**Identifying Stages of Glaucoma and Eye Diseases**

**Early via Fundus Image Analysis**

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nd Review

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# Problem Statement

This project focuses on automated glaucoma detection using Convolutional Neural Network (CNN) techniques on retinal fundus images, aiming to mitigate vision loss through early detection. The proposed algorithm surpasses existing methods in accuracy, providing a rapid and efficient tool for processing fundus images. The literature survey discusses diverse approaches, including the integration of retinex theory, Self-Organizing Neural Networks (Self-ONNs), and deep learning for glaucoma detection, showcasing advancements in the field.

# Existing Project

The existing project is to detect glaucoma in its initial stages. Early detection is crucial as it allows for intervention through exercises, meditation, and yoga, potentially preventing the progression of the disease to irreversible blindness. By creating a project that can detect the disease early, the aim is to provide patients with the opportunity to seek appropriate treatment and prevent the onset of incurable blindness, in this proposed project we including the detection levels of the glaucoma with its presence…

## Significance of the Problem

The study addresses the significance of early glaucoma detection through the development of a computational tool using Convolutional Neural Networks (CNNs) on retinal fundus images. By enhancing accuracy and efficiency, the proposed algorithm aims to mitigate vision loss and contribute to the effective management of glaucoma, a leading cause of irreversible blindness, especially among adults over 60.

## Brief Evolution of the existing solution

The existing solution involves the development of a Convolutional Neural Network (CNN) algorithm for automated glaucoma detection using retinal fundus images. This approach surpasses previous methods in accuracy, providing a rapid and efficient tool for early glaucoma detection and staging, addressing the challenges of limited labeled data and computational complexity in real-time applications.

### Literature Review-1

A Statistical Robust Glaucoma Detection Framework Combining Retime, CNN, and DOE Using Fundus Images

Challenge solved: This paper represents a Statistical Robust Glaucoma Detection Framework that combines Retinex, CNN, and DOE to improve the accuracy and robustness of automated glaucoma detection using fundus images, addressing the limitations of existing processes..

Key Idea of the paper: The key idea of the paper is to develop a Statistical Robust Glaucoma Detection Framework that combines Retinex, CNN, and DOE to improve the accuracy and robustness of automated glaucoma detection using fundus images.

Method / Algorithm: The methods/algorithms used in the paper include Retinex color enhancement, CNN with 4 convolutional layers, and a robust design of experiment (DOE) for optimal hyper-parameter determination.

Data Set Used: The study utilized 1450 color fundus images provided by KCGM Hospital in Taiwan for evaluating the proposed glaucoma detection framework.

# Literature Review-1

Experimental Results: The proposed framework demonstrated estimated sensitivity of 0.95, specificity of 0.98, and accuracy of 0.97, outperforming most archival automatic glaucoma detection approaches.

unique findings: The unique findings of the paper include the proposed generalized loss function, Retinex theory for color enhancement, and the use of robust design of experiment (DOE) for optimal hyper-parameter determination in glaucoma detection using fundus images.

Advantages: The proposed framework offers advantages such as high effectiveness, robustness, simplicity, and clarity in glaucoma detection using fundus images.

Disadvantages: The paper does not explicitly mention any disadvantages of the proposed framework for glaucoma detection using fundus images.

## Literature Review-2

Real-Time Glaucoma Detection From Digital Fundus Images Using Self-ONNs

Challenge solved: The paper addresses the challenge of real-time glaucoma detection from fundus images by proposing a novel approach based on Self-Organizing Neural Networks (Self-ONNs), which outperforms deep CNN models and achieves state-of-the-art performance levels with reduced complexity.

Key Idea of the paper:The key idea of the paper is to design principles for efficiently scaling up convolutional neural networks. By avoiding bottlenecks, using factorized convolutions, and introducing auxiliary classifiers, they enhance the Inception architecture, achieving improved performance with a modest increase in computational cost.

