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A REVIEW ON THE APPLICATIONS OF FUZZY EXPERT SYSTEM FOR DISEASE DIAGNOSIS

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Abstract: *Expert System (ES) is an intelligent computer program help to systematize, store and obtain appropriate medical knowledge needed by the practitioner/doctors in dealing with each complicated case and suggesting suitable diagnosis for decision-making procedure and fuzzy expert system has already proved its importance in medical field. In this paper, we presents the review of past work that has been carried out by various researchers based on fuzzy expert systems for the diagnosis of different types of disease.*

Keywords: *fuzzy logic, expert system, medical diagnosis, diagnosis of disease, fuzzy expert system.*

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INTRODUCTION

Expert systems are a branch of applied artificial intelligence. Expert Systems are a software application used to take an expert view in the absence of a human expertise. As human expertise in a particular domain is rarely and not able to present everywhere, so in that cases application of expert system is helpful to solve the real world complex problem there is need of expertise, as it is not possible that, everyone is expert in every field. The expertise give there expert view in particular domain area. Because it is not possible that expertise are present any time and everywhere so to overcome this problem we use expert systems.

An expert system is an intelligent computer program which captures the knowledge of a human expert on a specific area [1].The essential idea behind these expert systems is just that expertise on an exact area is transferred from a human to a computer [2]. The main reason of knowledge-based expert systems is to make the knowledge of a human expert and their experiences to be more frequently available, mainly in areas where they are not readily available. The excellence, effectiveness and quality of expert systems have increased in resent years [1]. Expert systems are applied in many different areas and medical field is one of them [3]. In medicine field expert systems are used to diagnose particular diseases and solve the medical problem [4], as well as to assist a physician in diagnosis of disease of a patient, solve the medical problems or help interpret medical test results.

FUZZY EXPERT SYSTEM

One of the most important applications of fuzzy logic is Fuzzy Expert System. In the world of medicine fuzzy logic play an important role for effective diagnosis of medical problems because Fuzzy Logic (FL) is conceptually simple and easy to understand and the mathematical concepts behind fuzzy logic are very easy. Fuzzy logic was originally introduced in 1965 by L.A. Zadeh [5]. Fuzzy expert system is a knowledge based system where fuzzy logic is used as a tool for developing relations between input and output data.

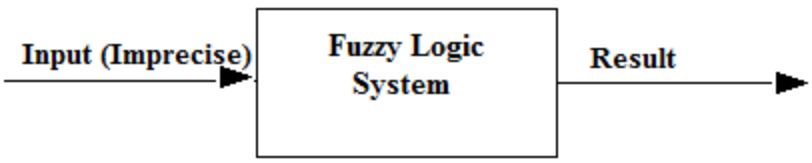

Figure 1: A fuzzy logic system accepting imprecise data and providing a decision

Fuzzy Expert System work in four stages: -

1. **FUZZIFICATION**- The fuzzificztion comprises the process of transforming crisp values into grades of membership for linguistic terms of fuzzy sets. The membership function is used to associate a grade to each linguistic term.

2. **INFERENCE**- A fuzzy inference system (FIS) is a system that uses fuzzy set theory to map inputs to outputs. The truth-value for the premise of each rule is computed, and applied to the conclusion part of each rule. This results in one fuzzy subset to be assigned to each output variable for each rule.

3. **COMPOSITION**- All of the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable. There are two methods for composition 1. MAX composition- in which, the combined output fuzzy subset is constructed by taking the point wise maximum over all of the fuzzy subsets assigned to variable by the inference rule.2.SUM composition- in which, the combined output fuzzy subset is constructed by taking the point wise sum over all of the fuzzy subsets assigned to the output variables by the inference rule.

4. **DEFUZZIFICATION**- which is used when it is useful to convert the fuzzy output set to a crisp value. There are more defuzzification methods in which Two of the more common techniques are the CENTROID and MAXIMUM methods.

