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RESEARCH ARTICLE

DIGITAL OSCILLOSCOPE BASED ON FPGATO USE A BIOMEDICAL RESEARCH

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Abstract

Recently widely used digital oscilloscopes based on personal computers. This oscilloscope consists of a specialized signal acquisition board which can be an external USB port device respect to computer. The user interface and signal processing software runs on the user's personal computer. In this work, digital oscilloscope based on programmable device FPGA only is proposed. The main three units oscilloscope control, data acquisition and VGA controller are fully implemented on the FPGA chip only. The required external units are ADC board and monitor. As result of the project we have designed and implemented the simple digital oscilloscope using PEGASUS FPGA board and AIO1 analog peripheral board from Digilent. The design implements common features of a conventional oscilloscope, such as sampling rate adjustment, hold and triggering.
While technical characteristics of the oscilloscope are limited, this could be used as laboratory experiment for medical students who study biophysics and physiology.

Introduction:

Monitoring of human physiological activity requires acquiring biomedical signals, such heart beating, pulse pulsation, skin resistance, breathe and brain electrical signals.

These signals has specific properties: They repeated with slow frequency while signal itself has high frequency components. Hence it's difficult to acquire these signals with ordinary analog oscilloscope, because to measure repeat frequency needs slow horizontal resolution while to obtain signal itself requires fast horizontal resolution. To deal with this controversial requirement for horizontal resolution is almost impossible for ordinary analog oscilloscopes.

One of advantage of digital oscilloscopes is that they can trace the waveform of slow repeated signals and storage signals for further processing. Recently widely used digital oscilloscopes based on personal computers. General block diagram of PC based oscilloscopes is shown next picture.

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Figure 1: Block Diagram of Digital Oscilloscope based on Computer.

A new type of oscilloscope is emerging that consists of a specialized signal acquisition board which can be an external USB port device. The user interface and signal processing software runs on the user's personal computer.

Objective:
In this work, digital oscilloscope based on programmable device FPGA only is proposed. The primary goal is to build oscilloscope with characteristics capable to obtain slowly repeated signals. General block diagram is presented on next picture.

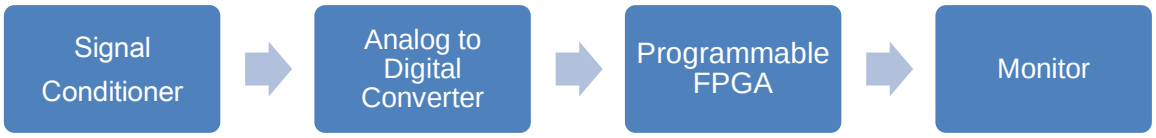

Figure 2: Block Diagram of Digital Oscilloscope based on FPGA

Materials and Methods:

AD7823 is used for analog signal acquisition and analog to digital conversion; the values obtained from the A/D conversion are routed onto the SPARTANII FPGA and stored in a memory module implemented in the FPGA; a video controller, also implemented on the SPARTANII, fetches these values and generates the appropriate video signals which are sent to the VGA output and used to display an image on a monitor connected to the board. The design implements common features of a conventional oscilloscope, such as sampling rate adjustment, hold and triggering.

Results:

The results of the project is that the project could be used as laboratory project for students who study FPGA based digital design course. They also could be used to study basic principles of digital oscilloscope.Technical characteristics of the digital oscilloscope based on FPGAare:

Input voltage range:	0-3.3V
Vertical scale:	550mV/div
Input signal frequency range:	0-1.25KHz
Horizontal scale:	400, 800
Sampling frequency:	2.5 and 1.25KHz
Display working mode:	Triggering and Hold

Discussion and Conclusion:

Ordinary analog oscilloscopes are not able to trace the waveform of human physiological signals, such heart beating and pulse pulsations, because their relatively slowly repeated frequency. So our purpose was to build simple oscilloscope based on FPGA chip with capable to draw signal waveform on the computer or beam projector screen.

The oscilloscope needs some improvement and enhancement to use it as human physiological signal tracing device. So future work could be next

- Signal stability except hold mode was not good. Reason of this is random shift of control signals of ADC. To achieve good stability these control signals should be strong synchronous with master clock signal. One of possible solution is to design signal acquisition module using detailed schematic approach.
- Design and implement of interface modules to acquire human heart and pulse signals. It required proper heart beat and pulse pulsation sensors and signal conditioners

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