Musik in bayern
ISSN: 0937-583x Volume 90, Issue 1 (Jan -2025)
https://musikinbayern.com **DOI https://doi.org/10.15463/gfbm-mib-2025-*372***

Comparative Study on Detection of Various types of Eye Diseases using ML Algorithms.

Mrs.R.Anitha,(First Author)
Department of Computer Science and Applications,
SRM Institute of Science and /technology,
Chennai, India – 600089,
anithar2@srmist.edu.in

Ms.Adyasha Samal(Second Author),
Department of Computer Science and Applications,
SRM Institute of Science and /technology,
Chennai, India – 600089,
adyashas@srmist.edu.in

Ms.G.V.Reshma(Corrsponding Author),
Department of Computer Science and Applications,
SRM Institute of Science and /technology,
Chennai, India – 600089,
reshmag@srmist.edu.in

To Cite this Article

Mrs. R.Anitha, Ms.Adyasha Samal, Ms.G.V.Reshma(Corrsponding Author),**," Comparative Study on Detection of Various types of Eye Diseases using ML Algorithms."** *Musik In Bayern, Vol. 90, Issue 01, Jan 2025, pp01-06*

Article Info
Received: 10-11-2024 *Revised: 16-12-2024* *Accepted: 23-12-2024* *Published: 03-01-2025*

Abstract— Machine Learning Algorithms are very much needed to detect various types of Eye Diseases because it analyses large datasets, reviews various patterns and produce accurate results. These Algorithms are also used to detect various eye diseases at an early Stage through Retinal Fundus Images, OCT Scans and field test results .This Paper discusses the methodologies used in the detection of various eye diseases using ML Algorithms. This Comparative Study provides access to various ML Algorithms that are used to detect the disease based on Accuracy, Efficiency and Interpretability

Keywords— ML Algorthms, OCT Scans

I. INTRODUCTION

The types of eye diseases, ranging from mild conditions to serious ones can cause significant vision loss or blindness.

1. Cataracts

The lens inside the eye will be clouded that leads to blurred vision. This disease occurs mainly due to aging but also occurs from injury, medications, or diseases like diabetes.

The severity of cataracts from slit-lamp images or photographs of the eye can be accessed using ML Algorithms.

2. Diabetic Retinopathy

This disease leads to the highest complication of diabetes where high blood sugar levels damage the blood vessels in the retina, that leads to vision impairment and blindness.

Retinal images are analysed and the signs of diabetic retinopathy such as microaneurysms, haemorrhages, and exudates are detected using Machine learning Algorithms

3. Glaucoma

It is a type of eye disease that damages the optic nerve, due to high intraocular pressure. It leads to gradual vision loss and blindness if untreated.

Glaucoma is detected by using Machine learning Algorithm by analysing optic nerve head images or by analysing the thickness of the cornea or the intraocular pressure.

4. Keratoconus

It is a condition where the cornea thins and becomes cone-shaped, distorting vision that leads to visual impairment.

Keratoconus can be detected using MLAlgorithms by analysing corneal topography maps. ML Models uses this map to identify the cone-shaped deformation.

5.Strabismus (Crossed Eyes)

It is a disease where the eyes are misaligned and do not point in the same direction. This can lead to double vision or poor depth perception.

ML Models are used to detect strabismus by viewing the alignment of the eyes in images and videos. ML Algorithms can track the movement of the eyes and detect any misalignment or abnormal eye position.

6.Conjunctivitis (Pink Eye)

Inflammation of the conjunctiva is caused by bacterial infection or viral infection or allergies. Symptoms include redness, itching, and discharge.

The conjunctivitis can be detected by analysing photographs of the conjunctiva for signs of redness, swelling, and discharge. ML Models distinguish viral, bacterial, and allergic types of Infection.

7.Pterygium: A growth of tissue on the conjunctiva that can extend onto the cornea can sometimes affects the vision.

Machine learning can analyse the growth of tissue on the conjunctiva through the eye images to detect pterygium.

II. METHODOLOGY

1.Machine Learning Models Used in Cataract Detection:

Convolutional Neural Networks (CNNs): CNNs are a division of Machine learning algorithms that are effective in image classification tasks. CNNs are trained to detect lens opacity and to classify the severity of Cataract (e.g., mild, moderate, severe). CNNs analyses a large dataset of labelled images of cataracts at different stages and learns its features.

Support Vector Machines (SVM): SVMs classify images based on predefined features extracted from the lens or eye structure for Cataract Detection

Random Forests and Decision Trees: These machine learning techniques can be used to detect the cataract severity by classifying various image features such as texture, shape, and the intensity of cloudiness in the lens.

