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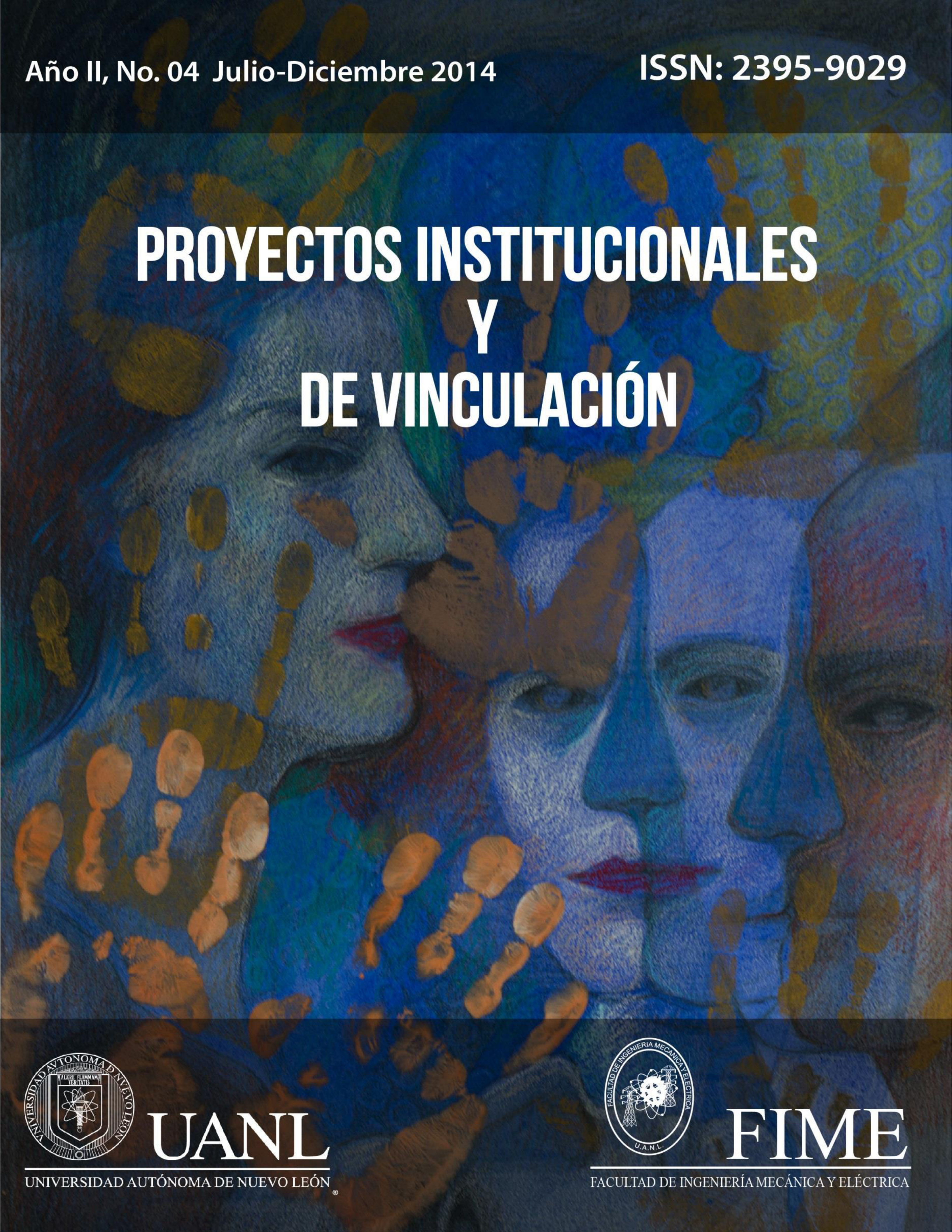
PROYECTOS INSTITUCIONALES Y DE VINCULACIÓN



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INFRARED GLUCOSE PORTABLE DEVICE

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ABSTRACT

There are quite a few persons worldwide with severe issues to control the glucose level on its blood. Only in Mexico, there are about 10 million persons with this disease and well over 13 deaths in 100 in this country are due to diabetes. In order to help to control this health issue, we are proposing a device to measure in a swift, simple and efficient way abnormality glucose levels in blood by using infrared sensors. Glucose shows a high absorbance to infrared wavelength. By using such characteristic, it is possible to develop a mobile, low-cost electronic device capable to analyse a blood sample by measuring the absorbance in it. The process is performed by using an array of infrared diodes controlled by a low-power consumption micro-controller as well as by several algorithms within a case.

