COMPACT PULSE OXIMETER USING PIC18F4550 MICROCONTROLLER

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Abstract: In this paper is propose one compact pulse oximeter system using a PIC18F4550 mircontroller, which use of USB (*Universal Serial Bus*) communication technology. The device has one LCD (*Liquid Crystal Display*) 20x4 to continuous check and has the possibility to get one parallel communication with a PC (*Personal Computer*) to analysis more detailed. The system is compound for oxygen saturation measures (SpO_2) and heart rate. The equipment is compact and show easy to handle and simple use.

1 INTRODUCTION

In the 80 decade beginning, already had emphasized the necessity of the improvement and of scientific development in the biomedic instrumentation area in Brazil, in order to reach the excellency of the medical services (Moraes & Vita, 1981).

With this mind and due to great integration capacity increase of the eletronics devices, as well as the fast technological advance of the microcontrollers, a wide development of applications in the diverse areas of biomedical engineering was allowed (Moron, 2005).

The oxygen is fundamental and vital for the correct functioning of each cell of the human body and its absence, for a drawn out time, it can cause the deaths of these cells (Webster, 1997). The pulse oximetry (Moyle, 1994 - Wukitsch, 1987) is a non-invasive method to measure the arterial oxygen saturation (SpO_2) using two diferents wavelenghts to determine the relative oxyhemoglobin concentration (HbO_2) and deoxyhemoglobin (Hb) in the blood. Already, the pulse oximeter is a device that uses an empirical measurement method and actually is an important SpO_2 continuous monitor device where it offers oxygen saturation results trustworthy similar the convencional methods.

In this article is propose a development of the compact pulse oximeter system. The system is compound for one prototype sensor, one software interface and one pulse oximeter device with a LCD 20x4, where the device contained one PIC18F4550 microcontroller that produce all control of the circuit. The PIC contained the USB technology integrated where the implementation and compacting was easily.

The primary interface has been the ubiquitous serial port. Intel developed the USB in the early 90s, and while many personal computers peripherals now support this interface. Each USB port can support up to 127 devices (Lichtel, 2004).

2 MATERIALS AND METHODS

2.1 Overview of the System

The aim of this study is to design and implement one compact system and with handle facilities and use to SpO_2 monitoring and heart rate. The figure 1 shows the architecture of the considered and developed system.

The major design requirements of project was the following: a) It should be portable and easy mobility; b) it should be easiness to get na supply source; c) it should have a userfriendly interface; d) Compacting of the circuit using the PIC18F4550; e) Possibility to record the data received in a PC; f) it should collect physiological data of arterial oxygen saturation and the heart rate (BPM).

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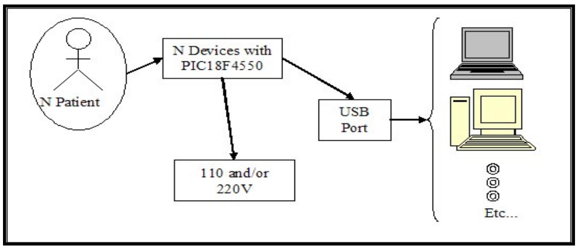

Figure 1: Overview of the development system. Device can be supply by PC or directly by AC 110/220V, using a converter to 5V.

2.2 Prototype Sensor

In the prototype device of the article hadn`t been use neither comercial sensor, it was developed one prototype sensor using comercials LEDs from CROMATEK and one photodiode TSL251R, from TAOSINC ,with transimpedance amplifier integrated. The LEDs has wavelengths of 660nm (red) and 940nm (infrared). The photodiode choice was done by yours caracteristics and someone are about transimpedance amplifier integrated, rise time about 70us, linear voltage response in respect to intensity light, spectral response and good angular displacement, becoming the alignment between emitter and receptor less critical.

2.3 Physiological Acquisition Signals Device

The compact pulse oximeter device using the microcontroller PIC18F4550 has the circuit supply directly by USB port. Using the USB cable, the device can be conect directly in PC and/or using the adaptor, where can be connected directly to electricity network and visualize the data directly on the LCD.