Gradient Boosting Machines (GBM): GBM models can be applied to refine the classification accuracy by focusing on the features of lens structure of eye for identifying cataracts.

2. Machine Learning Models Used in DR Detection

Convolutional Neural Networks (CNNs): CNNs are the most widely used Machine learning models for image classification tasks. CNNs are trained on large datasets of labelled fundus images to automatically identify patterns associated with DR. This model learns hierarchical features such as blood vessels, exudates, haemorrhages, and microaneurysms, which are indicative of DR.

Support Vector Machines (SVM): SVM is a traditional ML algorithm used for classification of images. SVM can be trained on image features such as texture, shape, and intensity extracted from retinal images to classify the presence and severity of DR.

Random Forests (RF) and Decision Trees: These ML algorithms can be used to classify DR based on extracted features from retinal images. RF and decision trees make decisions based on the patterns learned from the data.

Ensemble Methods: Ensemble models combine multiple individual ML algorithms to improve classification performance. For DR detection, ensemble methods may combine CNNs with SVM or RF or RNN models to increase accuracy.

Recurrent Neural Networks (RNNs): RNNs can be used in the analysis of time-series data from retina scans (temporal data) for tracking DR progression over time.

3.Machine Learning Models Used in Glaucoma Detection

Convolutional Neural Networks (CNNs): CNNs are Machine learning models well-suited for image-based classification tasks. CNN detects glaucomatous damage in fundus images and OCT scans by analysing the optic nerve head, cup-to-disc ratio, and retinal nerve fibre layer thickness.

Support Vector Machines (SVMs): SVMs are traditional ML models that can be used for classification tasks. SVMs are used to classify features extracted from retinal images or OCT scans based on the presence or absence of glaucomatous damage in glaucoma detection.

Random Forests and Decision Trees: This Model can classify glaucoma severity by analysing features such as the optic cup size, the thickness of the retinal nerve fibre layer (RNFL), and the optic cup to the optic disc ratio.

Recurrent Neural Networks (RNNs): RNNs, including Long Short-Term Memory (LSTM) networks, can be used for analysing time-series data like visual field test results, that enables the detection of glaucoma progression over time.

Ensemble Learning: Ensemble models combine predictions from multiple models (e.g., KNN, DNN, CNNs, SVMs, RF) to improve classification accuracy and robustness in Glaucoma Detection.

4.Machine Learning Techniques for Keratoconus Detection

1. Convolutional Neural Networks (CNNs)

CNNs are a part of Machine learning algorithms specifically designed to work with image data. They are highly effective in analysing corneal topography maps, pachymetry images, and OCT scans.

This Model is trained to identify patterns in the corneal surface, such as steepening, asymmetry, or irregularities, that are characteristic of keratoconus.

It also segment the cornea from OCT scans to analyse the thickness and curvature of different corneal layers, and thus helps in the early detection of keratoconus.

2. Support Vector Machines (SVMs:

SVMs are mostly used for classification tasks in machine learning. They work by finding an optimal hyperplane that separates different forms of data.

SVMs can classify corneal topography data into "normal" and "keratoconus" categories based on features extracted from topographic maps (e.g., symmetry, asymmetry). SVMs can also analyse pachymetry data to detect thin corneas which is a symptom of keratoconus.

3. Random Forests (RF)

Random Forests uses ensemble learning algorithms that use multiple decision trees to make predictions.

RF can be used to classify topography, pachymetry, and OCT data based on multiple features, such as corneal curvature, central corneal thickness, and elevation differences. It can detect the onset of keratoconus by examining patterns in these features.

RF models can also be used to predict the severity of keratoconus, that helps to provide appropriate treatment.

4. K-Nearest Neighbours (KNN)

KNN is a simple machine learning algorithm that classifies data based on its proximity to neighbouring data points.

KNN can be used for classifying corneal topography maps and pachymetry data. The algorithm can identify unusual patterns in corneal curvature or thickness that are like those seen in keratoconus patients.

5. Deep Neural Networks (DNNs)

DNNs are a more common class of neural networks that can learn complex patterns of data.

DNNs can analyse large datasets of corneal imaging data and extract high-level features for classifying keratoconus. They can be useful in integrating multiple data types (e.g., topography, OCT, pachymetry) for more accurate detection and classification in Keratoconus Detection.

6. Ensemble Learning

Ensemble methods combine multiple machine learning algorithms to improve overall performance.

