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Cataract Eye Detection Using Deep Learning

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ABSTRACT: The cataract eye illness causes the eyes to seem cloudy. Patients with cataracts tend to experience foggy or frosty vision. Cataract in one's eyes makes it difficult to read, drive, and even recognize faces. The World Health Organization estimates that 2.2 billion individuals worldwide suffer from near or distance vision impairment and 1 billion are moderately or severely blind, of whom 94 million people suffer from cataract. The signs of cataract vary depending on the type of cataracts, the person's lifestyle, and his or her visual needs, all of which have a big impact.Early identification of cataracts is essential for successful treatment and can significantly reduce the risk of blindness.

KEYWORDS: Convolutional neural network (CNN), Support Vector Machines (SVM), Fundus Image, Transfer learning, DenseNet.

I.INTRODUCTION

A crucial step in the diagnosis and treatment of this eye condition is the discovery of cataracts. Cataracts are a common eye condition that cause the lens to become cloudy, impair vision, and, if left untreated it could lead to blindness. Aging and gradual loss of crystalline lenses both contribute to the development of cataracts. The transparency and optical uniformity of the lens are maintained by the microscopic structure, chemical makeup, and other interconnected factors. An aging related gradual deposit of a yellow-brown pigment is seen on the lens. Additionally, this lessens the amount of light that reaches the eyes. Cataracts usually form gradually and can affect either one or both eyes. Pale colours, blurry vision, light haloing, sensitivity to bright light, and difficulty seeing in the dark are just a few symptoms. Alcohol, diabetes, smoking, and prolonged sunlight exposure are all risk factors for cataracts. In the past, it was very common among adults. But today, childhood cataract is one of the most significant factors contributing to severe disability and blindness in children. The fundamental need thus is the detection of cataract, which will be accomplished by utilising numerous ways. The usage of numerous automatic cataract detection techniques has increased in order to help identify cataracts using images taken by tools like cameras, ophthalmoscopes, and OCT machines. The severity of cataracts may be determined using these detection technologies, which can help doctors choose the best course of treatment for their patients. The accuracy and speed of diagnosis could be increased with the use of automatic cataract detection devices, which could ultimately result in improved outcomes for patients.

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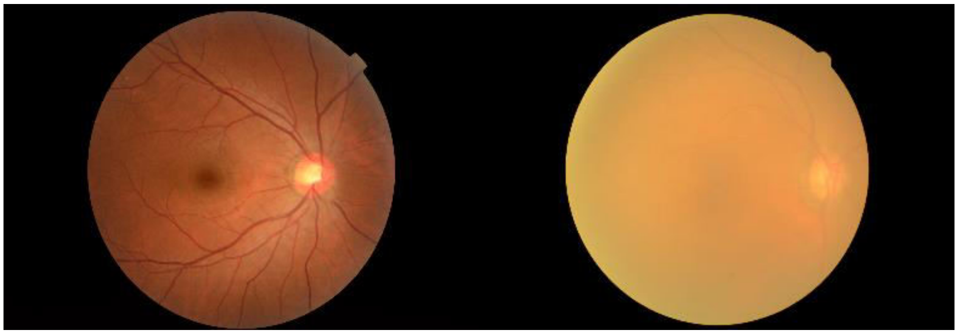

Fig 1: Fundus Image of normal eye and cataract eye.

II.LITERATURE REVIEW

1. **Sahana M, G. (2019). Identification and Classification of Cataract Stages in Old Age People Using Deep Learning Algorithm. VOLUME-8 ISSUE-10, AUGUST 2019, REGULAR ISSUE.**
The proposed method uses a deep convolutional neural network (CNN) to analyze input images and classify them into one of four cataract stages: no cataract, mild, moderate, or severe. The authors' method was successful in categorizing cataract phases with an overall accuracy of 91.5%, proving its efficacy. The benefits of an automated cataract detection system are covered in the article, including enhanced effectiveness, lower costs, and better access to healthcare. The authors use a dataset of fundus photos collected from mature individuals to demonstrate the efficacy of their approach and to highlight the potential for deep learning to enhance cataract diagnosis and therapy.

2. **Shruthi Bhat, Som Mosalagi, Tejal Bhalerao, PushpakKatkar and Rahul Pitale. Cataract Eye Prediction using Machine Learning. International Journal of Computer Applications 176(35):46-48, July 2020.**
This research describes a novel approach to cataract diagnosis based on machine learning algorithms. The performance of various machine learning methods, such as Random Forest, K-Nearest Neighbours, and Support Vector Machines, for cataract diagnosis is compared by the authors. The study shows the effectiveness of machine learning methods for identifying and classifying cataracts. The authors propose that their method can be applied to various eye illnesses and emphasize the significance of having a sizable and varied dataset for training the machine learning models. The study is however constrained using a single dataset and the absence of model validation on an additional dataset. Furthermore, the study does not address the clinical implications of their strategy, as well as the potential difficulties in adopting it in real-world clinical settings.

3. **Weni, I., Utomo, P.E., Hutabarat, B.F., & Alfalah, M. (2021). Detection of Cataract Based on Image Features Using Convolutional Neural Networks. Indonesian Journal of Computing and Cybernetics Systems, 15, 75-86.**
The convolutional neural network (CNN)-based cataract detection system is suggested in this paper. To improve the contrast and brightness of the photos, the authors preprocess them using methods like gamma correction and histogram equalization. Then, they use CNNs—deep learning models capable of automatically learning hierarchical representations of the image data—to extract features from the preprocessed images. The study shows that CNNs have a lot of potential for cataract identification and categorization. The authors show how deep learning models can be used to diagnose cataracts with high accuracy by automatically learning the features from the photos.

