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Anemia Diagnosis by Fuzzy Logic Using LabVIEW

Mahammad Firose Shaik
School of Electrical Engineering
VIT University, INDIA
mahammadfirose.shaik2015@vit.ac.in

Monica Subashini M
School of Electrical Engineering
VIT University, INDIA
monicasubashini.m@vit.ac.in

***Abstract*—Anemia is the most common hematological disorder affecting about one-fourth of the global population. Anemia can be defined as a decrease in the amount of hemoglobin in blood or lowered ability of the blood to carry oxygen. It goes unidentified in many people and sometimes symptoms may be undefined. Diagnosing anemia or being aware of the high probability of its occurrence is not an easy task to do. In this paper, we present a fuzzy logic for diagnosing the anemia and implementing the simulation through LabVIEW software. Using the proposed software and based on nine input blood parameters we conclude the existence of anemia and its types (we approached six most common types). And also with this software method of approach, we can employ more diagnosing types of anemia by developing more rules. The advantage of the software is fast evaluation of disease compared to manual analysis**

***Index Terms*—** *fuzzy logic system, Anemia, Anemia diagnosis, fuzzy model.*

I. Introduction

Anemia is one of the general diseases in most of the countries and 2% of the total causalities in the world each year are due anemia. So, the analysis and the treatment for anemia is very ambitious to save people all over the world. Anemia is a condition in which the body does not have adequate red blood cells. As anemia is a hematologic condition, a simple blood test called complete blood count (CBC) is essential for the diagnosis. The common symptom for anemia is feeling weak or fatigue. Analysis is the first step for the cure. Developing a software or computer program, called an expert system, aids in diagnosing the disease [3]. This expert system can reduce the errors.

In order to analyze information as well as collecting and extracting data mining rules we considered laboratory is Dr Kalyan Diagnostic Laboratory Multispecialty Research Centre as an information source. The mentioned database includes nine common parameters to diagnose different types of Anemia. Anemia is a disease which causes the shortage of red blood cells that are needed to provide sufficient Oxygen. Recognizing different types of this disease will help us to detect its symptoms and to prevent it.

The main aim of this paper is using the fuzzy logic in the virtual platform LabVIEW to detect whether the person is suffering from anemia or not and the type of anemia[9]. The conventional methodology is "Venipuncture", where the needle is inserted to draw the blood and the blood sample is tested. The sample count value is calculated by the laboratory persons and depending on the count value doctor decides the disease and here instead of doctor, the software detects the disease [4]. The fuzzy logic is very useful for the expert system the rules in the fuzzy logic are framed after consulting the doctor. Hence the doctor's decision making is same as the software result. In this paper we detect whether anemia is present or not and type by considering nine input blood parameters input parameters including Hemoglobin, Hematocrit, Mean corpuscular volume (MCV), Mean corpuscular hemoglobin concentration (MCHC), White blood cells (WBC), Total iron binding capacity (TIBC), Serum iron, Hyper segmented and Reticulocyte. We investigated Aplastic anemia (AA), Chronic anemia, Iron deficiency, anemia, Sideroblastic anemia, Myelophitisic anemia and Megaloblastic anemia types of major anemias by using this software and can, even more, diagnose types of anemia by developing more rules.

The main advantage of this diagnosing software is a fast evaluation of the disease. Comparing nine inputs and generating a result by the doctor takes time but by this software saves the time and more applications can be developed by using LabVIEW in Bio-medical field. The paper is structured as follows in section II we present the major types of anemia. The details of rules framing in fuzzy are explained in section III, the LabVIEW programming and the performance of proposed software in section IV. Finally, in section V, we present conclusion and future work.

II. Types of Anemia

In this subsection, we introduce most common types of Anemia.

Aplastic anemia (AA): It is caused due to the failure of bone marrow. This leads to the inability of bone marrow in replacing new blood cells. It can be due to the factors which destroy stem cells or due to a change in the bone marrow. This leads to the reduction of all three types of blood cells (pancytopenia) red blood cells (anemia), white blood cells (leucopenia), and platelets (thrombocytopenia). The term Aplastic refers to the impotence of the stem cells to produce the mature blood cells. This is rare but serious blood disorder leading to health issues of heart and lungs. The primary symptoms are bleeding and infections.

Chronic Anemia: It is a form of anemia observed in chronic infection, chronic immune activation, and malignancy. The high increase in the production of Interleukin-6 activates the hepcidin production that releases from the liver which reduces the iron carrier protein called ferroportin. This reduces the access of iron to the circulation. The mechanisms such as reduced erythropoiesis may also play role. Anemia of chronic inflammation is the preferred term since not all chronic diseases are associated with this form of anemia.

