Practical Work
Mandatory
UTN - FRBA 2024

Title:	Idea Strength Project Pulse Oximeter
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Idea Force of Work Practical Mandatory

Content

1. Brief description of the driving idea

The chosen project is an oximeter with the MAX30102 sensor as a signal meter. The aim is to configure the sensor, measure the signal by photoplethysmography digital and obtain blood oxygenation, as well as the heart rate of a person at rest. These data are intended to be transmitted from the sensor to the microprocessor with I2C in order to process them and send them to the LCD display of the INFOTRONIC board, as well as to view them in a graphical interface in QT with data and graphics on PC, for the latter the connection between the micro and the PC will be wireless through WIFI using TCP/IP protocol.

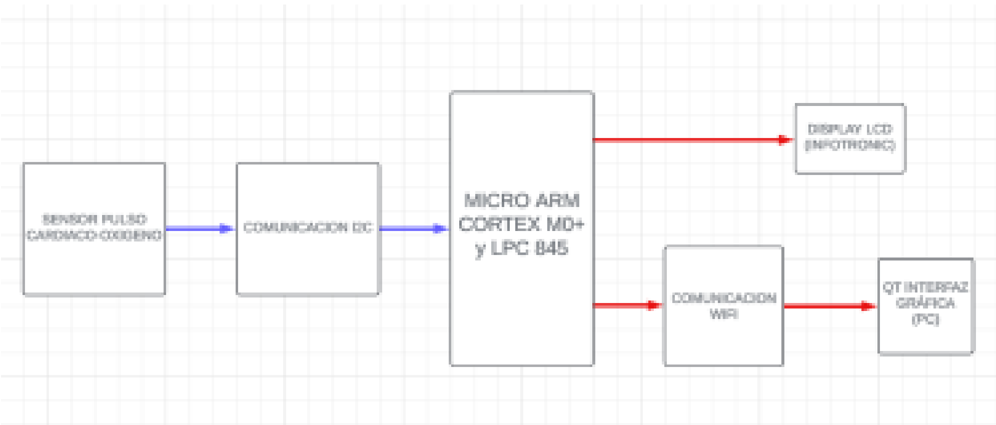
2. Introduction

We seek to enter electromedicine and study how the heart rate and blood oxygenation are measured using a digital sensor and what the meanings of these data are in the cardiovascular health of an individual, initially at rest. Here Asys and programming knowledge is combined to achieve a device adaptable to the specific needs of the Bioengineering Research and Development Group (GIBIO) within its cardiovascular assessment protocols at UTN.BA. To corroborate the operation, we seek to compare the measurements of our device made with another already on the market of the same type, also using currently tabulated reference values.

2.1. **Goals**

• Study and application of knowledge of the LPC845 stick. • Incorporate and better consolidate the theory of C++, OOP, Embedded Systems and ASYS.
• Unite application concepts with microprocessor concepts. • Learn to use the I2C protocol to obtain information read by the sensor and be able to send it to the micro to display data.
• Learn to use the TCP/IP protocol to establish WIFI communication and thus acquire knowledge of the IOT (Internet of Things).

2.2. **Block diagram**



Tools and equipment:

- MAX30102 heart rate and oxygen saturation sensor • ESP8266 WIFI module
- Micro LPC845
- Display LCD 16x2
- Serial-USB communication adapter
- Cables for communication
- Power supply
- PC or Notebook for QT graphical interface

Project Scope:

- Communication between LPC and PC: loading programs via USB and exchange of sensor data to PC via WIFI module TCP/IP protocol
- Communication between LPC and Max30102: I2C protocol
- Sensors: Max30102 – Oxygenation and heart rate
- Communication modules: Esp8266 – WIFI
- Output: 16x2 LCD display on Infotronic board and PC screen with QT graphic interface.

3. Detailed description of each block

Heart Rate-Oxygen Sensor: This sensor would be the MAX30102, which works with I2C communication protocol. It would function as a slave transmitter to the LPC.

I2C communication: The I2C block is a serial communication port and protocol to be able to relate the sensor to the micro. There are two basic elements, a master (LPC as receiver) and a slave (MAX30102 as transmitter). The bus consists of two lines called Serial Data (SDA) and Serial Clock (SCL).

