

Deep Learning based Human Eye Disease Predication System

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Abstract— Millions worldwide lose their eyesight yearly, normally from treatable eye diseases, if only identified early enough. What if we could find these conditions just before it is actually too late restorations of vision and transformations of lives? This is what our project is all about. We are devising a Deep Learning-based Eye Disease Prediction System which should be able to identify relevant eye diseases such as Glaucoma, Diabetic Retinopathy, Cataract, and Age-related Macular Degeneration (AMD) from retinal images, both fast and accurately. To do this, we are putting Convolutional Neural Networks (CNNs) and Transfer Learning to work for us, so that our system could learn from thousands of retinal images to detect certain deep subtle patterns which may not be quite apparent to the human observer. We combine the domains of advanced image preprocessing, feature extraction, and classification to deliver predictions that have got to be very accurate. We didn't stop there we made it practical. This system has a web-based interface that allows easy access for doctors and patients, thus bringing in quick, non-invasive, and cost-effective eye diseases screening for all of them. With this tool, we hope to make early detection of eye diseases easier, faster, and cheaper this way saving the gift of vision for many.

Index Terms— Eye Disease, fundus images, Glaucoma, Diabetic Retinopathy (DR), Age-related Macular Degeneration (AMD), Convolutional Neural Networks (CNN).

I. INTRODUCTION

Sight is probably the most important sense of all, and it dramatically alters the way a person perceives and interfaces with his environment. Unfortunately, millions around the world suffer from various eye diseases. If left unattended, they might lead to partial or total blindness. Many such conditions, including Glaucoma, Cataract, Diabetic Retinopathy, and Age-related Macular Degeneration (AMD), develop slowly and are often unnoticed until they have progressed to a very advanced stage. Most of them could have been prevented, or at least severe complications avoided, if diagnosis and intervention had occurred in a timely manner. This indeed makes a solid case for more effective, accessible, and reliable ways of early detection of eye diseases.

Eye condition diagnoses have typically been dependent on specialized instruments, expert ophthalmologists, and protracted procedures. While all of these methods are rightly effective, they are mostly beyond the reach of individuals living in rural locations or regions of minimal medical infrastructure. In cities, the sheer number of patients makes it difficult for health care providers to conduct timely screenings.

This difference between the demand for eye care and the available resources has contributed to the scene wherein globally the number of people with visual impairment is constantly rising.

Developments in computer science and medical imaging have contributed to new opportunities in this area in the past two years. One such promising approach is to use machine learning, and more specifically deep learning, for the automatic analysis of medical images. The deep learning model learns to detect subtle patterns in the retinal images that might indicate disease, when it is sufficiently and diversely trained. These models shall, therefore, act as the addition for healthcare professionals by supporting their work as a screening tool that enables faster and much more widespread detection of eye conditions compared with currently existing methods.

This paper is aimed at the automation of detection and prediction of eye diseases based on prevailing deep learning techniques. The result is expected to design a solution in analyzing the retinal fundus images, which is the most common sort of eye scan, and classifying them based on the presence of dedicated diseases. In essence, it would support medical professionals to identify high-risk cases efficiently and reduce the chances of misdiagnosis and improved patient care. Of course, this system is not limited to make life easier. More so in most developing and underdeveloped regions, qualified ophthalmologists are so scarce. An automated system that is reliable and affordable can be a stepping stone in achieving primary eye care in these areas. Such a system would also relieve the pressure in even the best-equipped hospitals and clinics by prioritizing patients demanding urgent attention and improving workflow while ensuring that no critical case is-overlooked.

II. LITERATURE SURVEY

Everyday life is extremely dependent upon vision, work, happiness, and all the other stressors. It happens to be among the most critical senses in humans. Unfortunately, best healthcare services fail to prevent diseases like Glaucoma, Diabetic Retinopathy (DR), Cataract, or Age-related Macular Degeneration (AMD), all of which are eye diseases. Impairments of vision due to such eye diseases tend to blind almost two-thirds of humans, even judging them from the world over. WHO estimates put nearly 2.2 billion people in worldwide standards as vision-impaired with almost half of these cases reportedly preventable or treatable early. In the case of India, the scenario is even worse, as it has huge numbers and very poorly scattered specialized ophthalmic services.