Iron deficiency Anemia: Iron deficiency is referred to circumstances where the amount of Iron existing in blood is decreased drastically. This kind of Anemia is common among teenagers and women before their Menopause. Blood loss during menstruation, chronic blood loss in case of peptic ulcer, hiatal hernia gastrointestinal bleeding, lack of iron in the diet, inability to absorb iron due to intestinal disorder, frequent blood donation can cause iron deficiency anemia.

Sideroblastic Anemia: It is a form of anemia in which the body is unable to utilize the available iron to produce haemoglobin that leads to the accumulation of iron in the mitochondria of red blood cells producing ringed side oblasts rather than healthy red blood cells. The sideroblastic anemia may be inherited or acquired

Myelophthisic Anemia: In this type of anemia the bone marrow fails because the normal bone marrow tissues are replaced by the abnormal tissues that restrict the production of red blood cells and platelets. This displacement is caused by fibrosis, tumors or granulomas.

Megaloblastic Anemia: Megaloblastic anemia is one of the macrocytic anemias. In this, the bone marrow produces large, abnormal, immature red blood cells. Due to abnormalities in the DNA synthesis, the cell growth is continued without division. The deficiencies of vitamin B12 (cobalamin) or vitamin B9 (folate) are the major causes of this type of anemia as these are the building blocks of healthy blood cell production.

III. FUZZY SYSTEM

The Fuzzy system is an extension of classical logical system. This system is very effective while dealing the cases with uncertainty and imprecision [1]. In this paper, fuzzy logic is implemented for evaluating the common types of anemia based on the parameters considered [8]. These are more helpful in the diagnosis than other symptoms. Based on the laboratory data the fuzzy rules are constructed [5].

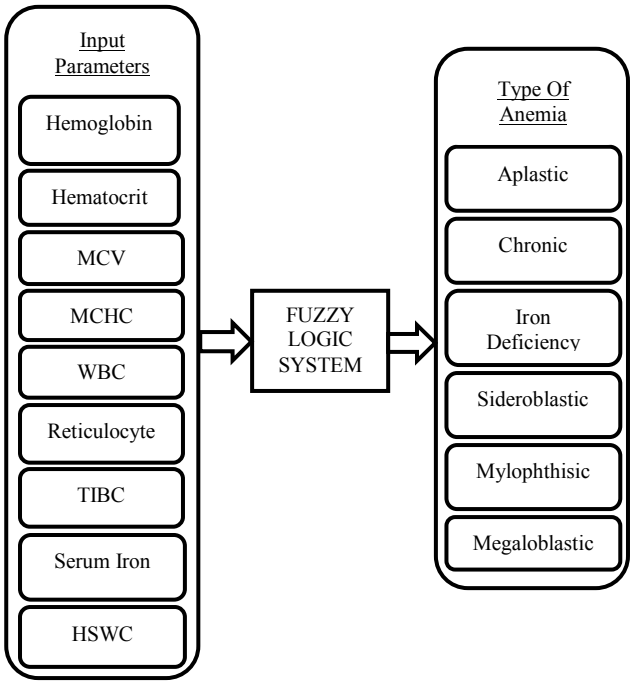

Figure 1. Anemia detection using fuzzy system

The procedure to define the fuzzy system [2] is

- Define the input-output variables i.e. linguistic variables
- Construct membership functions
- Fuzzification
- Construct IF-ELSE rules (fuzzy rules)
- Evaluating the rules
- Obtaining the output (interference)
- Defuzzification

The parameters are divided as very low (VL), low (L), medium (M) and high (H). Hyper segmented white cells are indicated as absent (A) and present (P) and the severity of each type of anemia is presented in three levels low (L), Medium (M) and high (H).

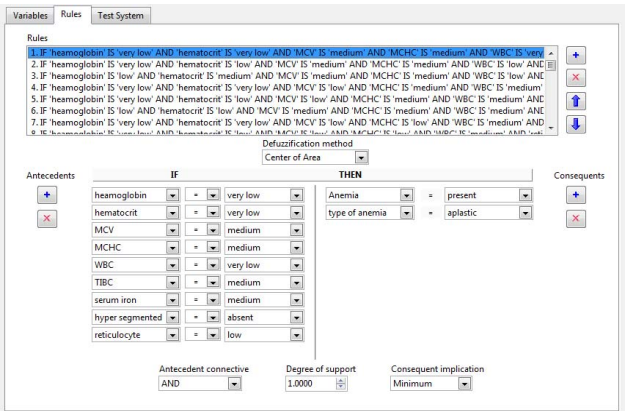

Figure 2. showing Aplastic anemia presence by writing the rules in rules section in fuzzy system designer

The framed fuzzy rules for the diagnosis of anemia are presented in table.1 and are implemented in fuzzy designer. The presence of aplastic anemia is shown in figure.2. The six types of anemia are examined based on the level of input parameters. Primarily the fuzzy system gives the information about the presence of anemia and it is able to indicate the severity of each type of anemia. Here, we considered only six types of anemias as these are the most common. If none of the types of anemia is highlighted but the presence of anemia is displayed then it is to be considered that the type of anemia is other than the considered six types of anemias.