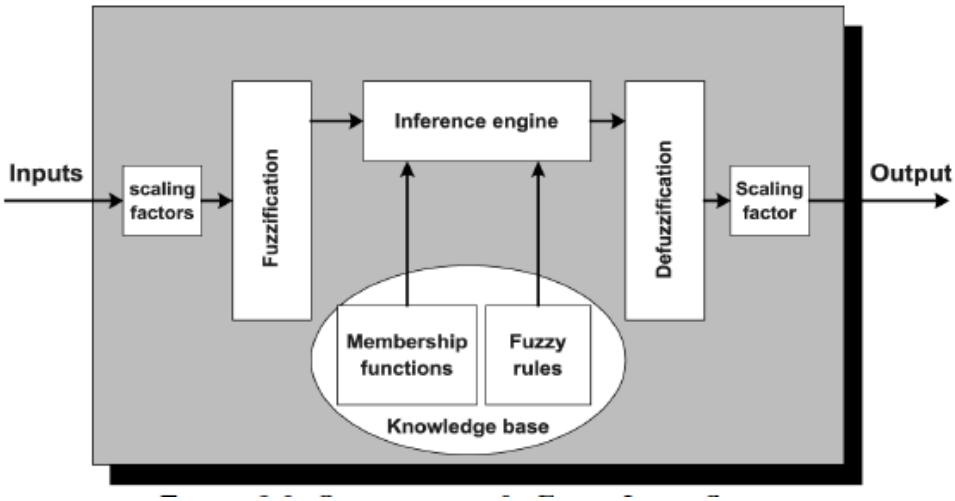

Figure 2: Components of a Fuzzy Expert System

Fuzzy expert system in medical field helps very much in the integration of patient data, patient care, and hospital management, facilitating research, clinical research and diagnoses

of the different types of diseases. In this paper we review the uses of fuzzy expert system in diagnosis of different types of disease. Following section shows the literature review of fuzzy expert system for diagnosis of different types of diseases.

LITERATURE REVIEW

1. Heart Disease-(1.1) Ali.Adeli, Mehdi.Neshat:

(IMECS, March 17-2010 Hong Kong)

In this paper author designed a fuzzy expert system for heart disease diagnosis, the designed system based on the V.A. Medical Center, Long Beach and Cleveland Clinic Foundation data base. The system has 13 input variable and one output variable. Input variables are chest pain type, cholesterol, blood pressure resting blood sugar, resting electrocardiography (ECG), maximum heart rate, exercise, old peak (ST depression induced by exercise relative to rest), thallium scan, sex and age. The output field refers to the presence of heart disease in the patient. It is integer valued from 0 (no presence) to 4 (distinguish presence (values 1, 2, 3, 4)). This system uses Mamdani inference method. The results obtained from designed system are compared with the data in upon database and observed results of designed system are correct in 94% [6].

(1.2)Sanjeev Kumar, Gursimranjeet Kaur:

(IJETT) – Volume 4 Issue 6- June 2013)

In this paper author objective is to detect the heart diseases in the person by using Fuzzy Expert System. The designed system based on the Parvati Devi hospital, Ranjit Avenue and EMC hospital Amritsar and International Lab data base. The system consists of 6 input fields and two output field. Input fields are chest pain type, cholesterol, maximum heart rate, blood pressure, blood sugar, old peak. The output field detects the presence of heart disease in the patient and precautions accordingly. It is integer valued from 0 (no presence) to 1 (distinguish presence (values 0.1 to 1.0).in this system author used Mamdani inference method. The results obtained from designed system are compared with the data in upon database and observed results of designed system are correct in 92% [7].

(1.3) Novruz Allahverdi, Serhat Torun, Ismail Saritas,

(International Conference on Computer Systems and Technologies - CompSysTech'07)

In this paper author designed a fuzzy expert system to determine coronary heart disease risk of patient for the next ten years. The designed system gives the user the ratio of the risk

and may recommend using one of three result ;(1) normal live (2)diet (3) drug treatment. This system used as an alternative for existing methods to determine coronary heart disease risk [8].

(1.4) Dr. A.V Senthil Kumar,

(International Journal of Science and Applied Information Technology (IJSAIT), Vol.2, No.2, Pages: 22-30 (2013))

In this paper author proposed an advanced fuzzy resolution mechanism uses predicted value to diagnosis the heart disease with five layers, each layer has its own nodes. The proposed mechanism is tested with Cleveland heart disease dataset. Advanced Fuzzy Resolution Mechanism was developed using MAT LAB. This method with predicted value technique can work more efficiently for diagnosis of heart disease and also compared with earlier method using accuracy as metrics [9].

