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Designing and Implementing Fuzzy Expert System for Diagnosis of Psoriasis

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ABSTRACT

Introduction: The differential diagnosis of Erythemato-Squamous disease is a very important issue in dermatology. These diseases include dermatitis seborrhea, lichen planus, Pityriasis rosea, Chronic Dermatiticand Pityriasis rubra pilaris. The differential diagnosis of psoriasis need to spend a lot of time and costs and incorrect or delayed diagnosis will lead to risky consequences for the patient. In this regard, a fuzzy expert system was created to diagnose psoriasis at any time and in any place.

Methods: In this study, an expert system is created to diagnose psoriasis based on fuzzy logic and rule-based database using MATLAB software. Also to test system the data from 190 patients with psoriasis was used among which 126 people with psoriasis were selected.

Results: The accuracy, sensitivity and accuracy of the system, was obtained 96%, 97% and 95%, respectively. The area under the ROC curve was obtained 0.97 and that of Kappa test was obtained 0.92 ($P < 0.001$).

Conclusion: Given the importance of early diagnosis of psoriasis, the use of expert systems can play an important role in preventing disease progression, reducing severe pain and costs.

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Introduction

Today the skin diseases due to factors such as bacteria, fungi, bad climatic conditions and exposition to intense sunlight have become prevalent (1). Psoriasis is a common skin disease and approximately one to three percent of the world's population is have this disease (2). The disease has a genetic predisposition and a dominant autosomal inheritance is seen in some families (3). The incidence of diseases is influenced by some environmental factors such as stress and in general we can say that the disease is dependent on environment genetics (4).

This disease is characterized by periods of exacerbation and remission that affects the patient mostly in terms of psycho and demoralizes and reduces the confidence of people and leads them to secrecy and isolation, and consequently inevitable psychological depression and incurable damages happen (2). Psoriasis often starts at a young age, but it can begin at any age, from the time of infancy to the old age. Men and women are almost equally affected by the disease (5). The aggravating factors are those such as infections, psychological factors, physical injuries, certain medications, sunlight hormonal and metabolic factors. England studies show that men and women with the disease die on average by 3.5 and 4.5 years earlier respectively (6).

Theoretical Foundations:

Skin with an area of between 1.2 to 2.2 square meters constitutes the largest organ of the body and serves important tasks such as protecting the body, regulating body temperature, and touching (7) psoriasis is a multi-factorial chronic skin condition in which Autoimmune responses play a role. The disease occurs when system by sending faulty signals accelerates the growth of skin cells and defects the normal skin (2,4). Clinical signs and symptoms of the disease include redness, scaling, engagement of outer surfaces of the joints (such as knees and elbows), worsening of the injury by being hit, bumps, and sometimes it comes with itch(8,9). Psoriasis diagnosis is primarily a clinical diagnosis based which is done based on clinical findings. The differential diagnosis of psoriasis need to spend a lot of time and cost and incorrect or delayed diagnosis will lead to risky consequences for the patients (9). The patients of this collection are assessed with ten with clinical symptoms (8). Psoriasis is a compositional disease that affects other organs other than skin. In patients with psoriasis, the patient's risk to develop diseases such as arthritis, cardiovascular disease, hypertension, obesity, diabetes and autoimmune disease intensifies (11).

The differential diagnosis of diseases of the erythematous Group is a very important issue in dermatology. The diseases of such group include psoriasis, Seboreic Dermatitis, lichen planus, Pityriasis rosea, Chronic Dermatitis and Pityriasis rubra pilaris. The diseases of such group have the same clinical symptoms in terms of redness and scaling (10).

Another disease that is associated with this disease, are those of the arteries and myocardial infarction (12 and 13). In the absence of timely diagnosis and treatment, the risk of severe disease progress and development of the erythroderma (redness all over the skin) and the loss of water and electrolytes, cardiac disorders and kidney and mortality

