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Detection of Anemia using Fuzzy Logic

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Abstract**:** Medical Science is considered as a field of uncertainty, vagueness and complexity. Fuzzy logic plays an important role to deal with these uncertainty, vagueness and complexity. Detection of diseases in medical is a very difficult task. To improve accuracy rate engineers helping in detection of the diseases by developing the Expert System using Fuzzy Logic. Fuzzy logic consists of many valued logic. It has varying values in the range of 0 and 1 instead of fix values. In this study, we developed a Fuzzy Expert system to detect Anemia on the basis of Symptoms as well as clinical test.

Keywords: **Anemia, Fuzzy Logic, Fuzzy Expert System, CBC Test**

1. INTRODUCTION

The blood that circulates throughout the body performs a number of critical functions. It delivers oxygen, removes carbon dioxide CO_2, and carries life sustaining nutrition's. By acting as the vehicle for long-distance messengers such as hormones, blood helps the various parts of the body communicate with each other. This is carried out by blood cells through working in partnership with the liquid part of the blood (plasma). Anemia is a condition where number of healthy RBC in the blood is lower than normal. It is due to low RBC's, destruction of RBC's or loses of too many RBC's. If your blood does not have enough RBC's, your body doesn't get enough oxygen it needs. As a result you may feel tired and other symptoms. But sometimes it is very difficult to detect anemia on the basis of symptoms only. In the domain of Anemia there is no such boundary between what is healthy and what is diseased. Having so many factors to detect anemia makes doctor's work difficult. So, Experts require an accurate tool that considering these risk factors and give some certain result for uncertain terms.

2. LITERATURE REVIEW

When the studies in the literature related with this classification application are examined, it can be seen that a great variety of methods were used. Among these, [5] Fuzzy System have been used to diagnose the different types of anemia on the basis of symptoms such as Irritability, tachycardia, Memory weakness, Bleeding and Chronic fatigue. Another, [6] diagnose Liver disease using fuzzy logic on the basis of CBC Test which uses 4 parameters such as WBC, HGB, HCT and PLT. [7] Ali.Adeli, Mehdi. Neshat proposed a system to diagnose the heart disease using fuzzy logic. [8] Nidhi Mishra and Dr. P Jha also develop a fuzzy expert system to diagnose the Sickle Cell Anemia.

3. OBJECTIVES

The Objectives are:

1. Detect Anemia using Fuzzy Logic.
2. Classify Anemia on the basis of Accuracy.

4. DESIGN MODEL

4.1 Introduction

Three steps are used to monitor general health and Anemia. But we are focusing only on the Tests and Procedures. Three steps are as follows:

1. Medical and Family Histories
2. Physical Exam
3. Tests and Procedures.

4.2 Design of Fuzzy Logic System

Design model divided into five steps:

1. Problem Specification & define linguistic variables.
2. Define Fuzzy sets.
3. Define Fuzzy Rule.
4. Encode Fuzzy Sets, Fuzzy Rules and Procedures to build Expert System.

5. METHOD

we describe the designing of the fuzzy expert system.

5.1 Design a Fuzzy Logic System

5.1.1 *Problem Specification & Define linguistic variables:* There are 3 input variables and 1 output variables.

Linguistic Variables:

- **For Input Variables**

Table 1 Linguistic Variables for Input Variables

S.No.	Input Variables	Linguistic Variables
1	Hemoglobin	HGB
2	Mean Corpuscular Volume	MCV
3	Mean Corpuscular Hemoglobin Concentration	MCHC

- **For Output Variables**

Table 2 Linguistic Variables for Output Variables

S.No	Output Variables	Linguistic Variables
1	Anemia	Types of Anemia

5.1.2 Define Fuzzy Sets:

- **Input Variables & Value Ranges:**

Table 3 Values for all Input Linguistic Variables[6]

S.No.	Linguistic Variable	Ranges	Values
1	HGB	5 - 13.8 grams/deciliter	Low
		13.9 to 16.3 grams/deciliter	Medium
		16.4 – 18 grams/deciliter	High
2	MCV	60 – 79.9 fl	Low
		79.9 to 100 fl	Medium
		100.1 - 120 fl	High
3	MCHC	28 - 31.9 grams/deciliter	Low
		32 - 36 grams/deciliter	Medium
		36.1 - 40 grams/deciliter	High

- **Output Variables & Value Ranges:**

Table 4 Values for all Output Linguistic Variables[6].

