Portable, High-Speed and Low-Cost FPGA based Spectral-Domain Optical Coherence Tomography (SD-OCT) device

Sachin S Munji[1], Ravikiran Manapuram[2]

[1,2]Tishyas Medical Device Development Solutions Pvt Ltd., Bangalore 560016, India

e-Mail: rdengineer01@medevplus.com[1], +919741279688[1], ravikiran@medevplus.com[2]

Conventional OCT device:

Optical Coherence Tomography based devices have extensive instrumentation and signal processing requirements:

- Computers or mini-PCs are used for image reconstruction that are bulkier and consume lot of power.
- Domestic computers or mini-PCs are having limitations of high-speed processing and so use graphical cards which increases the dependency, power consumption and the cost.

We solve the above-mentioned problems by replacing mini-PCs with FPGA (Field Programmable Gate Arrays) for data acquisition, raw data to image conversion, laser source (SLD) enable, MEMS and Liquid lens controlling. Using a single FPGA to do multiple processes and the capacity of FPGA increases performance and decreases the dependency of OS and interfacing controlling modules, power consumption and the cost.

Proposed design uses FPGA:

a. which is reconfigurable and reprogrammable device

b. for data processing which increases the speed and g. supporting controller dependencies

c. with new algorithm for calculating the linear fitting of data to get the better-quality interpolated data

d. most suitable for high-speed designs

e. to control the scanning optics

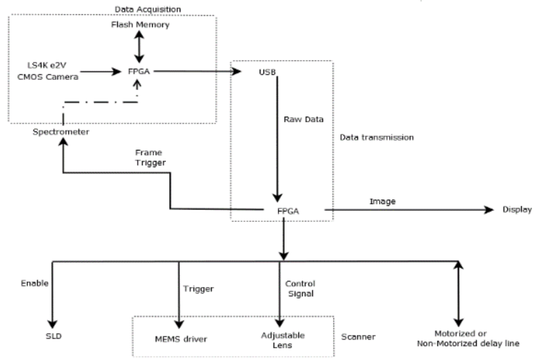
f. does the combined work of Computers or Mini PCs and the microcontroller for data processing, scanning optics control & Frame Rate Synchronization

a. algorithm uses K-Space conversion data array to the wavelength, which increases the linear fit of raw data to get better converted image

Components used:

- *CMOS sensor:* Detects the optical data from the scanner
- *Analog-to-Digital Converter:* Converts analog data from CMOS sensor to digital
- *Display:* It displays the image of processed data of the sample
- *FPGA:* It is used for data acquisition, processing of raw data, laser source (SLD) enables, scanning optics controls
- *Memory IC:* It stores the data acquisited, processed data, calculated values for processing, scanning optics control values and commands
- *Laser source (SLD):* It is the source of light
- *Motorized or Non-motorized delay-line:* It is used to get the reference signal as carrier signal imposed with the sample image data

Block Diagram:



Results:

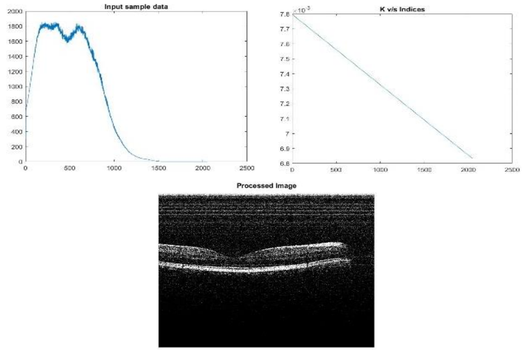
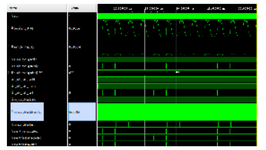


Fig 1. Matlab results proving the working of algorithm



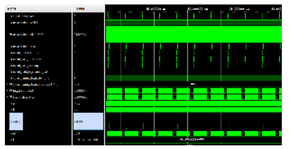


Fig 2. FPGA simulation results

Conclusion

- Our solution uses single device FPGA, which can be operated with low power supply or a battery
- FPGA is a reconfigurable device and hence can be used for upgradation of the system from the scratch
- We are using only FPGA and hence there are no other hardware dependencies
- The module is miniaturized and the cost of the product will be decreased to greater extent
- We are giving a solution for high-speed data acquisition and processing, which will increase the efficiency of the present existing systems

References:

- Teoman E. Ustun, Review of Scientific Instruments 79, 114301 (2008)
- Yin-Peng Huang, IEEE Access, October, 2020

Acknowledgements:

- We are thankful to Lumedica, for their support in understanding the working and hardware
- We are thankful to OSA for providing us the opportunity to present our novel idea
- This work is supported by BIRAC, Dept. of Biotechnology, India