

# Fuzzy Logic Based Expert System for Detecting Colorectal Cancer

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**Abstract** - Colorectal cancer (or bowel cancer) which occurs in both men and women around the world. It is called the silent killer. The death rate of colorectal cancer are greater in men than in women. It happens most commonly after age 50. The aim of this paper is to implement a fuzzy rule based expert system for detecting the colorectal cancer which assists the doctors to identify disease easily. It is an intelligent decision making system. Because fuzzy rule based expert system provides more accurate result than in traditional system. It considered uncertainty issues like ambiguity, vagueness and imprecision whereas traditional system could not handle it. To accomplish the diagnosis process taken different risk factor, signs and symptoms from patients and experts (doctors). Fuzzy rule based expert system consists of four parts such as knowledge base, fuzzifier, Fuzzy rule inference engine, defuzzifier. We used mat lab to design a fuzzy rule expert system based on Mamdani technique.

**Key Words:** Colorectal cancer diagnosis, Fuzzy logic, Expert System, Inference engine, Sign and symptoms, Risk factors.

## 1. INTRODUCTION

Colon and rectal cancer are combine known as colorectal cancer. According to American cancer society, colorectal cancer is the third leading cause of cancer death in both men and women. It causes 50,000 deaths per year. The peptic part of the human body are the colon and rectum which is also known as gastrointestinal (GI) system. The digestion process involves with small intestine and large intestine (colon and rectum). Generally cancer occurs in large intestine than in small intestine. The large intestine consists of two parts, first part is the colon and the second part is the rectum. The sign and symptoms of colorectal cancer depend on the location of cancer where it is creates. Colorectal cancer grows in the human body in slowly. That's why it is called the silent killer. Cancer starts from the polyp (tumour) and gradually it affects whole body. There are two common type of polyps: Adenomatous polyps, and inflammatory polyps are frequently seen in human body which causes cancer. Apr. 96% colorectal cancer are adenocarcinomas (grows in glandular cell). From my previous paper, colorectal cancers are categorized as sporadic (80%) and familial or hereditary (20%) colorectal cancer. Sporadic means patients have no previous family history, whereas hereditary means patients have family history of the disease [1] [2] [3] [4]. Most of the people are affected by this disease for Sporadic.

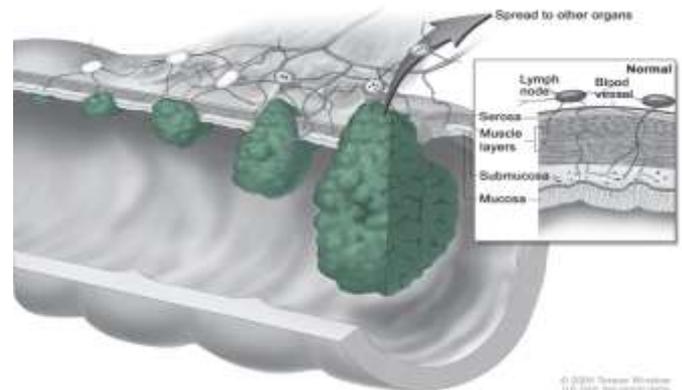


Figure 1: Colorectal cancer growth [2]

There are so many risk factors, sign and symptoms are included with colorectal cancer. Doctors cannot diagnosed colorectal cancer based on one sign and symptoms. Some symptoms are noticeable and some are not noticeable in early stage. Most Patients ignore some common symptoms like diarrhea, abdomen pain etc. But this type of symptoms are alarming for patients. Because it is one of the symptom which causes cancer gradually. So doctors do not get enough information for diagnosis cancer. It arises uncertainty. The main objective of this paper is to handle uncertainty through fuzzy logic expert system. Fuzzy logic can handle various types of uncertainty such as ambiguous, imprecision and vagueness.