increases. However, patients with psoriasis may experience progressive joint destruction and disability (11). The visible signs of the disease largely affect the patient's quality of life as well. To the extent that the impact of the disease on the patient's mental and physical condition is comparable to diseases such as cancer and diabetes (14). Sometimes with the disease progress, the symptoms of the patient's skin develops to such an extent that a scaly and oily skin experiences great difficulty in social interactions. These patients are often nervous, depressed, angry and disappointed (16, 17). Studies show that through many mental suffering and increased amount of smoking and alcohol, their health and other aspects are also at risk (15). Therefore precise understanding of doctors and experts on how to diagnose and treat the disease can play a major role in preventing the disease progression and reduction of costs (18). Clinical decision support system is an information system to help medical diagnose of health specialists in decision making for patients' care (19). Expert systems are a decision support system in the field of artificial intelligence which were developed in the mid-1960s with the aim of providing the skills of specialist personnel for non-specialist ones. Artificial intelligence in the medical field has diagnostic and identifying capabilities, storing and retrieving information in database, diagnosis and interpretation of medical images, treatment plan and control of disease (20). By using intelligent systems such as fuzzy expert systems the possibility to convert data collected by experts into information and use of this information in the right time is provided. This knowledge in the form of a fuzzy model and its rules can contribute in the detection and diagnosis of the disease and provide patients with timely treatment (21).

Given the importance of early and correct diagnosis of psoriasis to improve the quality of life of patients and public spending cuts, the need for continuous access to the knowledge and experience of practitioners is necessary (16). Due to the fact that access to experts in every time and every place is not possible, the researcher sought to create a fuzzy logic-based expert system for the diagnosis of psoriasis. The system is able to simulate the model of thinking and way of functioning of expert and have a diagnosis like that of a specialist. The system requires no special hardware and can run on personal computers.

Importance and Necessity of Study

Today, due to the spread of knowledge and more complex decision-making, the use of information systems especially artificial intelligence systems have become more important in supporting decision making systems (22). Artificial intelligence systems are referred to systems that have behaviors like intelligent similar to human behavior, including understanding complex situations, simulating human thought processes and reasoning practices and successful response to it, learning and the ability to acquire knowledge and reasoning to solve problems (22, 23). Spread of knowledge in the field of medical science and the complexity of decisions associated with the diagnosis and treatment (i.e. human life) has attracted the attention of specialists to use support system in medical decision. In the meantime, the use of different types of intelligent systems in medicine is increasing (24, 25), so that the effect of different types of Intelligent Systems in Medicine is studied (26).

The use of expert logic and knowledge control is another advantage of this system. When designing medical expert systems, specialized knowledge is extracted from the opinion of experts of that field (or clinical guidelines) and entered into the database. In recent years to solve many complex problems intelligent systems have been used and it is proven that fuzzy logic is a powerful tool for decision-making systems and systems of classification. Today fuzzy sets are frequently used in several areas such as information technology, decision-making, model recognition, data analysis, medical diagnosis and (9).

Diagnosis and decision-making about some diseases in certain issues can be sensitive and challenging for physicians (27). The differential diagnosis of psoriasis and early treatment is essential to reduce disease progression and reduce costs (14). By using this expert system in addition to sharing knowledge, promoting knowledge, ability to doing work in precarious conditions, having high performance, fast response time, reliability, intelligibility, reducing the risk, duration and survival, the physician will be able to make quick and coherent decisions to spend more time on evaluating the decision. The speed of analysis and access to recommendations in time and space is increased as well (6, 28). Designing and developing expert systems that use fuzzy logic and is able to use medical knowledge of expert that become available to non-expert individuals are useful for society, and especially patients.

Research Methodology

Research Types

The aim of this study is to develop and integrate technical knowledge with expert knowledge and creation of knowledge-based expert system for the diagnosis of psoriasis to provide services to society. The present study is an applied research seeking the benefits of fuzzy expert system for correct and timely diagnosis of psoriasis and reduction of its consequences in the country, this is why it is classified among the applied research.

Research population and sample

At the rules extraction stage, setting parameters, and key characteristics of diagnosis, the study population consisted of dermatologists. Also in the process of system assessment, the study population consisted of 190 patients who presented to dermatology clinics in the city in 2013-14 among which, 126 patients with psoriasis and 64 patients were with Seborrhea dermatitis, lichen planus, Pityriasis Rosea, Chronic Dermatitic and Pityriasis rubra pilaris.

