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Glaucoma Detection System (GDS); a Novel GUI based Approach for Glaucoma Detection

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ABSTRACT
Glaucoma is an ocular disease having common traits like, high eye pressure, injury to the Optic nerve and gradual vision loss. It affects peripheral vision and eventually results in cecity if left untreated. The existing techniques of pre-diagnosis of glaucoma incorporate measurement of Intra-ocular pressure, corneal thickness, and angle using tonometry, Pachymetry, and gonioscopy that are executed physically by the clinicians. These tests are followed by optic nerve head appearance examination for the complete diagnosis of Glaucoma. The diagnoses require regular examine, which is too expensive and time consuming. The accuracy and reliability of diagnosis is partial by the domain knowledge of different ophthalmologists. This work proposes fuzzy based decision making framework to subdue the issue diagnosis of glaucoma at initial stage. Fuzzy rule-based allows experts knowledge to consider symptoms of patient and then based on the rules developed gives a precise decision. Later the acquired results are compared with the ophthalmologist and observations are found to be 91.3% accurate. This technique is efficient and having low computational cost.
Keywords: Fuzzy Expert System; Ocular parameters; Graphical user interface; Glaucoma; FIS.

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I. INTRODUCTION

The therapeutic examination of an infection is a major problem in this world. The therapeutic branch is one in all the foremost recent branches that need engineering strategies to get the information. With new advances in therapeutic engineering and different management structures that have been selected by the utilization of artificial intelligence strategies [1]. Artificial intelligence has made a dynamic research that includes fuzzy logic, artificial neural networks and genetic algorithms.Each one of those systems collaborates and gives imperative information beginning with one type to another and oversees life threatening problems. The most open sort of artificial intelligence that gives help and aid to health specialist in perceiving infection is the change of the clinical diagnosis of decision support system [1].

Glaucoma is a significant human eye infection that causes permanent loss of vision. The key reason for glaucoma eye infection is the consistent loss of retinal fiber layerbecause of the extension in the intra ocular pressure inside the eyes. The boundary of these retinal nerve fibers is the change of acquired picture as signs to the brain, where these signs are considered as object. Harm to these nerve fibers makes blind spots and these blind spots leads to visual impairment [2].

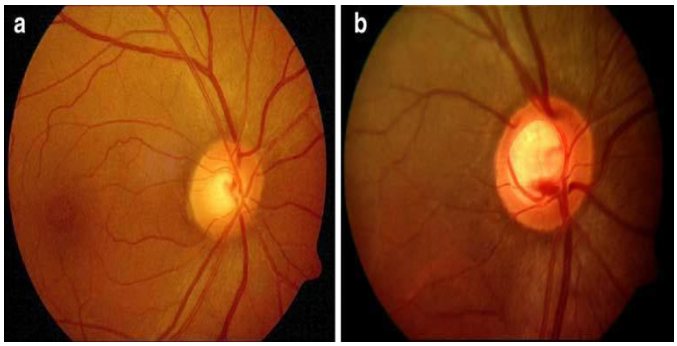

Figure 1:-a) Normal eye fundus image [12] b) Glaucomatous eye fundus image [12]

Glaucoma is a disease which is difficult to notice in early stage. There are number of techniques that are used to investigate the Glaucoma, for instance, tonometry, ophalmoscopy, Pachymetry, gonioscopy, perimetry, however these frameworks are costly, repetitive and require Special Skills [2]. Glaucoma is of two completely different types: Open Angle Glaucoma and Angle Closure Glaucoma. Open-angle glaucoma has a wide point between IRIS and cornea and besides known as wide edge glaucoma. because of this reason there's a basic need to develop more accurate and less expensive masterpiece for early determination of glaucoma. So, this paper proposed Fuzzy based decision making system for early diagnosis of Glaucoma whichmight be one amongst the useful applications with the capability to detect Glaucoma in early stage, Due to their intense lead it yields better results [2].

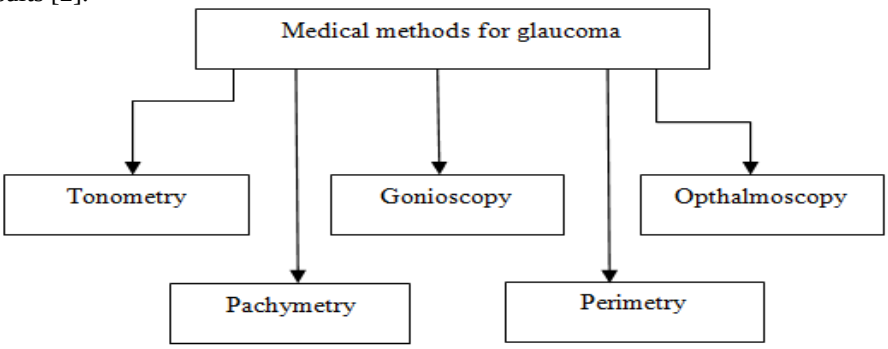

Figure 1:-c) Medical Methods to Diagnose Glaucoma [15]

