# EXPERT SYSTEM FOR DIAGNOSIS OF DIABETES: A REVIEW

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*ABSTRACT*

*Knowledge based intellectual systems can be engaged to diminish the number of deaths and the waiting time to meet the specialist. The system developed by imitating human astuteness could be engaged to help the medical doctors in getting result without consulting the experts. The system is not intended to replace the specialist or experts, but it is developed to help the general practitioner in diagnosing, predicting condition of a patient. Using these systems may be a cheering way out to diminish cost, time, human efforts and medical error. This paper focuses on diabetes, its types, symptoms, and risks associated with it. Moreover, it also discusses expert systems used in the field of medical sciences. Further, noteworthy contribution is also cited in this field.*

*KEYWORDS: Diabetes, Diagnosis, Expert System, Fuzzy Logic, Patient*

## I.   INTRODUCTION

Diabetes is a clinical syndrome distinguished by hyperglycemia due to absolute or relative deficiency of insulin. The lack of insulin affects the metabolism of the body. It causes to increase the blood sugar level. That is there is not enough insulin to reduce the percentage of glucose to its normal level [13, 14].

All the people with diabetes have one thing common. They have too much sugar or glucose in their blood. This is because a person who intake food is converted into glucose and the body is unable to remove glucose from the blood and deliver it to the cells as a source of energy in order to stay alive. A hormone called Insulin, secreted by the pancreas helps to convert glucose to energy [14].

### 1.1. Types of Diabetes

There are three main types of diabetes. The most common are,
a)        Type1diabetes
b)        Type 2 diabetes
c)        A third type of diabetes, gestational diabetes, occurs during some pregnancies.
In type 1 diabetes, patients make very little or no insulin at all. They must take insulin shots in order to live. In contrast, women with gestational diabetes and patients with type 2 diabetes do make insulin [15]. Gestational diabetes mellitus (GDM) is a type of diabetes which affects healthy pregnant women and typically improves or disappears after delivery [12].

### 1.2. The Risk Factors of Getting Diabetes

The main causes of diabetes are- Hereditary and genetics factors, Infections caused by viruses, Stress, Obesity (A weight that is 20% more than ideal body weight), Increased cholesterol level, Nutritional deficiency, High carbohydrate diet, No physical exercise, Overeating, Excess intake of oil and sugar, Tension and worries, Insulin deficiency, High blood pressure, Age 45 or older, Insulin resistance, Polycystic ovary syndrome. If you are on high levels of prednisone for asthma or allergies or other autoimmune diseases, you are very much at risk for diabetes [15].
There are some complication symptoms like- Fruity smell of breath and sweat, Bruises that won't go

away, Tingling or numbness in hands or legs, Delayed wound healing, A feeling of pins and needles in feet, Sores that won't heal, Burning pain in legs, feet, arms, Unexplained aches and pains. Other Symptoms are- Hair loss or thinning of hair, Leg pain, Sugar in urine, Dry mouth, Irritability, Sleep disorder, Dry or itchy skin, Gestational diabetes, Bladder, Skin, or vaginal infection (in female), Impotence (in male), Swollen red gums and loosing teeth, Lethargy, Over eating and rapid weight gain, Taking steroid medicine for Asthma, Loss of consciousness [13, 14]. The diabetes is causes of increasing Insulin or lack of Insulin and other signs, symptom.

The rest of the paper is organised as follows. Section II discusses different expert systems that are presently used in the field of medical sciences. A brief survey of noteworthy contribution of various authors is mentioned in section III. Section IV discusses the present database used for diagnosis of diabetes and finally, section V presents conclusion and future work.

## II.    EXPERT SYSTEMS IN THE FIELD OF MEDICINE

An expert system is a computer program that incorporates knowledge to solve complex problems and can either replace or assist a human expert [16, 3]. Many expert systems have been developed to diagnose diabetes and heart diseases, where diagnosis is complex and involves up-to-date parameters. Conigliaro et al. in [1] proposed an expert system for venous insufficiency in the human body using statistical evaluation to detect a set of particular symptoms among others.
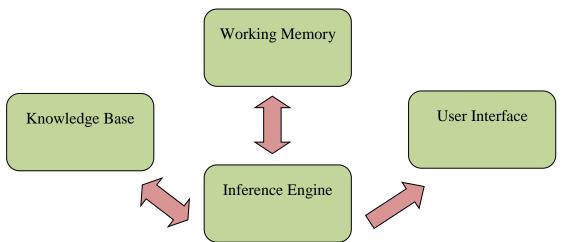


