Development of non-contact photoplethysmography device and its application for blood vessel occlusion detection and pulse oximetry.

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Introduction

Photoplethysmography (PPG) is an optical medical monitoring method that provides information about relative blood vessel volume changes. This method can be used for different diagnostic and monitoring purposes, for instance, heart rate and oxygen saturation measurements and blood vessel occlusion detection [1].

Non-contact photoplethysmography is a method that uses a camera to detect PPG signal from a distance. This method can be used in situations were contact PPG cannot be used, for example, over open wounds or skin burns. And today non-contact PPG monitoring becomes more and more common in different studies. But all these studies use computer based systems which are bulky.

The aim of this study was to develop a portable computer independent system based on FPGA (Field Programmable Gate Array), which could do all the necessary things for acquiring PPG signal from multiple areas of interest, calculating oxygen saturation in blood and illustrating it for user.

Device consists of seven main parts:

- FPGA, which does all the necessary data acquisition and processing;
- CMOS image sensor;
- LED array for lightening the observed area of interest;
- SDRAM for temporary data storage;
- USB transceiver for data transmission to computer;
- LCD screen for image illustration;
- Power supply

![Figure 1. Block diagram of the device](image1)

Specification:

- Cyclone III EP3C16F484C6 with clock of 200MHz
- 8 MB SDRAM
- FT2232H USB 2.0 Hi-Speed (480Mb/s) to FIFO
- Aptina MT9V032 monochromatic (752x480)
- 4.3" color TFT display

![Figure 2. Device prototype](image2)

![Figure 3. Screen of the device](image3)

Algorithm

To get a PPG signal from a video stream, firstly pixel groups of at least 16x16 pixels in each frame are binned together to amplify the pulsations, otherwise only a noise can be seen. Next all the pixel groups are put through a IIR or FIR filter to cut off the DC component and filter out high frequency noise. Pixel groups which doesn't exceed specific pulsation amplitude threshold are eliminated, considering that these areas are with weak or without any pulsations. All the other pixel groups are summed together to get maximal amplitude of PPG signal [2].

Results and Discussion

A successful development of portable non-contact PPG device has been begun. Currently a working prototype based on a development board is built and a construction of custom built portable device is in progress. The newly created device could have high potential not only in medical monitoring and diagnostics but also in security systems.

For further development it is planned to incorporate object detection and image stabilization to improve monitoring and diagnostic performance.

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References