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Artificial Intelligence in Medical Diagnosis

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Abstract
The logical thinking of medical practitioner involves a lot of subjective decision making and its complexity makes traditional quantitative approaches of analysis inappropriate. The computer based diagnostic tools and knowledge base certainly helps for early diagnosis of diseases. The intelligent decision making systems can appropriately handle both the uncertainty and imprecision. This paper discusses about the application potential of artificial intelligence in medical diagnosis. The fuzzy expert system has been presented specific to liver disease diagnosis.

Keywords - medical diagnosis; medical artificial intelligence; fuzzy expert system; liver disease

I. INTRODUCTION

The advancement in computer technology has empowered the software developers and domain knowledge experts to build more intelligent tools for assisting medical practitioners in making their decisions. In medicine, the relationship between disease and symptom is hardly ever one to one. So the differentiation of the diagnosis that shares an overlapping range of symptoms is inherently difficult for a doctor. An intelligent system can resolve real world problems using human knowledge and following human reasoning skills.

Artificial intelligence is a study to emulate human intelligence into computer technology and its potential in medicine has been expressed by many researchers. Fuzzy logic is one of the artificial intelligence techniques. It deals with uncertainty in knowledge that simulates human reasoning in incomplete or fuzzy data. Fuzzy logic has become an important field of study with a wide spread of applications in diversified fields including medical diagnosis. To quickly and accurately diagnose a patient, there is a critical need in employing computerized technologies to assist in diagnosis and access the related information. The complexity of medical practice makes traditional approaches of analysis inappropriate. Most medical diagnosis is full of uncertainty and imprecision. Fuzzy logic which is one of the soft computing techniques can render precise from what is imprecise. Fuzzy logic provides the opportunity for modeling conditions that are imprecisely defined. Fuzzy techniques in the form of approximate reasoning provide decision support and expert systems with powerful reasoning capabilities.

This paper presents the application potential of artificial intelligence in medical diagnosis and fuzzy expert system developed for the diagnosis of various diseases pertaining to various human organs. An illustrative example has been presented specific to liver disease diagnosis.

II. MOTIVATION

In the domain of medical diagnosis, there are numerous variables that affect the decision process thereby causing the differences in the opinions of the practitioners. There are many uncertain risk factors, so sometimes disease diagnosis is hard for experts. Having so many factors to analyze to diagnose the disease of a patient makes the physician's job difficult. So an accurate tool will be of a great help for an expert to consider all these risk factors and show certain results in uncertain terms. Motivated by the need of such an important tool, the professional form of artificial intelligence that is based on fuzzy logic for the diagnosis of the diseases pertaining to liver as well as other organs have been developed.

III. RELATED SURVEY

The studies reported on fuzzy expert systems in medical diagnosis covers wide spectrum including the need, importance, potential and approaches for designing of the expert systems for medical diagnosis applications [3], [4], [10], [13]. Computer assisted applications for patient's diagnosis and treatment seems to be the more recent area of interest [2], [5], [18]. The Fuzzy Expert System has proved its usefulness significantly in the medical diagnosis for the quantitative analysis and qualitative evaluation of medical data, consequently achieving the correctness of results.

The literature survey reveals that, the commercially available expert system shells are rigorously used to write the application specific rule-bases. It has been found that the frameworks are developed for generation of fuzzy expert systems with respect to specific diseases, general purpose diagnostic systems as well as for counseling of personal health [7], [16], [17]. Design of expert system frameworks for medical treatment and prevention of high risks related with the human health widened the scope for implementation of fuzzy concept in medical field [11]. Suitability of computer systems using fuzzy methods and computerized monitoring and medical decision making systems have been reported [6], [8], [9], [15]. The object oriented frameworks to construct FES are proposed [12], [14].

It has been notified that, 21% reported research is devoted towards the development of methodologies and models. The share of studies conducted at architectural development level of fuzzy expert system shells and frameworks have been also found to be significant, i.e. 14%. The neuro-fuzzy approach has been used by many researchers and developed many fuzzy expert systems incorporating artificial intelligence to it. The investigation reveals that, 13% studies are contributed to the development of neuro-fuzzy based expert systems.

Figure 1 shows the percentage distribution of studies reported based on classification of articles in last two & half decades. The graph shows an exponential growth in the interests of various researchers for the development of fuzzy applications in the medical field. The penetration of fuzzy concept in medical field seems to be at par up to the year 2000.

The recent span shows the exponential growth and more attention of researchers toward the development of fuzzy based expert systems specific to medical diagnosis. This accelerated trend intensifies the demand for focus on the development of more intelligent medical fuzzy expert systems.

