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BLOOD CELL MONITORING BASED ON FPGA, IMPLEMENTED USING VHDL

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Abstract

This paper showcases a system in the medical field which will assuage the limitations in today's blood cell monitoring since everything will be done digitally. Our work is a combination of image processing and its implementation in hardware. This system will not only store the information of patients' blood components, but it will also indicate the deficiencies using an Alert signal. Area wise storage of patients' information will help in Area Wise Analysis of data. This blood cell monitoring system is designed on Xilinx ISE 14.6 using VHDL and implemented on Spartan 3A based FPGA (Field Programmable Gate Array). In medical camps it is very difficult to test blood samples of thousands of people with pharmaceutical techniques and at that time this Blood Cell monitoring system will give proper ease to test blood samples as it will require few microscopic pics only and image processing will be done at ultra-high speed since we are using the FPGA. FPGA will itself process images, store relevant data and display them in proper fashion.

Key Words : FPGA, VHDL, MATLAB, RBC, WBC.

1. Introduction

Image processing has become an important part in terms of technology today. The world is analog but the importance of digital world is the focus of study today. Image processing helps a lot when there are a need of converting an analog image into digital form to access the benefits of digital technology [1].

Our work is a combination of image processing and its implementation on a hardware which can provide us with number of high speed and error free applications.

As we all know that the procedure used in the pathology for testing a blood sample and generating a report consumes a lot of time and there are always chances of human errors which can lead to messing up with the samples of different patients [2].

MATLAB is used for the processing of blood sample image and using FPGA (Field Programmable Gate Array) we are implementing a system which can read the blood sample image and detect the RBC and WBC deficiencies and generate alert signals for the same. This system is capable of storing and analyzing the samples of a number of people. These samples can be stored in the blocks of RAM memory in FPGA itself. The number of blood sample images can be stored in the different locations of memory which makes it easier to read and analyze the data whenever necessary. The count of cells per cubic milliliter of blood sample is the normal practice by a medical practitioner [3].

This system stores the information of the patients according to their area, which can be further helpful for detecting the problems in the food, water, etc. consumed by the area. The result of MATLAB is in binary form and we are using FPGA's RAM memory and further processing is done by FPGA itself which is explained in further sections of this paper.

2. Problem Statement

Blood cell monitoring system is mainly used for monitoring the blood cell of a human being or animal. It finds application in medical field for the treatment of the heavy disease.

The blood sample to be tested are passed through some chemical analysis, which is followed by the microscopic view of the sample. The microscopic view allows the expert to see and count the cells in the blood. Then the numbers of cells, i.e. RBCs and WBCs, are written with their standard values in the report. This report shows the amount of deficiencies in the blood for different cells.

This whole above process is very time consuming and requires a very high accuracy. This increases the chances of human errors as a person is involved in the whole procedure. As compared to the actual lab procedures, our system is very less time consuming and human errors are also eliminated as no person is required in the procedure, whole work is carried out by our Spartan-3A FPGA system. The detail system overview for the work is shown in Fig. 1

3. Methodology Used in this Work

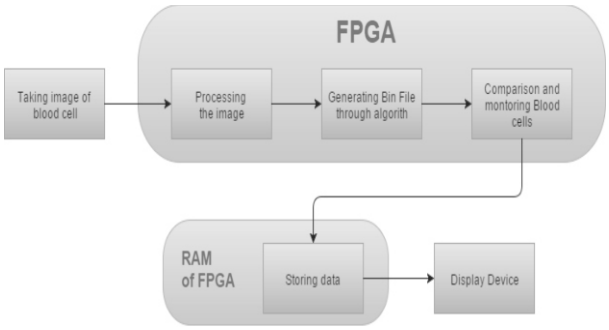

Fig.1 : System Overview

A. Image Processing

Image processing of the blood sample image is the very first step in our work. Image processing is carried out using MATLAB 8.1 platform. Fig. 2 and Fig. 3 depicts the Microscopic image of blood and WBC segmentation.

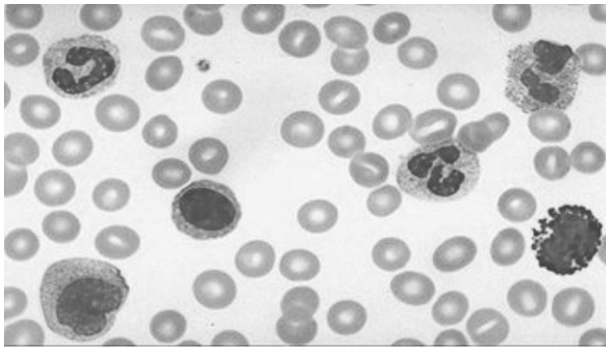

Fig. 2 : Microscopic image of blood

Fig. 3 : WBC Segmentation

Segmentation of cells are done by applying various noise removal and transformation techniques. This MATLAB algorithms for processing the image are converted into VHDL logic and loaded in the FPGA itself. This makes the whole system much easier as the part of image processing using MATLAB is also done by the same chip in FPGA.

B. Generating and Storing Binary File

The blood sample image processed using algorithms to generate a binary data of the sample. Hence, this sample is stored in the RAM memory of FPGA in the binary form [4]. There are number of RAM blocks used to store the patient's information area-wise. The purpose of converting the sample image in binary form is to make it compatible with the RAM memory which stores the data in the binary form [5]. Range of WBC and RBC is shown in the Table. 1

C. Comparison with reference

Table 1
Range of blood cells

NORMAL RANGE OF DIFFERENT BLOOD CELLS		
Cell	**Men**	**Women**
RBC count (million/mm^3)	**4.2-5.4**	**3.6-5.0**
WBC count (thousand/mm^3)	**4.5-11**	**4.5-11**
Platelet count (thousand/mm^3)	**150-400**	**150-400**

The blood sample to be tested must be compared with some reference standard. Hence in our system we will be storing some binary files in the RAM of FPGA as the standard reference values. This standard values contains the actual number of RBCs and WBCs required per cubic milliliter in the blood sample. The samples to be tested are stored in the RAM memory and they are compared with these reference values to find out the deficiencies in the blood.