Fuzzy set hypothesis was presented by Prof. Lofti Zahed in 1965 [3], which make it achievable to characterize questionable restorative qualities into human reasonable form [1]. The yielding application of the fuzzy logic has been used for different applications. The greatest advantage of the fuzzy expert framework lies in the way that analysts can demonstrate dubious, complex framework into straightforward human justifiable shape by utilizing human experience and learning as fuzzy guidelines as set of linguistic factors [4].The present paper discussed a master structure by making use of fuzzy logic to recognize Glaucoma from its suggested symptoms. The precise speculation is settled by using understanding data set a record having 6 special traits. By using medical expert data fuzzy standards are made that may be used as a bit of higher cognitive process. This paper gives data based on expert system for finding of Glaucoma. The therapeutic business using the field of man-made insight has viably moved from clinical research center o real applications. Moreover, laying out and implementing results for examination of Glaucoma by using fuzzy interference system is arranged. By including at least 6 symptoms of glaucoma fuzzy interference systems is made. The fuzzy rules based system utilizes therapeutic expert's data for knowing patient's s signs and give an exact decision per fuzzy guidelines are made.

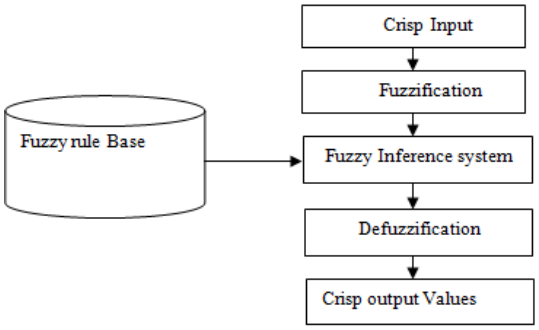

Figure 1:-d) Fuzzy Expert System [13]

II. RELATED WORK

In literature, there are different techniques used for detection of Glaucoma.

Inoue N.et al. [5] proposed two approach's discriminatory analyses and threshold processing to compute the proportion of the territory of optic disk and the zone of optic circle cup (named C/D ratio) and surveyed this system works well, however there is an issue that veins in the optic circle is vanished. To handle these issue researchers, build up another technique using design coordinating. Author assumed that new system will be viable to examine patient condition for glaucoma. Cheng J. et al. [6] proposed a brilliant structure for the examination of RetCam pictures for modified close/open angle classification.Author used two strategies which are edge recognition and arc identification to describe open and close glaucoma. Then they contrasted the results and Clinical database. Xu Y. et al. [7] demonstrated Image processing and learning based system was proposed to restrict and classify Anterior Chamber Angle (ACA), in light of multiscale HOG highlights. Agarwal A. et al. [8] introduced adaptive thresholding technique which fuses picture highlights like mean, variance and standard deviation to area the optic circle and optic disc from the fundus picture. Later they contrasted the results and clinical database and this system gives promising results over 90% precision. Aloudat M. et al. [9] proposed Haar filter that compute the edge of open and close them had eye-related ailments. Haveesh G. et al.[9] presented two strategies, picture processing and fuzzy glaucoma as a first step of choosing the thickness of the liquid available on the cornea. The researchers contrasted the result with the patients of the Jordanian Governmental hospital (Al AmeeraBasma Hospital). The patients had ages going between years old, and each one of them had eye-related problems [9]. Haveesh G. et al. [10] proposed two systems, image processing and fuzzy classifier to distinguish Glaucoma. Essential point of this paper is to compute CDR then arrange glaucoma based on estimation of CDR. The objective of this review is pre-preparing of retinal fundus picture for enhancing the quality which is required for further dealing with and to arrange a novel estimation to measure the cup to disk ratio of retinal fundus picture from the online database and arranging the infection by its critical symptoms using fuzzy classification in MATLAB. Lamani D. et al.[11] presented diverse parameters (Intraocular Pressure, Vertical Cup to Disk Ratio, Neuro Retinal Rim Thickness, Inferior Superior Nasal and Temporal Sector Ratio, Central Cornea Thickness) to analyze glaucoma and clinical instruments (Tonometry, Heidelberg retinal tomography, perimetry, Pachymetry, ophthalmoscopy, optical coherence tomography, GDx) used to examine the Parameters .Kumar B. et al. [12]demonstrated image processing technique for the detection of Glaucoma. The researchers utilized different strategies, for example, (PCA, combining textures and HOS) and contrasted their outcomes to find the precision. The researchers likewise utilized diverse classifiers (Bayes Classifier, SVM Classifier) to classify the glaucoma. This framework has 86% achievement rate of 200 original pictures for two phase classification with SVM. Ohri K. et al. [13] introduced Fuzzy based decision making for analysis of breast cancer for classifying malignant and benign. Author presented fuzzy guidelines which might be utilized to anticipate breast cancer risk and fuzzy outcomes are contrasted with clinical outcomes.

John A et al. [14] proposed fuzzy expert system for detection of Glaucoma for classifying Normal eye and Glaucomatous eye. Authors concluded that the fuzzy results are compared with clinical dataset and gives 88 % accuracy. Morales et al. [16] proposed a method for OD segmentation using Principal Component Analysis (PCA) and stochastic watershed transformation. PCA is used in the preprocessing stage to enhance the input images. The stochastic watershed transformation was applied on this image to obtain the OD. The method was evaluated on images from the DRIONS database and achieved an accuracy of 99.01%. The method shows an improvement for OD segmentation over other classical watershed segmentation methods. However, the method involves more computational complexity than other classical watershed segmentation methods.

