A METHODOLOGICAL ANALYSIS AND PREDICTION OF GLAUCOMA DISEASE

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Abstract.

In these recent times, aged people aren't seriously taking care of the body. Nowadays, young generations ignore small symptoms that may cause a serious problem or damage in the coming years. So, early prediction and treating the particular disease may avoid a risk factor. This paper analyses about glaucoma diseases which is related to ophthalmology,which is a treatment related to eye disorders. Glaucoma is a disease that causes people to be blind when it gets severe. In this paper different machine learning techniques are applied to analyse the accuracy and the highest accuracy is shown as a result of the predicted glaucoma using CNN. This system helps in early prediction of this disease and provides a new cure at the early stage before it would get worsen.

Keywords: Glaucoma Disease, SVM, Random Forest, Logistic Regression, Adaboost And CNN.

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1. Introduction

Glaucoma disease is a disease that causes damage to the drainage angle which puts a lot of pressure on the eye, which leads tooptical nerve damage and then results in blindness. In more detail, that aqueous humor will constantly create in the eye. The aqueous flows into the eye and it drains out. If the drainage angle does not work, this process it leads to putting pressure on the inside of the eye which may lead to optical nerve damage and the end result will be blindness. The symptoms of glaucoma disease are: it causes severe headache, eye pain, nausea, vomiting, blurred vision, halos around lights and eye redness. The average person is affected at nearly 40 years. This paper detailed the architecture, dataset, algorithms that are used for analysis and prediction modules, performance evaluation, comparing with existing systems and finally, references are discussed briefly in individual sections.

2. Related Works

A Comprehensive Review of Deep learning Strategies in Retinal Disease Diagnosis using Fundus Images – 2022". In this research of analysis, computer vision and machine learning techniques are growing continuously nowadays [1-5]. By using these advanced techniques retinal diseases diagnosis has been implement successfully with the help of artificial intelligence using fundus images. In this paper a review of comprehensive study leads to analysis about different techniques of

deep learning and image pre-processing methods to different strategies for retinal diseases diagnosis. This paper result shows eight major difficulties, methods and future scope that is present in the retinal diseases diagnosis system.

[6] "Alternations in Patients with First-Episode Depression in the Eyes-Open and Eyes-Closed Conditions: A Resting-State EEG Study – 2022". This system facilitates about the altered EEG which has been a major depression disorder (MDD) but till now there has been no solution found. This is due to many inconsistencies in the eye-open (EO) and eye-closed (EC) this may lead to alternations in the EEG system. Because of these misleading alternations in EEG it affects in health conditions. The proposed system implements the feature selection, logistic regression, SVM machine and linear discrimination algorithms are used for the analysis. This system shows a better resting condition and identifies the inconsistencies in EEG alterations. [7] "Automatic Detection of Diabetic Eye Disease Through Deep Learning using Fundus Images: A Survey – 2020". This system subjected to irregular production of insulin from pancreas which results in diabetes diseases. Many people may suffer from various diseases due to diabetes it been risk when the insulin did not produce in the body. In this system they proposed an aspect of analysis like datasets, image pre-processing of the system, various algorithms of deep learning used in the system and finally performance evaluation results are compared and represented as a survey. This survey helps to identify better performance among the existing system. [8] "Classification of Eye Diseases in Fundus Images – 2021". This system mainly focused about the eye disease that has been a major problem in the developed nations. Because of advancement in classifications it is easily to identify and classify types of various diseases. In this system they proposed a method that is convolutional neural network which can easily classify and identify the types of various eye diseases. This system achieved an accuracy of 99.89% which is better result than the existing system. [9] "Detecting Cataract using Smartphones – 2021". This system facilitates about the cataract which is related to an eye disease it causes eye blindness id this kind of disease is detect earlier it can be prevented from server damage to the eye. This system captures the image of lens by the smartphone and process the image to identify the cataract disease. This system implements SVM deep learning method to identify the efficiency of the system. This system shows the accuracy of 96.6% with the help of cameras and sensors it can process the images and identify the level of the disease.

