Design of FPGA based System to Determining the type of Human Blood Group

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Abstract: ***Our human blood is grouped into four types - A, B, AB, and O. The kind of antigen or protein on the surface of red blood cells will decide the type of blood group. By using the data of saliva and serum percentage in the immunoglobulin we can determine the type of blood group. Here in the paper we had proposed a FPGA based blood group testing system. To design this we had used Verilog HDL language and we tested it on Spartan 3e FPGA board. The most advantage of using FPGA is it is reprogrammable and optimization is possible.***

Keywords: Blood Groups, Antigen, Proteins, Immunoglobulin, Serum, FPGA.

I. INTRODUCTION

In the human body, blood is the most important element which helps in the transportation of substances like oxygen, nutrients, metabolic wastes etc [1]. It also helps in body system protection and regulation functions. In among the humans blood differs in terms of blood group or its type defined by the International Society of Blood Transfusion (ISBT) [2-3].

Blood group type is determined by the absence or presence of certain protein molecules called antibodies and antigens in the blood [4]. There were three hypotheses about the mutation and emergence of human blood groups. The ABO type locus has three main allelic forms, they are, A, B, AB and O are responsible for the productions of its glycoprotein also called antigens [5]. The mixing of alleles is inherited from parents that determines which glycoproteins (antigens) are found in human's blood cells and thereby determining their ABO blood group type. These groups will give the particulars of antigens present on the surface of Red Blood Cells (RBCs). Rh (with Rh D-positive or Rh D-negative blood types) system is also important to determine the presence of "Rhesus factor" on the surface of RBCs.

Immunoglobulin is also known as the antibodies. Plasma cells which are also known as white blood cells produce glycoprotein molecules. This immunoglobulin part in the immune responses is they help in specifically recognizing and binding to antigens [6]. These antigens may be viruses or bacteria. With the help of immunoglobulin we can destruct the antigens. Normally, the antibodies immune responses are exceedingly specific and highly complex. We have various immunoglobulin classes and subclasses (i.e. isotypes) differ in their biological features, structures, target distribution and specificity.

Serum, salivary protein and immunoglobulin concentrations have been measured in people of different ABO blood groups. Salivary protein concentrations vary markedly according to an individual's blood group tending to be particularly high in people of group-A, but have failed to show any parallel variation in serum protein concentrations [7]. No clear differences were detected in immunoglobulin concentrations, although salivary IgA concentrations tended to be slightly higher in ABH secretors than in non-secretors.

In this proposed work by using Verilog HDL we have developed a FPGA based data analysis system which is a reprogrammable and it can display the type of the blood group using the taken blood sample data [8-9]. Here we used a Spartan 3E FPGA kit for testing the functionality of the implemented hardware [10].

II. SYSTEM BLOCK DIAGRAM AND OPERATION

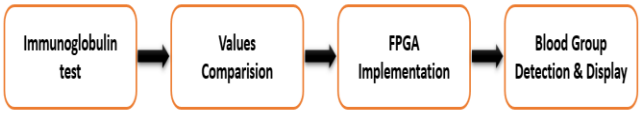

Fig. 1 Block Diagram for Proposed System

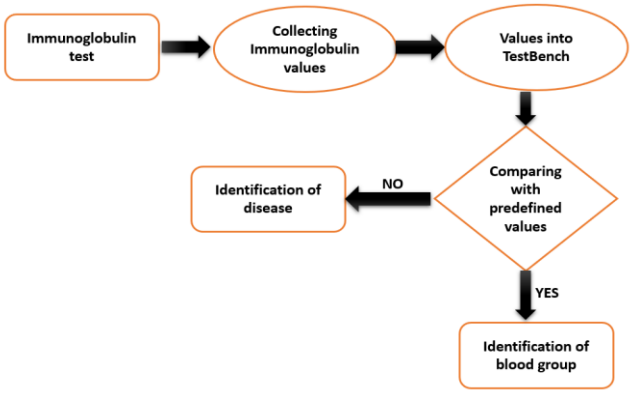

Fig. 2 Process Flowchart for Blood Group Detection

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The Detailed process of blood group detecting process is shown in figure 1 and figure 2 explains the blood group detection process flow in flowchart model.