A brief review of various literatures reveals that the research work was done on fundus images by using image processing to classify the disease and only one or two parameters are considered to detect disease but 1 or 2 parameters are not sufficient to detect Glaucoma This framework is an enhancement of our own work [14] and includes Graphical User Interface (GUI) for classifying Normal eye and Glaucomatous eye for both left eye and right eye individually and System also check Severity level of Glaucoma with 91.3% accuracy.

III. PROPOSED SYSTEM

This part rectifies the approach accepts in building the general fuzzy system for decision making framework. The fuzzy inference system is a structure which is dependent on fuzzy set speculation, grabs a fuzzy representation of patient's sign and likewise induces fuzzy relationship. With a particular objective to accomplish fuzzy depiction to fullest i.e. to fulfill high interpretability, the capability to deal with speculation is extremely hard. The word generalization suggests that ability to express the state-action as practical. Generalization rules permit additional rule base, quick acceptance and better fuzzy interpretability. A fuzzy dependent decision support system finishes expert data and involvement in cognizance of IF-ELSE rules to arrange fuzzy inference. Subsequently, a fuzzy expert structure allows a direct way to plan an arrangement with uncertain area. The given fuzzy set relating with an interest work describes the data credit to its correct enrollment and it should be in a range of (0, 1). Fuzzy is a set which has no new value and has a fuzzy

borderline. The triangular membership plot is a function having three variables a, b, c, where a and c signify feet of triangular with membership degree 0 and b represent peak of triangular with membership degree 1 and trapezoidal membership plot is a function having four variables a, b, c, d where a and d signify feet of trapezoidal with membership degree 0 and b and c represent peak of trapezoidal with membership degree 1.

IV. METHODOLOGY

In Fig 4 , For designing the expert system six input variables i.e. Intraocular pressure, cup to disc ratio, rim to disc ratio, Visual field, corneal Thickness, angle are used. These inputs are used to predict the health status of person. After selecting the input variables consecutive step is to fuzzify the variables i.e. we have to determine the fuzzy sets for every input variable and the corresponding range of the belonging to each fuzzy set. Fuzzy rule-based allows experts knowledge to consider symptoms of patient and then based on the rules developed gives a precise decision.

Online primary medical aid symptoms evaluation implies pointing out of those symptoms that are significant for the analysis of disease and then infer from the database/rule-base the possible disease.

Yes

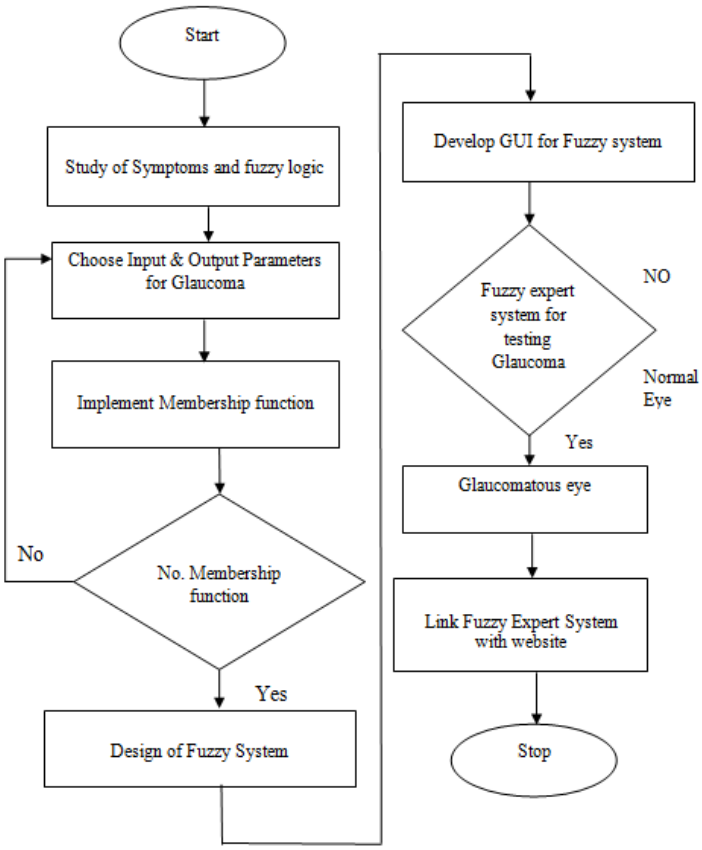

Figure 4: Methodology to Implement Proposed System

To design a Fuzzy diagnosis system, Fuzzy Inference System (FIS) andGraphical User Interface (GUI) are very powerful Toolbox in MATLAB. The FIS Editor displays instruction about a fuzzy inference system. There's a simple and understandable diagram at the down that shows the names of each input on the left and those of each output on the right. However, the number of inputs may be limited by the available memory of your machine.

4.1 Input Variables

For designing the expert system six input variables i.e. IOP, CDR, RDR, Visual field, corneal Thickness, Angle are used. These inputs are used to predict the health status of person. After selecting the input variables
Consecutive step is to fuzzify the variables i.e. we have to determine the fuzzy sets for every input variable and the corresponding range of the belonging to each fuzzy set.