[10] "Development of Prototype to Measure Intraocular Pressure if Eye Along with Gonioscopy – 2021". In this system of analysis, glaucoma detection has two process of testing tonometry and gonioscopy which requires experience in that field. So some ophthalmologists may avoid this kind of test. This system proposed a new method called

"Ton goniometry" which helps to identify the glaucoma disease. The gonio lens and the relation of Intraocular Pressure (IPO) and the implementation of LabVIEW help to improvise the sensing quality in the sensors. This system is implemented in goat's eyes. [11] "Different Eye Movement Behaviours Related to Artificial Visual Field Defects – A Pilot Study of Video – Based Perimetry – 2021". This system states about the Visual Field Defects (VFDs) that can cause eye blindness from various diseases. The Visual Field Defects (VFDs) observe the eyes behaviour if any unusual behaviour in the eye it detects and stores the data. And then the data will feed into artificial technology to correct its behaviour. This proposed method helps to repair the defects in the eye. [12] "Eye Blink Artifact Detection with Novel Optimized Multi-Dimensional Electroencephalogram Features – 2021". This system analysed about the Electroencephalogram analysis eye blink and nervous system diseases. The proposed system develops an eye blink artifact detection based on EEG features for analysis it uses K-means clustering (SNEO) and support vector machine (SVM) based on this it detects the eye blink and it prevents from eye blindness. This system has been implemented in children's hospital with a subject of 11 EEG database. [13] "Smart phones Speech Testing for System Assessment in Rapid Eye Movement Sleep Behaviour Disorder and Parkinson's Disease – 2021". In this system of analysis, the rapid increase of risk due to Parkinson's disease (PD) has been studied in this article. In this system they taken rapid eye movement (REM) sleep behaviour disorder (RBD). The proposed method of this system is to investigate the smartphone speech and predict the symptoms, depression and movements i.e. overall health condition of the patient. This system analysed 4242 voices recording and has the sensitivity of 74.9% and specificity of 73.2% of Parkinson's disease (PD). [14] "Solar Ultraviolent Exposure and Absorbed Irradiance of the Cornea and Anterior Chamber/Lens: A Monitoring Model using Porcine Eyes in a Machine – 2019". This system facilitates about Solar Ultraviolent (UV) can cause various eye diseases. A recent study states that most eye diseases caused due to UV radiation which can affect the tissue of a human directly. This system aims to detect the amount of radiation from the sunlight that affects the humans. In this system they used SEA Solar Elevation Angles and sunlight path to calculate the amount of radiation from sunlight it can affect the tissue.

3. Proposed System

3.1. Architecture

3.1.1. Algorithm Analysis Architecture

In this algorithm analysis architecture, the glaucoma related data is taken for analysis with various machine learning algorithms to check the specificity and sensitivity scores. Then the accuracy of various algorithms is compared in the final results.(see Fig. 1)

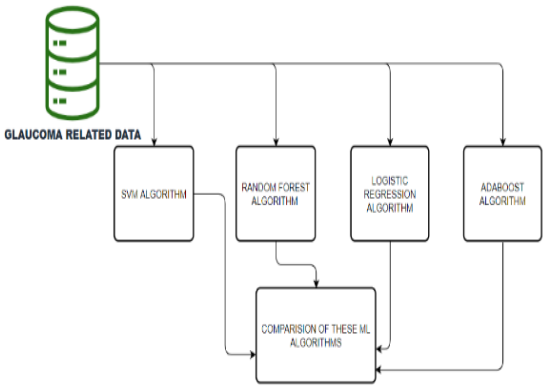

Figure 1. Methodological AnalysisArchitecture.

3.2. Prediction Architecture

In this prediction architecture, the glaucoma datasets are classified into train and test dataset each dataset contains nearly 400 images. These images are resized and labelled using convolution, pooling layers. Then the images train with glaucoma and then prediction of the glaucoma disease shown in the result in the form of images with labels actual and prediction. (see Fig. 2)

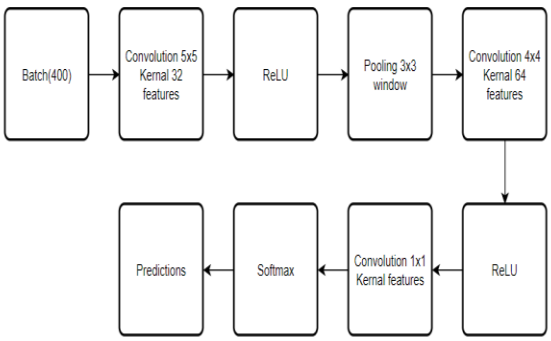

Figure 2. Prediction Architecture.