ARM Cortex M0+ microprocessor in LPC 845: This represents the main microprocessor to be used from the LPC845 stick.

Infotronic and user: They contain the LCD Display to show the data resulting from the measurements.

PC and QT Graphical Interface: Refers to the application associated with the graphical interface to display graphs and the data of the measurements made.

USB communication: It is a means of serial data communication between the PC and the programmable LPC to carry out code loading and control of all elements with code in an IDE.

WIFI communication: It is a means of communication using the TCP/IP protocol for sending and receiving data between the microphone and the PC.

4. Hardware Description

The relevant descriptions regarding the hardware used in the project are mentioned below. This involves technical characteristics and simplified explanation of the operation of the devices to be used.

4.1. Description

Next, we introduce the descriptions of hardware modules to be used outside the LPC845 y to the INFOTRONIC board.

MAX30102 Module: Heart rate and blood oxygen concentration sensor that works using a photodissolution method. This sensor uses photodetectors and optical elements to measure how blood behaves in light depending on its degree of oxygen saturation. The sensor measures oxyhemoglobin (HbO2) and hemoglobin (Hb) in arterial blood using a light source with a specific wavelength emitted by a diode. In addition, it has a red LED, an infrared LED, a photodetector, specialized optics, an ambient light filter between 50 and 60Hz, and a 16-bit delta sigma ADC converter allowing up to 1000 samples per second.

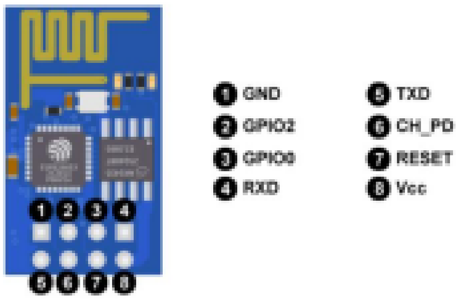
At the exit we obtain a photoplethysmograph signal, a signal whose value refers to the heart rate and a signal whose value is associated with blood oxygen saturation (SPO2).

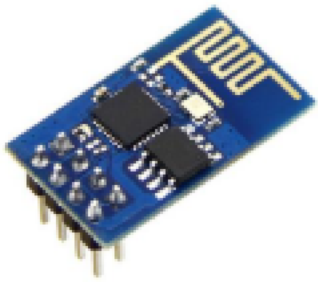
To operate, two voltages are needed: 1.8V to power the internal circuit and a voltage between 3.3V and 5V for the red and infrared LEDs. The module includes both on-board voltage regulators, so only a 5V supply is needed for power. The MAX30102 It has minimal current consumption, making it ideal for wearable applications, such as medical monitoring equipment, fitness assistants, and general wearables (smartwatch).

Some additional information:

- Maximum LED wavelength: 660nm / 880nm
- Typical working current: 60mA
- Maximum power: 0.3W
- Detection type: Light reflection
- Communication protocol: I2C
- Dimensions: 21mm x 15mm

ESP8266 module: It is a device that allows WIFI communication between the main hardware and the network or internet. In our case, the idea is to use it to send data to the PC. It is a low-consumption device, making it ideal for building portable and IOT devices. He ESP8266 is a microcontroller,
but we can use it through a circuit module to facilitate its programming. It is noteworthy to know that the supply voltage is between 3V and 3.6V although it could support up to 5V on the GPIO ports.





Regarding connectivity, we see that:

- Supports IPv4 and TCP/UDP/HTTP/FTP protocols
- It does not support HTTPS at first. If you do it through software, both on the TLS1.2 client and server
- It has 17 GPIO ports, but only 9 or 10 can be used. GPIO16 is special since it is connected to the RTC (Real Time Clock) • Can be configured with Pull-up or Pull-down resistance • Supports the main communication buses (SPI, I2C, UART)

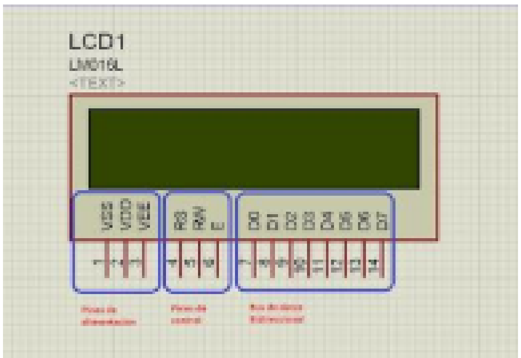
On the consumption side, it will depend on different factors, such as work modes, the protocols, the quality of the WIFI signal and, above all, whether we send or receive information. The current consumed ranges between 0.5μA when the device is off and 170mA when we transmit signal.