(1.5) Kantesh Kumar Oad, Xu DeZhi & Pinial Khan Butt

Global Journal of Computer Science and Technology: C Software & Data Engineering, Volume 14 Issue 3 Version 1.0 Year 2014, [Online ISSN: 0975-4172 & Print ISSN: 0975-4350].

In proposed system, author designed a fuzzy rule based expert system and also by using data mining technique and reduced the total number of attributes. In this system mainly focuses on cardiovascular disease diagnosis and the dataset taken from UCI (Machine Learning Repository). It can be more accurate then manual work. System modeled to diagnosis and detecting cardiovascular diseases, this system involves two major phases, one that performs classification and diagnosis and the other one that detects the rate of risks of the respiratory diseases. For this system author used mamdani inference system. [23].

2. cancer- (2.1) K. Lavanya, M.A. Saleem Durai, N.Ch. Sriman Narayana Iyengar,

(***International Journal of Latest Trends in Computing (E-ISSN: 2045-5364)*** **165** ***Volume 2, Issue 1, March 2011.)***

In this paper author designed a fuzzy rule based inference system to determine and identify lung cancer. This system accepts the symptom as input and provides the confirmed disease and stage as the output. This system can be calculating the membership function for both input as well as the output variable. The features of fuzzy logic toolbox is used to implement

the proposed system and is used as the medical diagnosis model for providing treatments to the patients as well as it can be used to assist the doctors [10].

(2.2) A. Malathi1 and A.K. Santra

(CARE Journal of Applied Research (ISSN 2321-4090))

In this paper, an attempt has been made to make use of neural networks and fuzzy logic in the medical field (carcinogenesis (pre-clinical study)). In this system neuro-fuzzy logic applied to the problems in both pre-clinical and post-clinical diagnosis. In this study, a fuzzy logic-based system for diagnostic decision support for pre-clinical diagnosis of cancer diseases is presented [11].

(2.3) Ismail Saritas, Novruz Allahverdi and Ibrahim Unal Sert,

(International Conference on Computer Systems and Technologies – *CompSysTech, 2003)*

In this study author proposed a fuzzy expert system for diagnosing, analyzing and learning purpose of the prostate cancer diseases.For this process prostate specific antigen (PSA), age and prostate volume (PV) was used as input parameters and prostate cancer risk (PCR) as output. This system allows determining if there is a need for the biopsy and it gives to user a range of the risk of the cancer diseases. There was observed that this system is rapid, economical, without risk than traditional diagnostic systems and can be used as learning system for medicine students [12].

(2.4) Victor Balanică, Ioan Dumitrache, Mihai Caramihai, William Rae, Charles Herbst,

(U.P.B. Sci. Bull., Series C, Vol. 73, Iss. 1, 2011, [ISSN 1454-234x])

In this paper author introduced a set of fuzzy rules that can be used to process the relevant data from breast cancer cases in order to give a breast cancer risk prognosis which can be qualitatively compared to that of an expert [13].

(2.5) K. C.Latha, B.Madhu, S. Ayesha, R. ramya, R. sridhar and balasubramanian International Journal of Computational Intelligence Techniques ISSN: 0976-0466 & E-ISSN: 0976-0474, Volume 4, Issue 1, 2013, pp.-114-117)

In this paper author designed a fuzzy decision support system to help in risk stratification of breast cancer, which helps as a decision supporting system. In this system age and cancer state used as a input variable and one output variable as risk status which is further divided into Not serious, Serious and Very serious. This system helps in the assessment of the breast

cancer risk. Despite the latest technological developments, the method and criteria used to quantify are reliable risk estimate and still subjective [14].