3.3. Dataset

The methodological analysis module contains 63 attributes and the prediction module contains 6 attributes in the CSV file and the images are approximately 650 images to predict the glaucoma disease.(see Fig. 3, 4 and 5)

	ag	at	as	an	ai	eag	eat	eas	ean	eai	...	tmt	tms	tmn	tmi	mr	rnf	mdic	emd	mv	Class
0	2.220	0.354	0.580	0.686	0.601	1.267	0.336	0.346	0.255	0.331	...	-0.018	-0.230	-0.510	-0.158	0.841	0.410	0.137	0.239	0.035	normal
1	2.681	0.475	0.672	0.868	0.667	2.053	0.440	0.520	0.639	0.454	...	-0.014	-0.165	-0.317	-0.192	0.924	0.256	0.252	0.329	0.022	normal
2	1.979	0.343	0.508	0.624	0.504	1.200	0.299	0.396	0.259	0.246	...	-0.097	-0.235	-0.337	-0.020	0.795	0.378	0.152	0.250	0.029	normal
3	1.747	0.269	0.476	0.525	0.476	0.612	0.147	0.017	0.044	0.405	...	-0.035	-0.449	-0.217	-0.091	0.746	0.200	0.027	0.078	0.023	normal
4	2.990	0.599	0.686	1.039	0.667	2.513	0.543	0.607	0.871	0.492	...	-0.105	0.084	-0.012	-0.054	0.977	0.193	0.297	0.354	0.034	normal

Figure 3. Dataset of Methodological Analysis Module.

	Filename	ExpCDR	Eye	Set	Glaucoma	Glaucoma_keyword
0	001.jpg	0.7097	OD	A	0	Normal
1	002.jpg	0.6953	OS	A	0	Normal
2	003.jpg	0.9629	OS	A	0	Normal
3	004.jpg	0.7246	OD	A	0	Normal
4	005.jpg	0.6138	OS	A	0	Normal

Figure 4. Dataset of Prediction Module.

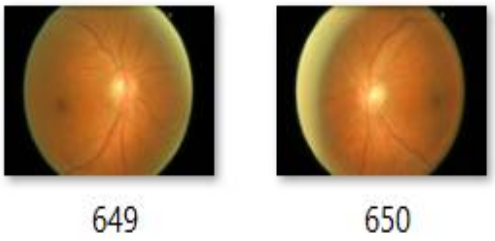

Figure 5. Images of Prediction Module.

3.4. Data Pre-Processing

In methodological analysis the null values and duplicates values are removed to provide a raw data into a clean data. In prediction module the images are resized in the required format. The actual dataset is split into

- Train dataset , Test dataset

3.5. Train Dataset

The train dataset contains nearly 400 images that is used to train this neural network with the help of trained and labelled images.

3.6. Test Dataset

The test dataset contains nearly 360 images, it same as the train dataset, if the train dataset fit in the module. The test dataset data also fit with minimal overfitting has been done.

3.7. Methodological Analysis

In methodological analysis different machine learning algorithms are taken to analysis the specificity, sensitivity and accuracy score to see the difference and better algorithm to analysis this type of diseases. The machine learning algorithms are SVM, random forest, logistic regression and adaboost. Support vector machine it is one of the supervised learning algorithms that is used for both the classification and regression problems, it gives the accuracy of 88% approximately. Next one is random forest to random decision forest is one of the tree model decision classifiers. It is also well suitable for classifier and regression problems. It gives the accuracy of 83% approximately. In more system it gives the best accuracy score but not for this system. The logistic regression it is also a supervised learning algorithm mostly used for prediction problems. It gives the accuracy of 85% approximately. Finally the adaboost most likely random forest mostly used for classification and regression problems, it gives the accuracy of 71% approximately. With this methodological analysis module, we compare with various machine learning algorithms to find the best accuracy in that particular algorithm.

Formulation,

$$Specificity = a[1][1]/(a[1][1] + a[1][0])$$

$$Sensitivity = a[0][0]/(a[0][0] + a[0][1])$$

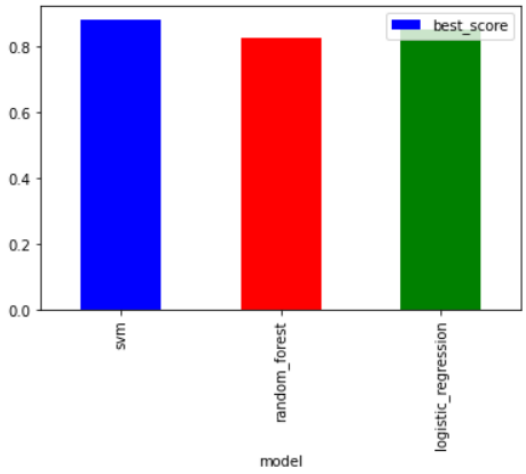

Figure 6. Best Scores of Algorithms.