The authors Rashid Amin et. al in[1] have discussed the Age, damage, and conditions like diabetes can cause a variety of anomalies in human eyes. The main causes of blindness in the world are diabetic retinopathy, macular degeneration, cataracts, and glaucoma. Early detection and diagnosis of various eye conditions are essential for prompt treatment and vision preservation.

This approach can be aided by the diagnosis of many eye diseases using medical image analysis. Image capture, region of interest extraction, feature extraction, and disease classification or detection are the steps involved in the deep learning-based diagnosis of numerous eye disorders.

The authors Mona Ashtari-Majlan et. al in[2] have explained the diagnosis of glaucoma, a major cause of permanent blindness in the world, is difficult since it depends on subjective assessment. Recent developments in deep learning and computer vision have shown promise for automated evaluation. With an emphasis on deep learning-based techniques, this paper offers an extensive review of research on AI-based glaucoma diagnosis using fundus, optical coherence tomography, and visual field pictures. Using particular selection criteria, we looked through Web of Science, PubMed, IEEE Xplore, and Google Scholar to find pertinent research that was published between 2017 and 2023.

The authors Rubina Sarki et. al in[3] have discussed the when a person has diabetes mellitus, also known as diabetes, their body either does not create enough insulin or does not react to the insulin that their pancreas releases. Over time, people with diabetes are more likely to develop a number of eye conditions. Thanks to developments in machine learning methods, Compared to manual detection, automated systems offer significant advantages in the early diagnosis of diabetic eye illness. Numerous cutting-edge research on the identification of diabetic eye illness have just been released. This paper offers a thorough analysis of automated methods for detecting diabetic eye disease from a number of angles, including: i) publicly available datasets, ii) picture preprocessing methods, iii) deep learning models, and iv) performance evaluation measures.

The authors Zhentao Gao et. al in [4] have discussed the prevalent eye condition that significantly contributes to blindness in diabetes people is diabetic retinopathy (DR). The best approach to managing the condition is prompt management and routine fundus photography screening. Interest in a computer-aided, fully automatic diagnosis of diabetes mellitus has increased due to the huge number of diabetic patients and their extensive screening needs. In contrast, deep neural networks have made significant strides in a number of tasks in recent years. We have created a dataset of DR fundus photos that have been labelled with the right treatment technique that is necessary in order to automate the diagnosis of DR and offer suitable recommendations to DR patients.

Authors Md Zahin Muntaqim et.al in[5] have discussed in order to prevent vision loss, eye problems, a major worldwide health concern, must be detected early. Because eye illnesses are so common, prompt treatment through early identification is required, making The development of an automatic detecting system is urgent. The development of such systems has been the focus of numerous researchers. However, issues including insufficient illness coverage, large computing demands, and ineffective features make it challenging for current methods to achieve high-performance accuracy.

The authors Yidong Chai et. al in [6] have explained the main causes of blindness worldwide is glaucoma, for which there is now no treatment. However, early detection is crucial since it allows for the prevention of additional vision loss. While deep learning models have demonstrated their benefits in natural picture analysis, their use in medical fields where data is scarce is limited because they typically rely on big datasets to learn to extract hidden features. As a result, creating a deep learning model for disease diagnosis using comparatively less data is both significant and difficult. In this work, we investigate the use of deep learning models to automatically diagnose glaucoma by combining retinal fundus images with domain knowledge.

The authors Chava Harshitha et.al in [9] have explained the common issue among diabetic individuals is diabetic retinopathy (DR), which ultimately leads to the beneficial loss of vision in some individuals. There is no cure to restore vision if this anomaly is not identified in its early stages. Therefore, early disease detection and therapy are the only ways to escape this irreparable predicament.

The ophthalmologists use the patients' retinal images, or "fundus images," of their eyes to maintain their vision. However, because ophthalmologists differ subjectively and have different considerations, this process of identifying an anomaly in a human eye by looking at another human naked eye takes time, money, and occasionally results in poor judgement.