Data collection tools:

In this study, the check list was used to collect the data needed to assess the psoriasis diagnosis fuzzy expert system. The check list was designed based on the views of four of the expert doctors and conveying the expert texts was designed in two parts consisting of demographic parameters including

patient's age and gender, and clinical symptoms including redness, scaling, lesion with distinct borders, itching, worsening the injury by hitting, multifaceted lesions, lesions around hair follicles, oral mucosal involvement, involvement of the knees and elbows, and scalp involvement. Field method was used for data collection and observation tools, check list, history and patient's physical examination are also used in this study. In addition, clinical symptoms with scales of very low, low, medium, high and very high were described

Data collection method:

In order to obtain medical knowledge and identifying the important factors affecting the diagnosis of psoriasis in the step of design and development of system, four dermatologists were interviewed, while the check list was prepared for evaluating fuzzy expert system in psoriasis diagnosis. The validity of the check list was approved by doctors and the mentioned check list was completed at the step of evaluating the performance of the fuzzy expert system in diagnosis of psoriasis, by observing the records of the patients with a final diagnosis of psoriasis.

Analysis of data:

To assess the compliance of the responds of the system with the recognition recorded by doctors, Kappa test was used. In order to express the results more clearly, ROC graph and the area under the graph was used.

The values of accuracy, sensitivity, precision of fuzzy expert system in diagnosis of psoriasis were calculated using the following definitions and their formula, the characteristics of the receiver was also reported in order to better assess the results of the use of fuzzy expert system in diagnosis of psoriasis.

TP: Patients with psoriasis, and the system also diagnosed them with psoriasis.

FP: Patients without psoriasis, but the system designed, presented the diagnosis of psoriasis.

TN: Patients without psoriasis, but other diseases were diagnosed by the system.

FN: Patients with psoriasis, and the system designed, diagnosed other diseases.

TP / (TP + FP) = sensitivity

TN / (TN + FN) = Accuracy

(TP + TN) / (TP + FP + TN + FN)) = correctness

Findings

The research steps:

In order to achieve the objectives of the research and create the fuzzy expert system in diagnosis of psoriasis, this study is done in four steps including system knowledge definition, system knowledge design, system knowledge acknowledgement and assessment system.

First step:

The purpose of this step is the identification and selection of knowledge resourse and then acquisition, extraction and analysis of knowledge. In this study first resources including books and specialized articles related to skin diseases as well as specialists and experts in the diagnosis of skin diseases were identified and then knowledge acquisition, extraction and analysis in the process of engineering the knowledge, was performed.

In this regard, the clinical symptoms and parameters of diagnosis of psoriasis were identified using books and specialized resources and after consultation with the four dermatologists, effective parameters in diagnosis of this disease and Seborrhea dermatitis, lichen planus, Pityriasis Rosea, Chronic Dermatitic and Pityriasis rubra pilaris diseases were finalized and the relationship between clinical parameters for decision with psoriasis and other diseases and the degree of their relationship were determined. Finally, the check list was provided by experts for final evaluation system.

Second Step:

The design phase included detailed design of knowledge and knowledge representation. At this step, how to organize knowledge in the system knowledge base, as well as how to display in the form of regulations, frameworks or logic, were identified. In this study the table of decision is used to organize the knowledge. This was done in three steps. In the first step, the decision-making system was designed in the following table. In the decision table, effective parameters in decision, which were actually the clinical symptoms, are located in columns and psoriasis and other diseases in the squamous erythema group, in order to diagnose differential psoriasis as the objectives of the system are located in rows. At the intersection of each row and column, are symptoms that indicate the onset of clinical symptoms in each patient and the relationship between clinical symptoms with the disease. Using this table, it was identified that to what extent, each of the clinical symptoms were effective in the diagnosis of the disease.

As stated, the system knowledge in the form of fuzzy sets, membership functions and fuzzy rules was proposed in the study. Accordingly, in the next step, the input fuzzy variables in fuzzy inference system based on their parameters were identified according to decision table for each of the 10 input fuzzy variables. Also according to the system objective, differential diagnosis between psoriasis and other diseases in lines of the decision table, were determined as output variables. So six outcome variables were created that each had independent fuzzy set and membership functions.

At the end of this phase of the study, the architecture of fuzzy inference system, differential diagnosis of psoriasis using fuzzy logic toolbox is designed in MATLAB software and evaluated at a later stage.