S.No.	Linguistic Variable	Ranges	Values
1.	Types of Anemia	HGB is 5 – 13.8 g/dl	MicroCytic HypoChromic
		MCV is 60 – 79.9 fl	
		MCHC is 28 – 31.9 g/dl	
2.		HGB is 5 – 13.8 g/dl	MicroCytic NormoChromic
		MCV is 60 – 79.9 fl	
		MCHC is 32 - 36g/dl	
3.		HGB is 5 – 13.8 g/dl	MicroCytic HyperChromic
		MCV is 60 – 79.9 fl	
		MCHC is 36.1 - 40 g/dl	
4		HGB is 5 – 13.8 g/dl	NormoCytic HypoChromic
		MCV is 80 - 100 fl	
		MCHC is	

		28 – 31.9 g/dl	
5		HGB is 5 – 13.8 g/dl MCV is 80 - 100 fl MCHC is 32 - 36 g/dl	NormoCytic NormoCHromic
6		HGB is 5 – 13.8 g/dl MCV is 80 - 100 fl MCHC is 36.1 – 40 g/dl	NormoCytic HyperChromic
7		HGB is 5 – 13.8 g/dl MCV is 100.1 – 120 fl MCHC is 28 – 31.9 g/dl	MacroCytic HypoChromic
8		HGB is 5 – 13.8 g/dl MCV is 100.1 – 120 fl MCHC is 32 - 36g/dl	MacroCytic NormoCHromic
9		HGB is 5 – 13.8 g/dl MCV is 100.1 – 120 fl MCHC is 36.1 – 40 g/dl	MacroCytic HyperChromic

5.1.3 Define Fuzzy Rules:

As we have total 3 input variables so total number of possible non conflicting fuzzy inference rules are $3^2 =$ 9 rules.

First 3 rules are for Symptoms based testing:

1. If (irritation is Effective) && (Heart_Rate is High) && (Disorder is cancer) then HGB is low.
2. If (irritation is Effective) && (Heart_Rate is High) &&(Disorder is cancer) && (Blood_Loss is Stomach / intestine bleeding) then HGB is low.
3. If (irritation is Effective) && (Heart_Rate is High) && (Disorder is cancer) && (Blood_Loss is Stomach / intestine bleeding) && (Weak_Memory is Effective) then HGB is low[5].

Further, 3 rules are for the classification of anemia on the basis of MCV only:

4. If (HGB is Low) && (MCV is Low) then MicroCytic is High.
5. If (HGB is Low) && (MCV is Medium) then NormoCytic is high.
6. If (HGB is Low) && (MCV is High) then MacroCytic is high.

At last 9 rules are for the further classification of anemia on the basis of all three parameters such as HGB, MCV, & MCHC.

7. If (HGB is Low) && (MCV is Low) && (MCHC is Low) then MicroCytic is HypoChromic.
8. If (HGB is Low) && (MCV is Low) && (MCHC is Medium) then MicroCytic is NormoChromic.
9. If (HGB is Low) && (MCV is Low) && (MCHC is High) then MicroCytic is HyperChromic.
10. If (HGB is Low) && (MCV is Medium) && (MCHC is Low) then NormoCytic is HypoChromic.
11. If (HGB is Low) && (MCV is Medium) && (MCHC is Medium) then NormoCytic is NormoChromic.
12. If (HGB is Low) && (MCV is Medium) && (MCHC is High) then NormoCytic is HyperChromic.
13. If (HGB is Low) && (MCV is High) && (MCHC is Low) then MacroCytic is HypoChromic.
14. If (HGB is Low) && (MCV is High) && (MCHC is Medium) then MacroCytic is NormoChromic.
15. If (HGB is Low) && (MCV is High) && (MCHC is High) then MacroCytic is HyperChromic[6].

Table 5 Illustration of applied rules with Respect to MF[6]

Rule No.	**Linguistic Variable 1**	**Linguistic Variable2**	**Linguistic Variable 3**	**Result**

	(HGB)	(MCV)	(MCHC)	
1	Low	Low	Low	MicroCytic is HypoCHromic
2	Low	Low	Medium	MicroCytic is NormoChromic
3	Low	Low	High	MicroCytic is HyperChromic
4	Low	Medium	Low	NormoCytic is HypoChromic
5	Low	Medium	Medium	NormoCytic is NormoChromic
6	Low	Medium	High	NormoCytic is HyperChromic
7	Low	High	Low	MacroCytic is HypoChromic
8	Low	High	Medium	MacroCytic is NormoChromic
9	Low	High	High	MacroCytic is Hyperhromic

5.1.4 Build Fuzzy Expert System:

Form:

Figure 1 Input Form

6. RESULTS AND DISCUSSION

Table 6 Input Values for Results

S. No	Input Variable	Values Ranges	Ranges Selected
1	HGB	10.9 g/dl	5< 10.9 < 18 g/dl
2	MCV	31.00 fl	60< 31.00 < 79.9 fl
3	MCHC	30 g/dl	28< 30 <31.9 g/dl

Figure 2 Result from given Input Values

7. CONCLUSION

In this paper, fuzzy logic is applied to classify and detect Anemia on the basis of CBC Test. The success of fuzzy detection in its application to a real clinical case shows that fuzzy detection is an improvement of probabilistic logic. Results have been shown from this fuzzy expert system with past time expert system are more efficient and less expensive. It detect anemia on the basis of both Symptoms and CBC Test. From the viewpoint of an end-user, the results of this work can facilitate laboratory work by reducing the time and cost.

8. FUTURE WORK

The future work will focus on developing a machine learning approach to classify different types of anemic RBCs in microscopic images. The method described in this dissertation can be extends in future very efficiently. We can classify anemia on the basis of RBC structure using digital image processing. We can also provide some CBC reports and load that report as it is in our system and detect anemia in future. We can also detect anemia and classify it only on the the basis of CBC Test without using symptoms test.

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