For keratoconus detection, ensemble methods might combine CNNs with KNN, RNN, SVMs or RF to improve accuracy in detecting and classifying the disease. This approach reduces the occurrence of misclassification and enhances model robustness.

5.Machine Learning Models for Strabismus Detection:

Support Vector Machine (SVM): This Model can be trained on extracted features such as pupil misalignment for classification.

Random Forests: It is effective for binary classification of Extracted features (e.g., strabismus vs. normal eyes).

K-Nearest Neighbours (KNN): It uses a simple classifier based on proximity in feature space.

6. Machine Learning Models for Detection of Conjunctivitis:

Support Vector Machines (SVM): SVMs can classify images based on extracted features such as redness, texture, or geometric characteristics of the eye.

Random Forest: This Model can classify Images based on colour and texture features, and provides a robust model even with noisy data.

K-Nearest Neighbours (KNN): This Model Works well in classification of images when the data is in high-dimension. (e.g., pixel values or feature sets from images).

7.Machine Learning Models for Pterygium Detection:

Support Vector Machines (SVM): SVM classifier can be used to classify the images into two categories: "pterygium" and "normal." based on the extraction of features such as size, shape, colour, and texture It can also be used to classify different severity levels of pterygium.

Random Forest: Random Forest is a robust ensemble learning technique, that can classify images based on a variety of features such as geometric or textural features and also handles noisy data better.

K-Nearest Neighbours (KNN): KNN can be used to classify images based on their proximity in the feature of space, making it suitable when there is huge number of extracted features.

III. COMPARITIVE ANALYSIS

The Comparison of Detection of different types of Eye Diseases using various Machine learning Models and their accuracy is tabulated as follows:

TABLE I. CATARACT DETECTION

Catract Detection	Machine Larning Algorithms			
	CNN	***SVM***	***RF***	***GBM***
Accuarcy %	95-99	85-92	85-90	85-90

Fig. 1. Accuracy Comparison for various Ml Models

TABLE 2 DIABETIC RETINOPATHY

DR Detection	Machine Larning Algorithms			
	CNN	***SVM***	***RF***	***RNN***
Accuarcy %	94-99	85-90	85-92	70-85

Fig. 2. Accuracy Comparison for various Ml Models

TABLE 3 GLAUCOMA

Glaucoma Detection	Machine Larning Algorithms			
	CNN	***SVM***	***RF***	***RNN***
Accuarcy %	90-98	75-90	80-88	70-85

Fig. 3. Accuracy Comparison for various Ml Models

TABLE 4 Keratoconus

Keratoconus Detection	Machine Larning Algorithms			
	CNN	***SVM***	***RF***	***KNN***
Accuarcy %	90-98	70-85	75-85	65-80

Fig. 4. Accuracy Comparison for various Ml Models

TABLE 5 Strabismus (Crossed Eyes)

Strabismus Detection	Machine Larning Algorithms		
	SVM	***RF***	***KNN***
Accuarcy %	75-85	75-85	70-80

Fig. 5. Accuracy Comparison for various Ml Models

TABLE 6 Conjunctivitis (Pink Eye)

Conjunctivitis Detection	Machine Larning Algorithms		
	SVM	***RF***	***KNN***
Accuarcy %	75-85	70-85	65-80

Fig. 6. Accuracy Comparison for various Ml Models

TABLE 7 Pterygium

Pterygium Detection	Machine Larning Algorithms		
	SVM	***RF***	***KNN***
Accuarcy %	75-85	70-85	65-75

Fig. 7. Accuracy Comparison for various Ml Models

IV.CONCLUSION

Machine Learning (CNN-based models) have consistently shown superior performance for detecting eye diseases across various conditions, including **cataract**, **diabetic retinopathy**, **glaucoma**, **strabismus**, **conjunctivitis**, and **pterygium**. These models typically achieve **high accuracy** (90% to 99%) because they can **automatically extract relevant features** from raw image data without the need for manual feature engineering.

Transfer learning techniques, such as **fine-tuning VGG16** or **ResNet**, have significantly boosted the performance of CNNs, making them more effective even with smaller datasets.

Traditional machine learning models like **SVM**, **Random Forest**, and **Gradient Boosting** can still provide useful results when combined with **feature engineering** (e.g., **eye landmarks**, **pupil positions**, **shape characteristics**), but they are generally less accurate than CNN-based models for complex image-based tasks.