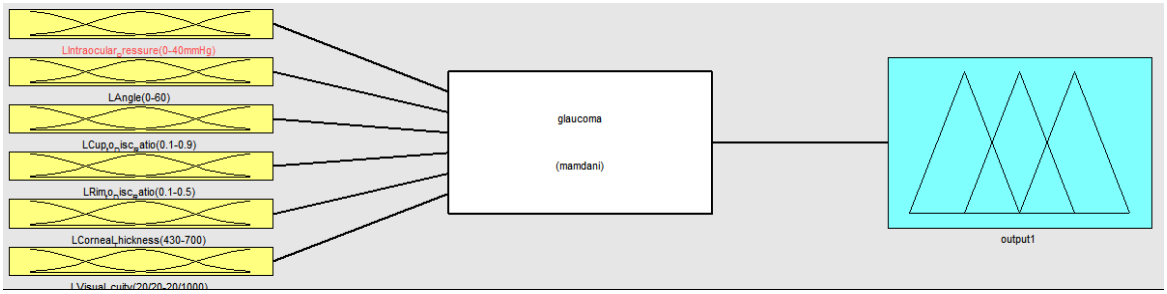

Figure 4.1) Mamdani FIS Editor with 6 inputs & 1 output.

4.2 Membership Function Editor

Membership function editor is used to define the shapes of all the membership functions associated with each variable.The Membership function editor is the tool that lets you display and edits all of the membership functions for the entire fuzzy inference system, including both input and output variables.

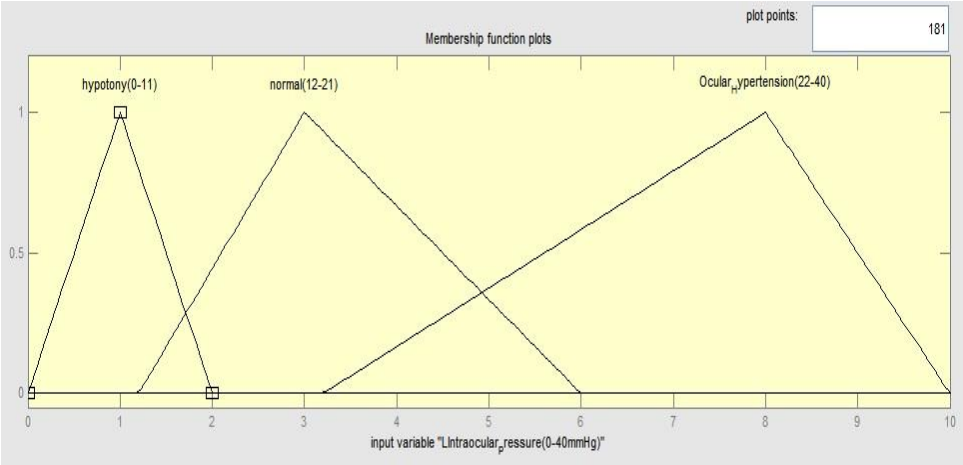

Figure 4.2:-a) membership Plot for Intraocular Pressure

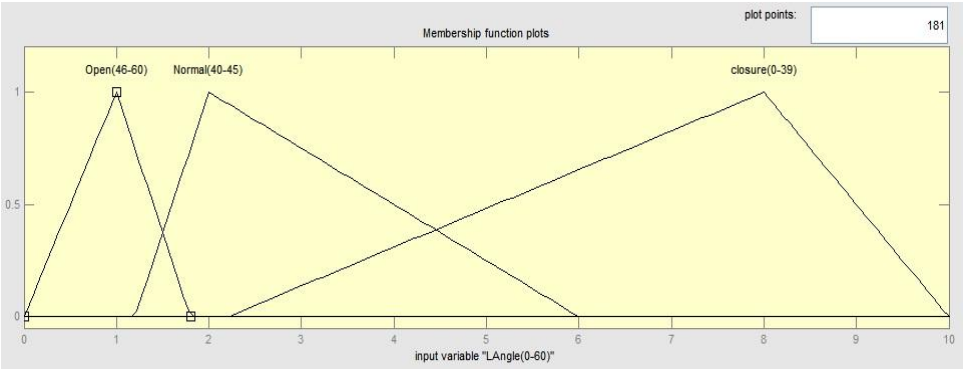

Figure 4.2:-b) membership plot for Angle

It is the method of the unification of the rules. The membership functions of the entire rule previouslyantecedentlyclipped during rule evaluation are taken and combined into one fuzzy set. The process a number of clipped subsequentmembership functions are changed into one fuzzy set for each output variable. The inference methodology used is the Mamdani inference method.

4.3 Rule Editor

Rule Editor is for editing the list of rules that defines the performance of the system.It comprises of an outsized editable text field for displaying and writing rules. Rule Editor is in addition has some acquainted With landmarks constant as those inside the FIS (fuzzy Inference system) Editor and Membership perform Editor, along with the menu bar and also the status line.

