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Enhanced Fuzzy Rule Based Diagnostic Model for Lung Cancer using Priority Values

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***Abstract*— In this paper we design a fuzzy rule based medical model to detect and diagnose lung cancer. The disease is determined by using a rule base, populated by rules made for different types of lung cancer. The algorithm uses the output of the rule base (i.e. the disease name) and the symptoms entered by the user; it also uses the priority and severity values to determine the stage of cancer the patient is in. Both these results (disease name and stage) help the diagnostic logic to determine the treatment for the patient with accuracy. Our medical diagnosis deals with a complex analysis of all the information gathered about our symptoms. Domain expert's knowledge is gathered to generate rules and stored in the rule base and the rules are fired when there exist appropriate symptoms. The system is implemented for the medical diagnosis and treatment for the patients as well as it can be used to assist the doctors.**

***Keywords*— Fuzzy rule base, medical diagnosis, priority value, stages and lung cancer.**

I. Introduction

The advent of computers and information technology in the recent past has brought a drastic change in the fuzzy rule based model. Information gathered from the domain experts must be transferred to knowledge and must be used at the right time .These Knowledge can be incorporated in the form of fuzzy model in the detection and diagnosis of lung cancer. Lung cancer is the most common cause of death in both men and women throughout the world. The American Cancer Society estimates that 219,440 new cases of lung cancer in the U.S. will be diagnosed and 159,390 deaths due to lung cancer will occur in 2009. According to the U.S. National Cancer Institute, approximately one out of every 14 men and women in the U.S. will be diagnosed with cancer of the lung at some point in their lifetime. The lung cancer is the most difficult cancer to be treated. Every year ten millions of people die with lung cancer [1].

Lung Cancer is the second most dangerous disease in the world (for example: Small Cell Lung Cancer, Non-small Cell Lung Cancer). However, there are many effective medicines which can cure these lung cancers, the danger is that the patients always ignore some initial symptoms of lung diseases and they are only afraid when those symptoms are likely to appear. But at that time, it seems to be more difficult to treat those diseases. In diagnosing lung cancer, doctors have to cope with many difficulties, the patient's symptoms are usually not clear; the similarities in some lung disease's symptoms are difficult to identify. Doctors always have to test many times before making a decision. So the diagnosis result depends on not only patient's symptoms but also the doctor's experiences. Lung cancer is now still popular and very dangerous disease in many countries in the world. Patients are unaware of some initial symptoms of lung diseases. The principal cause is that patients always go to hospital at a critical stage when treatment becomes difficult. Also, doctors are dubious about some similarities in lung diseases. Wrong decision means wrong treatment and the patient would suffer more.

II. Related Work

Researchers developed many methods to diagnose lung cancer. An expert system is designed to diagnose the heart disease and is based on fuzzy logic it uses the dataset of V. A. Medical center. All the symptoms are considered and membership function is calculated for both input and the output variable. Finally, a rule base is created and rules are fired based on the symptoms of the patient. This system only provides information about the disease but not about stage and treatment [2]. A fuzzy expert system is developed to determine coronary heart disease risk of patients and gives the user the ratio of the risk for normal live, diet and drug treatment [3]. A Fuzzy rule based lung disease diagnostic system combining the positive and negative knowledge was developed using contexts, facts, rules, modules and strategies of knowledge representation to identify medical entities and relationship between them for diagnosis of lung cancer [4]. An Intelligent system for Lung cancer diagnosis is designed that detects all possible lung nodules from chest radiographs using image processing techniques and feed forward neural networks. It classifies the nodules into cancerous and non-cancerous nodules [5]**.** The main purposes of the modified c-means radial basis functions are to diagnose the cancer diseases by using fuzzy rules with relatively small number of linguistic labels, reduce the similarity of the membership functions and preserve the meaning of the linguistic labels [6]. For patients with lung cancer, induction of high-risk cytochrome p450 genotypes may accelerate catabolism of volatile organic compounds that are excreted in the breath, so that their abundance in breath may provide biomarkers of lung cancer [7]. In PET/CT Images, the exact position of boundary of the tumor was manually identified, five optimal threshold features and two gray level threshold features of the tumors were extracted from the B-mode ultrasonic images, an optimal feature vector was obtained using K-means cluster algorithm and a back propagation, artificial neural network was applied to classify lung tumors [8]. Dynamic tumor-tracking irradiation treats the lung as an elastic object and analyzes the deformation based on linear Finite Element Method. The doctor planning the radiotherapy can reproduce the movement of the lung tumor by freely adjusting the regions, displacements, and phases of the boundary conditions while comparing the position of the lung tumor in an X-ray photograph [9]. In Intelligent medical chromatic image understanding system for lung cancer cell identification based on fuzzy knowledge representation and reasoning, image analysis and a low-level feature extraction process follows a two-layer rule-based fuzzy knowledge model to represent the domain knowledge needed for image understanding task [10].