3. Asthma-(3.1) Ashish PateL, Jyotsna Choubey, Shailendra K Gupta, M. K. Verma, Rajendra Prasad, Qamar Rahman.

(Proceedings of international Multiconference of Engineers and computer scientists 2012 Vol-1IMECS, March 14-16, 2012 Hong Kong)

In this paper author developed an automated system using a self-organizing fuzzy rule-based system. In which five input variables have been taken (DSF (Day time symptoms frequency) and NSF (Night time symptoms frequency) PEFR (Peak Expiratory Flow Rate), PEFR variability and SaO2 (Saturation of oxygen) and one output for the decision of the asthmatic conditions. For designing of fuzzy inference system rule base play major role in its performance and fine tuning process optimizes the membership functions stored in the data base. The results of this fuzzy rule-based inference system was found to be correct when compared with the field data output [15].

(3.2) *S. Krishna Anand, R. Kalpana and S. Vijayalakshmi*

(Middle-East Journal of Scientific Research 14 (11): 1435-1444, 2013, ISSN 1990-9233 © IDOSI Publications, 2013)

In this paper author designed a fuzzy expert system that takes into account details of various patients and identifies the problem the patient is likely to encounter. In order to reduce the complexity of the overall system, several subsystems with independent intelligent controllers have been designed. Besides, sensitivity analysis has also been carried out to test the extent of relevance of specific inputs [16].

(3.3) M.H. Fazel Zarandi, M. Zolnoori, M. Moin and H. Heidarnejad

(Archive of SID **Transaction E: Industrial Engineering Vol. 17, No. 2, pp. 129-142c Sharif University of Technology, December 2010)**

In this paper author developed a fuzzy rule-based expert system for diagnosing asthma at initial stages. A knowledge representation of this system is provided from a high level, based on patient perception, and organized into two different structures called Type A and Type B. Type A is composed of six modules, including symptoms, allergic rhinitis, genetic factors, symptom hyper-responsiveness, medical factors and environmental factors. Type B is composed of 8 modules including symptoms, allergic rhinitis, genetic factors, and response

to short-term drug use, bronchodilator tests, challenge tests, PEF tests and exhaled nitric oxide. The final result of the system is de-fuzzified in order to provide the assessment of the possibility of asthma for the patient [17].

4. Blood Pressure- (4.1) Mayilvaganan M and K.Rajeswari

International Journal of Emerging Trends & Technology in Computer Science *(IJETTCS)* Volume 3, Issue 1, January–February 2014, [ISSN 2278-6856]

In this paper a fuzzy logic system is introduced in order to help users in providing accurate information of blood pressure (BP) due to the high level of blood pressure (BP) classification is not appropriate, through fuzzy logic system classifies BP between 0 and 1 [18].

(4.2) Vishal Chandra, Pinki Singh

International Journal of Advanced Research in Computer Science & Technology (IJARCST), Vol. 2, Issue 2, Ver. 1 (April - June 2014), ISSN : 2347 - 9817

In this paper author used methodology for the automated development of fuzzy expert system and designed a web based fuzzy expert system for the management of hypertension (High Blood Pressure) using fuzzy logic approach. Systolic blood pressure, diastolic blood pressure, age and body mass index were taken as input variable and hypertension risk was taken as output. Designed expert system is based on clinical observation, medical diagnosis and expert knowledge. Designed system is based on M.G.M. Hospital, Jamshedpur [19].

5. Malaria- (5.1) X.Y. Djam, G. M. Wajiga, Y. H. Kimbi and N.V. Blamah

Internatinal journal of pure and applied sciences and technology, 5(2) (2011), pp. 84-108

[ISSN 2229 – 6107]

In this paper author present a fuzzy expert system for the management of malaria [FESMM] and providing a decision support platform to malaria researchers, physicians and other healthcare

practitioners in malaria endemic regions. The developed FESMM composed of four components knowledge base, fuzzification, inference engine and defuzzification. Author used root sum square method for fuzzy inference process and centre of gravity method was used for defuzzification. Fuzzy expert system was designed based on clinical observations, medical diagnosis and expert knowledge [34].

(5.2) Ojeme Blessing Onuwa

An International Open Free Access, Peer Reviewed Research Journal, Published By: Oriental Scientific Publishing Co., India. June2014, Vol.7, No. (2):Pgs. 273-284

[ISSN: 0974-6471]

This paper work focused on Fuzzy Expert System for malaria diagnosis. It is simple to use, portable, low cost and makes malaria diagnosis more rapid and accurate. It supports medical practitioners and assists malaria researchers to deal with the vagueness, imprecision and time-consuming found in traditional laboratory diagnosis of malaria, and provide accurate output based on the input data [20].