A blood sample is put in a substrate within the case. Once analysed, the glucose level of such sample is analysed and displayed on a screen.

Keywords: Glucose analysis, Opto-Electronic analysis, Arduino, Low-Cost, Portable

INTRODUCTION

There are quite a few persons worldwide with severe issues to control the glucose level on its blood. Only in Mexico, there are about 10 million persons with this disease and well over 13 deaths in 100 in this country are due to diabetes. In order to help to control this health issue, we are proposing a device to measure in a swift, simple and efficient way abnormality glucose levels in blood by using infrared sensors.

A swift, portable, easy-to use, low-cost device is developed by using a set of commercial electronic devices in order to analyse a blood sample at 940 nm, at which glucose shows a high absorbance degree.

The hardware that was developed to detect the glucose level included a set of infrared diodes, an array of photo-transistors that are capable to detect photons emitted at a key wavelength and a data acquisition board that uses a low-cost and power micro-processor such as Arduino. To complement such hardware, a few routines were custom developed to match the requirements of the application.

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Project Development

Blood and in special glucose have a key absorption wavelength that matches in the infrared spectra. This characteristic offers quite large variations whilst analysed. If blood under test has a large quantity of glucose, absorption will be reflected straightforward on the analysis results in comparison with a low level glucose sample. Figure 1 shows a blood spectra absorption level.

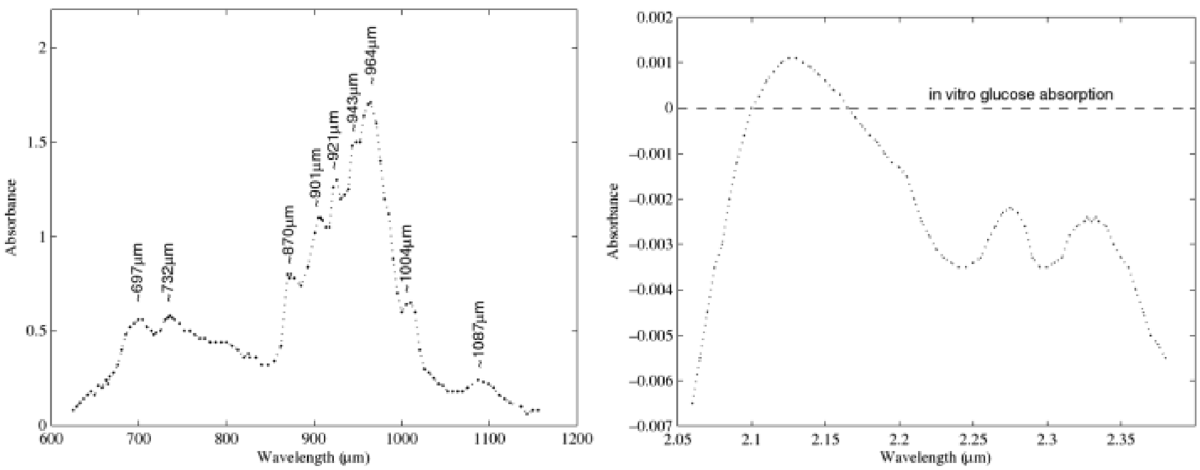

Figure 1 Absorption spectra for glucose at a set of wavelengths [1].

Figure 1 shows the absorption spectra for glucose. It is shown the spectral level for a set of wavelengths, in our case the wavelength between 900 and 1000 nm. At such wavelengths the absorbance is high for our applications. Nowadays, glucose level measurement is a rather common practice for elderly people, mainly. To analyse it, we require a sample of blood to put it on a substrate and analyse it. Instead of use voltage or current as in other old fashion devices, we are applying a shade of light at 940 nm for which we are using anemitter diode LED IR 333 and aphototransistor as a photo-receptor IR PTI1302B/C2 [2, 3]. Once transmitted, the signal is reduced after it has been passed through the sample.