V REFERENCES

[1] Glaucoma Detection using GAN-based Domain Adaptation Approach,S.Kalaiselvi; S. Poorani;A. Amirtharaj; M. Mythreyan; G. Vignesh Kumar

2023 International Conference on Sustainable Computing and Smart Systems (ICSCSS) Year: 2023 | Conference Paper | Publisher: IEEE

[2] Domain Adaptation Using DCGAN For Glaucoma Diagnosis, Siddhi Chourasia; Rhugved Bhojane; Rushikesh Patil; Deepali M. Kotambkar,2023 IEEE 8th International Conference for Convergence in Technology (I2CT) Year: 2023 | Conference Paper | Publisher: IEEE

[3] Glaucoma Disease Detection Using Hybrid Deep Learning Model, Manikandan J; Sidharth Raj M; Yogesh Kumar R; Sasi Varma C, 2023 Eighth International Conference on Science Technology Engineering and Mathematics (ICONSTEM),Year: 2023 | Conference Paper | Publisher: IEEE

[4] Synthesis of Optical Nerve Head Region of Fundus Image ,Anurag Deshmukh; Jayanthi Sivaswamy,2019 IEEE 16th International Symposium on Biomedical Imaging (ISBI 2019)Year: 2019 | Conference Paper | Publisher: IEEE

[5] Generating Twin VFs of Unlabeled and Unpaired VF through Generative Model, Zhenyu Zhang; Haogang Zhu,2023 IEEE International Conference on Bioinformatics and Biomedicine (BIBM) Year: 2023 | Conference Paper | Publisher: IEEE

[6] Unsupervised Domain Adaptation Based Image Synthesis and Feature Alignment for Joint Optic Disc and Cup Segmentation, Haijun Lei; Weixin Liu; Hai Xie; Benjian Zhao; Guanghui Yue; Baiying Lei, IEEE Journal of Biomedical and Health Informatics, Year: 2022 | Volume: 26, Issue: 1 | Journal Article | Publisher: IEEE

[7] Utilizing Advanced Deep Learning for Accurate Multilabel Classification of Ocular Diseases,M Kiran Mayee;M Humera Khanam, 2024 1st International Conference on Cognitive, Green and Ubiquitous Computing (IC-CGU),Year: 2024 | Conference Paper | Publisher: IEEE

[8] Glaucoma Prediction Using Deep Learning Techniques - A Comparative Study, P. Malin Bruntha;Iwin Thanakumar Joseph S;Saravanan S;D. Narmadha;Suresh Subramanian; G. Naveen Sundar, 2024 1st International Conference on Cognitive, Green and Ubiquitous Computing (IC-CGU)

[9] Automated cup-to-disc ratio evaluation for generalised glaucoma diagnosis using deeplabv3+, Alice Divya Nelson;J Raghul;A Devika Gireesh;Kalpana George;S S Anup , 2024 IEEE 12th International Symposium on Signal, Image, Video and Communications (ISIVC)

[10] Convolutional Neural Network Based Glaucoma Detection and Classification using Optic Disc Localization, Mahesh B Elgart. C. Manjunath;Raj Kumar Patra;Sripelli Jagadish;Debarshi Mazumder ,2024 International Conference on Integrated Circuits and Communication Systems (ICICACS)

[11] Glaucoma Detection Using Ensemble Techniques with InceptionV3, VGG16 and ResNet50, Puttaraj Kajagar;Ajeet Shyanavad;Anupama P Bidargaddi;Vinod Soddi;Prashant Ibrahimpur;Meena S M, 2024 International Conference on Advances in Modern Age Technologies for Health and Engineering Science (AMATHE)

[12] Performance Analysis of Deep Learning Models for Accurate Glaucoma Detection, Sambhav Dixit;Bhupendra Singh Kirar; Dheraj Kumar Agrawal ,2024 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS)

[13] Multi-Modal AI/ML Integration for Precision Glaucoma Detection: A Comprehensive Analysis using Optical Coherence Tomography, Fundus Imaging, RNFL, and Vessel DensityT Raghunathan;Aditya Mishra;Akhilesh Kumar Mahur;Balaji B 2024 2nd International Conference on Artificial Intelligence and Machine Learning Applications Theme: Healthcare and Internet of Things (AIMLA)

[14] Automated Glaucoma Detection from Fundus Images using Deep Learning, J.Nageswara Rao;Gurijala. Kusuma Priya;Shaik. Sadiya Tabassum;Shaik. Khaleel, 2024 3rd International Conference on Applied Artificial Intelligence and Computing (ICAAIC)