The membership functions and rules are retrieved from the FL fuzzy load which contains the .fs (dot fs) file. The .fs file is a file from fuzzy system designer where we design the membership functions for the input and rules are generated. This file is appended to the Fl fuzzy load. The crisp output is compared with a constant and according to the relation the case executes. The case structure is used to execute the cases. The front panel is a user interface panel where we enter the crisp inputs and the related output is displayed. After the sample is tested the generated values are entered in the front panel.

Table 1. Fuzzy rules to detect presence of anemia and anemia

Type of anemia	Aplastic anemia			Chronic anemia			Iron deficiency			Sideroblastic anemia			Myelophitisic anemia			Megaloblastic anemia		
Anemia Condition	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**	**H**	**M**	**L**
Hemoglobin	VL	VL	L	VL	VL	L	VL	VL	L	L	L	L	L	L	L	VL	VL	L
Hematocrit	VL	L	M	V .L	L	L	VL	L	L	L	L	L	L	L	L	VL	L	L
MCV	M	M	M	L	L	M	L	L	L	L	M	H	M	M	M	H	H	H
MCHC	M	M	M	M	M	M	L	L	L	L	L	L	M	M	M	M	M	M
Reticulocyte Count	L	L	L	L	M	M	L	L	L	M	M	H	L	L	L	L	VL	L
WBC	VL	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	L	L
TIBC	M	M	M	L	L	L	H	H	H	H	H	H	M	M	M	M	M	M
Serum iron	M	M	M	L	L	M	L	L	L	H	H	H	M	M	M	M	M	M
Hyper segmented	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P

IV. SOFTWARE IMPLEMENTATION USING LABVIEW

LabVIEW is the abbreviation for Laboratory Virtual Instrumentation Engineering Workbench. It is a platform for a visual programming language and is developed by National Instruments. LabVIEW programs are known as virtual instruments, or VIs, because of their appearance and imitation of physical instruments operation, such as oscilloscopes and multi meters. LabVIEW contains a set of tools for acquiring, analyzing, displaying, and storing data, as well as tools to help you troubleshoot code you write.

The laboratory tests do not give conclusive results always. In such a case the fuzzy logic is useful for diagnosing anemia [7]. The doctor may struck to conclude the type of anemia from the laboratory reports. The fuzzy logic with the concept of membership function helps the diagnosis by giving the highest possibility options. The steps and their implementation are discussed in the following sections along with their respective results.

The figure.3 shows the block diagram for diagnosis of anemia. The fuzzy controller gives the crisp output according to the rules in the rules base [1,2,6]. The total no of input considered in this diagnosis are nine and we can increase our inputs if necessary. These nine values are given as inputs to the fuzzy controller which fuzzifies the input and gives the crisp output.

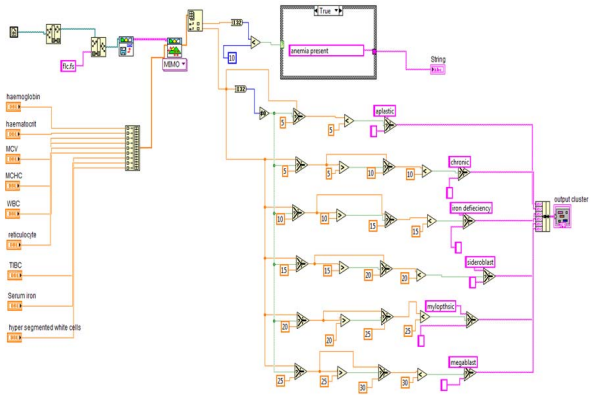

Figure 3 The block diagram of diagnosis in LabVIEW

The front panel is a user interface panel where we enter the crisp inputs and the related output is displayed. After the sample is tested the generated values are entered in the front panel. Based on different test results, the presence of different types of anemia are displayed in the user interface panel. In figure.4 the test is conducted for a healthy person and the status of string is displayed as anemia absent. A low level of blood parameters resulted in aplastic anemia and chronic anemia shown in figure 5(a) and figure 5(b) respectively. The low level of hemoglobin, hematocrit, reticulocyte count, MCV, MCHC and a high level of TIBC resulted in iron

deficiency anemia in figure 5 (c). Different iron deficiency anemia cases are considered here such as iron 4th anemia shown in figure 5 (d), iron MY anemia shown in figure 5 (e). The high level of MCV and the presence of hypersegmented whitecells show the presence of megaloblastic anemia presented in figure 5 (f).