The previous papers on medical diagnosis present data mining techniques using case based reasoning, genetic algorithms, fuzzy logic and many other methods for pattern recognition. These systems are highly accurate and provide information in a wide range of formats (text, images, clusters etc.) but are very complex and difficult to be implemented. The system proposed in this paper is very simple and the implementation is very easy. Computational study in medical diagnosis is still in its infancy stage and simpler but accurate systems are the need of the day.

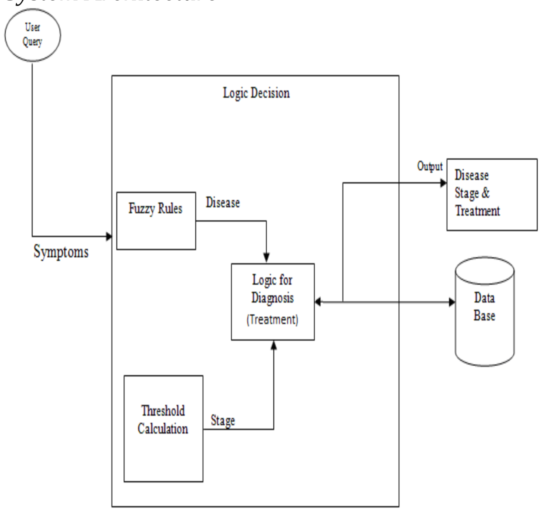
III. PROPOSED WORK

This paper deals with the technique used to determine the disease name, stage and the diagnostic treatment using the algorithms and a rule base (developed specifically for a disease).Here the physician takes the symptoms of a patient as input and based on his symptoms, proper diagnostic treatment is prescribed to a patient. Each symptom has its own priority value and the physician assigns membership values to the linguistic variables i.e. slight, low, medium, high and critical. Priority values are assigned according to the symptoms. For example, if blood in sputum is the key symptom that determines the occurrence of lung cancer then it is given higher priority when compared to other symptoms. We assign membership value which is between 0 and 1.

Our ultimate goal is to describe a fuzzy logic technique used to determine the disease name, stage and the diagnostic treatment for the lung diseases based on the patient symptoms. In the proposed system the patient will enter the symptoms as input and based on the symptoms proper diagnostic treatment will be prescribed to a patient. Each symptom has its own priority value and an assigned membership values to the linguistic variables i.e. very low, low, medium, high and very high. The algorithm developed uses the rule base to determine the disease name based on the symptoms entered by the patient. This rule base consists of rules developed for a particular type of lung cancer and determines the type of lung cancer a patient has. Based on the severity of the symptoms entered the algorithm calculates the total membership of the symptoms and the threshold value for this total membership. Then it creates the ranges which represent the different stages of cancer such as Limited, Extensive, and Stage I-IV.

The diagnosis logic based on these results (i.e. the disease name and the stage) and the rule base developed determines the appropriate diagnostic treatment for the patient. The rules populated in this rule base are developed for different types of lung cancer. These rules take into account the disease and the cancer stage determined by the algorithm to prescribe the treatment.

A. System Architecture



B. Proposed Algorithm

1. Select n number of symptoms. *i.e.*, Population or operational data. Assign some priorities values (weight) to the symptoms. For example, psymptom i=pi , where i=1 to n.
2. Now choose the severity for symptoms and assign some membership values to the linguistic variables; very low = 0, low = 0.25, medium = 0.5, high = 0.75, very high = 1. Symptom i = very low || low || medium || high || very high where i=1 to n.
3. Calculate the total value *i.e.*, support
   Total= $\sum_{i=1}^{n}(\text{symptom i} * \text{psymptom i})$
4. Now calculating high and low values
   Highvalue= $\sum_{i=1}^{n}(\text{psymptom i}) * 1$
   Lowvalue= $\sum_{i=1}^{n}(\text{psymptom i}) * 0$
5. Now calculating the membership function i.e fuzzy value(FV)
   FV=Total value/Highvalue(total weight)