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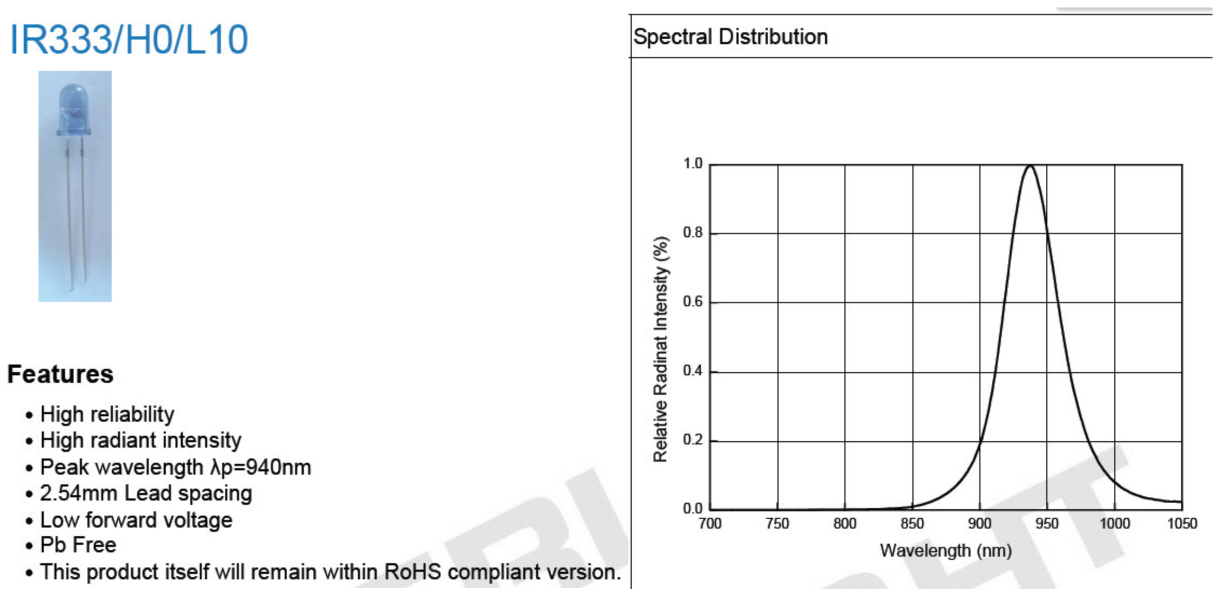

Figure 2. : Infrared diode characteristics when as emitter (left) and spectral curve as a wavelength function(right). At 940 nm it is shown that the spectra have a larger intensity [2].

The deference between the emitted and the received signal will be measured and compared with a set of samples in order to accurately show the glucose levels as a normal and those with abnormal glucose levels. As the system that we developed is low-cost, we are not going to sweep a large amount of wavelengths. Nevertheless, it is possible to have a customise system when required.

To analyse the large amount of information obtained from the photo-receptors, it is required a microcontroller to realise a whole set of operations that the custom made routines requires. For this low-cost and low-power consumption apparatus we used an Arduino. To complement the system, a LCD screen is also used to display the information processed by the Arduino [4]. Also, a connection with a PC through a USB port that emulates an UART port, this to calibrate the system.

Electronic Boards

As we developed the electronic system in an efficient way, it was chosen to have only two boards that will contain the entire electronic hardware. The boards are divided into the Shield and IR board. The Shield board encompasses the LCD screen, the set of push-buttons as well as the microcontroller system. On tother hand, the IR board has the entire arrays of LEDs and photodetectors. Figure 3 shows the PCB diagrams for the Shield and IR Boards.

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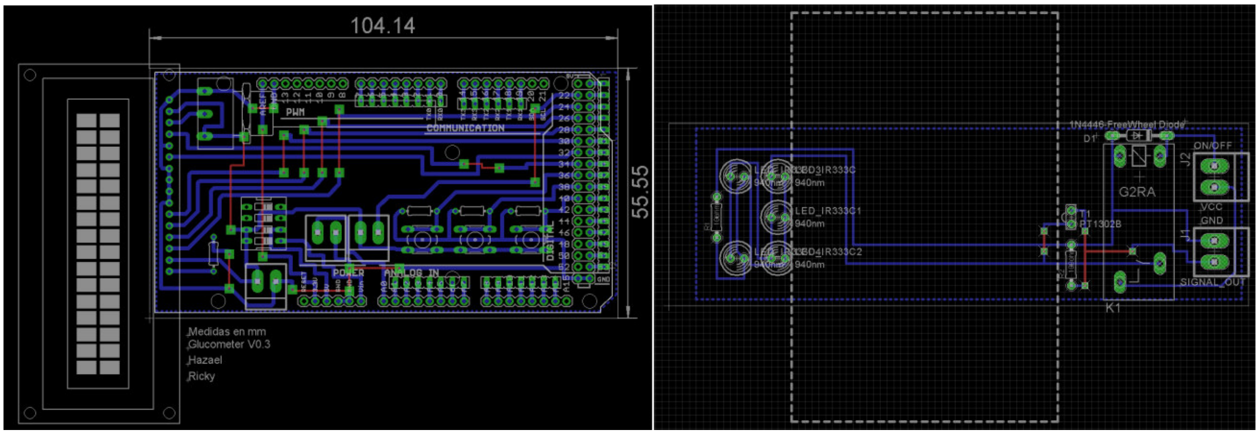

Figure 3: Schematic diagrams for the Shield and IR boards.