Steps Involved

1. First the required blood sample is tested for the immunoglobulin concentrations, as show in Figure3.
2. Various immunoglobulin values from the given sample of the blood are collected.
3. These collected values are given as input values to determine the blood group of the patient.
4. These given input values are compared with the predefined values which are already determined for various blood groups and the predefined values are specified in Table1.
5. If the given immunoglobulin values match any predefined values of any blood group, it will display the name of the blood group related to the blood group values.

Table. 1 Predefined Concentrations of Immunoglobulin

Serum Immunoglobulin concentration (mg %)				
Blood Group	O	B	A	AB
IgA	243	230	241	210
IgM	147	154	130	113
Salivary Immunoglobulin Concentration (mg %): {Value/100}				
Blood Group	O	B	A	AB
IgA	91	85	100	77
IgG	65	84	56	13

Process Involved in Identifying Blood Group

1. Blood group of given samples is identified by using the immunoglobulin values present in the sample (In Table1). Given sample can be said to be blood group 'O' if the given input serum immunoglobulin concentration of the IgA and IgM match the predefined values that is for IgA it should be 243 and for IgM it should be 147.
2. We can also determine the blood group basing on the salivary immunoglobulin concentration. For blood group 'O' the IgA and IgG values should be 91 and 65 respectively.
3. Similarly, for a sample (In Table1) to be said that it is of type 'A' blood group the serum immunoglobulin concentration of IgA should be 241. If we provide salivary immunoglobulin concentration the IgA concentration should be 100. IgG concentration should be 56. The IgM concentration should be 130.
4. For blood group 'B' the IgA and IgM concentrations should 230 and 154 respectively. The salivary immunoglobulin concentrations of IgA and IgG for 'B' type blood group should be 85 and 84 respectively.
5. Finally, for blood group 'AB' the serum immunoglobulin concentrations of IgA and IgM should be 210 and 113 respectively. The salivary immunoglobulin concentrations of IgA and IgG for blood sample to be 'AB' should be 77 and 13 respectively.

Figure 2 shows the different types of immunoglobulin.

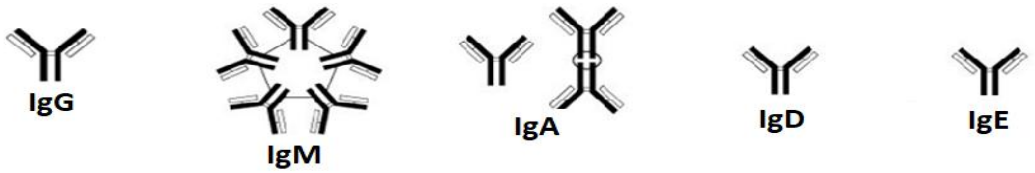

Fig. 2 Structures of different types of Immunoglobulin

III. FPGA SYNTHESIS ANALYSIS AND SIMULATION RESULTS

Field Programmable Gate Arrays (FPGAs) are becoming a critical part of every system design. For this Module design we have used Xilinx (Spartan-3) family. We have developed total hardware using Verilog HDL code. Figure7 shows the RTL (FPGA) schematic view of Blood Group Analyzer modules. The Blood Group Analyzer FPGA device utilization is used as LUTs are 33, input buffers are 64, output buffers 16, number of slices 20. The Maximum combinational Path Delay is 12.629ns. Out of Total Delay 9.405ns is Logic Delay which is 74.5% of the Total Combinational Path Delay and the remaining 25.5% is Route Delay which is 3.224ns. Total No. of Paths 960 and destination ports are 7. Figure 4 shows the FPGA Module of Blood Group Analyzer. Figure 5 shows the FPGA RTL and Technological Schematics of Blood Group Analyzer. Figure 6 shows the Simulation Timing results of Blood Group analyzer. Table 2 gives the device utilization report.