Method / Algorithm: The proposed method in the paper is based on Self-Organizing Neural Networks (Self-ONNs), which offer an alternative to deep CNNs for glaucoma detection with reduced computational complexity.

Data Set Used for Experiments:The experiments in the paper were conducted using three benchmark glaucoma datasets: ACRIMA, RIM-ONE, and ESOGU.

## Literature Review-2

Experimental Results:The experimental results showed that the proposed Self-ONNs approach achieved superior glaucoma classification performance compared to deep CNN models, with a significant margin in F1-score, and outperformed several competing techniques while maintaining reduced computational complexity.

unique findings:The unique findings of the paper include the demonstration of the effectiveness of Self-Organizing Neural Networks (Self-ONNs) for glaucoma detection, which outperformed deep CNN models and achieved stateof-the-art performance levels with reduced computational complexity.

Advantages: The advantages of the proposed Self-ONNs approach include its superior classification performance, reduced computational complexity, and ability to be integrated into a decision support system for real-time glaucoma detection.

Disadvantages: The disadvantages of applying deep CNN models to glaucoma detection include susceptibility to data scarcity, high computational complexity, and the requirement for specialized hardware.

## Literature Review-3

Gaze Exploration Index (GE i)-Explainable Detection Model for Glaucoma

Challenge solved: The Gaze Exploration Index (GE i)-Explainable Detection Model achieved an accuracy score of 0.80 in screening visual field loss in glaucoma patients, with significant differences observed in eye movement behavior between glaucoma and normal participants during visual exploration tasks..

Key Idea of the paper:The paper introduces a Gaze Exploration Index (GE i)-Explainable Detection Model using eye-tracking and deep learning to identify distinct eye movement patterns in glaucoma patients during visual tasks. Method / Algorithm used: The method used in the paper involves the utilization of deep learning models and eye gaze analytics to develop a Gaze Exploration Index (GE i)-Explainable Detection Model for Glaucoma.

Data Set Used: The study utilized a dataset comprising 98 cases, with 67% allocated as the training dataset and 33% as the testing dataset, for the development and evaluation of the Gaze Exploration Index (GE i)-Explainable Detection Model for Glaucoma.

## Literature Review-3

Experimental Results: The Gaze Exploration Index (GE i)-Explainable Detection Model achieved an accuracy score of 0.80, demonstrating its effectiveness in predicting unseen samples and improving the accuracy of the model.

unique findings: It highlights the algorithm's potential for improving screening accuracy, emphasizing the importance of ongoing research to address limitations and enhance clinical implementation.

Advantages: The Gaze Exploration Index (GE i)-Explainable Detection Model offers an explainable and interpretable approach to glaucoma detection, leveraging eye-tracking technology to analyze eye movement patterns and improve the accuracy of screening and detection.

Disadvantages: One of the limitations of the Gaze Exploration Index (GE i)-Explainable Detection Model is that it requires the use of specialized eye-tracking equipment, which may not be readily available in all clinical settings.

## Literature Review-4

**Deep Learning-Based Glaucoma Detection with Cropped Optic Cup and Disc and Blood Vessel Segmentation**

Challenge solved: The deep learning-based approach addresses challenges in glaucoma detection, such as accurate optic cup and disc segmentation, blood vessel analysis, and early diagnosis.

Key Idea of the paper: The paper introduces a deep learning-based approach for glaucoma detection using optic cup and disc segmentation and blood vessel analysis to improve early diagnosis.

Method / Algorithm used: The proposed method utilizes the U-Net architecture for optic cup and disc segmentation and the Mobile Net V2 for classifying fundus images into healthy and glaucomatous ones.

Data Set Used: The study utilized five public datasets: RIM-ONE, ORIGA, DRISHTI-GS1, ACRIMA, and REFUGE, containing a total of 2,787 fundus images for testing the glaucoma detection algorithms.