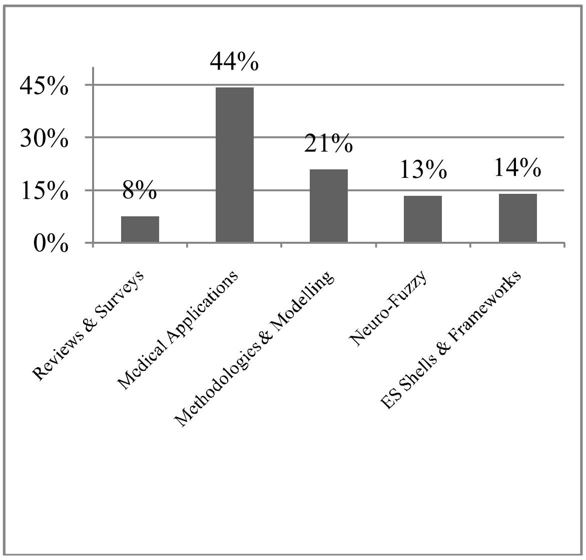

Figure 1. Percentage distribution of studies reported based on classification of articles

IV. FUZZY EXPERT SYSTEM DESIGN

A disease is usually characterized by directly observable symptoms that prompt the patient to visit a physician. A series of clinical observations are undertaken to detect the presence of a disease. In this medical fuzzy expert system design, the first step is determination of input and output variables. There are six input variables and one output variable. The symptoms of the disease are expressed by the deviation of the observations from their normal values. All input variables their description value, associated fuzzy sets and their membership function ranges are presented in the Table I.

A. System for diagnosis of liver disease

The developed diagnosis fuzzy expert system consists of a smart user interface that enables user to select the appropriate symptoms and input the numeric clinical values of various parameters. Further, the organ specific test data is accepted from the patient. Laboratory test results are converted into fuzzy compatibility values reaching from zero to unity by consideration of the linguistic medical concepts. This fuzzified data is used to infer diagnosis with knowledge contained in a knowledgebase. Figure 2 represents the hierarchy of components of medical fuzzy expert system.

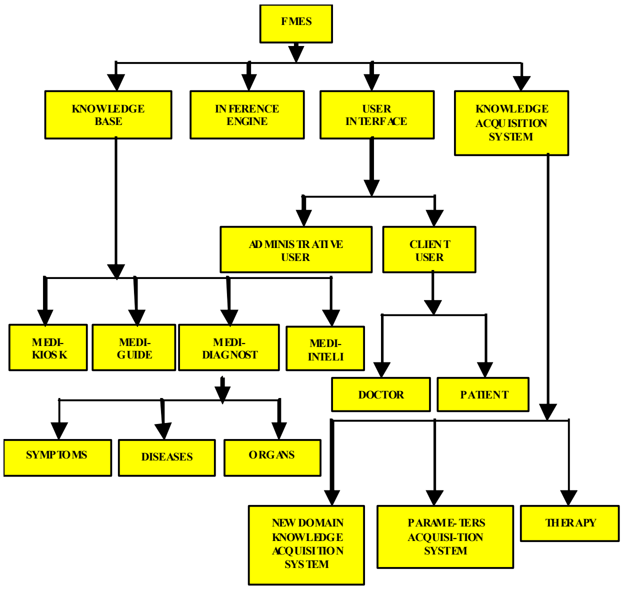

Figure 2. Hierarchy of components of medical fuzzy expert system

Fuzzy relations were calculated for all linguistic medical concepts between test results and diagnosis by using the obtained fuzzy sets with the given set of patient data. It is necessary to obtain crisp output for the purposes of evaluation of the fuzzy model; defuzzification was used to produce crisp values on an arbitrary scale of the fuzzy output variable as the risk of heart disease.

The system accepts physiological inputs specific to the patients. The user has to select the symptoms so as to come at certain conclusion. The symptoms are classified as habits, feeling, pain, loss, swelling, blood in, other and organs. User selects appropriate symptoms from the available options. Moreover, the system is empowered to accept the laboratory readings, echo and x-ray observations. Table 1 shows the inputs and their normal ranges which fuzzy expert system accepts.