(5.3) Priynka Sharma, DBV Singh, Manoj Kumar Bandil and Nidhi Mishra

International Journal of Information and Computation Technology.Volume 3, Number 7 (2013), pp. 633-640, [ISSN 0974-2239]

In this paper the main objective of author to designed the decision support system for mosquito born disease diagnosis mainly rural areas (or) remote areas. This decision support system is very useful in the diagnosis of disease and early detection of disease lead to save patients life .This system is useful to help doctors or users to diagnosis the disease of patient in a short time and effectively via the identified symptoms. The proposed system is designed and developed by using MATLAB's GUI feature with the implementation of fuzzy logic [21].

6. Back Pain Disease- Mohammed Abbas Kadhim, M.Afshar Alam, Harleen Kaur

International Journal of Innovative Technology & Creative Engineering, vol.1 no.9 sep 2011(ISSN: 2045-8711)

In this paper author produced a Fuzzy Expert System (FES) to diagnosis of back pain disease based on the clinical observation symptoms using fuzzy rules. The clinical observation symptoms which processed by fuzzy expert system may be used fuzzy concepts to describe that symptoms such as (little, medium, high). The parameters used as input for this fuzzy expert system were Body Mass Index (BMI), age, and gender of patient as well as the clinical observation symptoms. The proposed expert system can help to diagnosis of back pain disease and produce medical advice to the patient. The system implemented and tested using clinical data that is correspond to 20 patients with different back pain diseases. The proposed system implemented using Visual Prolog programming language ver. 7.1 [22].

7. HIV – (7.1) Kjhlda Hassan Zarei, Ali VahidianKamyad and Ali Akbar Heydari

Hindawi Publishing Corporation Computational and Mathematical Methods in Medicine Volume 2012

The present study proposes a fuzzy mathematical model of *HIV* infection consisting of a linear fuzzy differential equations (FDEs) system describing the ambiguous immune cells level and the viral load which are due to the intrinsic fuzziness of the immune system's strength in HIV-infected patients [24].

(7.2) Imianvan A. A.,Anosike U.F , Obi J. C.

Global Journal of Computer Science and Technology Volume 11 Issue 12 Version 1.0 July 2011, [Online ISSN: 0975-4172 & Print ISSN: 0975-4350]

The focal point of this paper is to describe and illustrate the application of fuzzy cluster means system to the diagnosis of HIV. It involves a sequence of methodological and analytical decision steps that enhances the quality and meaning of the clusters produced. The proposed system eliminates the uncertainties often associated with analysis of HIV test data. This paper presented a diagnostic fuzzy cluster means system to help in diagnosis of HIV using a set of symptoms and demonstrates the practical application of ICT (Information and Communication Technology). In this advanced system which used a set of clustered data set is more precise then the traditional system. This fuzzy cluster means system proposed and tested in this paper appears to be more natural and intelligent way of classification and matching of symptoms to HIV [25].

8. Hypertension- Rupinder Kaur, Amrit Kaur

International Journal of Engineering Research and Application (IJERA), March-2014, *ISSN: 2248-9622*

In this paper author designed a fuzzy expert system to diagnose hypertension for different patients. Fuzzy expert system is based on set of symptoms and rules. The input parameters for this system are age, body mass index, blood pressure, heart rate, diabetes, physical activity, genetics and the output parameter is risk of hypertension. This system is a very efficient, less time consuming and more accurate method to calculate the risk of hypertension [26].

9. Hypothyroidism- P.B. Khanale and R.P. Ambilwade

Journal of Artificial Intelligence 4 (1):45-54, 2011, [ISSN-1994-5450]

In this paper author used fuzzy logic in diagnosis of pulmonary embolism, cortical malformations, rheumatic and pancreatic diseases, hepatitides and diabetes. Author proposed a fuzzy inference system for the diagnosis of thyroid disease specially hypothyroidism.This system is helpful for patients and doctor to identify the disease at early stage [27].