Table 1 - Value of experts in diagnostic parameters

diagnosis parameter	The average value (0 to 4)
Redness	4
scaling	4
Itching	2
Lesion with distinct borders	3
Worsening the injury by hitting	4
multifaceted lesion	0
oral involvement	0
knee and elbow involvement	3
scalp involvement	3
lesions around hair follicles	1

Third step:

The purpose of this step was to ensure the completeness and accuracy of the system. In this regard, after the designation of user of system interface based on doctors and end users, coding and implementation was done using MATLAB software. The user interface has a data entry form, including the patient's age and symptoms. After deduction inference by inference engine, user interface uttered the diagnosis result along with an explanation and the degree of certainty.

At this point, the system was validated by a physician and researcher and responsibility of the system for each of the test samples, were analyzed and existing knowledge in the system, membership functions of fuzzy variables, parameters, fuzzy rules, and their weights were reviewed and investigated again and so little changes were made in the decision table and rules and knowledge base of the system. After the change, the system was inspected again.

Fourth step:

The final step of the life cycle in creating the system, was evaluating the system. At this point, system's performance was improved and modified according to comments, suggestions and experiences. Data needed for the evaluation system based on the check list designed at the first step, were collected from patients' data in study population. The system was validated using the data collected and the result of system diagnosis was recorded and was compared with the final diagnosis by a doctor. Sensitivity, precision and accuracy of the system was calculated and assessed, and ROC graph was drawn to display the results graphically. Recently it has been shown that these curves have significant medical applications in making decisions. The graph of ROC performance of system is drawn to graphically display system efficiency and performance. In this diagram, the closer to one the area under the curve, the better system performance and efficiency. In the evaluation phase, in order to modify and improve system performance, little changes in the output fuzzy variables, parameters of some membership functions and also fuzzy rules weights was created and again validated with the participation of experts. At each step of system validation, steps one, two, three (knowledge definition, knowledge design and knowledge verification) and four were repeated.

Data analysis:

To assess the extent of compliance of the recognition system with the records by doctors in files, Kappa test will be used. In order to express the results more clearly, the ROC curve and area under the curve will be used.

Also the values of accuracy, sensitivity, and precision of fuzzy expert system in diagnosis of psoriasis, they are calculated using the above definitions and its formula and receiver performance characteristics have been reported in order to better investigate the outcomes of the use of fuzzy expert system in diagnosis of psoriasis. MATLAB is the main tool of analysis.

System Architecture:

Database system:

Decision-Making for Psoriasis Diagnosis

To detect and differentiate psoriasis from other diseases of Erythema group, we must first identify diagnostic parameters of this disease. By studying the literature and interviews with two expert doctors the following parameters and features were identified in the diagnosis of psoriasis. These parameters include redness, scaling, itching, lesions with clear margins, exacerbation of the injury by being hit, multi-faceted lesions, lesions around hair follicles, oral mucosal involvement, engagement of knees and elbows and involvement of the scalp. In addition, clinical symptoms with the scales of very low, low, medium, high and very high are described. After identification of parameters, in an interview with four expert doctors, they were asked to value each parameter between 0 to 40. In this way, each of the parameters in the psoriasis diagnosis was specified in comparison with other types of diseases of erythema. The above system makes decision based on the relationship between clinical symptoms and disease, and the degree of their association, so the basement for the design of database system has been this relationship that include:

Psoriasis / always: redness, scaling, worsening of injury by being hit

Psoriasis / often: lesion with distinct borders, involvement of knees and elbows, involvement of scalp

Psoriasis / usually: itching
Psoriasis / sometimes: involvement of hair follicles
Psoriasis / never: multiple lesions, oral mucosal involvement
Specified clinical signs of the column of the decision-making table and diseases were placed in first rows of the table. The symptoms listed below which are recorded in decision-making Table, suggest a defined relationship between clinical symptoms and disease.
4: They always exist (100%),
3: They often exist (70 to 100%),
2: They usually exist (40 to 70%),
1: They Sometimes exist (greater than 0 to 40%),
0: They never exist.