## Literature Review-4

Experimental Results:The proposed system achieved an accuracy of 98.6% with 97.6% sensitivity and 92.3% specificity in glaucoma detection.

unique findings:The study introduced a novel dataset of 634 retinal fundus images from the Bangladesh Eye Hospital and developed a new dataset by segmenting blood vessels from retinal fundus images using the U-net model.

Advantages:The use of blood vessel segmented fundus images led to lower training times and slightly compromised accuracy, offering a potential advantage in terms of efficiency.

Disadvantages:The U-net model was unable to precisely segment the cup and disc section of the fundus images, indicating a limitation in cup-disc segmentation.

## Literature Review-5

The Use of U-Net Lite and Extreme Gradient Boost (XGB) for Glaucoma Detection

Challenge solved: The paper proposes a glaucoma detection technique using a modified U-Net Lite model and an XGB algorithm, achieving high accuracy with fewer parameters and potential implications for early detection and prevention of glaucoma-related vision loss.

Key Idea of the paper: The paper introduces a glaucoma detection technique using a modified U-Net Lite model and XGB algorithm, aiming for high accuracy with fewer parameters and potential implications for early glaucoma detection.

Method / Algorithm used: The proposed technique uses a modified U-Net Lite model for segmentation and an Extreme Gradient Boost (XGB) algorithm for feature selection and classification in glaucoma detection.

Data Set Used: The proposed technique was trained and tested on the DRIONS, DRISHTI-GS, RIM-ONE V2, and RIM-ONE V3 databases for glaucoma detection.

## Literature Review-5

Experimental Results: The proposed technique achieved an AUC-ROC score of 0.936, an accuracy of

0.883, a precision of 0.893, and a recall of 0.883 for glaucoma detection on both the RIM-ONE V3 and the DRISHTI-GS databases. unique findings: The proposed technique achieved high accuracy in glaucoma detection with a significantly lighter architecture compared to the original U-Net model, making it a cost-effective and efficient solution for early glaucoma detection.

**Advantages:** The proposed technique has the advantage of being computationally efficient, achieving stateof-the-art accuracy in glaucoma detection, and eliminating the need for a threshold value in the detection process. **Disadvantages:** The proposed technique is limited by poor image quality affecting optic cup segmentation and does not account for the influence of other ocular diseases on glaucoma detection.

## Literature Review-6

AIROGS: Artificial Intelligence for Robust Glaucoma Screening Challenge

What is the Challenge solved: The AIROGS challenge aims to improve the early detection of glaucoma using artificial intelligence algorithms that can effectively analyze color fundus photographs for glaucoma screening.

Key Idea of the paper: The key idea of the paper is to address the performance drop of AI solutions for glaucoma screening in real-world scenarios by organizing the AIROGS challenge to develop robust and reliable AI solutions.

Method / Algorithm used: The AIROGS challenge evaluated various containerized algorithms submitted by participants to develop robust AI solutions for glaucoma screening using color fundus photographs.

Data Set Used:The AIROGS challenge dataset includes around 113,000 color fundus photographs from about 60,000 patients and 500 different screening centers, making it the largest publicly available dataset for glaucoma screening.

## Literature Review-6

Experimental Results: The experimental results include the performance comparison of AIROGS algorithms on the AIROGS test set, REFUGE test set, and GAMMA, showing higher scores on external datasets. unique findings: The study revealed that AIROGS algorithms achieved high performance but lower robustness compared to human experts, indicating the challenge of developing robust AI solutions for glaucoma screening.

Advantages: The use of containerized algorithms allowed for reproducibility, facilitated inference on other data, and prevented manual manipulation of the test set, ensuring the integrity of the evaluation process.

Disadvantages: The study did not prohibit the use of external fundus data for development, potentially introducing unfairness, and it was challenging for the challenge organizers to verify if the training containers did not contain any weights pre-trained on other data.