The electronics board embedded with LCD as well as the microcontroller is shown in Fig. 4

Figure 4: Electronic board that depicts the LCD screen as well as the microcontroller and the connection for the IR board.

Mechanical Development

The main idea of this section relies in the fact that we require a holder in which put the blood samples to be shaded by the infrared LEDs and in the opposite side to be whole the receptors.

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The case was designed to be made out of acrylic with a slab of 4 mm thick. The base of such slab is linked to the IR-board as shown in Fig. 5

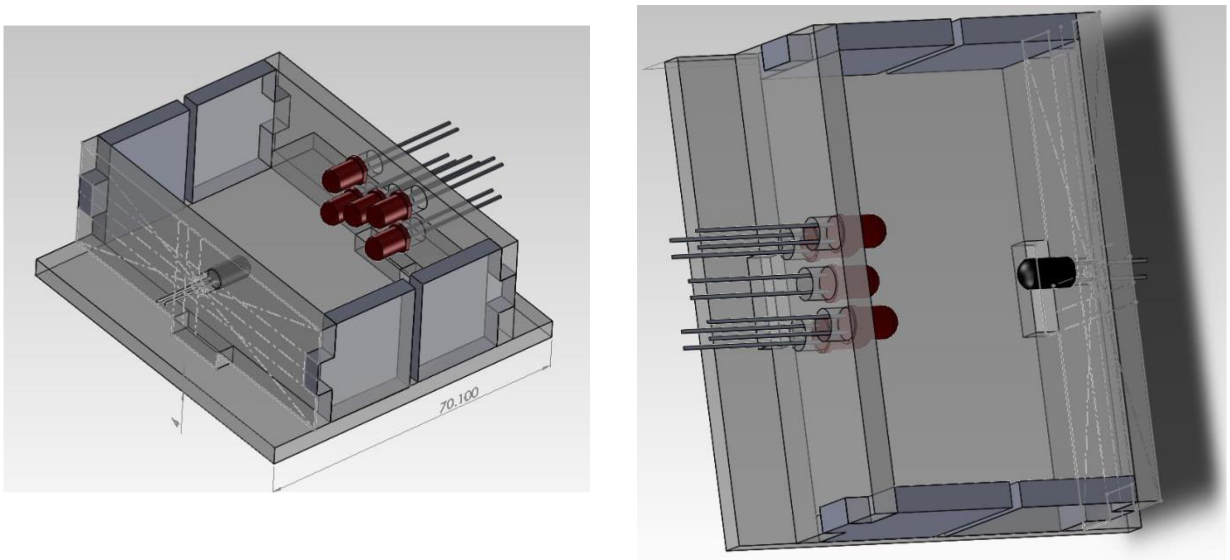

Figure 5: Schematic diagrams of the case in which both receptor and transmitter will be housed.

The software developed has a connection with Arduino. In here, the software reads the ADC embedded within the Arduino board in which the IR receptor is plugged. The analysis runs twice, once to calibrate it as a reference and the second one, to have accurate measurements, runs 100 times each 10 ms and calculate the average. Finally, the algorithms developed will calculate the average sample absorbance.

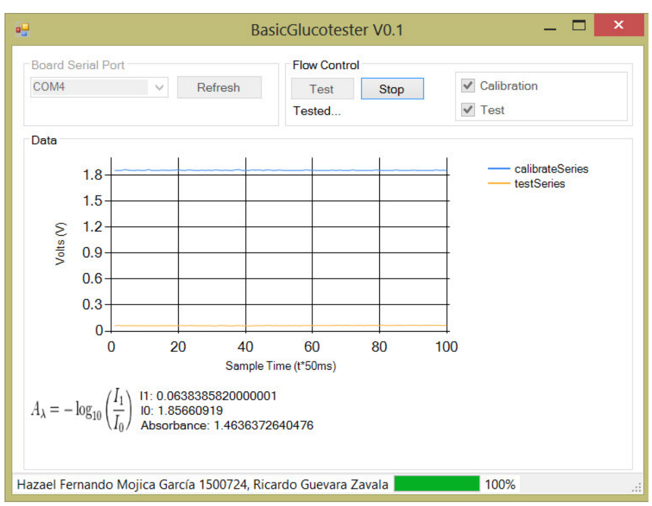

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Figure 6: Frontend of the software developed to measure the glucose level through wavelength absorbance

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The ADC has a voltage reference of 3.3 V and it has a sample rate of 10 bits. According to these levels, the resolution for the system is 0.00322 V.

