ULPGC Universidad de Las Palmas de Gran Canaria | Escuela de Ingenierías Industriales y Civiles

Trabajo Fin de Grado
Grado en Ingeniería Electrónica Industrial y Automática

Junio de 2024

Diseño de Prototipo de Laboratorio Remoto de Imagen Hiperespectral aplicado a Biomedicina

Autor: Álvaro Díaz González Tutor: Eduardo Gregorio Quevedo Gutiérrez Cotutor: Antonio José Rodríguez Almeida

Introduction and objective

Remote laboratories have emerged as an innovative solution, allowing students and researchers to access and interact with experiments remotely via communication technologies.

The main objective of this project is to analyse and characterize a Hyperspectral Imaging (HSI) laboratory at Institute for Applied Microelectronics (IUMA), followed by the design and validation of a remote laboratory that enables the use of this technology.

The emerging development of Hyperspectral Imaging (HSI) in biomedical applications underscores the need for education and familiarization with this technology.

Providing students access to HSI remote laboratories can spark interest and accelerate knowledge development. Moreover, due to equipment costs and calibration complexities, enhancing safety and automating tasks unsuitable for student handling, a remote laboratory is essential to bring HSI closer to students.

Methodolodgy

1. State of the art study
2. Familiarization with the capture equipment
3. Development of the remote laboratory prototype
4. Evaluation of the results

Solution analysis

- **Structural and motion solution.** A leadscrew displacement system with stepper motors was chosen for axis displacement. The structure is built using aluminum profiles and 3D-printed components integrate the displacement system and the HS camera.
- **Electronic solution.** A development board based on an ESP32 is used to act as an intermediary between user interaction and the sensors and actuators that will control the laboratory. Also have cameras to provide video streaming.
- **Software solution.** Provides the interface through which remote users can access, manipulate, and obtain results from experiments.

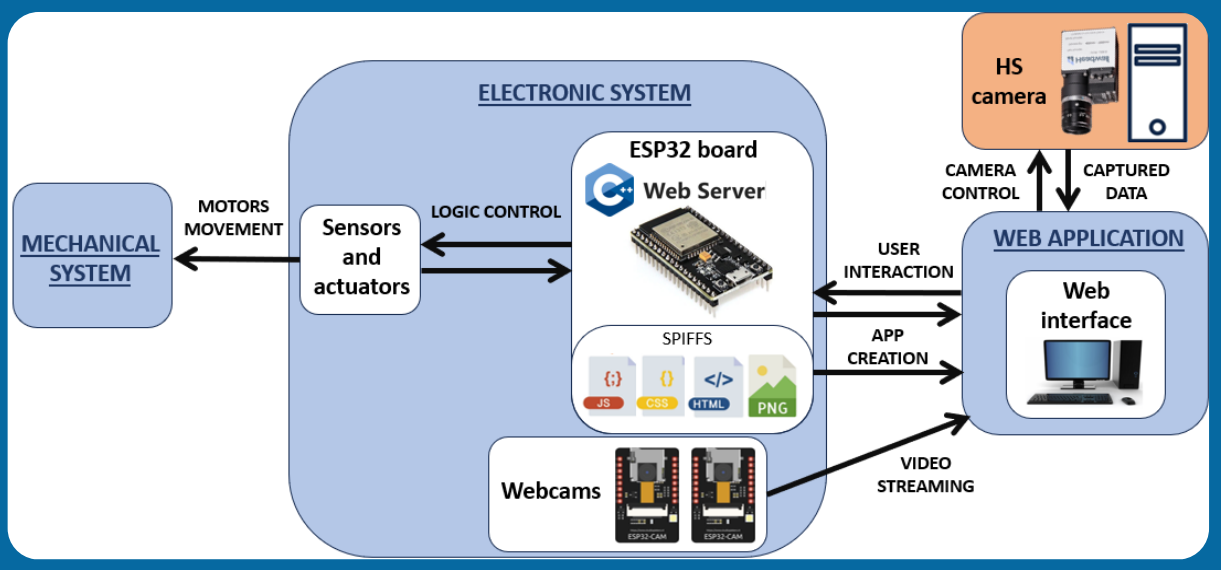

Figure 1. Connection among the main systems and components of the prototype

Results

By applying the adopted solutions and integrating the mechanical system, the electronic system, and the web application, the remote laboratory is constituted. As a result, we have a remote HIS laboratory controlled from an interface that includes a camera selector, information display for the selected camera, and an event log on the left side. On the right side, the live camera feed, camera height relative to the target, and control buttons are presented. Movement control buttons for the Z and Y axes are intuitive, with automatic calibration, capture, and return to origin functionalities.

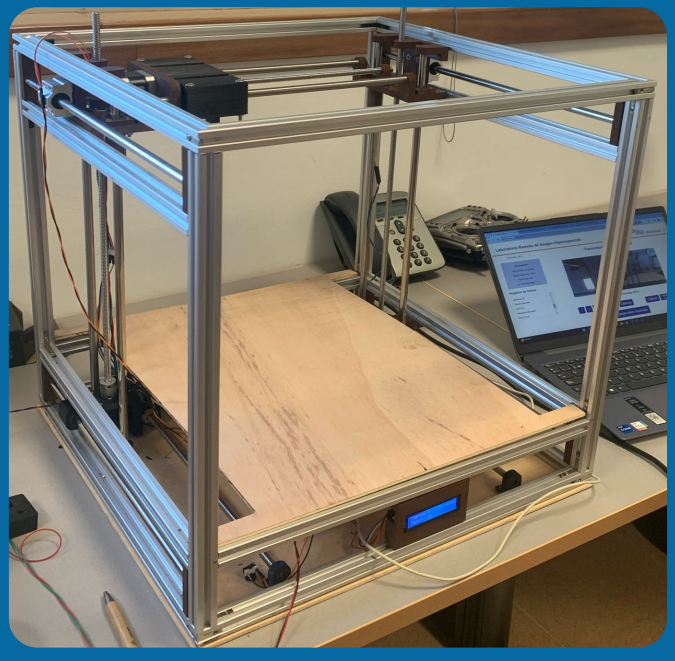

Figure 2. Final appearance of the prototype

Figure 3. Interface of the web application of the prototype

Conclusions

Remote laboratories reduce and eliminate traditional laboratories limitations and motivate students.

With this prototype, students control key aspects of the camera's operation remotely and receive live video and data feedback to improve the experience. They are required to understand HSI technology to complete laboratory tasks. The flexibility of the prototype expands its potential applications beyond HSI.

Future work

Future research is needed and collaboration among educational institutions is emphasized as essential for transitioning to remote laboratories.

In the context of this project, there are still outstanding requirements to fulfil, including remote access, connection with a hyperspectral camera, and implementing login page functionality, among other future work proposed for subsequent versions of the prototype.