Wrocław University
of Science and Technology

Health data aquisition by smartband

Construction of smartband capable to collect health data about the user. Compact design should include a motion sensor, heart rate monitor and a way to communicate with the user and the computer. Final device use Bluetooth Low Energy communication protocol to push data to computer or smartphone and led strip for user notifications.

Author: Dawid Śliwa

Intermediate Project
Instructor: Witold Paluszyński
Faculty of Electronics
Wroclaw University of Technology and Science
http://www.pwr.edu.pl
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1 Introduction

The purpose of this project is to develop wereable device that could acquire health data from person who is wearing it. After reviewing the available sensors decided to choice three type of data: motion (accelerometer and gyroscope), blood pressure and oxygenation (pulseoximeter). A very important in this project was also way of communication with band. Firstly bluetooth HC-05 module was chosed, but it was not good idea due high power consumption. It was replaced by HJ-580x Bluetooth Low Energy module. First device prototype was developed very quickly what also caused few bugs in hardware. Fortunately with some fixes it was almost operational. A major mistake was incorrect connection of Li-Ion charger. Due this error device could not work without power wire. For the purpose of this classes a first prototype of smartband was used but in parallel with work on it a new version is developed for future research. New version will get additional sensor of Galvanic Skin Response (measure skin conductance), wirelles charging and new SoC embedding microprocessor and bluetooth LE radio.

Main goals of this project:

- Design an schematic and PCB of smartband
- Read raw data from sensors
- Perform pre-treatment of data by some algorithms/filters
- Communicate wirelessly with computer or smartphone via Bluetooth Low Energy
- Visualisation of data and recording

2 Hardware

First prototype is using a STM32L051C6T6 MCU as a main unit for collectiong data form sensors, making some simple processing of it and sending results through bluetooth to computer or smartphone. It was chosen due low power consumption, relative high computing power and wide number of interfaces. PCB was designed in Circuit Maker by Altium and was made manually by photochemical method. The Figure 1 is presenting board after etching.

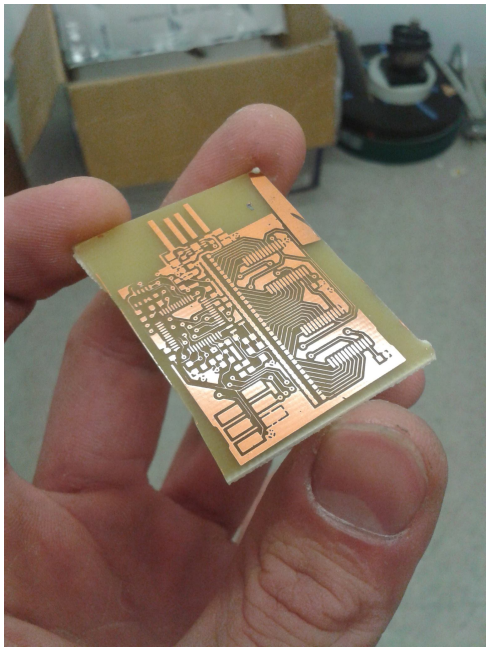

Figure 1: Top side of smartband PCB

2.1 Sensors

All sensors on PCB are connected by I2C bus. First one is an IMU (Inertial Measuring Unit) with provide information about acceleration and angular rate in three dimension. Selected LSM6DS3 IC produced by STMicroelectronics was due few embedded functions such as step counter and double-tap recognitsion. Second sensor is pulse oximeter with purpose is to read heart beat rate and blood oxidation. MAX30100 IC was chosen for this task. It illuminates the skin with two colors of light alternately and read reflected beam by photo-resistor. IR light is used to determine heart rate and Red light gives information about oxidation. Last one sensor is an ambient light sensor. An VCNL4020 IC was choiced due small form factor. It is used to adjust LED brightness according to light conditions.

2.2 Communication

Smartband is communicating with devices by Bluetooth Low Energy protocol. For this purpose HJ-580x module is used. It is very small (5x6.2mm) and cheap (about 7$). Board is equipped with DA14580 SoC and BT antenna. Data transmission is done by UART protocol with is transparent from MCU point of view.

2.3 Notifications

User of the band is notified about some events by LED strip. It is controlled by two 16-channel LED Driver SCT2024CSSG with is connected to MCU by SPI protocol. This integrated circuits are simple shift registers with latch. Dimming of LEDs is done by applying PWM signal to Output Enable pin. This strip can also work as persistence of vision display by fast rotation of wrist. This feature is shown on Figure 2.

Figure 2: Displaying ”1234” number by POV

3 Software

3.1 MCU

Software on MCU is written in C language with usage of ST HAL (Hardware Abstraction Layer) library and STM32CubeMX initialization code generator. Microcontroller simply read new data from sensors when they are ready, perform several operation on them and send results trough Bluetooth to computer or smartphone. For IMU readings an kalman filter is used to obtain angle and angular speed around wrist. This data are base of POV display algorithm. General schematic of program flow is shown on Figure 3

3.2 Desktop & mobile

Desktop app was written in QT. It allow to search and connect to Bluetooth Low Energy devices, read shared data, present is on line chart and record them. Figure 4 present main window of an application. User can choice with data should be displayed on chart by clicking on check boxes and also adjust axes

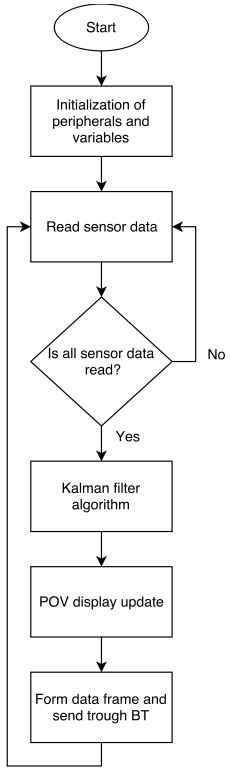

Figure 3: Flow of an uC Program

to best fit presented data. Due the multi-platform philosophy of qt environment it is possible to compile this same code to other devices. It successfully launch on android operating system. Only problem was not suitable user interface to touch input.