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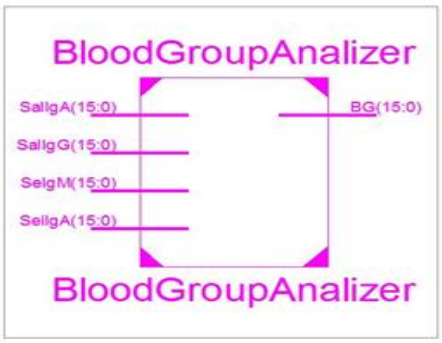

Fig. 4 Blood Group Analyzer Designed Block

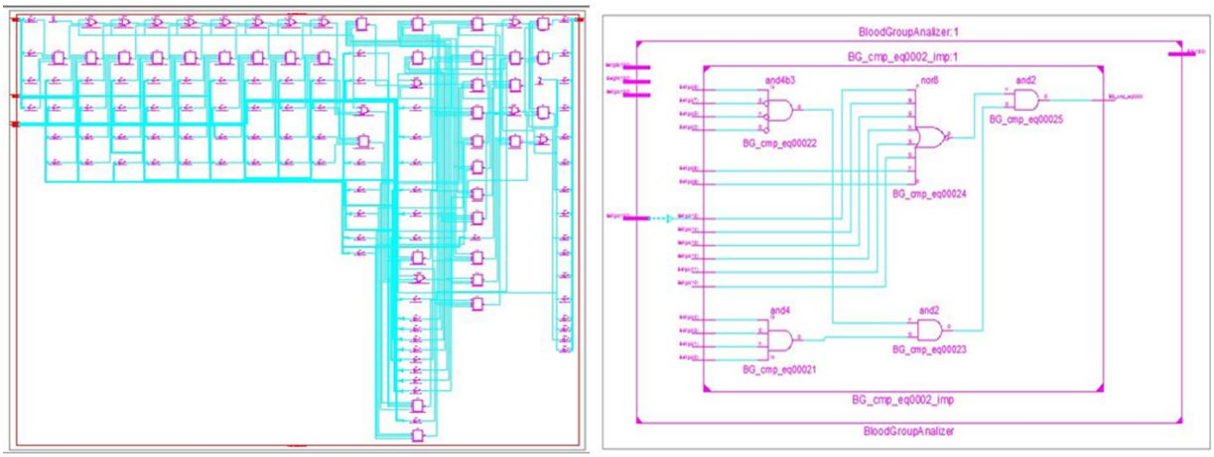

Fig. 5 FPGA RTL and Technological Schematics of Blood Group Analyzer

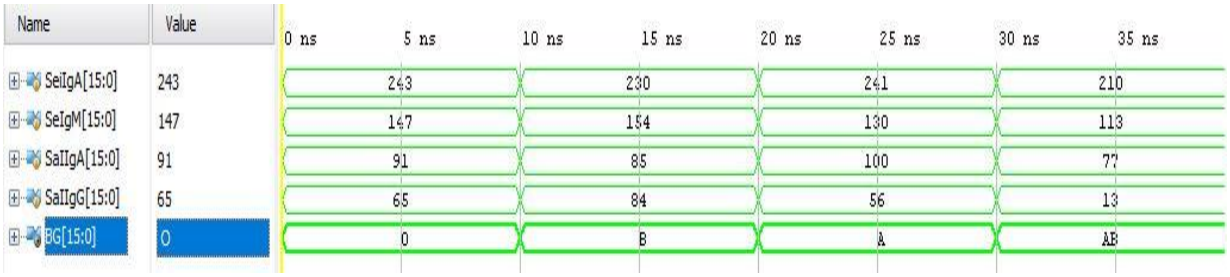

Fig. 6 Simulation Waveforms

Table. 2 Device Utilization Report

Name of the Device	Utilization
No of Slices	20
No of LUTs	33
No of Input Buffers	64
No of Output Buffers	16