TABLE I. Inputs variables and their normal ranges

Input Variables	Description	Normal Level	Membership Functions
MCV	Mean Corpuscular Volume	80-96 fl	MCV (S,M,B)
ALP	Alkaline Phosphates	20-130 IU/L	ALP (L,M,H)
SGPT	Gamma Glutamyl Transpeptidase	4-36 IU/L	SGPT (L,M,H)
SGOT	Serum Glutamyl Transpeptidase	8-33 IU/L	SGOT (L.M,H)
GGTP	Serum Glutamic Oxaloacetic Transaminase	5-40 IU/L	GGPT (L,M.H)

DRINK	No of alcoholic beverages drunk per day	0.2-1 L	DRINK (L,M,H)

B. Membership Functions

The membership functions of all the input and output parameters are designed and represented in Figure 3 to Figure 9. The range of values and respective fuzzy sets of inputs are given in table 1. The parameter range is divided into three fuzzy sets, namely, 'low', 'medium' and 'high'. The membership functions of fuzzy sets are of triangular and trapezoidal types as shown in Figure 3 to Figure 9.

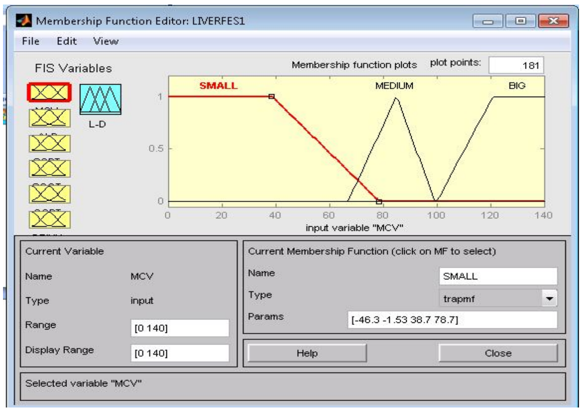

Figure 3. Membership functions of Mean Corpuscular Volume

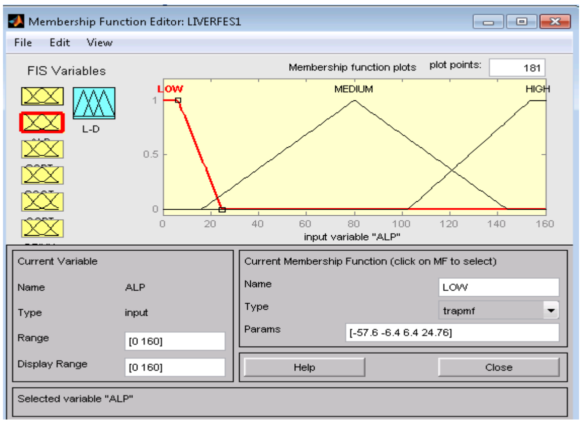

Figure 4. Membership functions of Alkaline Phosphates

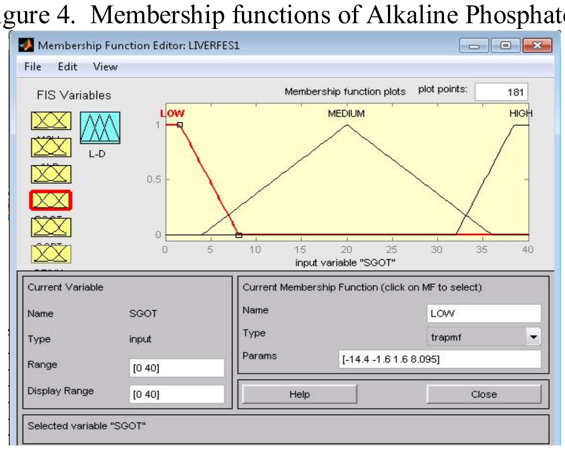

Figure 5. Membership functions of Serum Glutamyl Transpeptidase

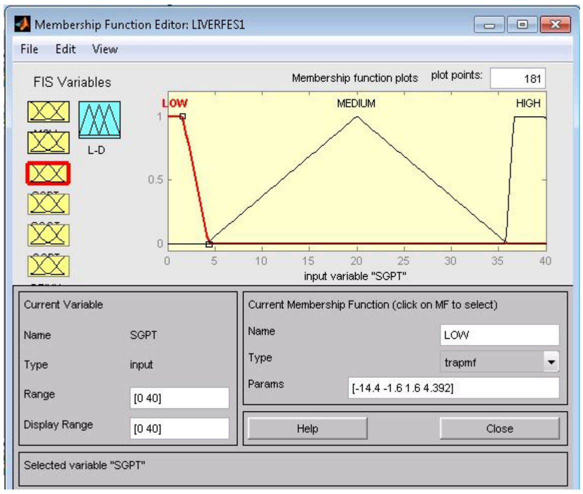

Figure 6. Membership functions of Gamma Glutamyl Transpeptidase

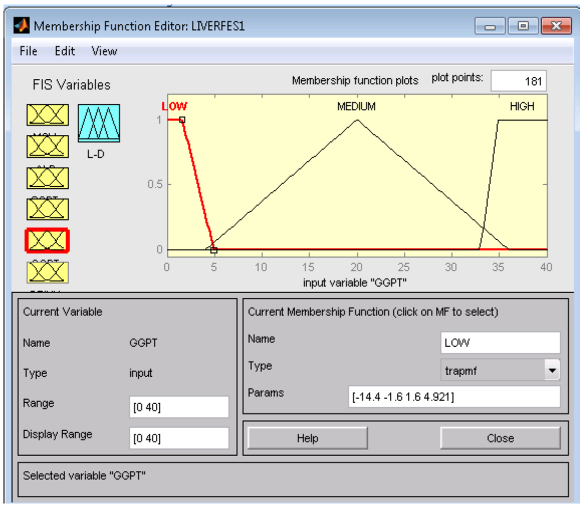

Figure 7. Membership functions of Serum Glutamic Oxaloacetic Transaminase

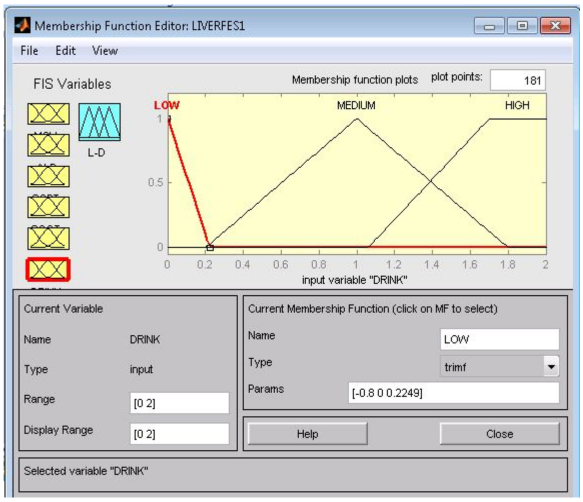

Figure 8. Membership functions of Drink

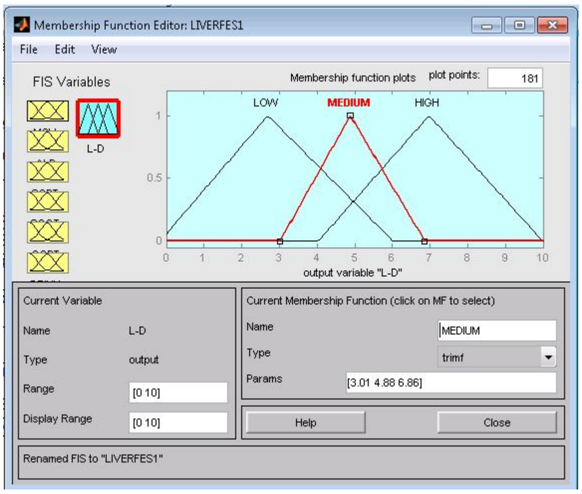

Figure 9. Membership functions of Output Liver Disease Risk

V. SYSTEM OUTPUT

