EYE GLAUCOMA DETECTION USING MACHINE LEARNING

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ABSTRACT

Glaucoma is a chronic eye disease leading to irreversible blindness by damaging the optic nerve of the eye. It is caused due to elevated intraocular pressure inside the eye. Detecting glaucoma is the most challenging process in the case of open-angle glaucoma (OAG) due to the lack of initial symptoms. In this paper, we propose an image processing technique to analyze and categorize the fundus image of the eye as a glaucomatous or healthy image based on the cup-to-disc ratio (CDR) value and feature extracted through Deep learning. The assessment of CDR is the foundation to detect glaucoma, the CDR value will increase from 0.6 – 0.9 when affected by this disease. Image processing techniques are used to extract the optic cup and optic disc region in the fundus image, and further by calculating the CDR value glaucomatous images are categorized. Overfitting is avoided by adopting a data augmentation technique. . The system is trained and the results demonstrate that the technique had a good accuracy in classifying the fundus images as healthy or glaucoma.

Keyword: - *Glaucoma detection prediction, Screening, Machine Learning & Convolutional Neural Network*

1. INTRODUCTION

Glaucoma, a progressive optic neuropathy frequently linked to elevated intraocular pressure, stands as a primary cause of irreversible blindness worldwide. The insidious nature of open-angle glaucoma (OAG), characterized by the absence of noticeable early symptoms, complicates timely diagnosis. Consequently, the prompt detection of glaucoma is paramount for effective management, treatment initiation, and the mitigation of potential vision loss. This paper introduces an innovative image processing methodology integrated with deep learning to analyze retinal fundus images for automated glaucoma detection. Our approach leverages the well-established cup-to-disc ratio (CDR) as a foundational metric, complemented by features extracted through a Convolutional Neural Network (CNN). By combining traditional image analysis for CDR assessment with the robust learning capabilities of deep learning, and further enhancing user interaction through a developed graphical user interface (GUI), this research aims to contribute to more efficient and accessible glaucoma screening. The promising results obtained from training and evaluating our system underscore the potential of this technique for accurate classification of fundus images into healthy and glaucoma categories.

2. EYE GLAUCOMA DETECTION

Glaucoma damages the optic nerve, leading to irreversible blindness, often without early symptoms (especially in open- angle glaucoma). Early detection is vital. Current methods involve eye pressure checks, vision tests, and optic nerve exams. Image processing and artificial intelligence, particularly analyzing eye fundus images to assess the cup-to-disc ratio and using deep learning, are increasingly used to automate and improve detection accuracy for timely treatment and vision preservation.

2.1 User Interaction Modes

- These are the ways users communicate with systems. Common types include:
- GUI (Graphical User Interface): Using visuals like icons and menus.
- CLI (Command-Line Interface): Typing text commands.
- NLI (Natural Language Interface): Using spoken or typed natural language.
- Touch Interface: Interacting by touching a screen.
- Gesture-Based Interface: Using body movements.
- VUI (Voice User Interface): Speaking commands.
- BCI (Brain-Computer Interface): Direct brain communication.

2.2 Key Features

- Core Functionality: It directly contributes to the main purpose of the project or product.
- High Value: It provides significant benefit or solves a crucial problem for the target user.
- Differentiation: It often sets the project or product apart from competitors or existing solutions.
- User Focus: It's something that users will actively use and appreciate.
- Feasibility (for a project): It's achievable within the project's scope and constraints.

3. METHODOLOGY

The Eye glaucoma detection involves several stages as shown in Figure 1:

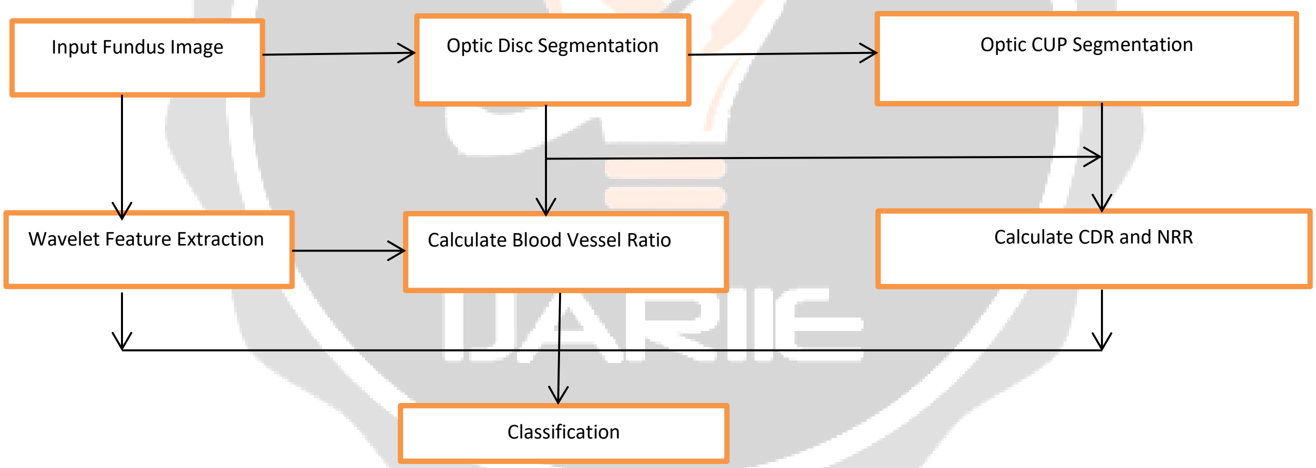

Fig -1: Methodology of Eye Glaucoma Detection

The Eye Glaucoma Detection follows a systematic machine learning development lifecycle, involving the following key stages:

- Input Fundus Image: This is the initial step where a digital image of the fundus (back of the eye) is provided for analysis. This image serves as the raw data for all subsequent processing.
- Optic Disc Segmentation: The optic disc, a bright circular region where the optic nerve exits the eye, is identified and separated from the rest of the image.
- Optic Cup Segmentation: Within the optic disc, the optic cup, a central depression, is delineated. The size and shape of the optic cup relative to the optic disc are important indicators for certain eye conditions.