III. PROBLEM STATEMENT AND OBJECTIVE

A. Problem Statement

Vision is one of the most important factors in human life, affecting an individual directly in the performance of his daily activities and maneuvering around an environment while still keeping a decent quality of life. Sadly, eye conditions linked to Glaucoma, Diabetic Retinopathy, Cataract, and Age-related Macular Degeneration (AMD) have become predominant reasons behind globally rising vision impairment and blindness. The reports on health care and surveys show that vast percentages of blindness around the world are reversible if timely diagnosis is sought.

A very disturbing fact is that most of these diseases can be cured or prevented from advancing to serious ones if they get diagnosed early.

IV. PROPOSED SYSTEM

The planned solution, given the greater prevalence of eye disorders coupled with the inadequacy of existing diagnostics, is the creation of a Web-Based Eye Disease Prediction and Detection System underpinned by Deep Learning. Not only does this system aim to detect any current diseases, but it is also aimed at predicting the possible risk of future occurrences based on retinal and OCT (Optical Coherence Tomography) images. Thus, the system would ideally give timely and cost-effective ocular health insights to ophthalmologists, health workers, and, indeed, the patients themselves.

In simple terms, this solution will allow users to upload their retinal scans (either OCT images or fundus images) on a web application, and the system will run the scans through a trained deep learning model. This analysis will take just seconds, after which a diagnostic report shall be issued containing the probability of diseases such as Glaucoma, Diabetic Retinopathy, Cataract, and Age-Related Macular Degeneration (AMD), grading their severity, and giving recommendations for follow-up consultations.

V. PROPOSED SYSTEM SOLUTION

- To design and develop an AI-based system capable of early prediction and diagnosis of multiple common eye diseases and To create an easy-to-use, web-based platform where patients or healthcare providers can upload OCT or fundus images.
- To provide accurate, real-time, and interpretable predictions, supporting clinicians in their decision-making process and To develop an affordable and scalable solution suitable for both urban and rural healthcare setups, to facilitate early intervention by identifying diseases even at a preliminary stage, which is often missed in traditional diagnosis.

- To reduce the dependency on highly expensive diagnostic equipment and constant ophthalmologist availability and to build a system adaptable to continuous learning by integrating newly collected data over time.

A. Solution to the Proposed System

The proposed system comprises two major components:

- Deep Learning-based Prediction Module and Web-Based Application Interface, these components will work in synchronization to provide an end-to-end solution for disease detection and prediction.
- Deep Learning-Based Prediction Module, this module serves as the core of the system where actual image analysis and prediction take place. The model will be trained using a large collection of annotated OCT and retinal images, covering different classes such as:
- Healthy (Normal), Glaucoma, Diabetic Retinopathy, Cataract, Age-Related Macular Degeneration.

VI. SYSTEM ARCHITECTURE

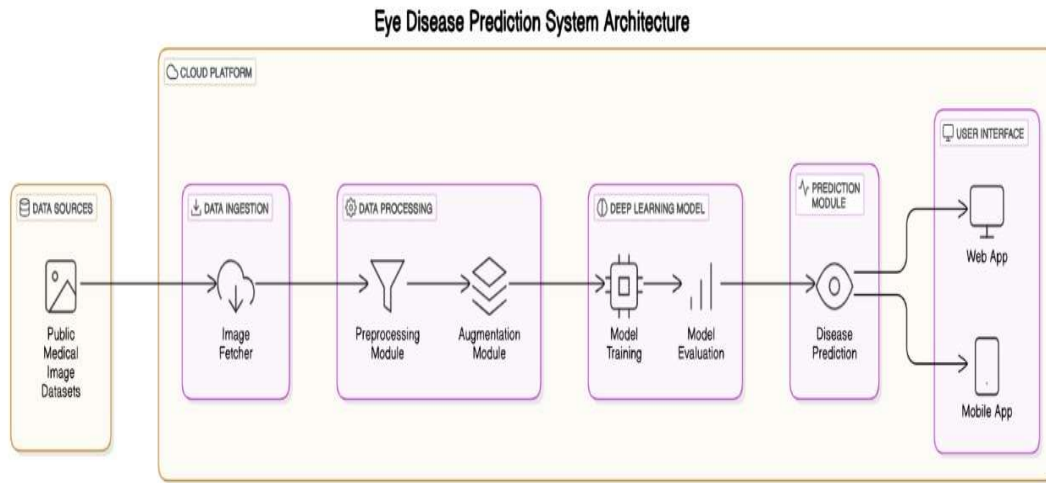


Fig 1: Eye Disease prediction system architecture

The system architecture concerning the paper can be segmented in layers.