In fuzzy logic the inference mechanism decides the sequence used in firing the rules to obtain the desired solution. All the rules are fired at the same time. The fuzzy rule base for this study is designed with the help of a medical doctor. More than hundred rules have been defined pertaining to liver diseases using the patient disease database as well as the expert knowledge on the disease domain. The designed expert system uses the rules to diagnose patient's illness based on their laboratory tests and manifested symptoms.

The output shows the presence or absence of risk for liver disease subjected to given the values of input parameters. The rules consist of antecedent and consequent parts. All the rules fire to some extent in the antecedent part of the fuzzy system. The fuzzy expert system computes the probabilities and determines output value in terms of percentage of the risk of liver disease on the scale of 0 to 10. The risk value is divided into three fuzzy sets, namely, 'Risk low', 'Risk Medium' and 'Risk High'. The membership functions of fuzzy sets of output are of triangular types as shown in Figure 9.

VI. CONCLUSION

The application of artificial intelligence has been reported in the field of medical diagnosis. An example of the fuzzy expert system developed for the diagnosis of liver diseases, using visual basic and MatLab fuzzy tool box is presented. The knowledge base and rule base comprising more than 100 rules exclusively pertaining to liver disease is the utility of the system. The system is of predictive type and very effective for the diagnosis of diseases related with multiple organs like, heart, liver, lung, kidney, abdomen, bladder, brain, prostate, eyes and ears. The system accepts inputs in the form of physiological, radiological and clinical parameters from the user. Moreover, the user can select general as well as specific symptoms from the pre-build symptoms library.