The USB port has 5V and 500mA, this is enough to supply the circuit. The circuit is compound for first condicionning step signal, that proceeding from the sensor, that have a filter pass-band and a signal gain. After the signal treatment the PIC is responsible for diverse other necessary functions of the pulse oximeter device. The sampling frequency that the microcontroller works is 1kHz and takes care of to the necessities of the Nyquist theorem and prevents the aliasing problem. The prototype also has a LCD 20x4 to visualize the data received for the optic sensor. The implementation of the LCD in the system becomes interesting therefore is not necessary no complex computational system to get the value of SpO2 and the cardiac beating. In figure 2 the diagram of blocks of the physiological signals acquisition system can more be seen detailed.

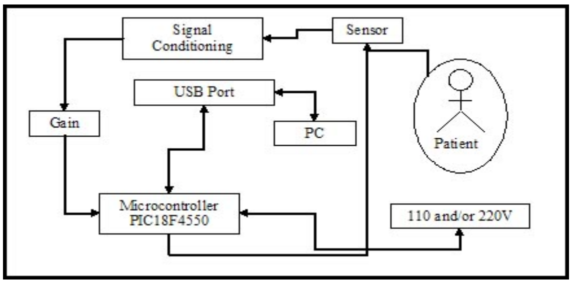

Figure 2: Diagram of blocks of the compact pulse oximeter device.

3 RESULTS

All the prototype system had been developed and implemented. The device (already with protection circuit), which includes the physiological signals is compound (120x80x30mm) and light (<300g). In figure 3 the image prototype device circuit can be seen. The photo of the pulse oximeter with LCD connected together with the USB cable and the eletricity network found in the figure 4. For the sensor development was done one photospectroscopy of the LEDs that had been used in the prototype, to verify if they are in the specific band wavelenght fo the aplication. In figure 5, the graphs of the tests realized through with the emitters can be seen.

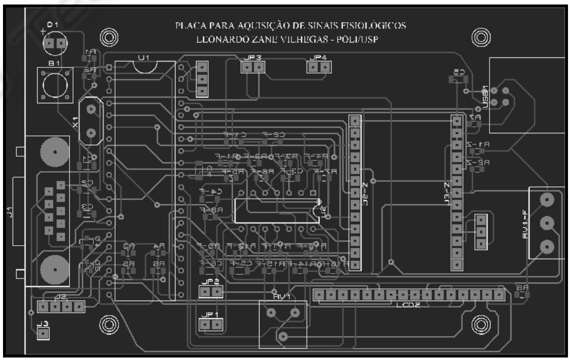

Figure 3: Image of the prototype pulse oximeter device circuit using the PIC18F4550.

The prototype sensor was development with the concern to keep total isolated of the invironment. In figure 6 it can be seen the sensor images, the armored cable and used connector DB9 to realize the connection with device.

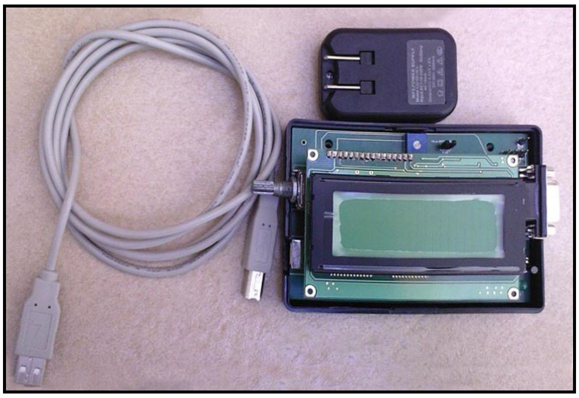

Figure 4: Photograph of the device with the connected LCD, USB cable and adapter for electricity network.

a)

b)