[15] Early Glaucoma Detection through ANSAN-Infused Retinal Vessel Segmentation, Keerthivasan E;Senthil Kumar Thangavel;Madhusudana Rao Nalluri;Somasundaram K;Sathyan Parthasaradhi;Meenakshi Y Dhar;Avadhani Bindu, 2024 International Conference on Inventive Computation Technologies (ICICT)

[16] Classification of Glaucoma Severity Stages Using Deep Learning, Passawut Uttakit;Panawit Hanpinitsak;Sukhumal Thanapaisal;Pattarawit Polpinit 2024 21st International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)

[17] Glaucoma Detection through Synergistic Combination of Image Processing and Deep CNN using MATLAB B, Subbarayudu; Harshitha Yadalam; Jeevana Seepiri;Jayalakshmi Bhogathi, 2024 5th International Conference for Emerging Technology (INCET)

[18] Glaucoma Identification Using Convolutional Neural Networks Ensemble for Optic Disc and Cup Segmentation,Sandra Virbukaitė;Jolita Bernata vičienė;Daiva Imbrasienė,IEEE Access Year: 2024 | Volume: 12 | Journal Article | Publisher: IEEE

[19] CA-Net: A Novel Cascaded Attention-Based Network for Multistage Glaucoma Classification Using Fundus Images,,Dipankar Das;Deepak Ranjan Nayak;Ram Bilas Pachori,IEEE Transactions on Instrumentation and Measurement Year: 2023 | Volume: 72 | Journal Article | Publisher: IEEE

[20] Automated Tool Support for Glaucoma Identification with Explainability Using Fundus Images,Thisara Shyamalee;Dulani Meedeniya;Gilbert Lim;Mihipali Karunarathne,IEEE Access Year: 2024 | Volume: 12 | Journal Article | Publisher: IEEE

[21] Selective Routing-Based Optic Disc Segmentation for Glaucoma Diagnosis,Goutam Balla;Mohammad Farukh Hashmi;Deepali M. Kotambkar,IEEE Sensors Letters,Year: 2024 | Volume: 8, Issue: 5 | Journal Article | Publisher: IEEE

[22] Glaucoma Grading Using Multimodal Imaging and Multilevel CNN,Marcos Melo Ferreira;Geraldo Braz Junior;João Dallyson Sousa de Almeida;Anselmo Cardoso Paiva, IEEE Latin America Transactions Year: 2023 | Volume: 21, Issue: 10 | Journal Article | Publisher: IEEE

[23] Predicting Clinician Fixations on Glaucoma OCT Reports via CNN-Based Saliency Prediction Methods,,Mingyang Zang;Pooja Mukund;Britney Forsyth;Andrew F. Laine;Kaveri A. Thakoor, IEEE Open Journal of Engineering in Medicine and Biology Year: 2024 | Volume: 5 | Journal Article | Publisher: IEEE

[24] Performance Evaluation of Retinal OCT Fluid Segmentation, Detection, and Generalization Over Variations of Data Sources, Nchongmaje Ndipenoch;Alina Miron;Yongmin Li, IEEE Access Year: 2024 | Volume: 12 | Journal Article | Publisher: IEEE

[25] Reconstruction-Driven Dynamic Refinement Based Unsupervised Domain Adaptation for Joint Optic Disc and Cup Segmentation, Ziyang Chen;Yongsheng Pan; Yong Xia ,IEEE Journal of Biomedical and Health Informatics, Year: 2023 | Volume: 27, Issue: 7 | Journal Article | Publisher: IEEE

[26] Geometric Correspondence-Based Multimodal Learning for Ophthalmic Image Analysis, Yan Wang;Liangli Zhen;Tien-En Tan;Huazhu Fu; Yangqin Feng;Zizhou Wang;Xinxing Xu;Rick Siow Mong Goh;Yipin Ng;Claire Calhoun;Gavin Siew Wei Tan; Jennifer K. Sun; Yong Liu; Daniel Shu Wei Ting , IEEE Transactions on Medical Imaging, Year: 2024 | Volume: 43, Issue: 5 | Journal Article | Publisher: IEEE

[27] GLIM-Net: Chronic Glaucoma Forecast Transformer for Irregularly Sampled Sequential Fundus Images, Xiaoyan Hu;Ling-Xiao Zhang; Lin Gao; Weiwei Dai.

[28] Xiaoguang Han; Yu-Kun Lai;Yiqiang Chen, IEEE Transactions on Medical Imaging,Year: 2023 | Volume: 42, Issue: 6 | Journal Article | Publisher:I