Visible light communications for the smart industry

Academic Year: (2024 / 2025) **Review date: 21-01-2025**

Department assigned to the subject: Signal and Communications Theory Department

Coordinating teacher: MORALES CESPEDES, MAXIMO

Type: Electives ECTS Credits : 3.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Basic knowledge about digital communications

LEARNING OUTCOMES

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG3: Knowledge of basic and technological subject areas which enable acquisition of new methods and technologies, as well as endowing the technical engineer with the versatility necessary to adapt to any new situation.
ECRT6: Ability to conceive, develop, organize and manage telecommunication networks, systems, services and infrastructures in residential (home, city, digital communities), business and institutional contexts, responsibility for set up, continuous improvement, together with knowledge of social and economic impact.
RA1: To acquire the knowledge and understanding of the general basic fundamentals of engineering, as well as, in particular, of multimedia communications networks and services, audio and video signal processing, room acoustic control, distributed multimedia systems and interactive multimedia applications specific to Sound and Image Engineering within the telecommunications family.
RA3: To be competent to carry out engineering designs in their field within Sound and Image Engineering, working as a team. Design encompasses devices, processes, methods and objects, and specifications that are broader than strictly technical, including social awareness, health and safety, environmental and commercial considerations.
RA5: Be competent to apply the knowledge acquired to solve problems and design audiovisual networks and services, to configure their devices, as well as to deploy adaptive, personal audiovisual applications and services on them, bringing network intelligence to the value for the user, maximising the potential of multimedia networks and services in the different social and economic spheres, knowing the environmental, commercial and industrial implications of the practice of engineering in accordance with professional ethics.

OBJECTIVES

The student should aquire the following competences:

- Understand the needs for the communication systems in the framework of the Industry 4.0
- Acquire the knowledge for satisfying the requirements of the communications systems in the Industry 4.0.
- Acquire the capacity of analyze the transmission of information over the optical spectrum (visible light)
- Acquire the capacity to design, analyze and optimize signal processing algorithms that perform the main functions of a digital receiver (modulation, synchronization, channel estimation / equalization, detection, decoding) in a visible light communication system.
- Acquire the capacity to design and analyze complex communication systems that combine several

classes of signal processing algorithms for visible light communications.

DESCRIPTION OF CONTENTS: PROGRAMME

Unit 1. Introduction
During the introduction, the framework of the visible light communications and their role in the radioelectric spectrum is presented. Within this framework the need for exploiting alternative bandwidth is shown. After that, the communication needs of the smart industry and how the visible light communications are explained. Finally, a brief overview of the standards that regulate the visible light communications is carried out.

Unit 2. Propagation of the visible light
Design of a transmission scheme for visible light communications and presentation of its elements, i.e., LED lights, photodiodes, amplifiers¿ Description of the point-to-point channel and the effects of the diffuse components within industrial environments. Highlight the difference between the free-space optical channel and the radiofrequency channel.

Unit 3. Modulation and detection of information through visible light communications
Analysis and implementation of modulation, signal detection and decoding schemes for visible light communications. Single carrier and multi-carrier (OFDM) schemes. Management of the constraints given by the features of the optical channel. Multi-transmitters (MIMO) optical schemes.

Unit 4. Geolocation based on visible light communication
Implementation of geolocation services based on the deployment of LED light in industrial environment. Modeling and accuracy of the geolocation services.

Unit 5. Internet of Things based on visible light communications
Management of sensors networks in industrial environment through visible light communications. Compatibility with traditional standards based on radiofrequency and grouping of the set of communications through and optical gateway. Internet of Thing as required platform for obtaining realistic datasets that feed artificial intelligence algorithms.

Unit 6. Practice, practical case
Study of practical case employing the knowledge obtained through the subject. Use of Matlab for simulations.

LEARNING ACTIVITIES AND METHODOLOGY

Theoretical lessons and problems
The lessons are composed of theory and practical examples with the aim of providing a better understanding.

Lab practices
Simulation of the practical cases described during the theoretical lessons.

Practica case.
A practical case in the framework of the optical communications for the industry 4.0 is proposed for simulation and analysis.

ASSESSMENT SYSTEM

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

The final mark is obtained as a weighted sum described below,

- Participation: 10%
- Exercises proposed during the classes: 20%
- Lab practices: 20%
- Practical case (final work): 50%

BASIC BIBLIOGRAPHY

- Kaushik Kumar, Divya Zindani, J. Paulo Davim Industry 4.0: Developments towards the Fourth Industrial Revolution , Springer, 2019

- Mohamed Gado, Doaa Abd El-Moghith Li-FI Technology for Indoor Access: Li-Fi , LAP LAMBERT Academic Publishing, 2015

- Sliven Dimitrov, Harald Haas Principles of LED Light Communications. Towards Networked Li-Fi, Cambridge University Press, 2018