**Figure 1.**  Organization of an expert system

In the area of medical sciences, numerous expert systems have been developed. These are:
- PUFF: Pulmonary disease diagnosis
- VM: Monitoring of patients need to intensive care
- ABEL: Diagnosis of acidic materials and electrolytes
- AI/COAG: Blood disease diagnosis
- AI/RHEUM: Rheumatic disease diagnosis
- CADUCEUS: Internal medicine disease diagnosis
- ANNA: Monitoring and treatment analysis
- BLUEBOX: Depression diagnosis and treatment
- MYCIN: Microbial disease diagnosis and treatment
- ONCOCIN: Treatment and management of patient's chemotherapy
- ATTENDING: Anesthesia management education
- GUIDON: Microbial disease education

## III.    LITERATURE SURVEY

It is about giving importance to one or more specific symptoms influencing the output on a large scale during diagnosis and treatment. Santos and Mookerjee in [2] proposed a technique to reduce the cost of working with expert systems. A cost-effective expert system can be designed using an already

formulated rule base with a given input set, the probability of having each input in the input set, and by minimizing the output cost. Innocent and John in [5] proposed a computer based fuzzy diagnostic system. The expert system incorporates temporal information of a disease at various stages. To represent the time specific information, fuzzy logic is used.

Esfandiar et al. in [28] presented a study on medical data mining. Medical data mining is important for knowledge acquisition in expert systems and improves the overall performance and accuracy. Data mining can handle various types and formats of data. The author categorizes various studies on medical data mining on the basis of different approaches like classification, hybrid technology, association and clustering. Kalpana and Kumar in [17] proposed a fuzzy determination procedure for improving accuracy, and for simplicity of diabetes diagnosis. Fuzzy based determination mechanism consists of fuzzy implication, fuzzy inference, and fuzzy aggregation. The system is deployed using a fuzzy rule base just before the defuzzification. Seising in [6] proposed the use of fuzzy sets and fuzzy relations for representing vague classes efficiently. A better representation of knowledge leads to effective decision-making and, hence a reliable and efficient Computer Aided Diagnostic system can be developed. Palma et al. proposed in [7], an approach to evaluate a disease in time-specific manner. The whole diagnosis procedure can vary with time. Temporal diagnosis is an important aspect of model-based diagnosis. The procedure considers the dynamic features of a disease and includes them and their pattern of dynamism for diagnosis. Then the parameters are modelled by fuzzy based time-specific Constraint Network. Roychowdhury et al. in [4] proposed an expert system using fuzzy logic controller and genetic algorithm. The fuzzy controller forms rule base in online mode. The rule base is subjected to the genetic algorithm for fine tuning and optimizing membership functions in the knowledge base. Gupta et al. in [29] proposed the use of fuzzy logic with neural network for the treatment of diabetes. Fuzzy rules are formulated whose fine tuning is performed by NN. Neuro-fuzzy approach is used for learning and adaptation of the diagnosis framework. A client-server approach is highlighted for knowledge acquisition. Kahramanli and Allahverdi in [11] presented an approach involving neural network and fuzzy logic. ANN reduces the problems related dimensionality of symptoms and is a cost effective approach. Using fuzzy neural networks, we can represent continuous data and its classification efficiently.

Calegari and Sanchez in [10] proposed fuzzy ontology architecture. Fuzzy ontology uses semantic correlation to define fuzzy relationships and define the knowledge base effectively. The authors also proposed an information withdrawing algorithm to consider all the entries in the query and define the relationships among these entries to give accurate output. Yager and Petry in [8] proposed a theoretical and logical approach for data summarization. For the user, to have control over the information that is to be used in decision-making, summarization enables the use of the concept/attribute hierarchies for such purpose. Fuzzy set approach is used to construct the concept/attribute hierarchies. Summarization tries to satisfy various requirements like minimum coverage and maximum relevance, succinctness, and usefulness related to a dataset. This type of summarization also satisfies descriptive data mining. Higher levels of the summarization are fuzzy in nature and it can be used both for a single attribute and multiple attributes. Lee and Wang in [18] proposed a diabetes fuzzy ontology for diabetes diagnosis. Classical ontology cannot perform decision making using fuzzy data. The ontology needs to first identify the class membership of (depending on symptoms and concepts) the patient on par with his/her diagnosis inputs such as age, glucose concentration, etc., and after that a personal diagnosis is performed. The knowledge base is created using concepts and fuzzy relations using fuzzy variables and fuzzy numbers.