Table 2 – Table of created Expert System Decision-making

	redness	scaling	lesion with distinct borders	itching	worsening of injury by being hit	multiple lesions	lesions around hair follicles	oral mucosal involvement	involvement of knees and elbows	involvement of scalp
Psoriasis	**4**	**4**	**3**	**2**	**4**	**0**	**1**	**0**	**3**	**3**
Seborrhea dermatitis	**2**	**2**	**1**	**3**	**0**	**0**	**1**	**0**	**0**	**3**
lichen planus	**1**	**0**	**3**	**3**	**3**	**3**	**2**	**4**	**2**	**2**
Pityriasis Rosea	**3**	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**2**	**1**
Chronic Dermatitic	**3**	**1**	**2**	**3**	**0**	**0**	**0**	**0**	**2**	**2**
PRP	**3**	**2**	**2**	**2**	**0**	**0**	**2**	**0**	**2**	**0**

Semantic system Network of Psoriasis Recognition
Semantic networks are a graphical notation to represent knowledge that are a set of Node and bows. Nodes represent entities or concepts and arcs are evidence for an association between entities.
In these shapes the ultimate goals i.e. the disease name and the decision-making factors or diagnosis of disease are shown in the ellipses so that the direction of the disease is toward the symptoms. The diseases name in the network root node and the name of the symptoms are placed in the middle nodes.
Clinical signs that are the same in terms of incidence in patients are placed in one category and one rule is dedicated to them. On any of the symptoms the number of the rule is shown along with the weight.

Inputs, Outputs and Membership Functions of the System:
The first part of a fuzzy inference system is Fuzzification of input variables. The input variables are fuzzificated according to membership functions and the sets which are determined for them as well as the algorithm or set of fuzzy rules. Input variables of system that are the diagnostic criteria for psoriasis in the decision-making table are defined with membership functions and their fuzzy sets as following:
The system has six output variables for which membership functions and identical fuzzy sets are considered so that system computes the risk of any disease.

Membership functions of system of psoriasis diagnosis:
Inputs of psoriasis diagnosis system include redness, scaling, itching, lesions with distinct borders, worsening the injury by being hit, multifaceted lesions, oral mucosal involvement, involvement of knees and elbows, scalp involvement and lesions around hair follicles. All these variables are quantitative. The fuzzy set of these inputs is between zero and five and shows five bell-shaped membership function, five very low, low, medium, high and very high status.

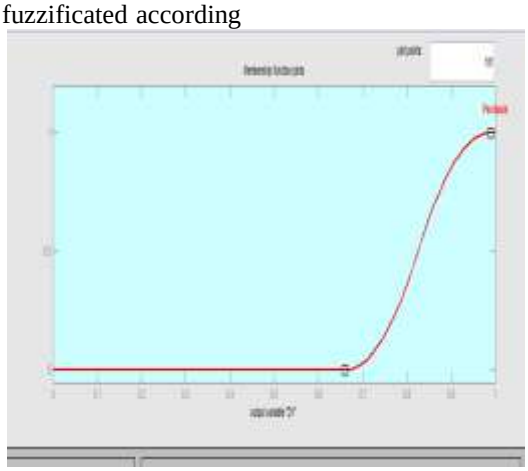


Figure- (3) Membership functions of system of psoriasis diagnosis

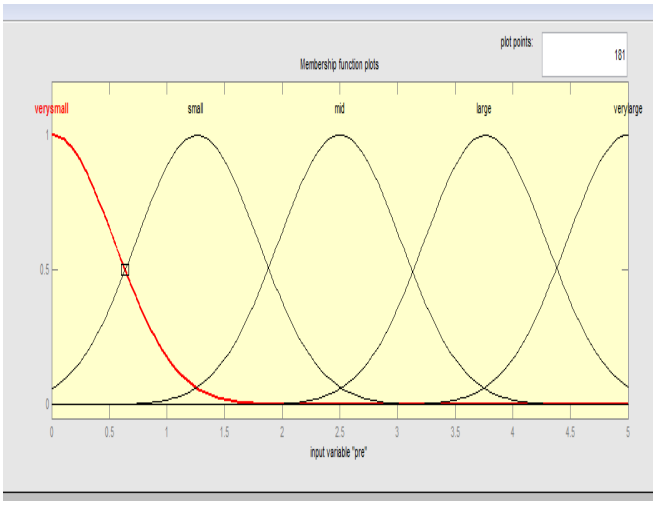


Figure (2) membership functions of the input variables

Fuzzy Rules of Psoriasis Diagnosis System:

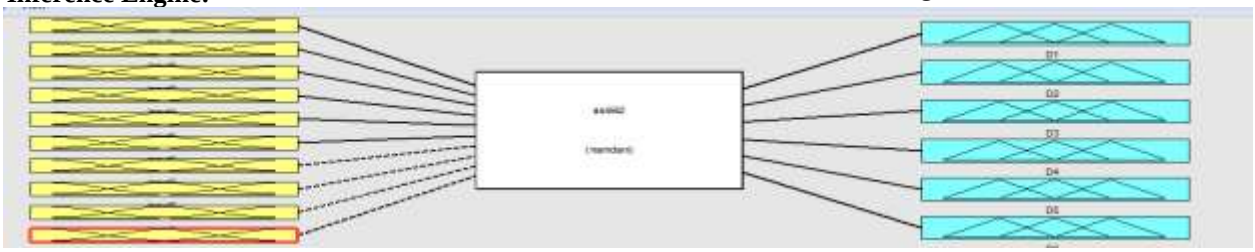
Rules and their weights are defined based on the decisions provided. For each group of clinical symptoms that is combined a law is intended. Weight intended for the symptoms of "4", "3", "2", "1", are, 1, 0. 8, 0. 5 and 0. 2 respectively. The rules are prepared and stored in the system according to the doctors.

Fuzzy Inference Engine:

Inference engine designed to diagnose psoriasis is created based on Mamdani model. And to determine the characteristics of fuzzy inference, different models were assessed. As Mamdani fuzzy model is able to provide the human experience, this model was finalized with Min-Max features as AND- OR operators and mass center Centroid)) for defuzzification. In this system the following steps are performed:

1. *Fuzzification of input:* During this stage, each input is mapped to a value between zero and one.
2. *Applying of fuzzy operators*: in this step fuzzy operators are applied on the assumption part of the rules.
3. *Applying the implication procedure*: At this stage, according to the results obtained for each rule in the previous step as well as the weight of each rule, the impact of the rules on output are specified.
4. *Accumulation of outputs*: In this stage, based on the number of outputs the fuzzy rules can be combined and for each output a fuzzy set is made.
5. *Defuzzification*: During defuzzification, fuzzy set for each output can be converted to a number.

After determining the numerical values of each of the diseases in psoriasis diagnosis system and comparison of their values with each other in case that the output related to the rest of disease become more, the psoriasis disease and otherwise other diseases will be diagnosed.



Figure(4) Psoriasis System Architecture

User Interface:

The user interface system is designed with cooperation of experts and is codified and implemented by the researcher through MATLAB software. Receiving input from the user and transmitting them to the inference engine and then receiving and displaying the system for the user is the main task of this part. Receives the data input related to patient from the user, and this information are as a radio button or numbers. Then performs some processing on data and sends them as numeric values to the fuzzy inference engine. The user interface output, receives diagnosis output from the inference engine. The user interface compares the differential diagnosis of psoriasis and other diseases and announces the final diagnosis of system with certainty and for information of user. If the uncertainty of suffering other diseases is greater, diagnosis of other diseases are displayed. Uncertainty factor or the risk of disease is a number between zero and one as a result of inference engine diagnosis. Figure 6 shows the result of implementing fuzzy rules system. Figure 5, shows the relationship between clinical symptoms of redness and lesions with distinct borders with psoriasis disease for the patient in the form of a three dimensional level.

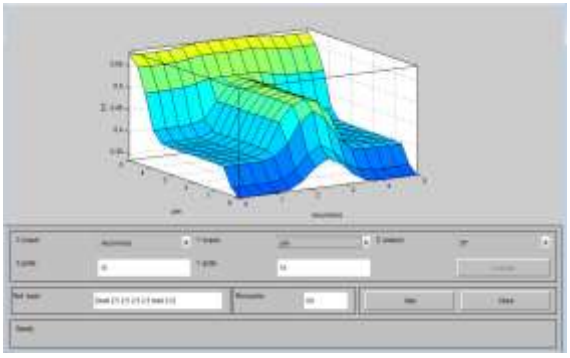


Figure 5 surface monitor for two input variables

Figure- (6) Monitor for fuzzy expert system rules at runtime

Yellow rectangles indicate fuzzification of input fuzzy variable values and the red lines show the fuzzy values. Blue rectangles show output fuzzy set of each rule, for example, the first blue rectangle shows the output fuzzy rule for psoriasis.

Assessment:

Fuzzy expert system for diagnosis of psoriasis by using the data of 190 patients with psoriasis was assessed. The information is about patients who presented to specialized skin research center in Tehran in 2014-15. Among them, 126 patients with psoriasis and 64 people were with squamous erythema group of diseases.