A. Data Input Layer

The first step in the system comprises uploading of an OCT or retinal image through the web interface by the user and uploading could be by the patients themselves or through any medical professional.

B. Pre-processing Layer

The uploaded image undergoes several automated pre-processing steps on the server and operations like resizing, normalization, and contrast enhancement are done in order to prepare the image for model input, this layer ensures that all images are in the same format; eliminating the chances of any variation due to different devices or conditions of imaging.

C. Deep Learning Model Layer

The trained Convolutional Neural Network receives this pre-processed image for actual disease prediction and for each disease class, the model computes the probability, and picks the one with the highest probability as the final prediction, at the same time, the model returns a confidence value that indicates how certain the prediction is.

D. Result Processing Layer

The predicted result will be converted into simple language understandable by people and this would mean the name of the disease (or "Healthy" if there is no disease detected), a confidence score, and a very short advisory on whether the patient needs to be referred to a doctor.

E. Web Application Layer

The user interfaces directly through the web interface for sending results back to the user and this interface will show results to the user with user-friendly format and devoid of technical mumbo-jumbo, the user will have the option of either downloading or printing the results for their reference when needed.

VI. RESULT AND DISCUSSION

Presently, the greatest reliance for eye disease diagnosis lies with the examination of retinal fundus images obtained by certain apparatuses processed by an expert ophthalmologist. This method is highly dependent on the locality of specialists, and this poses a major challenge in more rural or semi-urban areas with restricted access to trained medical professionals and diagnostic facilities. In other situations, where these facilities are available, the increasing workload from growing numbers of patients delays diagnosis and treatment. Since these maladies may pass unnoticed or may be misinterpreted due to human fatigue or other limitations, detection at later stages makes treatment options either limited or generally less effective.

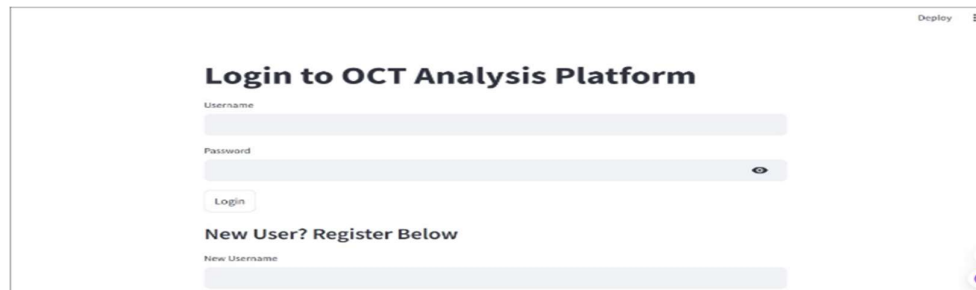


Fig 2: Login page



Fig-3- OCT Retinal Analysis platform



Fig-4- Sample output

VII. CONCLUSION

To promote early detection of eye diseases based on deep learning, the project is meant to speed up and improve the access of the whole process of diagnosis. The algorithm scans retinal images and uses Convolutional Neural

Networks to find conditions such as diabetic retinopathy, glaucoma, and cataracts with an established level of high accuracy. The system is a web-based application that allows medical practitioners and the public to screen the eye without the need for sophisticated equipment or expertise. Early detection serves to avert severe visual impairment cases, while this system serves to fill the blockage where medical resources do not exist. Traditionally, investigation has been a long-and dependent process on specialists; however, this automated system gives quick and accurate results.

FUTURE SCOPE

Enlarge disease detection: Currently, the setup works more or less for three eye diseases- diabetic retinopathy, glaucoma, and cataracts. However, further enhancements can include conditions like macular degeneration, retinal detachment, uveitis, and keratitis into the model. Users would then take pictures of their own retinal images using the inbuilt smartphone cameras, connect these into retinal imaging devices, and pre-screen these images before they visit the professionals. A further kind of extension is that allows telemedicine access so patients who are not able to come physically can get their diagnostics done remotely and early intervention planned thereafter.

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