Ahmed et al. in [25] presents a study of current expert systems, their key features, shortcomings, and guidance for the development of new expert systems. Rule-based expert systems have both conventional techniques like DBMS and knowledge base. The authors have also compared expert systems based on their domains and language of coding. Rahaman in [22] proposed a diabetes diagnosis system using JAVA Netbeans7.1 Graphical User Interface (GUI) with SQL server for dataset management. The system covers all aspects of telemedicine like asking the user for the presence of risk factors, the results of medical evaluation, symptoms and other questions about lifestyle and diet. As an output, it will issue a statement depicting the stage of severity of the diabetes like 'very slight', 'slightly', 'very high', and 'high'. Campos-Delgado et al. in [9] proposed a closed loop approach for glucose -insulin control regime. Monitoring of insulin dosage is done on a daily basis and besides this a short duration dose control regime is followed before each meal in a day.

Frequent measurement of glucose is done in order to achieve accuracy. A target of glucose level is set for each day, which can change according to variations in metabolism in an individual. Such regime is important to follow in order to avoid a hypoglycemic condition. Davood et al. in [25] proposed a fuzzy model for controlling diabetes mellitus using a recursive least square method. The model involves controlling diet regime among the patients using inputs like weight, time of meals, duration of the simulation and glucose concentration to the fuzzy expert system. Body sugar and carbohydrate intake level is decided each day using MATLAB based glucoSim Simulator.

**Table 1.** Comparison of the existing expert systems in terms of accuracy.

| S. No. | Author | Year | Technique | Accuracy (%) |
|---|---|---|---|---|
| 1 | Isa and Mamat [20] | 2011 | Clustered-HMLP | 80.59 |
| 2 | Aibinu et al. [21] | 2011 | ARI+NN | 81.28 |
| 3 | Chikh M.A et al. [23] | 2012 | AIRS2 | 82.69, 89.10 |
| 4 | Ozcift A. [24] | 2012 | RBF+eACC | 76.30 |
| 5 | Ahmad F. et al. [26] | 2013 | Improved GA | 80.4 |
| 6 | Anuja Kumari et al. [27] | 2013 | SVM | 78 |
| 7 | Ravi et al. [30] | 2014 | GA + SVM | 77.3 |

## IV.   DATABASE USED FOR DIAGNOSIS OF DIABETES

Generally, Pima Indian Diabetes (PID) [31] is used in the diagnosis of diabetes. PID consists of 768 cases. It has only two decision classes, one is tested negative for diabetes 500 (65%) instances and the other is tested positive for diabetes (35%).  Each subject has eight attributes, including: Number of times pregnant, Plasma glucose concentration a 2 hours in an oral glucose tolerance test (OGTT), Diastolic blood pressure (mm Hg), Triceps skin fold thickness (mm), 2-hour serum insulin (mu U/ml), Body mass index (weight in kg/(height in m)^2), Diabetes pedigree function, Age (years).

## V.   CONCLUSION AND FUTURE WORK

Medical diagnosis is normally done by the experts. But still many cases are reported of erroneous diagnosis and wrong treatment. Patients advised to undergo a lot of tests for treatment. In many circumstances, not all the tests add towards proper diagnosis of a disease. As the medical and related data keeps on growing day by day, it is difficult to predict about a disease that a patient may be diagnosed with. The effective prediction about a disease and its related diagnosis can be determined based on the particular patient's past medical history.

This paper focuses on today's most severe disease, diabetes. It also discusses different expert systems that are presently used in the field of medical sciences. In addition to this, a brief survey of related papers is also discussed. In future, our aim is to design and develop a fuzzy based control system in order to enhance the efficiency to diagnose diabetes.

### ACKNOWLEDGEMENTS

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