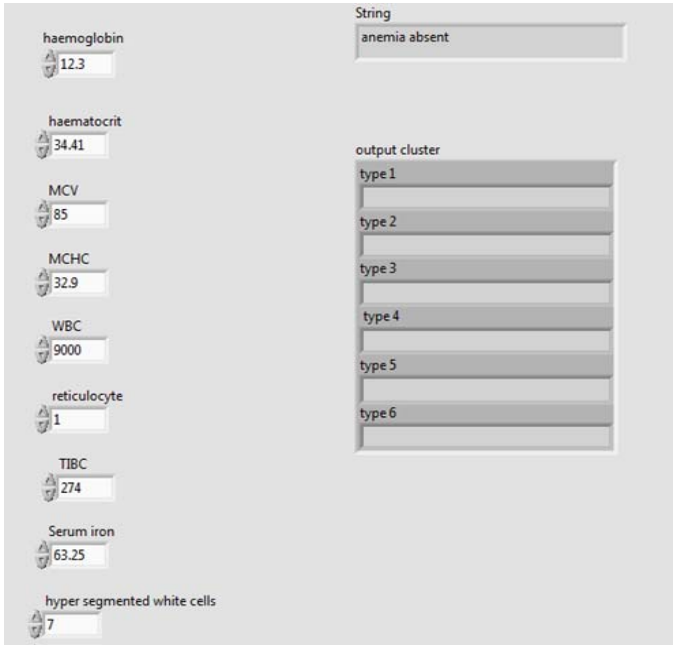

Figure 4: Anemia absent case

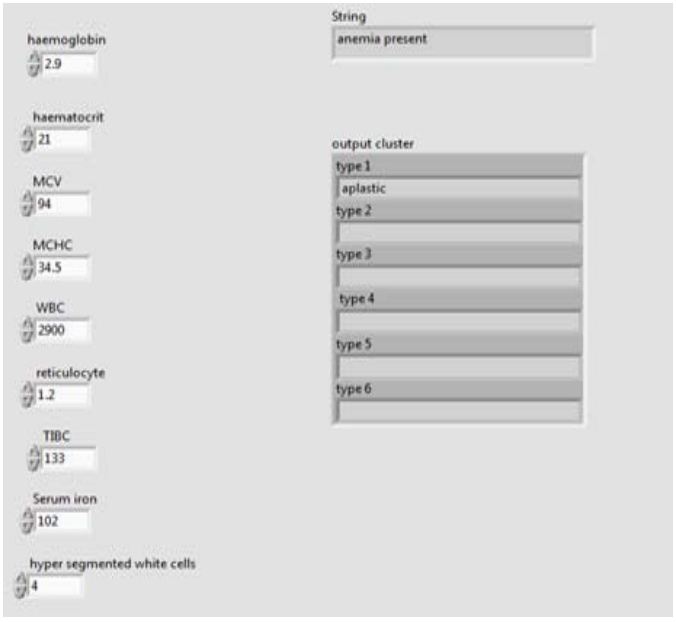

Figure 5(a). Identification of Aplastic anemia

Figure 5 (b). Identification of Chronic anemia

Figure 5(c). Identification of Iron Deficiency anemia

Figure 5(d). Identification of Sideroblastic anemia

Figure 5(e). Identification of Myelophthisic anemia

Figure 5(f). Identification of Megaloblastic anemia

V. Conclusion

This paper presents a new approach for the design and diagnosis of anemia using the concept of fuzzy logic in LABVIEW. With the laboratory test results, anemia is diagnosed and reported immediately. The method adapted here gave accurate results consistently in different cases assuring the reliability and robustness of the system.

Based on the requirements and conditions the rules in the fuzzy logic system can be modified. So any medical practitioner can be able to implement this software to diagnose anemia and other diseases also. The program work is carried out to design a fuzzy system that is able to give the dietary suggestions and medical advises for the control of respective type of anemia based on its level of severity in future.

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Mahammad Firose Shaik received B.Tech degree in electronics and instrumentation engineering from Jawaharlal Nehru Technological University, Kakinada and M.Tech degree in electronics and communication engineering from Andhra University, Visakhapatnam. Currently he is pursuing PhD in VIT University Vellore. His interests are in the area of wireless body area communication, micro electro mechanical systems and virtual instrumentation.

Monica Subashini is working as an Associate professor in the school of Electrical engineering, VIT University. She completed B.Tech in electronics and instrumentation in the year 2001 and M.Tech in Applied Electronics in the year, 2007. She obtained her doctoral degree from VIT University in 2014. Her research area includes, Sensors and Signal conditioning, Bio-Imaging and 3D Modelling. Dr. Monica also works in the area of Semiconductor devices and circuits, VLSI and Wireless networks.