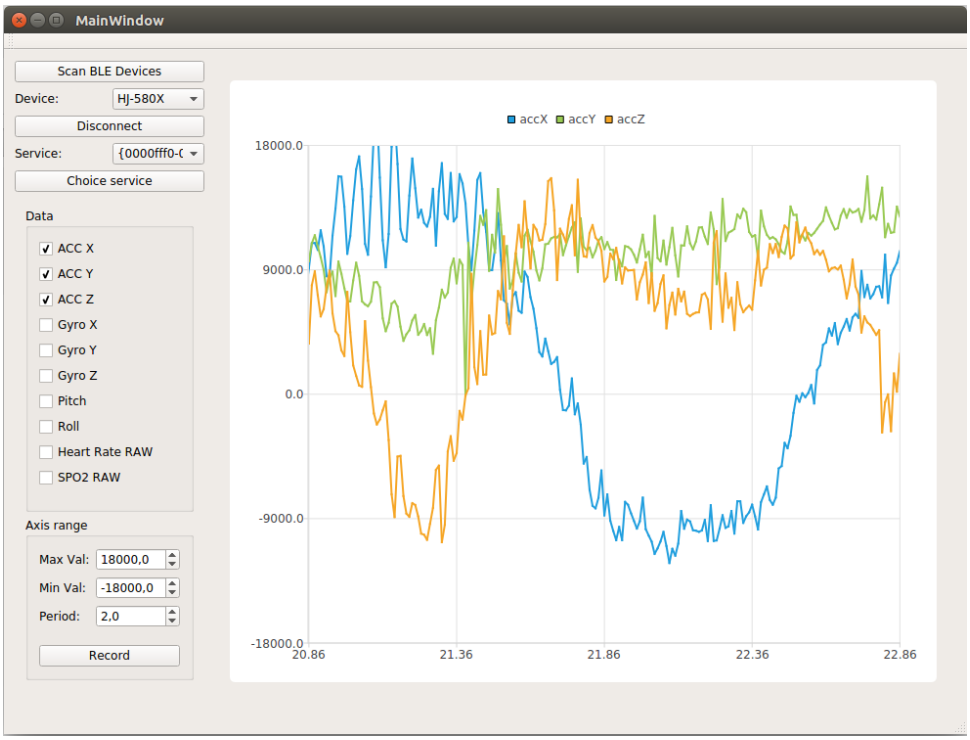

Figure 4: Desktop application main window

4 Results

In the result all goals have been achieved with better or worse effect. Smartband with was used in this project is shown on Figure 5. The device itself have some faults but it is good platform to test some algorithms and record data. After end of this classes project will be still developed. Considering the done mistakes currently is designed a new version of PCB with will try to fix previous errors and add some new features and solutions.

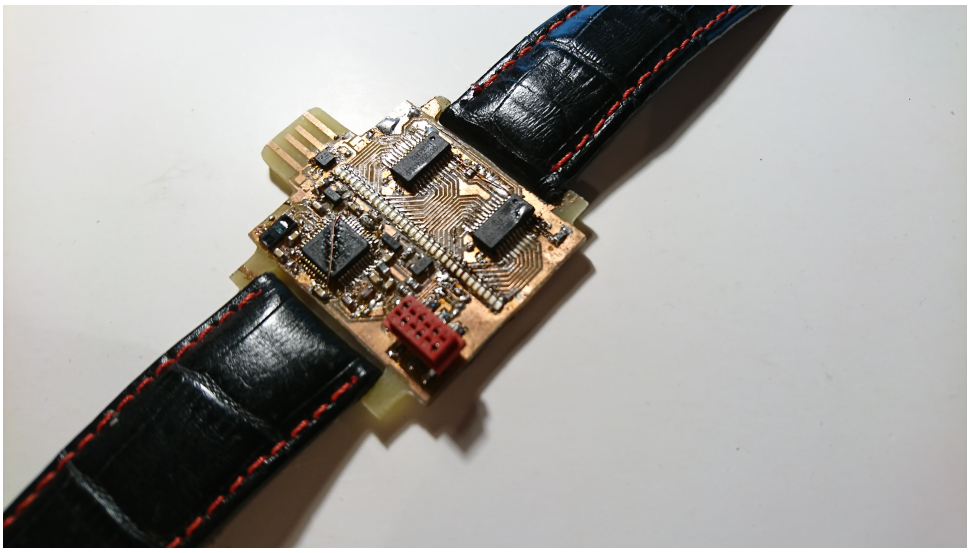

Figure 5: Picture of an smartband

5 References

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