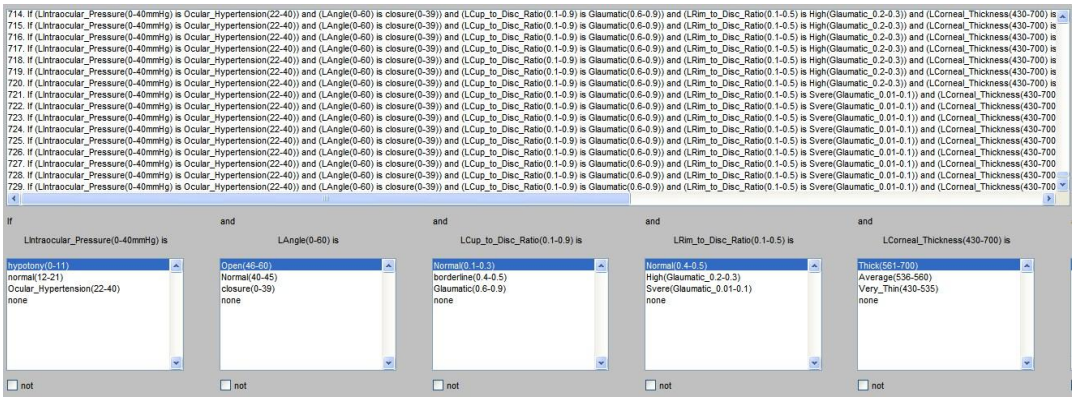

Fig 4.3:-rule editor

4.4 Fuzzification and Defuzzification

Fuzzification is the initial step in the design of any fuzzy expert system. It is the technique of mapping a crisp value of an input to membership degrees in several fuzzy Linguistic variables. Defuzzification is the inverse process of fuzzification. It's the method of combining fuzzy output of all the rules to give one crisp value. Thus crisp value output is given by the defuzzification method after estimating its input value.

V. EXPERIMENTAL RESULTS

5.1 Rule Viewer

Rule Viewer to analyze the fuzzy inference system. Use this viewer as a diagnostic to check for instance, the individual membership function shapes implication the results. The Rule Viewer displays the instructions of the complete fuzzy inference process. In addition, there are the now intimate items like status line and the menu bar. In the lower right, there is a text field where you can enter a specific input value. Fig 5.1 displays the rule viewer of the proposed system. It indicates the outcome of entire proposed system. From the left side at the peak we get defuzzified values, we get =5.79 which means person is Normal.

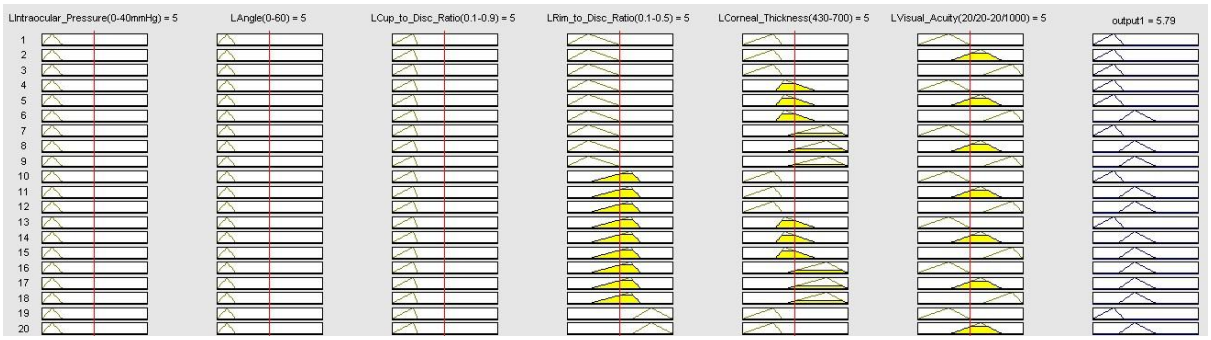

Fig 5.1: - Rule Viewer

5.2 Surface Viewer

Surface Viewer to analyze the dependence of one of the outputs on any one or two of the inputs that is, it create and plot an output surfaceplot for the fuzzy inference system. It generates a 3-d surface from two input variables and one output variable of a FIS.