IV. CONCLUSION

In this paper we have proposed a method to determine the blood group using immunoglobulin concentration values. It has been implemented on the FPGA using Verilog HDL. Blood group can be determined manually but there will be human errors when there is a need to process large number of samples. So, using FPGA we can process large number of data and we can get achieve the output in very small amount of time. Through this we can also implement a hardware model. We can dump our code on to FPGA (field programmable gate array) and implement a hardware model Spartan 3e. The time to delivery, Speed and accuracy are the major things that we need to keep in mind. Compared to the man-made errors the errors done by the systems are less and the results are more accurate.

REFERENCES

1. F. P. Xavier, L. G. A. Silva and C. D. M. Regis, "ABO/Rh Blood Typing Method for Samples on Microscope Slides by using Image Processing Techniques", IEEE LATIN AMERICA TRANSACTIONS, VOL. 16, NO. 3, March 2018, PP 885-890.
2. Yaw-Jen Chang, Walter Hong-Shong Chang, Yu-Te Lin, "Detection of RBC Agglutination in Blood Typing Test Using Integrated Light-eye-Technology (iLeyeT)", IEEE International Symposium on Bioelectronics and Bioinformatics (IEEE ISBB 2014), 11-14 April 2014, Chung Li, Taiwan, PP 1-4. DOI:10.1109/ISBB.2014.6820952
3. Yaw-Jen Chang , Ching-Wei Huang, Zh-Wei Chen, Jiun-Yi Chou, Ging-Ho Hsiue, "Design of Microfludic Chip for Blood Typing System", International Conference on System Science and Engineering (ICSSE 2011), 8-10 June 2011, Macao, China, PP 521-524, DOI: 10.1109/ICSSE.2011.5961958.