(Or) we can say Support(Highvalue)=FV

6. Now dividing into N ranges between high and low values
   B (i+1) = lowvalue + (k * highvalue / N)
   where k = 0 to N and I =0 to N.
7. Now Check
   For each i=0 to N-1
   If(total >= b(I + 1) && total < b(I + 2)) Then
   Stage=”Sj” where j=1 to N+1
   Else if (total==b(i+2))
   Then stage=”Sj+1”
8. Now check
   For each j=1 to N+1
   if(stage is equal to ("Sj"))
   { cancertype="type j"; treatment="treatment j";
   }
   Else
   {
   cancertype="type j+1";
   treatment="treatment j+1";
   }

C. Fuzzy Rule Base

Our system makes use of fuzzy rule base to make decision for the diagnosis of disease, and the efficiency of the system depends on the fuzzy rules generated. Rule based systems are mainly used in medical diagnosis. In this ,the knowledge base stores all information about the symptoms and disease in the form of rules in the Rule base. The rules are generated as per the data gathered from domain expert. The proposed system consists of three modules -Doctor Login module, Implementation module and Report module .Doctor Login module is used to check the authenticated doctor. Only the authenticated doctors have the rights to view the patient records.

Implementation module is used to determine disease and stage based on the user selected symptoms. Fuzzy logic or Fuzzy rule is used to determine the disease and threshold calculation is used to determine the stage of the disease. Report module is used to display disease, stage and treatment for the particular disease. It also stores the user information in database for reference by doctor.

IV. Results and Discussions

To evaluate the working of the proposed system, the proposed algorithm is executed for a list of patients with the symptoms. Based on the priority and severity of the symptoms entered the algorithm calculates the total membership of the symptoms and the threshold value for the total membership. Then it creates the ranges which represent the different stages of cancer such as Limited, Extensive, Stage I-IV. Our proposed system yielded good results and can be used in diagnosis of the lung cancer in an efficient way at very low cost.

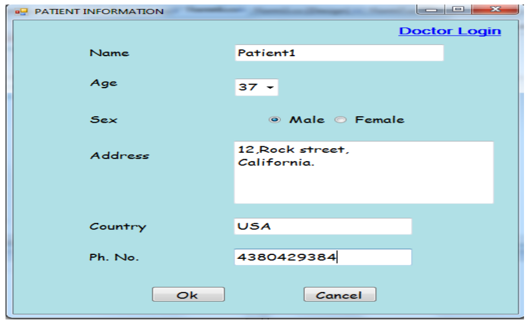


Fig 2 Doctors enter the patient information for diagnosis

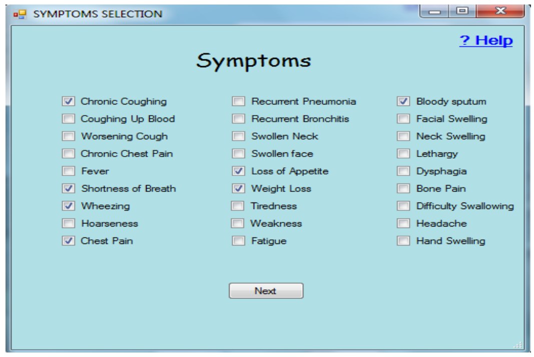


Fig 3 Details for the patients about a particular symptom.

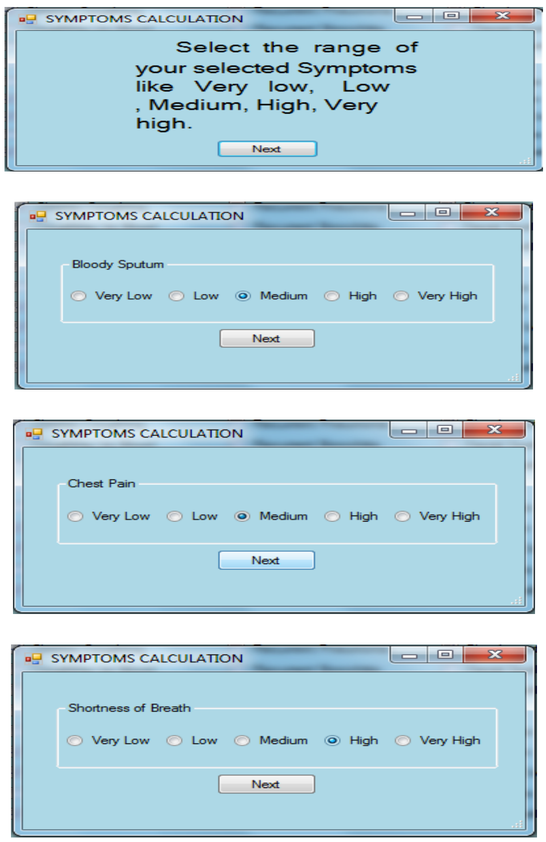


Fig 4 Selecting the range of each symptom.