## 2. LITERATURE REVIEW

Fuzzy logic was conceived by Lotfi Zadeh, a professor at the University of California at Berkley. It is a problem-solving control system methodology. The application of fuzzy logic has radically increased since 1990, ranging from production, finance, marketing and other decision making problems to micro-controlled based process system and large-scale process control systems. Besides it is used in various sectors such as diagnosis of different type of disease (Lung cancer [11], heart disease [8], Epistaxis [9], cardiac diseases [6]), evaluation of education system, Students' performance evaluation [10], projects evaluation and so many. All of these paper has proved that the fuzzy rule based system provides more accurate result than traditional system. Ramjeet Singh Yadav, P. Ahmed was proposed a fuzzy set based algorithm named C-Means clustering algorithm for academic performance evaluation. This system handles imprecision and lost data [12]. Fuzzy expert system plays an important role in the medical sector for diagnosis of different disease. It brings out fruitful results using quantitative and qualitative data analysis. Farzad Vasheghani et al. was proposed type-2 fuzzy inference engine for diagnosis of Lung cancer. This

system consists of two-step process, one step is taking risk factor and another takes symptoms. This system only showed two factors age and score [11]. From my previous paper, I explained belief rule based expert system for detecting colorectal cancer [4] and got an effective results. In this paper we had used nine sign and symptoms and divide them into three categories. This paper tries to bring out ignorable sign and symptoms rather than all common symptoms. Most of the patients were unable to explain these sign and symptoms clearly. Diarrhea, abdominal pain etc. is a common type of disease. Maximum patients cannot elucidate for how many times they are suffering by diarrhea or when his/her pain is started. Even they don't notice their bowel movement, blood in the stool. But this is the critical sign and symptoms for colorectal cancer patients. Despite of being good knowledge experts (doctors) are not capable to identify all symptoms as well as disease proficiently. The reason behind of it: gap of communication, inexperience, false test and report or shortage of test. This system helps to the doctors to diagnosis disease efficiently. If anytime Patients sees any abnormality in their body, they can easily use this system without any cost. Moreover the fuzzy logic expert system handles uncertainty issues and delivered accurate results.

### 3. OVERVIEW OF AN EXPERT SYSTEM AND FUZZY INFERENCE SYSTEM

Expert system which is computer programs that acts as a human expert. It consists of two main parts such as knowledge base and inference engine. The knowledge base stores sign and symptoms, rules and all related data as an input. Then Inference engine is applied to convert input values into output values (produce new knowledgeable information) using IF-THEN rules. Fuzzy expert system working with four main parts 1) Fuzzification 2) knowledge base 3) Fuzzy inference engine and 4) Defuzzification. 1st step, Fuzzification: Collected input values and convert input values into degree of membership function using linguistic values. In this paper used high, medium and low as linguistic values. 2nd step, Knowledge base stores all information. It consist of sign and symptoms which is stored into the database and fuzzy if-then rules. Inference engine is applied on fuzzy rules for implementing various operations. Finally, Defuzzification converts the inference results into crisp output values. The steps of Fuzzy inference expert system:

- A. Crisp input values
- B. Fuzzification
- C. Fuzzy Rule Inference system
- D. Defuzzification
- E. Crisp output values

The architecture of an expert system and fuzzy inference system have showed in below figure 1 and 2.