4. Amol Dhande, Pragati Bhoir, Varsha Gade, "Identifying the blood group using Image Processing", International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 03 , Mar-2018, PP 2639-2642.
5. Rehab S. Ali, Tamer F. Hafez, Ali Badawey Ali, Nadia Abd-Alsabour, "Blood Bag: A Web Application to Manage All Blood Donation and Transfusion Processes", International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 22-24 March 2017, Chennai, India, PP 2125-2130. DOI: 10.1109/WiSPNET.2017.8300136.
6. Radha R. Mahalle, S. S. Thorat, "Smart Blood Bank System Based on IoT", International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 05, May-2018, PP 3836-3839.
7. Haihong Lin, Haotian Yu, Jichun Li, Encai Zhang, Guannan Chen, "Raman Spectroscopy Analysis Based on Fourier Transform for ABO Blood Group Identification", International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI 2017), 14-16 Oct. 2017, Shanghai, China, DOI: 10.1109/CISP-BMEI.2017.8302232.
8. Fazal Noorbasha, M. Manasa, R. Tulasi Gouthami, S. Sruthi, D. Hari Priya, N. Prashanth, And Md. Zia Ur Rahman, "FPGA Implementation Of Cryptographic Systems For Symmetric Encryption", Journal of Theoretical and Applied Information Technology, 15th May 2017. Vol.95. No 9, PP. 2038-2045
9. Fazal Noorbasha, C.H. Vainatheyi, R. Goutham, P. Raviteja, B. Karthik, "Implementation of Image Secured Hybrid AES - DNA Algorithm Using Verilog HDL", Jour of Adv Research in Dynamical & Control Systems, Vol. 10, 02-Special Issue, 2018, PP. 452-458.
10. G Divya, Fazal Noorbasha, "Implementation of DNA Based Cryptography Using OTP Random Key Generation Process", Jour of Adv Research in Dynamical & Control Systems, Vol. 10, 02-Special Issue, 2018, PP. 481-490.
11. Yadlapati, A., Kakarla, H.K. An Advanced AXI Protocol Verification using Verilog HDL (2015) Wulfenia, 22 (4), pp. 307-314.
12. Bindu Bhargavi, K., Hari Kishore, K. Low Power Bist on Memory Interface Logic (2015) International Journal of Applied Engineering Research, 10 (8), pp. 21079-21090.
13. Charan, N.S., Kishore, K.H. Recognization of delay faults in cluster based FPGA using BIST (2016) Indian Journal of Science and Technology, 9 (28).
14. Hari Kishore, K., Aswin Kumar, C.V.R.N., Vijay Srinivas, T., Govardhan, G.V., Pavan Kumar, C.N., Venkatesh, R.V. Design and analysis of high efficient UART on spartan-6 and virtex-7 devices (2015) International Journal of Applied Engineering Research, 10 (9), pp. 23043-23052.
15. Kante, S., Kakarla, H.K., Yadlapati, A. Design and verification of AMBA AHB-lite protocol using Verilog HDL (2016) International Journal of Engineering and Technology, 8 (2), pp. 734-741.
16. Bandlamoodi, S., Hari Kishore, K. An FPGA implementation of phase-locked loop (PLL) with self-healing VCO (2015) International Journal of Applied Engineering Research, 10 (14), pp. 34137-34139.
17. Murali, A., Hari Kishore, K., Rama Krishna, C.P., Kumar, S., Trinadha Rao, A. Integrating the reconfigurable devices using slow-changing key technique to achieve high performance (2017) Proceedings - 7th IEEE International Advanced Computing Conference, IACC 2017, art. no. 7976849, pp. 530-534.
18. A. Surendar, K. H. Kishore, M. Kavitha, A. Z. Ibatova, V. Samavatian "Effects of Thermo-Mechanical Fatigue and Low Cycle Fatigue Interaction on Performance of Solder Joints" IEEE Transactions on Device and Materials Reliability, P-ISSN: 1530-4388, E-ISSN: 1558-2574, Vol No: 18, Issue No: 4, Page No: 606-612, December-2018.
19. N Bala Dastagiri K Hari Kishore "A 14-bit 10kS/s Power Efficient 65nm SAR ADC for Cardiac Implantable Medical Devices" International Journal of Engineering and Technology (UAE), ISSN No: 2227-524X, Vol No: 7, Issue No: 2.8, Page No: 34-39, March 2018.
20. N Bala Dastagiri, Kakarla Hari Kishore "Reduction of Kickback Noise in Latched Comparators for Cardiac IMDs" Indian Journal of Science and Technology, ISSN No: 0974-6846, Vol No.9, Issue No.43, Page: 1-6, November 2016.
21. N Bala Dastagiri, K Hari Kishore "Analysis of Low Power Low Kickback Noise in Dynamic Comparators in Pacemakers" Indian Journal of Science and Technology, ISSN No: 0974-6846, Vol No.9, Issue No.44, page: 1-4, November 2016.
22. Meka Bharadwaj, Hari Kishore "Enhanced Launch-Off-Capture Testing Using BIST Designs" Journal of Engineering and Applied Sciences, ISSN No: 1816-949X, Vol No.12, Issue No.3, page: 636-643, April 2017.
23. Dr. Seetaiah Kilaru, Hari Kishore K, Sravani T, Anvesh Chowdary L, Balaji T "Review and Analysis of Promising Technologies with Respect to fifth Generation Networks", 2014 First International Conference on Networks and Soft Computing,ISSN:978-1-4799-3486-7/14,pp.248-251,August 2014.
24. P Bala Gopal, K Hari Kishore, R.R Kalyan Venkatesh, P Harinath Mandalapu "An FPGA Implementation of On Chip UART Testing with BIST Techniques", International Journal of Applied Engineering Research, ISSN 0973-4562, Volume 10, Number 14 , pp. 34047-34051, August 2015.
25. Avinash Yadlapati, Hari Kishore Kakarla **"**Design and Verification of Asynchronous FIFO with Novel Architecture Using Verilog HDL**"** Journal of Engineering and Applied Sciences, ISSN No: 1816-949X, Vol No: 14, Issue No: 1, Page No: 159-163, January 2019.