- Wavelet Feature Extraction: This step involves extracting various features from the fundus image using wavelet transforms. These features can capture subtle textural and structural information important for classification.
- Calculate CDR and NRR: The Cup-to-Disc Ratio (CDR) and Neuroretinal Rim (NRR) measurements are calculated. These are critical parameters used in the diagnosis and monitoring of glaucoma.
- Classification: In the final stage, all the extracted features and calculated parameters are fed into a classification algorithm. This algorithm then determines the presence or absence of a specific eye condition or categorizes the image based on its characteristics.

4. PROPOSED SYSTEM

Our system analyzes fundus images using image processing to calculate the Cup-to-Disc Ratio (CDR) and a Convolutional Neural Network (CNN) for automated glaucoma classification. A user-friendly GUI allows for image input and result display. This integrated approach aims for accurate and accessible glaucoma detection..

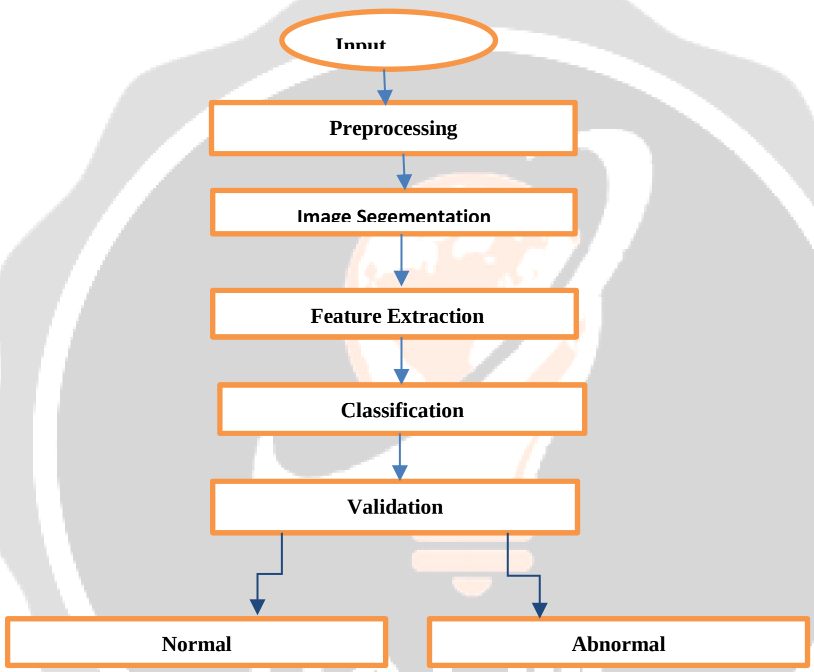

Fig -2: Workflow of Eye Glaucoma Detection

4.1 System Architecture Overview

Our glaucoma detection system integrates several key stages:

- Image Input: Fundus images are fed into the system (e.g., via GUI upload).
- Preprocessing: Images are enhanced for better analysis.

Analysis Modules:

- CDR Calculation: Optic disc and cup are segmented to determine the cup-to-disc ratio.
- Deep Learning (CNN): A trained neural network analyzes the images for glaucomatous features.

5. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The integration of artificial intelligence, particularly deep learning and convolutional neural networks, has significantly improv NO uracy and speed of glaucoma detection using retinal fundus images. These automated systems reduce human error and enable early diagnosis, potentially saving vision. Current literature shows promising results, yet challenges such as dataset variability, model generalization, and real-time deployment remain.

Future work should focus on developing explainable AI models, enhancing cross-population accuracy, integrating multi-modal data, and creating lightweight models suitable for mobile screening in remote areas. Clinical validation and regulatory alignment will also be crucial for real-world adoption.

6. REFERENCES

[1] Automatic Detection of Glaucoma via Fundus Imaging and AI– *Coan et al., 2021, explores AI techniques for glaucoma diagnosis using fundus images.*

[2] Deep Learning Algorithms and Glaucoma Detection: *A Revie – Raja & Jothilakshmi, 2021, reviews DL methods applied to glaucoma detection.*

[3] Glaucoma Detection using Fundus Images with Mimetic Filtering and CNNs– *Carrillo et al., 2023, combines image filtering and CNNs for detection.*

[4] Automated Glaucoma Screening with Cup-to-Disc Ratio Computation– *Mvoulana et al., 2019, proposes unsupervised segmentation for optic nerve analysis.*

[5] Image Processing Techniques for Glaucoma Detection: *A Review– Sarhan et al., 2019, reviews traditional image processing-based glaucoma detection.*

[6] Retinal Glaucoma Detection: An Overview– *Naik et al., 2022, summarizes recent advancements in automated glaucoma detection.*

[7] GPT-4V for Glaucoma Detection and Feature Identification– *Jalili et al., 2024, uses GPT-4 Vision for analyzing fundus images*

[8] Computational Methods in Glaucoma Research– *Kim et al., 2023, surveys computational techniques and future directions in glaucoma research.*

[9] Glaucoma Detection using CNNs– *Esengonul & Cunha, 2023, explores CNN-based image analysis for glaucoma identification.*

[10] Familial Normal Tension Glaucoma Genetics– *Fox & Fingert, 2023, investigates the genetics of familial glaucoma cases.*