentation of their work in class.

Alternatively, the student has the possibility of passing the subject by means of the global evaluation in the official calls for exams. The evaluation will be carried out through the presentation of the work of the subject, the research paper and the report, as well as an exam based on the practices carried out by the student in an autonomous way on the dates established by the centre.

6. Sustainable Development Goals

7 - Affordable and Clean Energy
9 - Industry, Innovation and Infrastructure
13 - Climate Action