## Literature Review-7

Systematic Development of AI-Enabled Diagnostic Systems for Glaucoma and Diabetic Retinopathy

Challenge solved: The use of AI, particularly in machine learning and deep learning, addresses the challenge of segmenting retinal vessels from fundus images, contributing to automated diagnosis of chronic diseases such as glaucoma and diabetic retinopathy

Key Idea of the paper: This paper presents a modified deep learning model for accurate retinal vessel segmentation, crucial for developing automated systems for early detection and treatment of eye diseases

Method / Algorithm used: The paper utilizes a modified ColonSegNet model for retinal vessel segmentation and applies data augmentation to address the issue of limited graded images

Data Set Used:The research utilizes retinal image datasets including DRIVE, STARE, and CHASE-DB for performance evaluation of the deep learning models

## Literature Review-7

Experimental Results:The study highlights the challenges in developing automated systems for eye disease classification and emphasizes the importance of data augmentation, pre-processing techniques, and addressing computational complexity for deploying large-scale population screening

Unique findings:The study highlights the challenges in developing automated systems for eye disease classification and emphasizes the importance of data augmentation, pre-processing techniques, and addressing computational complexity for deploying large-scale population screening

Advantages:The proposed automated system for disease diagnosis using deep learning models offers fast, reliable, and preferable screening for large-scale population-level programs, and can assist medical experts in decision-making

Disadvantages: The manual assessment by doctors is prone to error due to the huge burden, and the computational complexity of deep learning models for retinal vessel segmentation increases the overall system complexity.

## Literature Review-8

Pupillary Complexity for the Screening of Glaucoma(2021)

Challenge solved:The study proposes a new analysis framework to automatically investigate changes in the complexity of pupillary signals for the screening of glaucoma, addressing challenges such as the need for skilled personnel and special clinical settings.

Key Idea of the paper:The study uses Higuchi's fractal dimension, permutation entropy, and conditional entropy as complexity measures for analyzing pupillary signals in an automatic and unsupervised framework for the screening of glaucoma.

Method / Algorithm used:The study uses Higuchi's fractal dimension, permutation entropy, and conditional entropy as complexity measures for analyzing pupillary signals in an automatic and unsupervised framework for the screening of glaucoma.

## Literature Review-8

Data Set Used:The study used pupillary data from 13 glaucoma patients, 13 age-matched healthy controls, and 11 young healthy controls, recorded using a commercial eye tracker with a sampling rate of 60 Hz. Experimental Results:The experimental results in the paper include the evaluation of different deep learning techniques for diabetic retinopathy (DR) classification, with an average accuracy of about 91% and promising classification performance overall .

What is the unique findings:The demonstrates the potential of pupillary complexity as a biomarker for glaucoma and highlights the significant differences in complexity measures between glaucoma patients and healthy controls, suggesting the possibility of using pupillary data for detecting glaucoma.

Advantages:The proposed automatic analysis framework for pupillary data is cost-effective, portable, and can be used in primary healthcare facilities for the screening of glaucoma.

Disadvantages: The study's limitations include a small sample size, the need for further investigation into the correlation between pupillary complexity and glaucoma severity, and the requirement for validation with a larger number of participants.

## Literature Review-9

Automated Vision-Based High Intraocular Pressure Detection Using Frontal Eye Images

Challenge solved:1. Key features extracted for intraocular pressure detection include Contour Angle, Red Area Percentage, Pupil/Iris ratio, and Contour Distance

1. Utilizing a fully convolutional neural network (FCN) improves screening by enabling accurate segmentation and feature extraction from frontal eye images
2. This framework has the potential to enable early detection of glaucoma, leading to timely intervention and prevention of vision loss

Key Idea of the paper:The key idea of the paper is to use a vision-based framework with a fully convolutional neural network to extract features from frontal eye images for early screening of high intraocular pressure..

Method / Algorithm used:The method involves utilizing a fully convolutional network for sclera and iris segmentation, followed by feature extraction and classification using support vector machine and decision tree classifiers.