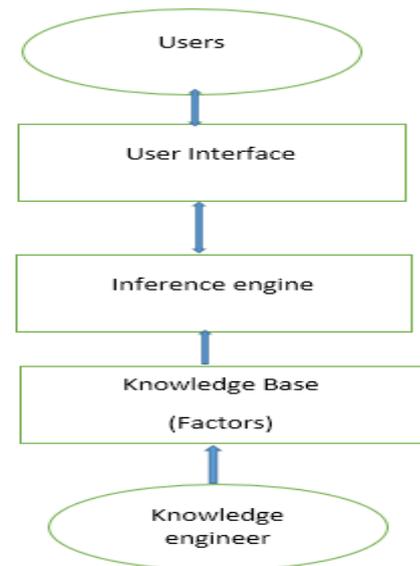


Fig-1: The architecture of an Expert system

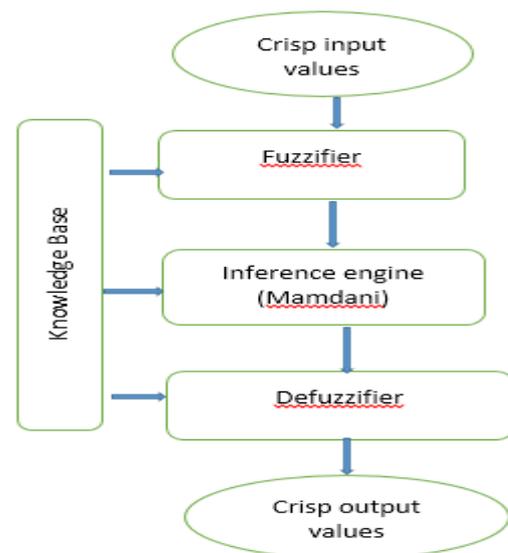


Fig 2: The architecture of Fuzzy Inference system

### 4. IMPLEMENTATION OF THE SYSTEM

In this paper we design a fuzzy logic based expert system for detecting colorectal cancer. This system consists of various sign and symptoms and risk factors. The aim of this paper to assist those people who are not concern about colorectal cancer and ignored common sign and symptoms. There are several factors which causes cancer and this factors are seen when cancer has developed. In early stage patients ignores some common symptoms like abdominal pain, diarrhea, weakness and fatigue etc. If anyone loss his/her Weight gradually like 10 pounds or more in six months or less so it could be a sign of cancer. Another one is long-term abdominal pain. Besides weakness and fatigue which are also sign and symptoms of heart, diabetes and anemia. Most of the symptoms are unnoticeable but it could be a alarming

sign for patients. To detect the possibility of colorectal cancer this paper emphasizes on five unnoticeable sign and symptoms abdominal pain, diarrhea, rectal bleeding, unexpected weight loss, and weakness and fatigue. Here we used nine sign and symptoms and divide them into three categories. The sign and symptoms of colorectal cancer are shown in below Table 1 [4].

**Table 1:** Factors of Colorectal cancer

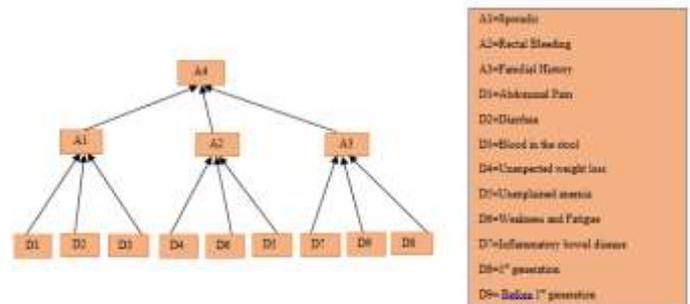
Risk factors	Sign and symptoms	Uncertainty
Familal or hereditary history	<ul style="list-style-type: none"> <li>Inflammatory bowel disease</li> <li>1st generation</li> <li>Before 1st generation</li> </ul>	Incompleteness
Sporadic	<ul style="list-style-type: none"> <li>Abdominal pain</li> <li>Diarrhea</li> <li>Blood in the stool</li> </ul>	Ignorance, Imprecision, Incompleteness
Rectal bleeding	<ul style="list-style-type: none"> <li>Unexpected weight loss</li> <li>Unexplained anemia</li> <li>Weakness and fatigue</li> </ul>	Ambiguous, Imprecision, vagueness