10. Human Disease Diagnosis-(10.1) Mir Anamul Hasan, Khaja Md. Sher-E-Alam and Ahsan Raja Chowdhury

(Journal of Computing, Volume 2, ISSUE 6, JUNE 2010, ISSN2151-9617)

Human disease diagnosis is a complicated process and requires high level of expertise. Any attempt of developing a web-based expert system dealing with human disease diagnosis has to overcome various difficulties. This paper describes a project work aiming to develop a web-based fuzzy expert system for diagnosing human diseases. Now a days fuzzy systems are being used successfully in an increasing number of application areas; they use linguistic rules to describe systems. This research project focuses on the research and development of a web-based clinical tool designed to improve the quality of the exchange of health information between health care professionals and patients. Practitioners can also use this web-based tool to corroborate diagnosis. The proposed system is experimented on various scenarios in order to evaluate it‘s performance [28].

11. Fever- S. Govinda Rao M. Eswara Rao D. Siva Prasad

International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 8, August – 2013, ISSN: 2278-0181

In this paper author designed an expert system which diagnosis the fever, provided food-diet and medicine. This rule based system takes initial details regarding to user like age, sex, body temperature and gives the list of common symptoms regarding to fever to diagnose the severity of the fever initially [29].

12. Devesh D. Nawgaje, Rajendra D.Kanphade

International Journal of Engineering Science and Technology (IJEST), [ISSN : 0975-5462] NCICT Special Issue- Feb 2011.

In this paper author presented a Fuzzy Inference System (FIS) approach to detect edge within color bone marrow microscopic images, which is robust with regard to variable

illuminant level conditions and takes into account color components stability degrees. For each image pixel they get the similarity degree between its color and the system colors, what makes algorithm design much easier because allows to emulate experts image edge detection skills. The same fuzzy rule base is then implemented on DSP TMS320C6711 which provides real time implementation. [30].

13. Memory Low- Komal R. Hole, Vijay S. Gulhane

International Journal of Advance Research in Computer Science and Management Studies, Volume 2, Issue 1, January 2014,[ISSN: 2321-7782 (Online)].

The proposed system initially discussed different approaches in designing of Medical Diagnosis Expert Systems with focus on all the information about the memory loss. It is an attempt to focus on some of very important diseases related to memory loss like Alzheimer's disease, Parkinson's disease, Huntington's disease, and multi-infarct which are among the most common types of memory loss diseases [31].

14. Arthritis - S.Singh, A. Kumar, K. Panneerselvam , JJ.Vennila

Journal of Medical systems, 2012 June.

Arthritis is a chronic disease and about three fourth of the patients are suffering from osteoarthritis and rheumatoid arthritis which are undiagnosed and the delay of detection may cause the severity of the disease at higher risk. Thus, earlier detection of arthritis and treatment of its type of arthritis and related locomotry abnormalities is of vital importance. A system for the diagnosis of Arthitis using fuzzy logic controller (FLC) is designed which is, a successful application of Zadeh's fuzzy set theory. It is a potential tool for dealing with uncertainty and imprecision [32].

15. Anesthesia- Mirza Mansoor Baig, Hamid Gholamhosseini and Michael j. Harrison,

Wseas transactions on circuits and systems, issue 1, volume 11, january 2012.

Fuzzy Logic Based Smart *Anaesthesia* Monitoring System to enhance the developed diagnostic alarm system for detecting critical events during anaesthesia and to accurately diagnose a hypovolaemia event in anaesthetized patients [33].

16. Migraine- Vishal Chandra

International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064

In This paper author presented an expert system tries to determine and diagnose migraine using symptoms which are vague properties. Vague means things or properties that can not

measure in terms of crisp logic in other words there is no sharp boundary between yes or no. Migraine has many symptoms on the basis of these symptoms author determined the condition of migraine weather migraine is mild moderate and severe and he used Matlab for solution of problem [35].

CONCLUSION

In this paper we are tried to present a detailed review of previous work carried out by various researchers in the field of development of fuzzy expert system for diagnosis of various diseases.

And we came out with conclusion that fuzzy expert system can be able to capture expert knowledge before it is lost and the fuzzy expert system can help junior doctors and Practitioner's in complicated and different types of disease diagnosis and decision making process.

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