## Literature Review-9

Data Set Used: The paper uses a dataset of 400 frontal eye images, including 200 with normal intraocular pressure and 200 with high intraocular pressure, for training and testing the proposed framework.

Experimental Results: The proposed framework achieved an accuracy of over 97% in detecting high intraocular pressure, outperforming previous methods, and showed robustness in distinguishing between high intraocular pressure and other eye diseases.

Unique findings: The unique findings of the paper include introducing a fully convolutional network for eye sclera segmentation and correlating new sclera contour features with intraocular pressure, as well as proposing a novel vision-based framework for early screening of high intraocular pressure using frontal eye images..

Advantages:The advantages of the proposed framework include non-contact and non-invasive assessment, high accuracy in detecting high intraocular pressure, and the potential for use in personal home screening without professional assistance.

Disadvantages: The proposed framework may be limited by the assumption of consistent imaging conditions and the need for further validation with diverse demographics and ethnicities.

## Literature Review-10

Development of Prototype to Measure Intraocular Pressure of Eye Along With Gonioscopy

Challenge solved: Tono goniometry addresses the challenges of limited access to eye care facilities in rural areas and the uneasiness caused by separate glaucoma testing procedures by combining tonometry and gonioscopy into a single instrument

Key Idea of the paper: The key idea of the paper is to develop a prototype called Tonogoniometry that combines tonometry and gonioscopy into a single instrument, making glaucoma testing easier, time-saving, and less uncomfortable for patients

Method / Algorithm used:

The method involves embedding a vibration sensor on a 3-mirror goniolens to measure intraocular pressure and visualize the anterior chamber angle, with the sensor output recorded and analyzed using LabVIEW

Data Set Used:

The paper does not mention any specific data sets used, as the focus is on the development of the

Tono goniometry prototype and the methodology used to measure intraocular pressure

## Literature Review-10

**Experimental Results:** The experimental results showed a strong correlation between the pressure applied to the goat eye sample and the magnitude of the vibration sensor output, with a high repeatability rate of the sensor output for constant intraocular pressure

**Unique findings:** The unique findings include the development of a prototype that combines tonometry and gonioscopy into a single instrument, providing a more efficient and less uncomfortable method for measuring intraocular pressure and visualizing the anterior chamber angle

**Advantages:** The advantages of the Tonogoniometry prototype include its cost-effectiveness, time-saving, portability, and ability to reduce patient discomfort by combining two contact procedures into one

**Disadvantages**: The potential disadvantages include the need for further validation through detailed

experimental studies, limitations in preserving the corneal biomechanical properties during experimentation, and the lack of exploration by researchers and commercial eye care device manufacturers

Comparison of existing system-Existing Ideas

|  |  |
| --- | --- |
| TITLE | Existing Ideas |
| M. Kumar, S. P. Singh, U. Chauhan, D. Sharma and S. Chauhan, "Glaucoma  detection using image processing," 2022 4th International  Conference on Advances in Computing,  Communication Control and  Networking (ICAC3N), Greater Noida, India, 2022, pp. 1037-1041, doi:  10.1109/ICAC3N56670.2022.1007399  5. | •Image processing techniques to aid in the early diagnosis of glaucoma  •CDR technique to detect glaucoma |

Comparison of existing system-Algorithms

|  |  |
| --- | --- |
| TITLE | ALGORITHM |
| R. Yugha, V. Vinodhini, J. R.  Arunkumar, K. Varalakshmi, G.  Karthikeyan and G. Ramkumar, "An  Automated Glaucoma Detection from  Fundus Images based on Deep Learning  Network," 2022 Sixth International  Conference on I-SMAC (IoT in Social,  Mobile, Analytics and Cloud) (ISMAC), Dharan, Nepal, 2022, pp. 757-  763, doi: 10.1109/I-  SMAC55078.2022.9987254. | Bi-Directional Feature  Pyramid system modules of EfficientDet-DO using the calculated characteristics from EfficientNet-B0  Deep Learning based strategy called  EfficientDet-DO with EfficientNet-B0 serving as its foundation |