Here we ignored unnecessary symptoms and have taken alarming sign and symptoms which are common but most of the patients doesn't think it. The process of fuzzy inference expert system consists of fuzzy logic designer, membership function for both input and output values, Fuzzy rule editor, Rule viewer for fuzzy logic and surface viewer. There are three input such as Sporadic, Rectal-bleeding and Genetics/Familal history considered as antecedent part and one output that is Colorectal cancer which is consequent. Each of the input consists of three attributes. The attribute of Sporadic are abdominal pain, Diarrhea and blood in the stool; attribute of rectal-bleeding are unexpected weight loss, unexplained anemia and weakness and fatigue and the attribute of familal history are inflammatory bowel disease, 1<sup>st</sup> generation and before 1<sup>st</sup> generation. In fig-4 showed that the overall information of CRC. Fig-5 shows the membership function for input and output values. We determine the membership function using linguistic variables such as high, medium and low for both input and output values. For example: Sporadic range of high 80-100, medium 50-75 and low 0-45. From the consultation of doctors we have collected all data. In fuzzy logic there are 3 input and the total number of rules is 27. Fuzzy inference expert system are applied for 27 rules are shown in fig-6 and fig-7. In fig-7 showed that the first three columns for input values(antecedent part ) and the right one column for output values (consequent part).

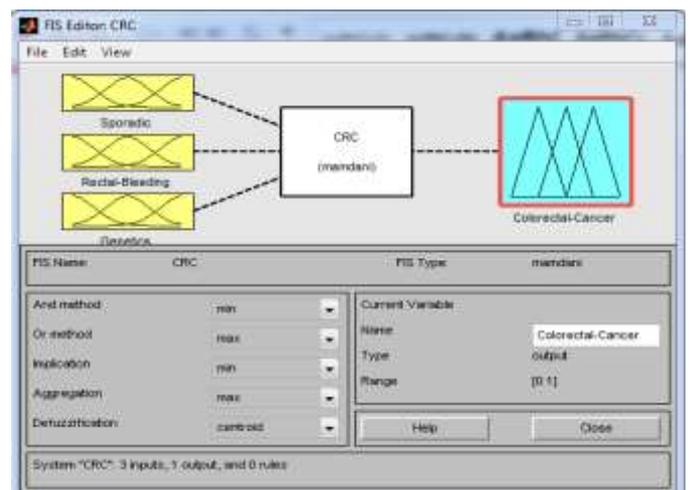
Here applied Fuzzy IF-THEN rules for both columns. For example:

"If sporadic is Low and rectal bleeding is high and genetics is high then the suspicion of Colorectal cancer is high".

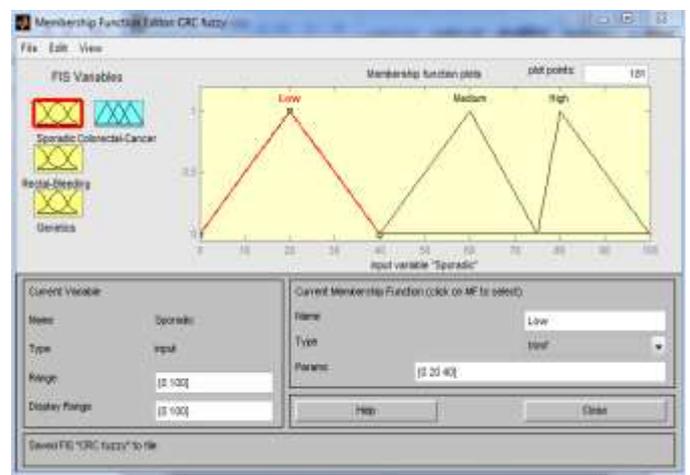
After fuzzification and defuzzification we reached our final crisp output values. The fuzzy logic based expert system provides more accurate results than traditional system. From my previous paper, the heirarchical representation of Colorectal cancer have showed in below [4]:



**Fig-3:** The heirarchical representation of CRC [4]



**Fig-4:** Input and output form of fuzzy logic using MATLAB



**Fig-5:** Membership function of fuzzy logic

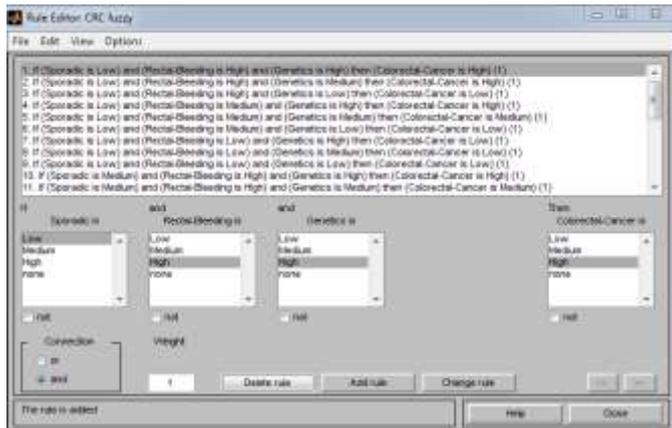


Fig-6: Rules used for fuzzy logic

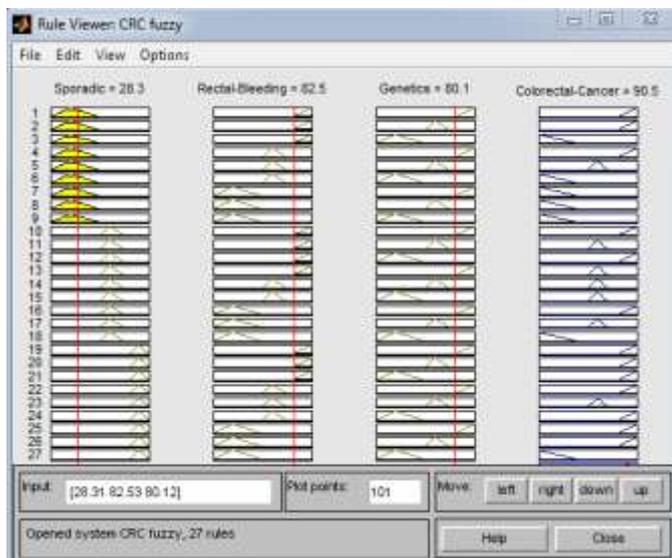


Fig-7: Rules viewer for fuzzy logic

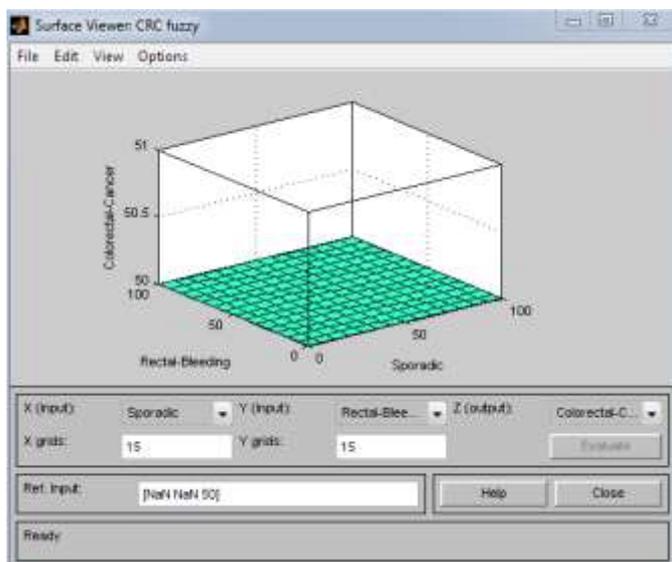


Fig-8: Surface view for the factors

### 5. CONCLUSIONS

In our Bangladesh most of the people are living with poverty. Most of the people are not going to the doctors for regular check-up. Screening is the best test for early detection of cancer. Early detection of cancer may save our life. The objective of my paper is to design a user friendly fuzzy logic based expert system for the detection of colorectal cancer. Therefore people may get proper result by using this system. This system could be helpful for doctors to making their decision easily. Sometimes experienced doctors are not able to detect proper disease because of uncertainty issues. Here we considered all ignorable sign and symptoms for assess colorectal cancer. Fuzzy logic based expert system can handles uncertainty.

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