After selecting the symptoms, patients need to select the range for each symptom.

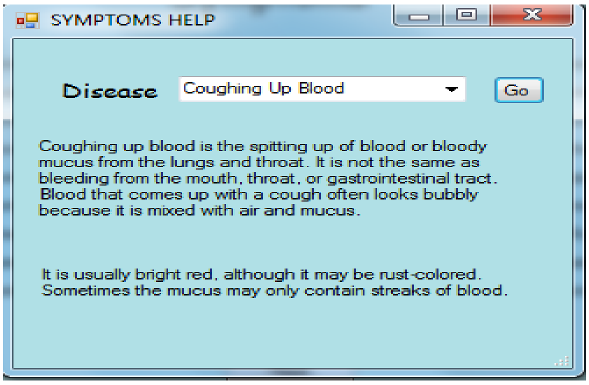


Fig 5 Provides information and other details about a symptom

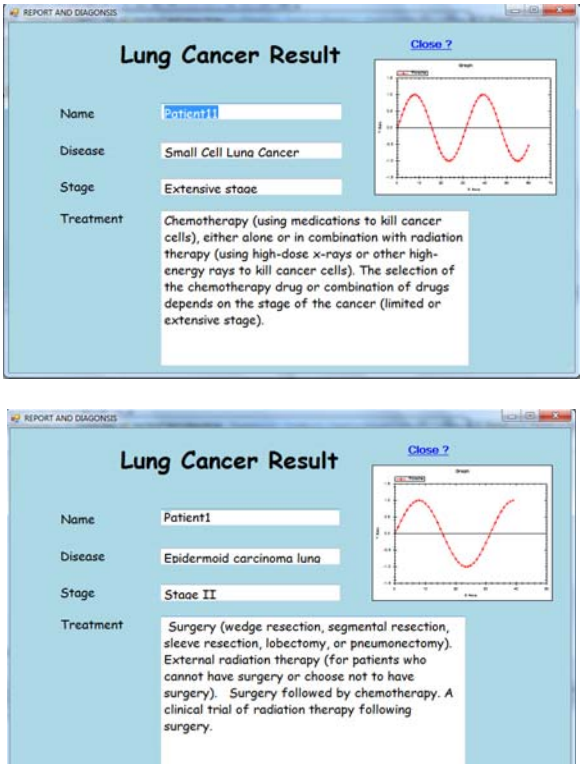


Fig 6 Results of patient diagnosed with disease name, stage and the diagnostic treatment for the lung cancer based on the patient symptoms.

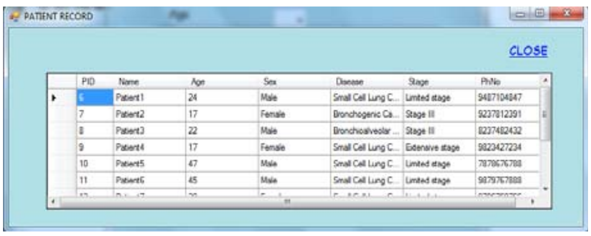


Fig 7 Displays a list of patient details with the diagnosis of Lung Cancer

V. CONCLUSION/FUTURE WORK

The developed system yields a good result and serves as an expert medical diagnosis system even for ordinary users as it is simple and easy to implement. This system is useful to the physician as well as the user for determining the type of lung cancer, stage and necessary treatment for the cancer. The main feature of this system is that we can perform easy modification and continuous updating of the database. This system is compatible with other techniques as the database can be used with case based reasoning and other mining methods.

The main challenges in this proposed work is to provide accurate result to the patient and to make them aware of lung cancer in the early stage itself, thereby reducing the complexity to take treatment at an early stage. The accuracy can be increased by implementing more analysis techniques on the same database used in the system along with the current algorithm. To increase the system efficiency, we can make use of neuro-fuzzy system and rough sets.

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