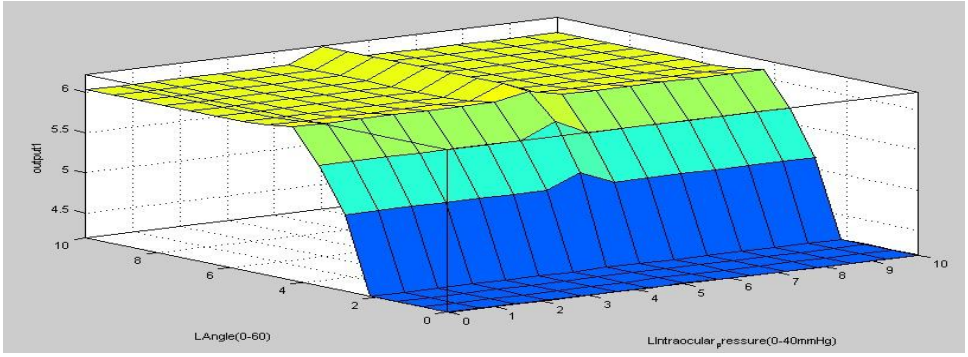

Figure 5.2:-a) Surface view of Intraocular Pressure and Angle

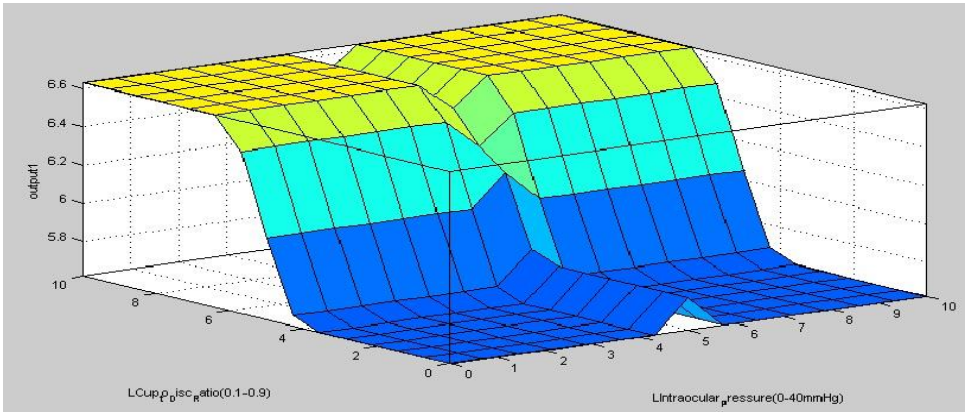

Figure 5.2:-b):-Surface view of Intraocular Pressure and Cup to disc ratio

5.3 Graphical User Interface

MATLAB GUI (MATLAB Graphical User Interface) is the boundary information from the MATLAB graphic objects created for human-computer interaction.

guide automatically generates 2 forms of MATLAB files; one is for MATLAB interface figures and another is for m-file,accustomed store the command operates of the MATLAB program.

The m-file provides code to initialize the graphical user interface and contains a framework for the Graphical user interface click-backs, the routines that execute once a user interacts with a GUI component. Using the M-file editor, you'll add code to the click-backs to perform the functions you wish.

