Design and implementation of ‘HydroPore’ Electronic System

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***Abstract*—This document summarizes a Final Grade’s Project whose objective is to develop all the electronics that will control an experimental setup. This project includes PCB design, coding and development of a user interface.**

***Keywords*—PCB; C Coding; Python; Arduino; Experimental setup; Electronics; LVDT; Load Cell.**

I. INTRODUCTION

The experimental setup consists of an extern structure that will support an internal construction. The internal is formed by a base with a rock at the top and, just above, there’s another structure with another rock that fits perfectly with the first one. Above the second structure we can find death weight that will apply a vertically force. The objective is to move 10 mm the lower structure forcing the two rocks to rub each other. Before the start of the movement, the system will be saturated of water and during the experiment we need to measure:

- Horizontal displacement of the lower structure.
- Vertical displacement of the higher structure.
- Water pressure difference.
- Water removed from the system thought the holes on the 4 laterals.
- Applied force vertically with death weight.
- Applied force horizontally to move the base.

Our objectives can be divided into 4 subobjectives:

1. Study the problem and propose a solution to the manager.
2. Design and implementation of the PCB that will control the system.
3. Develop the software that will manage the PCB.
4. Develop an interface to make the control of the system user friendly.

II. MATERIALS AND METHODS

A. Materials

- LVDT [1]: to measure vertical and horizontal displacement. They are located in position marked with number 1 on Fig 1.
- Load cell [2]: to measure vertical and horizontal applied force. They are located in position marked with number 2 on Fig 1.
- Water pressure sensor [3]: to measure changes of pressure between movements. It is located in position marked with letter ‘Q’ on Fig 1.
- Ultrasonic sensor [4]: to have a security limit of the movement. Will be located at the end of the movement range of the structure.
- Serial cameras [5]: to know how much water has been removed from the system. Will be one of them on every side of the structure.
- Actuator [6]: to move the structure. It is located in position marked with ‘σ_T’ on Fig 1.

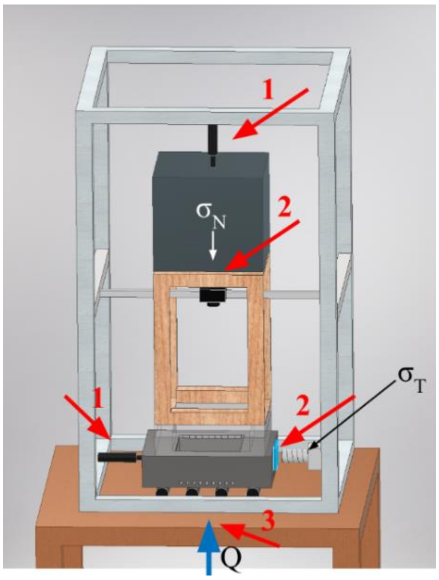

Fig 1. ‘HydroPore’ experimental setup.

B. *Methods*

We have divided the design of the system in 4 layers:

- Physical layer: includes all the transducers and the mechanicals.
- Electronics layer includes the PCB and all the components.
- Control layer: includes the software of the microcontroller and the Arduino.
- User layer: includes the methods that the user has to interact with the system.

A layer design helps us to correct the course of any decision during the development of the project without changing a lot of aspects. Physical and electronics layer are palpable; control and user layers are logic.

We have designed the system going from the physical layer to user layer.

III. RESULTS

The initial propose to the head of the project has been approved and developed.

Hardware designed meets the expectations. It is capable of collect all transducers data, process it and export to a PC via UART.

PCB is designed according to EN 55011:2016 norm about electromagnetic emissions on a scientific equipment. In Fig 2 we can see the results.

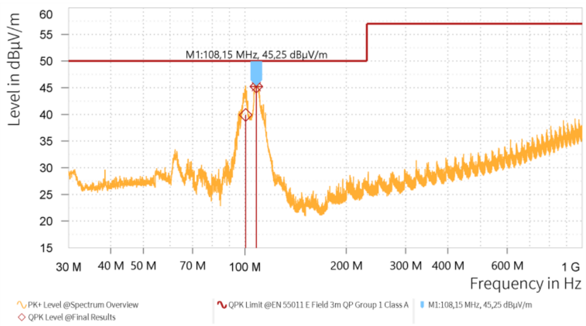

Fig 2. Results of radiated emissions according to EN-55011.

The software can monitor all the system and detect errors.

User interface can send commands to interact with the system and get data from it with a user-friendly format.

IV. DISCUSSION

After all the explanations of the heads of the project, we traced a solution to meet the requirements.

The PCB is a four-layer design, all of them dedicated to signals. The equipment is placed in a methacrylate cage, to avoid having current circulating through a metal case.

We have tested radiated emissions in a semi-anechoic chamber as we see in Fig 3.

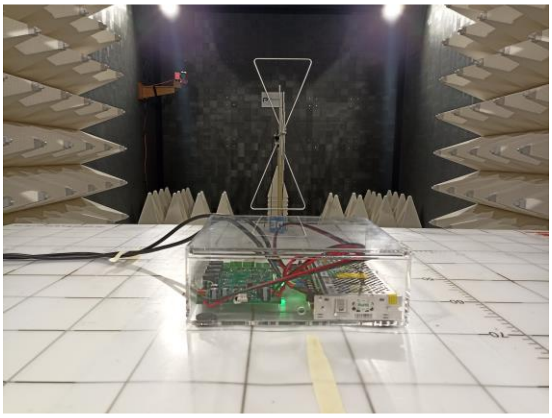

Fig 3. EUT in the semi-anechoic chamber.

Developed software can control all the electronics and can collect of transducers data, process it and send it to PC via UART.

The user interface is based on an application that have different buttons assigned to all commands that we can send to PCB, as we see in Fig 4.

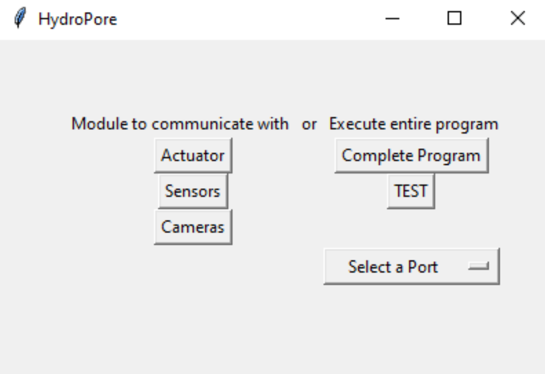

Fig 4. Main window of the user interface.

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