3.8. Prediction Module

The dataset contains nearly 650 images related to glaucoma disease. For prediction module CNN is used to predict the glaucoma with the help of the image processing methodology in CNN. CNN contains an artificial neural network that has neurons in the form of learnable weights and biases. The numerical weights are turned on, so that the training process is done with the

reorganization of various images which may respond correctly with this recognized image. The neurons exchange information between each other. The neural network consist of multiple layers, each layer stores the given input and the process outcome in each layer. The convolutional neural network stores the image as a matrix format from top to bottom with the given dimensions. The pooling layer consist of maximum pooling, average pooling and minimum pooling based on the respective input cases. The images are trained and tested which the help of this neural network and predicted the glaucoma disease. The accuracy of this CNN is 76% approximately.

3.9. Prediction Outcomes

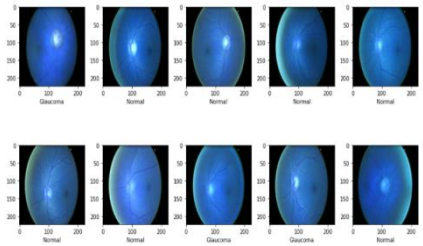

Figure 7. Trained Data.

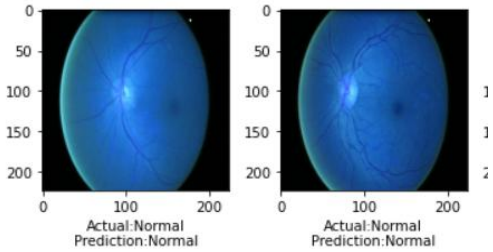

Figure 8. Prediction Module Outcome.

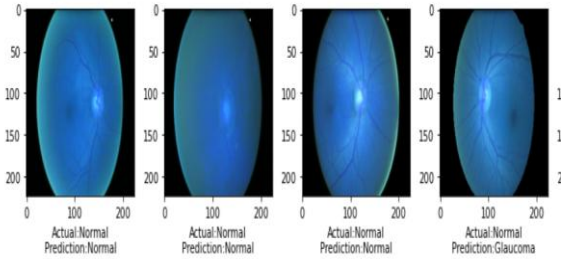

Figure 9. Prediction Module Outcome.

4. Performance Evaluation

Table 3. System Specification.

HARDWARE/SOFTWARE	SPECIFICATION
HARD DISK	1 TB
RAM	4 GB(Min)
TOOL	Jupiter Notebook
LANGUAGE	Python 3.0

In methodological analysis different machine learning algorithms are used to find the better accuracy than the other algorithms. The prediction modules uses CNN for image processing. So, as a result this system implements SVM, random forest, logistic regression, adaboost and CNN algorithms to analysis the better accuracy for this glaucoma prediction system. The accuracy is calculated with different metrics like confusion matrix, correlation, f1-score, recall are used to evaluate the accuracy.

Accuracy - Accuracy is a ratio of correctness in a given input is known as accuracy.

$$Accuracy = \frac{TN + TP}{TN + FP + TP + FN}$$

Precision - Positively predicted values are known as precision.

$$Precision = \frac{TP}{TP + FP}$$

Recall - Calculates the true positive rate.

$$Recall = \frac{TP}{TP + FN}$$

F1 – Score - It is calculated as a mean of both precision and recall.

$$F1\ score = 2 * \frac{Precision * Recall}{Precision + Recall}$$

Were,

TP – True Positive

TN – True Negative

FP – False Positive

FN – False Negative

Confusion matrix - Confusion matrix is defined as a square matrix that has both data instance and predicted label.