RESULTS

Once whole sections of the main project have been tested, those are assembled and by using a set of samples, a set of tests were implemented. In here, it was shown the affectivity and accuracy of the system.

Figure 7 shows the entire project running.

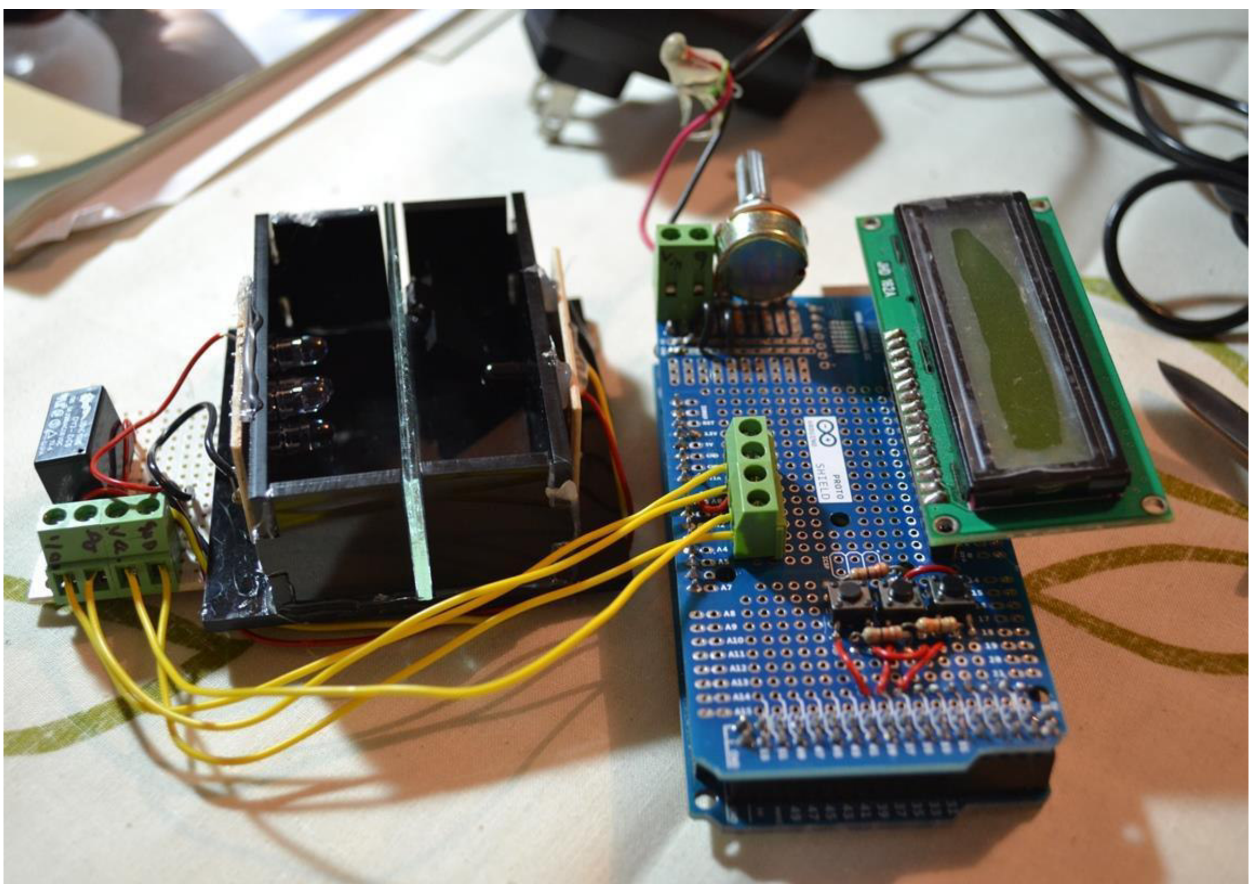

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Figure 7: Full project that shows the entire set of boards. In here the LCD and microcontroller is located on the Shield board and the case in which the IR board is plugged in.

The variations found shows that the system is robust due to the number of samples that it takes over a whole sample. By measuring it and by having an average number, it is possible to reduce the noise from different sources as well as increase the accuracy of the system. We are looking forward to have the equipment test under a set of conditions to ensure its robustness.

CONCLUSIONS

As conclusions, the equipment developed to analyse glucose on a blood sample is low-cost, low-power consumption and accurate. The system can be affordable for a broad range of people with different necessities.

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