Research Field And Department	Optoelectronics and Visible Light Communications - Department of Electronic Technology (UC3M)
Supervisor	Juan Carlos Torres
Title of the Work	Experimental Implementation of a BPSK Visible Light Communication System Using a Software-Defined Radio

Abstract:

This project aims to design and experimentally validate a **visible light communication (VLC)** link using **Binary Phase Shift Keying (BPSK)** modulation implemented through a **software-defined radio platform (ADALM-Pluto).** The concept builds upon the IEEE 802.15.7 standard for optical wireless communication [1] and previous research on optoelectronic VLC interfaces [2,3]. The student will generate and process BPSK signals digitally [4], convert them to optical intensity using a driven LED, and detect the received signal through a photodiode and transimpedance amplifier. Signal acquisition and demodulation will be carried out in **GNU Radio** or **MATLAB**, following approaches demonstrated in prior SDR implementations [4,5].

The project will allow the evaluation of bit error rate (BER), signal-to-noise ratio (SNR), and optical channel response under different ambient light conditions. This work bridges **optoelectronic hardware** and **software-defined communications**, providing hands-on experience with both RF and optical system design.

Main Tasks to Carry Out:

- Review the fundamentals of BPSK modulation and its adaptation for optical channels.
- Configure and calibrate the ADALM-Pluto SDR for low-frequency (baseband) operation.
- Design and implement the LED driver circuit for optical intensity modulation.
- Build and characterize a photodiode receiver with transimpedance amplifier design.
- Implement digital demodulation and signal analysis in MATLAB.
- Measure BER, received optical power, and system stability under different illumination conditions.
- Prepare a final technical report.

References/Bibliography if required

[1] IEEE Standard for Short-Range Optical Wireless Communications, IEEE Std 802.15.7-2018, 2018.

[2] J. C. Torres Zafra, J. S. Betancourt Perlaza, C. I. del Valle Morales, and R. Vergaz Benito, "Optoelectronic Interfaces for a VLC System for UHD Audiovisual Transmission in Mobility Environments," Sensors, vol. 24, no. 17, p. 5829, 2024.

[3] S. N. Ismail, M. H. Nordin, A. A. Zainal, and R. S. Abdullah, "A Review of Visible Light Communication (VLC) Technology," AIP Advances, vol. 10, no. 2, pp. 020289-1–020289-12, 2020.

[4] D. T. Miller, "Demonstration of GNU Radio High Data Rate BPSK 10 Mbps Modem — Real-Time with Only Multi-Core General Purpose Processors," in Proc. 11th GNU Radio Conf., 2021.

[5] Y.-H. Kim, D. Lee, and H. K. Kim, "A Measurement Study of ADALM-Pluto SDR as an IEEE 802.15.4 Radio," in Proc. Int. Conf. on ICT Convergence (ICTC), 2022, pp. 1319-1321.