D. Monitoring RBCs and WBCs

The comparison logic will generate an alert signal if the deficiencies of RBCs and WBCs are found in the blood. In addition to this, the number of RBCs and WBCs in the blood sample are counted and displayed on the display device.

The deficiencies in the blood of people living in certain area can be monitored and updated regularly to detect the problems in the area. This can be really very helpful to improve the deficiency causing elements such as water supply in the area.

4. Results and Discussions

The proposed blood monitoring system is built on a FPGA based system [6]. To evaluate the performance of the system, the algorithm was simulated and implemented on SPARTAN 3A. The device can provide clock up to GHZ using DCM and DLL functions. The basic clock rate of our FPGA is 12MHz. The images of the blood sample used in the system are generated using MATLAB 8.1.

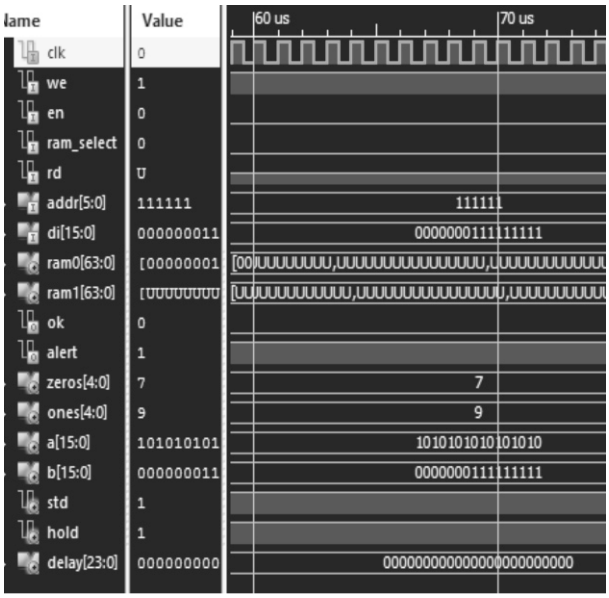

Fig. 4 : VHDL Simulation On Xilinx

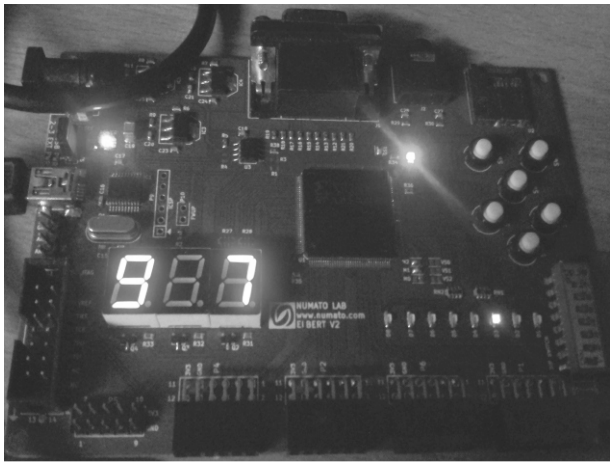

Fig. 5 : FPGA Implementation

The Fig.4 and Fig.5 shows the simulation results of the VHDL code and its implementation on Spartan3A FPGA. The VHDL code was written and simulated in XILINX ISE 14.6.

5. Conclusion

The design investigated the feasibility of using the Blood cell monitoring technique to monitor different types of blood cell and person information [7]. Calculation and simulation were conducted successfully to generate the alert signal [8]. The algorithms implemented, allows us to store and compare the data and substantial decrease of processing time over classical method using FPGA. The complete RTL schematic of the system is shown in Fig. 6.

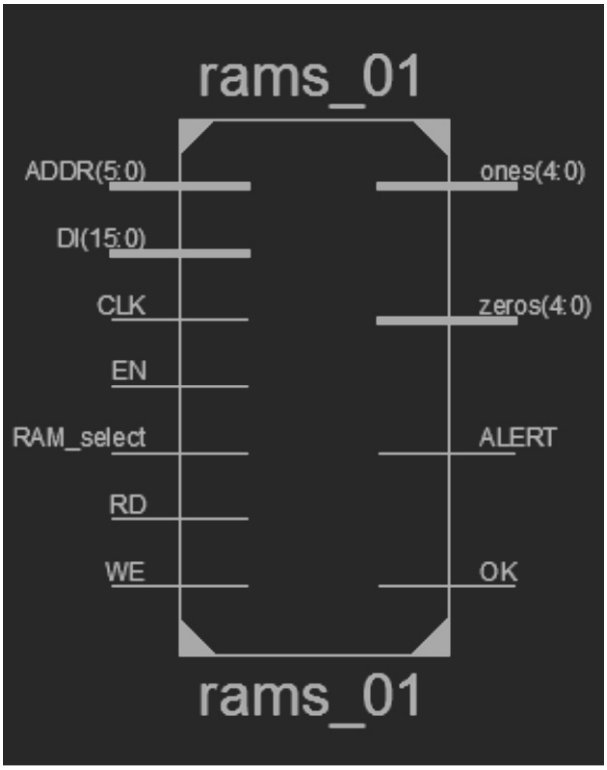

Fig. 6 : RTL schematic

Area-wise analysis of patients' blood can be a very important factor to improve and update the medical facilities of different areas and provide them with the uncontaminated and rich food.

The system architecture adds the beauty so that one FPGA can also monitored the temperature and heart beat simultaneously without increasing the processing time.

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