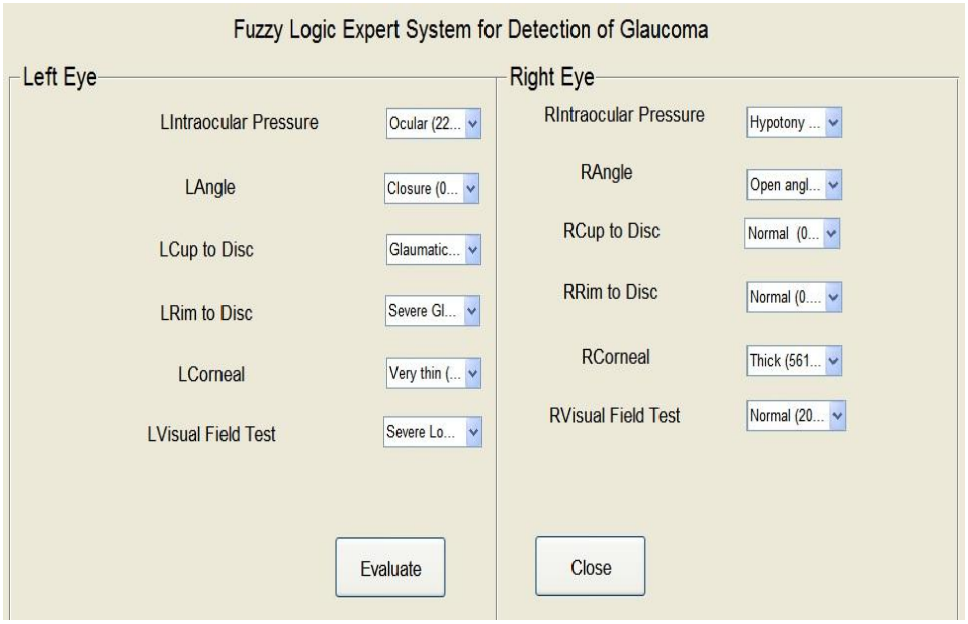

Figure 5.3:-a) Glaucoma Detection GUI with Input Parameters

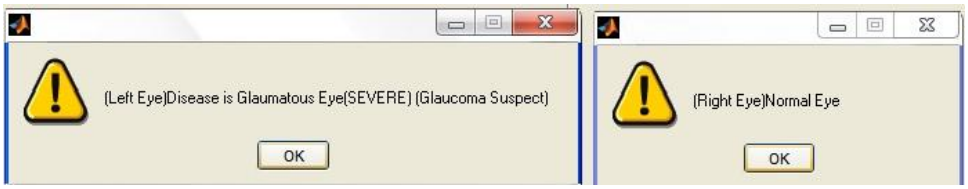

Figure 5.3:-b) GUI showing Decision on Glaucoma according to Input Parameters

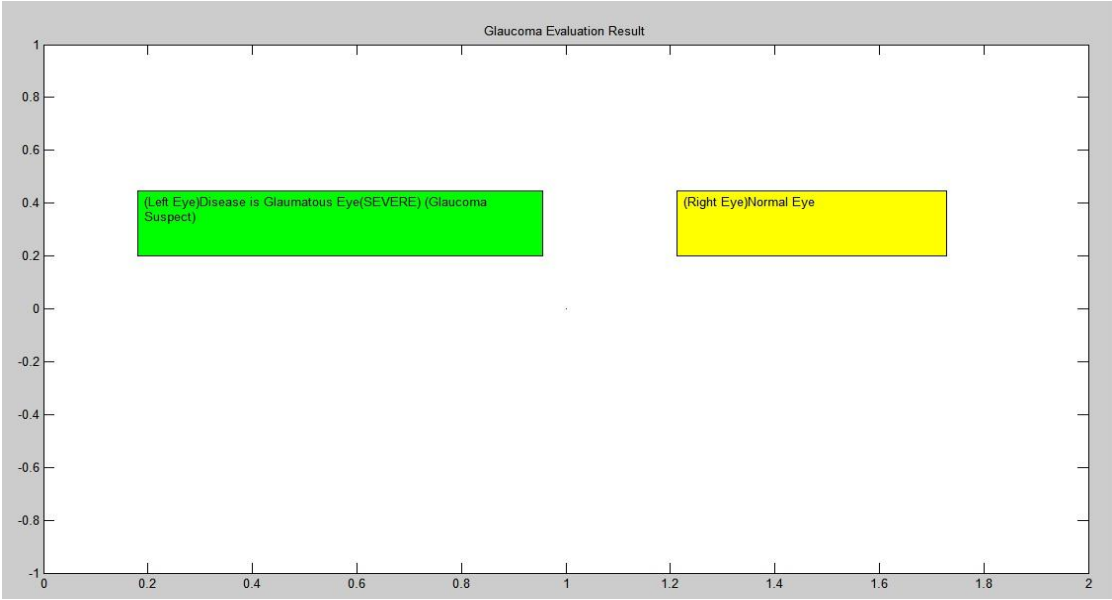

Figure 5.3:-c) Glaucoma Detection for Both Eyes

There are six parameters that are used to detect glaucoma are intraocular pressure (IOP),angle, cup to disc ratio (CDR), rim to disc ratio (RDR), corneal thickness, visual field test. In graphical user interface (GUI), we used six parameters on both left eye and right eye. The results will be evaluated of each eye (Left and Right) one by one based on fuzzy rules and dataset.

Firstly we took dataset of 150 participants from ophthalmologists and then we analyzed these dataset with fuzzy expert system. Our proposed system presents recognition of normal eye and glaucomatous eye on the basis of parameters (IOP, CDR, RDR, Angle, Visual Field, and Corneal Thickness).Fuzzy rule-based allows experts knowledge to consider symptoms of patient and then based on the rules developed gives a precise decision.Theoutcome of 137 dataset was similar with the outcome of Ophthalmologists. For same evaluated results accuracy of our system is compared with respect to expert advice using relationship as:

$$\alpha = \frac{\beta}{\gamma} \times 100 \qquad [12]$$

α = Accuracy of fuzzy expert system

β = No. of correct decisions

γ = Total No. of patients

we have reached 91.3% accuracy by doing this whole process.A sample of 50 Fundus images. After extracting the features from fundus images such as optic disk, optic cup, Neuroretinal rim, ocular parameters such as CDR and RDR are evaluated for a database of around 50 images to classify them as glaucoma tic or Normal. These samples are collected from the hospitals of Jalandhar and Ludhiana (Punjab). For classifying the fundus images as Glaucomatous or Normal, Fuzzy System was used.

The Table represents the result of CDR and RDR computed by proposed method for the test images and the Doctor's Observation. It was found that all the glaucomatous images were classified as Glaucomatous by Fuzzy classifier while out of 10 normal images, 2 were wrongly classified as Glaucomatous.

TABLE I- Glaucoma Detection Parametric Comparison for different Patients

Sample	CDR	RDR	Doctor's Observation	Proposed System Results	Compared Results
1	0.32	0.21	Glaucoma	Glaucoma	Yes
2	0.40	0.39	Glaucoma	Glaucoma	Yes
3	0.18	0.26	Glaucoma	Glaucoma	Yes
4	0.52	0.35	Glaucoma	Glaucoma	Yes
5	0.48	0.15	Glaucoma	Glaucoma	Yes
6	0.41	0.24	Glaucoma	Glaucoma	Yes
7	0.38	0.46	Glaucoma	Glaucoma	Yes
8	0.26	0.25	Glaucoma	Glaucoma	Yes

9	0.36	0.41	Glaucoma	Glaucoma	Yes
10	0.34	0.43	Glaucoma	Glaucoma	Yes
11	0.13	0.50	Normal	Glaucoma	Yes
12	0.19	0.57	Normal	Normal	Yes
13	0.19	0.62	Normal	Normal	Yes
14	0.15	0.55	Normal	Normal	Yes
15	0.22	0.58	Normal	Normal	Yes
16	0.30	0.36	Glaucoma	Normal	No
17	0.34	0.38	Glaucoma	Normal	No
18	0.16	0.56	Normal	Normal	Yes
19	0.18	0.51	Normal	Normal	Yes
20	0.32	0.49	Normal	Normal	Yes

VI. CONCLUSION & FUTURE SCOPE

Glaucoma is most extensive disease today, so early recognition is exceptionally important to keep individuals experiencing Glaucoma. Early finding is the highest loyalty choice which gives medical doctors to separate Normal eye and Glaucomatous eye. In this proposed paper, we have exhibited a fuzzy structure on decision supportive network for the finding of Glaucoma. The proposed fuzzy interference framework predicts the Normal eye and Glaucomatous eye.

The proposed strategy can manage different sources of input which can be far superior to handle vulnerability during investigating period. The outcome of proposed system is compared with clinical dataset of 150 patients; the system gives promising results over 91.3% accuracy. This present framework can be extended by expanding number of inputs. Therefore, This Technology will have a Great Impact in Future and will be beneficial for Society.