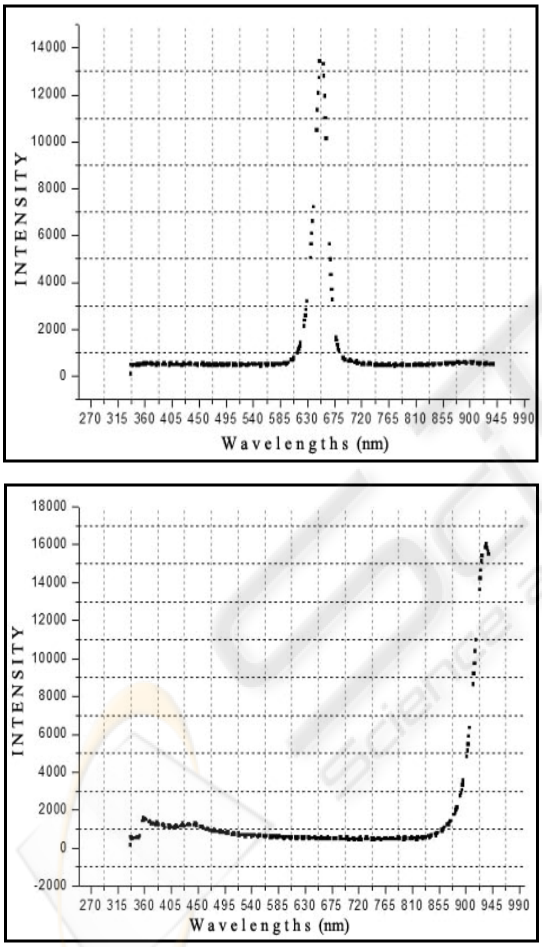

Figure 5: Photospectroscopy: a) LED 660nm (red); b) LED 940nm (infrared).

The program of use for interface the pulse oximeter device with the PC was developed through the utilization of LabVIEW software. The program has the information about amount of oxygen arterial blood (SpO_2), of the photopletysmography signal

a)

b)

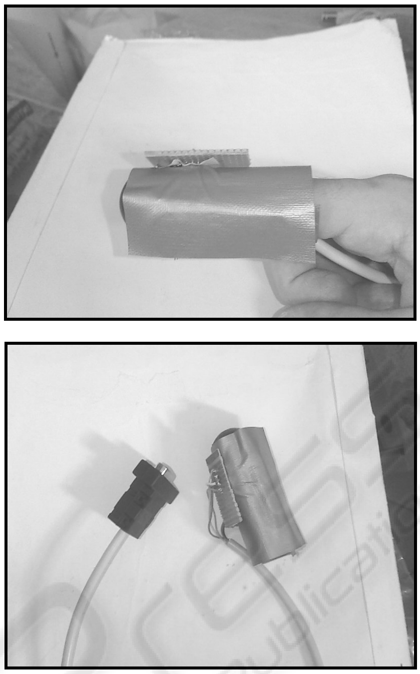

Figure 6: Pototype sensor: a) Sensor to hardwired to the indicating finger; b) Sensor with covering against surrounding light connected with one armored cable and connector DB9.

and heart rate. The software also diverse other funtions as for example, to record the data of the signals received by device, acknowledgment of emergency, etc. In figure 7 the display of the software main control developed for interface of the system can been seen.

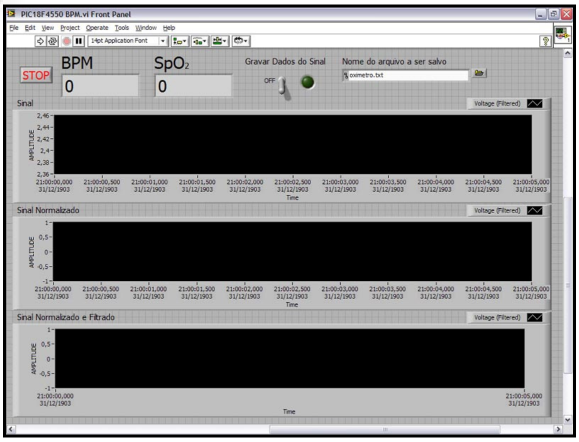

Figure 7: Main display of the responsible interface fo the communication with the device.

4 CONCLUSIONS

The pulse oximeter device using the microcontroller PIC18F4550 was developed. In the module are measured physiological samples of oxygen saturation in the arterial pulse, of photopletysmography and heart rate. The software developed to interface with the computer revealed very friendly however. With resources limited fo not being the focus of the article. The data presented in the LCD are oxygen saturation and cardiac frequency. The supply device for the USB port using a PC or the adapter presented great easiness and fastest in its aplication. The photopletysmography are not presented in the LCD for the display not to be graphical.

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