REFERENCES

[1] K.P. Adlassnig, G. Kolarz, W. Scheithauer, "Present State of the Medical Expert System CADIAG-2," *Methods of Information in Medicine*, vol. 24, pp. 13-20, 1985.

[2] A. Ahmed, A. Bigand, V. Lethuc, P.M. Allious, "Visual Acuity of Vision Tested by Fuzzy Logic: An Application in Ophthalmology as a Step Towards a Telemedicine Project," *Information Fusion*, vol. 5, pp. 217-230, 2004.

[3] A. Ali, V. Singh, "Potentials of Fuzzy Logic : An Approach To Handle Imprecise Data," *American Medical Informatics Association*, vol 2, no. 4, pp. 358-361, 2010.

[4] A. Ameri, H. Moshtaghi, "Design and Development of Expert System in Differential Diagnosis of Maxillofacial Radio-lucent Lesions", http://idt.mdh.se/kurser/ct3340/archives/ht08/papers RM08/21.pdf.

[5] M. Z. Asghar, A. R. Khan, M. J. Asghar, "Computer Assisted Diagnoses For Red Eye (CADRE)," *Int. J. of Compouter Science & Engineering,* vol. 1, no. 3, pp. 163-170, 2009.

[6] A. Banerjee, A. K. Majumdar, A. Basu, "A Fuzzy Expert System Approach Using Multiple Experts For Dynamic Follo-up of Endemic Diseases," *Sadhana, India*, vol. 19, no. 1, pp. 51-73, 1994.

[7] E. Binaghi, I. Gallo, C. Ghiselli, L. Levrini, K. Biondi, "An Integrated Fuzzy Logic And Web-Based Framework For Active Protocol Support," *International Journal of Medical Informatics*, vol. 77, pp. 256-271, 2008.

[8] K. Boegl, K. P. Adlassnig, Y. Hayashi, T. E. Rothenfluh, H. Leitich, "Knowledge Acquisition in the Fuzzy Knowledge Representation Framework of a Medical Consultation System," *Artificial Intelligence in Medicine*, vol. 30, pp. 1-26, 2004.

[9] A. Ciabattoni, T. Vetterlein, K. K. Adlassnig, "A Formal Logical Framework for Cadiag-2," *Studies in Health Technology & Informatics*, vol. 150, pp. 648-652, 2009.

[10] R. L. Engle, B. J. Flehinger, "Why Expert Systems for Medical Diagnosis are not being generally used: A valedictory opinion," *Bulletin of the New York Academy of Medicine*, vol. 63, no. 2, pp. 193-198, 1987.

[11] I. Jung, G. Wang, "User Pattern Learning Algorithm based MDSS (Medical Decision Support System) Framework under Ubiquitous," *World Academy of Science, Engineering and Technology*, vol. 36, pp. 184-188, 2007.

[12] H. H. Owaied, M. M. Qasem, "Developing Rule-Case-Based Shell Expert System," *Proc. of Int. MultiConf. of Engineers & Scientists*, vol. 1, 2010.

[13] JCR Pereira, P. A. Tonelli, L. C. Barros, N.R.S. Ortega, "Defuzzification in Medical Diagnosis," *Advances in Logic, Artificial Intelligence & Robotics*, pp. 202-207, 2002.

[14] Y. Qu, T. Fu, H. Qiu, "A Fuzzy Expert System

Framework Using Object Oriented Techniques," *IEEE Pacific Asia Workshop on Computational Intelligence and Industrial Applications*, vol. 2, pp. 474-477, 2008.

[15] R. Seising, "A History of Medical Diagnosis Using Fuzzy Relations", *Fuzziness in Finland'04*, pp. 1-5, 2004.

[16] C. Snae, M. Brueckner, "Personal Health Assistance Service Expert System," *World Academy of Science, Engineering and Technology : A Biological & Biomedical Sciences*, vol. 4, no. 2, pp. 109-112, 2008.

[17] M. G. Tsipouras, C. Voglis, D. I. Fotiadis, " A Framework for Fuzzy Expert System Creation - Application to Cardiovascular Diseases," *IEEE Transactions Biomedical Engg*., vol. 54, no. 11, pp. 2089-2105, 2007.

[18] T. Vetterlein, A. Ciabattoni, "On the (fuzzy) Logical Content of CADIAG-2," *Fuzzy Sets and Systems*, vol. 161, pp. 1941-1958, 2007.