SIGNIFICANCE STATEMENTS

This study discovers the easier, faster and cheaper way to it is detect glaucoma. It is beneficial for the society as it is possible to detect glaucoma with only two of the six tests available. The patient can opt for more tests for better clarity if the first two show normal eye according to our Fuzzy expert system. This system also shows the level of severity of glaucoma i.e.

a) Normal eye
b) Mild Glaucomatous eye
c) Moderate Glaucomatous eye
d) Severe Glaucomatous eye

This study will help the researcher to uncover the critical faster detection of glaucoma which usually takes some time to get detected as the six tests are expensive. This test involves six parameters i.e., tonometry, ophalmoscopy, Pachymetry, gonioscopy, perimetry. previous researcher used a maximum of two parameters.
Thus, a new theory on easier, faster and cheaper detect of glaucoma may be arrived at.

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REFERENCES

[1]. Walia, N., Tiwari, S.,Sharma, A., Singh H, 2015. A Decision Support System for Tuberculosis Diagnosability. International Journal on Soft Computing.6: 1-13. DOI: 10.5121/ijsc.2015.6301.
[2]. Pravitra.,T. C. Manjunath., Lamani, D., Chandrappa S. and H. S. Ranjan.2015. Different Clinical Parameters to Diagnose Glaucoma Disease. International Journal of Computer Applications. Volume 116 – No. 23: 42-46. DOI: 10.5120/20295-2743.
[3]. Rawat, K., Burse, K., 2013. A Soft Computing Genetic Neuro-Fuzzy Approach to Data mining and its Application to Medical Diagnosis. InternationalJournal of Engineering and Advanced Technology. vol. 3: 409-411.
[4]. Balancia, V., Rae, W., Dumitrache, I.,Caramihai, M., 2011.Evaluation ofBreast Cancer Risk by using Fuzzy Logic.University Politehnica of Bucharest Scientific Bulletin, Series C 73.1,vol. 73, pp 53-64.
[5]. Inoue, N., Yanashima, K., Magatani, k., Kurihara, T., 2005.Development of a simple diagnostic method for the glaucoma using ocular Fundus pictures. 27th Annual International Conference of Engineering in Medicine and Biology Society. Shanghai, China. 17-18 Jan, IEEE. pp- 3355-3358.
[6]. Cheng, J., Liu, J., Lee, B.H., Wong, D.W.K., Aung, F.Y.T., Baskaran, M., 2010. Closed Angle Glaucoma Detection in RetCam Images.32nd Annual International Conference of the IEEE EMBS Buenos Aires.Argentina, August 31 – September 4.IEEE. pp: 4096 4099.

[7]. Xu, Y., Lee, B.H., Tan N.M., Liu J., Wong D.W.K., Aung T., Baskaran M., 2012. Anterior Chamber Angle Classification UsingMultiscale Histograms of OrientedGradients for Glaucoma Subtype Identification. 34th Annual International Conference of the IEEE EMBS San Diego. California USA, 28 August - 1 September. IEEE. pp: 3167-3170,.
[8]. Agarwal, A., Gulia, S., Chaudhary, S., Dutta, M.K.,Burget, R., Riha, K., 2015. Automatic Glaucoma Detection using Adaptive Threshold based Technique in Fundus Image. Telecommunications and Signal Processing 38th International Conference. Prague Czech Republic, 9-11 July. IEEE. pp- 416-420.
[9]. Faezipur, M., andAloudat, M., 2015. Determining the Thickness of the Liquid on the Cornea for Open and Closed Angle Glaucoma Using Haar Filter. Systems, Applications and Technology Conference Long Island. Farmingdale, NY, USA, 1-1 May. IEEE. pp: 1-6.
[10]. Haveesh, G., Hegde, G., Bhatkalkar, B., Prabhu,S., 2015. Glaucoma detection and its classification using image processing and fuzzy classification. Proceedings of4th World Conference on Applied Sciences, Engineering & Technology. Kumamoto University, Japan, 24-26 October. BRCORP. pp- 291-295.
[11]. Pravitra.,T. C. Manjunath., Lamani, D., Chandrappa S. and H. S. Ranjan. 2015. Different Clinical Parameters to Diagnose Glaucoma Disease. International Journal of Computer Applications. Volume 116 – No. 23: 42-46. DOI: 10.5120/20295-2743.
[12]. Kumar, B.N., Chauhan, R.P., Dahiya,N., 2016. Detection of Glaucoma using Image processing techniques. International Conference on Microelectronics, Computing and Communications . Durgapur, India. 23-25 Jan. IEEE. pp. 1-6.
[13]. Ohri, K., Singh, H., Sharma,A., 2016. Fuzzy Expert System for diagnosis of Breast Cancer. International Conference on Wireless Communications, Signal Processing and Networking, Chennai, India. 23-25 March. IEEE. pp 2487- 2492.
[14]. John, A., Sharma, A., Singh, H., Rehani, V., 2017. Fuzzy based decision making for detection of Glaucoma. 8th International Conference on Computing Communication and Networking Technologies. IIT Delhi, 3-5 july. IEEE.
[15]. Five Common Glaucoma Tests. (n.d.). Retrieved September 14, 2017, from http://www.glaucoma.org/glaucoma/diagnostic-tests.php
[16]. Morales, S., Naranjo, V., P´erez, D., Navea, A., Alca˜niz, M., 2012. Automatic detection of optic disc based on PCA and stochastic watershed. Signal Processing Conference (EUSIPCO), 2012 Proceedings of the 20th European, Bucharest, Romania. 27-31 Aug. IEEE. pp 2605–2609.

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