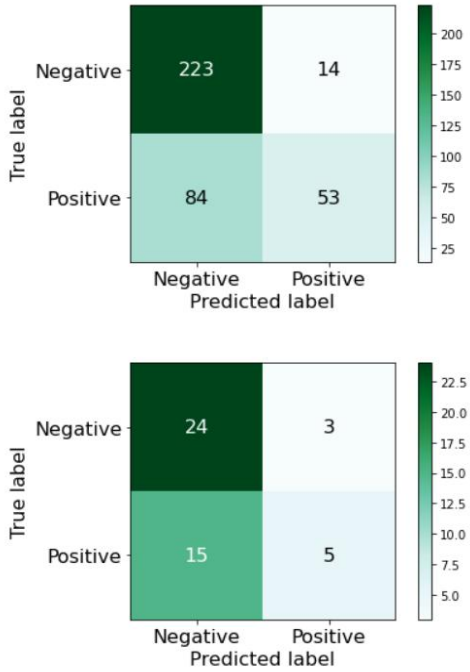

Figure 10. Confusion Matrix.

Correlation matrix - It displays the linear relationship among the dataset.

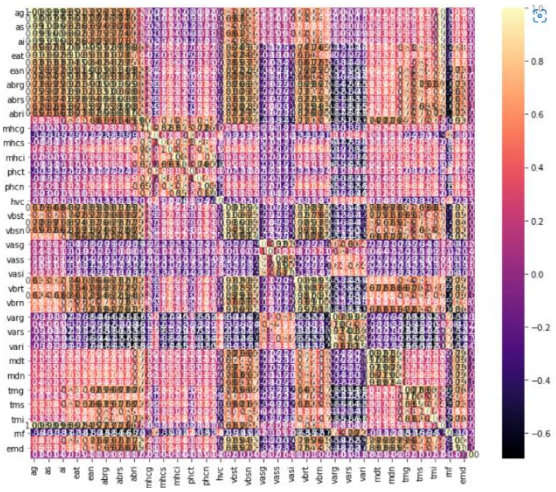

Figure 11. Correlation Matrix.

Formulation,

$$mean\_tpr + = interp(all\_fpr, fpr[i], tpr[i])$$

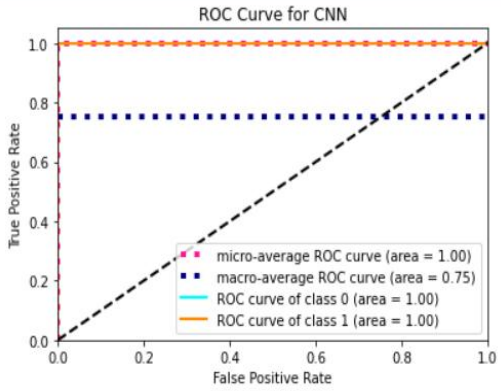

Figure 12. ROC Curve for CNN.

5. Performance Measure

Table 4. Performance Measure.

Algorithms	Accuracy
SVM	88%
Random forest	83%
Logistic regression	85%
Adaboost	71%
CNN	76%

6. Comparing With Existing System

"REAL TIME GLAUCOMA DETECTION FROM DIGITAL FUNDUS IMAGES USING SELF-ONNS"[2] 2021, in this paper the algorithm mainly used was self-ONN with this algorithm they achieved 73.7, 75.3, and 74. They also used CNN algorithm and they achieved 68 and with ResNet- 69.8, VGG 19 – 77.3 and Xception – 71.2 these are the algorithms they used and achieved accuracies. In our system

we achieved SVM – 88, Random Forest – 83, Logistic Regression – 85 and AdaBoost – 71 these are the methodologic analysis of machine learning. We achieved more than the existing system. In prediction module we use CNN algorithm for image processing which and we achieved 76 which is more than the existing.

7. Conclusion and Future Work

In this increasing population many people didn't predict or check the symptoms for a disease form early stage. They didn't take a chance to clarify any type of issue from early symptoms. With age group of 40 to 60 aged people are affected due to this glaucoma disease. The large countries like China, Europe, Africa, Latin America and India had the highest ratio of glaucoma to adult population. Usually this type of disease affect majorly around 40 to 60. But nowadays it happen to adults due to lack of sleep and other it cause a change of lifestyle. In 2020, about 80 million people has glaucoma worldwide and this number is expected to increase to over 111 million by 2040. So, be aware of these kinds of diseases and try to check the doctor in an early stage or any other symptoms shown. In future advanced algorithms may rise it will may better than this machine learning algorithm and make the system more user friendly that it might helpful to predict the early stage of glaucoma and prevent from blindness easily.

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