Accuracy:

Also, among 64 people suffering from other diseases 61 subjects were diagnosed correctly. The accuracy of diagnostic system is calculated by using the following formula which is equal to 0. 968

Accuracy = (123 + 61) /190 = 0.968

System Sensitivity and Accuracy:

To evaluate the performance of the system in case of separating sick items from non-sick ones accuracy and sensitivity is used. The following formula was used to calculate the sensitivity and accuracy. According to the data in the table, the system has an accuracy of 0.95 and sensitivity of 0.97. ROC curve was used to display graphics system performance. In this diagram the horizontal axis shows accuracy -1 and the vertical axis indicates sensitivity. The more the AUC is a closer to 1, the more is the performance of the system (29). In addition, the area under the curve of graph is a good indicator to evaluate system performance that AUC fuzzy expert system 0.97 is created, which shows the high efficiency of the system.

Accuracy = 61 / (61 + 3) = 0.95, sensitivity = 123 / (123 + 3) = .976

Kappa Test:

Kappa test is used to measure the level of compliance between actual diagnosis with system diagnosis. In order to ensure that the system output is not accidental, the results of the evaluation system was compared with the actual diagnosis and kappa test was used for this purpose. The maximum amount Kappa is 1 that is the impact of luck in response (29), In psoriasis system kappa coefficient is equal to 0.92 (P < 0. 001) and evaluated based on the interpretation of migration and Landks (30).

According to the table the coefficient is calculated as follows:

kappa = (po-pe) / (1-pe)

po = (123 + 61) /190=.968

pe = [(123 + 3) / 190 * (123 + 3) / 190] + [(61 + 3) / 190 * (61 + 3) / 190] =. 543

kappa = (. 968-.543) / (1-.54) =. 92

Value of K	Interpretation
Lower or equal to 0	No relationship
0 to 0.2	Very weak relationship
0.21 to 0.4	Weak relationship
0.41 to 0.60	Medium relationship
0.61 to 0.8	strong relationship
0.81 to 1	Very strong relationship

Table 3 - Table of kappa coefficient division

ROC (Receiver operating characteristic) diagram:

Since no method exists to evaluate and compare the appropriate diagnostic tests except for using the ROC curve, therefore the ROC curve was used to display system performance. In this method the area under the curve is a suitable characteristic for showing the efficiency of the system. In this diagram the horizontal axis shows accuracy -1 and the vertical axis indicates sensitivity. The more the AUC is closer to 1, the more is the system performance. In addition, the area under the curve of graph is a good indicator to evaluate system performance that AUC fuzzy expert system 0.97 is created, which shows the high efficiency of the system.

Discussion and Conclusion:

The current system was assessed using data from 200 patients suffering from disease and psoriasis. Accuracy, precision and sensitivity of system, was calculated 0.96 0.95 0.97 percent, respectively. To assess compliance of diagnose system with records registered in the profile, the Kappa test p <0. 0001, k =. 92 was used. The closer the coefficient, the more compliance has it with diagnosis system in the patient's records. The area under the ROC curve is obtained 0.97 as well. The results show that the there is a very close and strong relationship between the diagnosis system and final diagnosis by a doctor. And systems designed for the diagnosis of psoriasis are quite reliable. But it should be noted that the results of assessing the system is provided using data of four specialized centers and it is necessary to be examined with more data centers. In addition, the following general benefits can be considered for the diagnosis of disease through using expert system.

- The designed system simulates the behavior of dermatologist
- This proposed system is accurate, fast and cheap
- The system can also be used by the patient
- The system can also be used by medical students for educational purposes.
- The experimental results show that the fuzzy expert system works much better than an inexperienced doctor.

Due to the fact that skin lesions are visible, skin diseases in medicine are one of the few groups that by using IT systems, the disease can be detected with precision, accuracy and sensitivity such as this project without a doctor. In the past, studies have been limited in some diseases. In the future we can conduct the diagnosis through expert fuzzy systems, neuro-fuzzy systems, expert systems, data mining, decision support systems and other techniques, of most skin diseases carefully, with a very high sensitivity and accuracy. Also, in these researches superficial indices and skin lesions are more closely investigated, that is even led to quicker diagnosis of skin diseases by dermatologists.

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