Comparison of existing system-RESULTS

|  |  |
| --- | --- |
| TITLE | RESULTS |
| G. Charulatha, M. U, K. K. G, N.  Sasirekha and M. N, "A Robust  Framework for Glaucoma Detection and  Segmentation of Real Time Fundus  Images using Hybrid ASCL  Model," 2022 International Conference on Automation, Computing and Renewable Systems (ICACRS),  Pudukkottai, India, 2022, pp. 1244-1250, doi:  10.1109/ICACRS55517.2022.10029026. | Region of Interest (ROI) identification is carried out using the sharpest point technique, and input picture processing is performed to use the AlexNet structure. Additionally, the SegNet design is used to divide the optic disc as well as optic cup, and LightGBM classifier along with CNN are used to classify the data. |

Comparison of existing system-Unique Findings



Unique Findings

TITLE

Region of Interest (ROI) identification

A Robust Framework for Glaucoma Detection and

Segmentation of Real Time Fundus Images using Hybrid

ASCL Model

GLAUCOMA PRESENT OR NOT PRESENT

Glaucoma Detection using Convolution Neural Networks

TILL TRAINING WITH THE MODEL

Early Glaucoma Detection Using Machine Learning

Algorithms of VGG-16 and Resnet-50

IMPLEMENTED mimetic anisotropic filtering

Glaucoma Detection using Fundus Images with Mimetic

Anisotropic Filtering and Convolutional Neural Networks

ONLY PRESENCE OF GLAUCOMA

An Automated Glaucoma Detection from Fundus Images based on

Deep Learning Network

Detect glaucoma by image processing

Glaucoma detection using image processing

AIM & Objective

* AIM

The aim of the study is to develop a computational tool for automated glaucoma detection using Convolutional Neural Network (CNN) techniques on retinal fundus images. The project focuses on achieving early glaucoma detection to mitigate vision loss and demonstrates superior accuracy compared to existing methods

* Objectives

The objective of the study is to develop and evaluate a Convolutional Neural Network (CNN) based computational tool for automated glaucoma detection using retinal fundus images. The focus is on achieving early detection, identifying disease levels, and mitigating vision loss through efficient and accurate processing, surpassing existing methods in accuracy.

Tools and data set required for implementation

Tools:

Programming Language: Python

Deep Learning Frameworks: TensorFlow

Pre-trained Models: ImageNet

Data Analysis and Visualization: Pandas, Matplotlib or Seaborn

Image Processing: OpenCV

Research Tools: pycharm

Machine Learning Libraries: Scikit-learn

Specific Deep Learning Models: VGG16, CNN MODEL

Date Set Details:

The paper utilizes fundus images from the Kaggle dataset, consisting of 4126 images with labels representing No, Mild, Moderate, Severe for the classification of Glaucoma.

## Anticipated outcome/ result

The proposed Convolutional Neural Network (CNN) algorithm for automated glaucoma detection, trained on retinal fundus images, surpasses existing methods in accuracy, offering a promising solution for early detection and mitigation of vision loss. The study's outcomes highlight the algorithm's efficiency, making it highly suitable for rapid processing applications and contributing to the advancement of glaucoma screening technology with user interface – flask framework and glaucoma types prediction.

## Summary of your presentation

This project focuses on automated glaucoma detection using Convolutional Neural Network (CNN) techniques on retinal fundus images, aiming to mitigate vision loss through early detection. The proposed algorithm surpasses existing methods in accuracy, providing a rapid and efficient tool for processing fundus images. The literature survey discusses diverse approaches, including the integration of retinex theory, Self-Organizing Neural Networks (Self-ONNs), and deep learning for glaucoma detection, showcasing advancements in the field.