It has 3 modes of operation:

- Active mode, which involves transmission and reception of data. • Sleep mode, where only the RTC is active to maintain synchronization. It remains in alert mode for possible events that cause it to wake up. It keeps the connection data in memory and thus there is no need to re-establish the connection with the WIFI. It consumes around 0.6mA up to 1mA.
- Deep sleep, where the RTC is on, but not operational. You must go through sleep mode before waking up and entering active mode. In this state it is as if it were turned off and all the data thatand are not stored they are lost. It consumes around 20μA.

Display LCD 16x2: It is a screen that works by modifying the amount of light that passes through liquid crystals. These are between two layers of glass, each covered by a pattern of conductive tracks. When a voltage is applied to one of these patterns, the liquid crystals orient themselves in a way that allows or blocks light, depending on the polarity of the applied voltage.

This liquid crystal screen is used to display information in a graphical way, using characters, symbols or small drawings depending on the model. It is governed by a microcontroller which directs all its operation. That it is 16x2 means that it has 2 rows of 16 characters each. The pixels of each symbol or character vary depending on each model.



We can divide the wiring into the power pins, control pins and bidirectional data bus pins. In addition, we have led backlight anode and led backlight cathode pins.

- **Power pins**
  Vss: GND
  Vdd: 5V
  Water: corresponds to the contrast pin, it can be regulated with a 10K potentiometer connected to Vdd
- **Control pins**
  RS: Corresponds to the data control register (0) or data register (1) selection pin. The RS pin works parallel to the data bus pins. When RS is 0, the data present on the bus belongs to a control/instruction register, and when RS is 1, the data present on the bus belongs to a data register or a character.
  RW: corresponds to the writing (0) or reading (1) pin. Allows you to write data on the screen or read data from the screen. AND: corresponds to the enable pin. If E is 0, the LCD is not activated to receive data, but if E is 1, it is active and we can write or read from the LCD.

- **Data bus pins**
  The bidirectional data bus comprises pins D0 to D7. To communicate with the LCD, we can do so using the eight bits of the data bus (D0 to D7), or using the four most significant bits (D4 to D7).

We can also define three important memory areas:

La memoria DDRAM (Data Display Ram), which corresponds to a memory area where the characters that are going to be represented on the screen are stored.

CGROM memory, which is an internal memory where a table is stored with the characters that we can display on the LCD.

CGRAM (Character Generator Ram) memory, where our own characters can be stored.

4.2. **Link to data sheets already collected**

• MAX30102:

https://www.analog.com/media/en/technical-documentation/data-sheets/max30102.p

df • ESP8266:

https://www.espressif.com/sites/default/files/documentation/0a
esp8266ex_datasheet_en.pdf

• LCD DISPLAY 16x2:

https://www.sparkfun.com/datasheets/LCD/HD44780.pdf

5. Description of the application developed on PC

The application that we will develop will allow the visualization and management of the system status. It will connect with the other modules via WIFI, and the interface will allow you to observe the information obtained by the different sensors (heart rate and blood oxygen concentration), as well as different graphs to help understand the information provided.

6. Conclusions

In this project we seek to develop code that allows, on the one hand, the configuration and start-up of the three modules mentioned in the hardware description, considering the necessary memory areas, as well as the connection protocols between the micro and these devices. The micro that we will define as the brain of our project will be the ARM Cortex M0+, which
It is on the LPC845. On the other hand, we will seek to program a main application that allows us to view all the data of interest on the screen of a PC from a graphical interface in QT. This aims to display numerical data and some graphs with which the user can interact in a very simple way.