4. **Junayed, M.S., Islam, M., Sadeghzadeh, A., & Rahman, S. (2021). CataractNet: An Automated Cataract Detection System Using Deep Learning for Fundus Images. IEEE Access, 9, 128799-128808.**
The research suggests CataractNet, a deep learning-based automated method for cataract identification. CataractNet classifies fundus images as either normal or cataractous using a deep convolutional neural network (CNN) with residual connections. With the use of transfer learning and data augmentation approaches, the authors train the network to have a sensitivity of 99.8% and a specificity of 97.2% on the test set. In contrast to conventional approaches, deep learning algorithms for medical image analysis have the potential to produce diagnoses that are more precise and objective. Thus, the paper describes a promising strategy for automated cataract detection using deep learning algorithms.

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5. **Khan, Mohammad &Masud, Mehedi & Faruk, Omar. (2021). Cataract Disease Detection by Using Transfer Learning-Based Intelligent Methods. Computational and Mathematical Methods in Medicine. 2021. 1-11. 10.1155/2021/7666365.**
   The research suggests a deep learning-based automated cataract detection method based on transfer learning. The feature extractor used by the authors to classify cataracts is a pre-trained convolutional neural network (CNN). The suggested method significantly outperforms conventional methods, with an accuracy of 97.6%. The authors emphasize the limits of standard cataract detection approaches, which can be time-consuming, subjective, and reliant on the ophthalmologist's knowledge. They suggest that deep learning-based automated cataract diagnosis could offer a more effective and trustworthy screening tool, thereby enhancing patient access to care and lightening the load on medical professionals. Using transfer learning-based intelligent algorithms, the research proposes a potential strategy for automated cataract identification. It further demonstrates the effectiveness of deep learning methods.

6. **V.Harini&V.Bhanumathi. (2016). Automatic cataract classification system. 2016 International Conference on Communication and Signal Processing (ICCSP), 0815-0819.**
   The study suggests a system for automatically categorizing distinct forms of cataracts that makes use of deep learning techniques. The system is made to examine detailed pictures of the eye taken using a slit-lamp microscope. A feature extraction module and a classification module make up the system's two primary parts. In order to extract pertinent characteristics from the input photos, the feature extraction module employs a convolutional neural network (CNN) that has already been trained. The retrieved features are then sent to the categorization module, which divides the cataract into one of three categories based on their location: nuclear, cortical, or posterior subcapsular. The suggested approach may help ophthalmologists diagnose and treat cataracts more precisely and effectively, which could enhance the quality of patient care.

III.METHODOLOGY OF THE PROPOSED SYSTEM

The proposed system uses image pre-processing. It is important for improving the quality of retinal images, since images with low quality can reduce the system's performance and it is necessary to ensure that all the images are consistent and that the features of the image are enhanced. The CNN model is trained by feeding a training dataset to the model. This is supposed to predict whether the image belongs to class cataract or non-cataract.

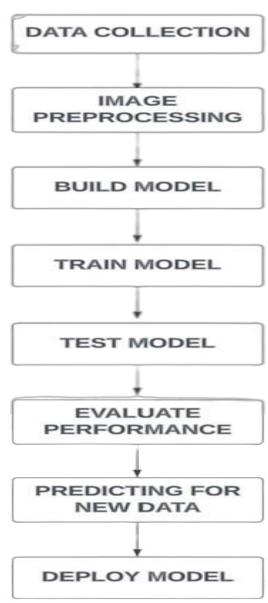

Fig 2: Implementation methodology

The proposed system usesDenseNet.It is a type of convolutional neural network (CNN) that has been used for various image classification tasks, including the prediction of cataracts in eye images.DenseNet differs from traditional convolutional neural networks (CNNs) in that it has skip connections that connect each layer to every other layer in a feed-forward fashion. This dense connectivity improves the flow of information through the network and makes it easier for the model to learn complex features in the data.DenseNet has been successfully used in a wide range of computer vision tasks, including image classification, object detection, and segmentation.

Data Collection:

Collecting a diverse dataset of eye images is crucial for building an accurate cataract prediction model. The dataset should include fundus images of both healthy eyes and those with cataracts. It's important to ensure that the images are high-quality and properly labeled, so that the model can learn to accurately distinguish between the two classes.

Image Preprocessing:

Preprocessing the eye images involves preparing them for input into the DenseNet model. This can include resizing the images to a specific size, normalizing pixel values to a standard range, and cropping the images to focus on the relevant regions. These preprocessing steps help to standardize the input data and remove any irrelevant information.

Training:

Training the model involves feeding the preprocessed eye images and corresponding labels into the DenseNet model and adjusting the model's parameters to minimize the loss function. The goal of training is to teach the model to accurately classify eye images as either healthy or cataractous.

Evaluation:

After training the model, it's important to evaluate its performance on a separate test dataset that the model has not seen before. This helps to determine how well the model generalizes to new data. It's important to ensure that the model's performance is sufficient for the intended use case.

Deployment:

Once the model has been trained and evaluated, it can be deployed in a production environment to predict cataracts in new eye images. This may involve integrating the model into a larger software system or app, or deploying it as a standalone API. It's important to monitor the performance of the model in production and make updates or improvements as necessary.

IV.RESULTS

We developed a DenseNet-based model to detect cataract in fundus images.The graph below displays the created model's accuracy.

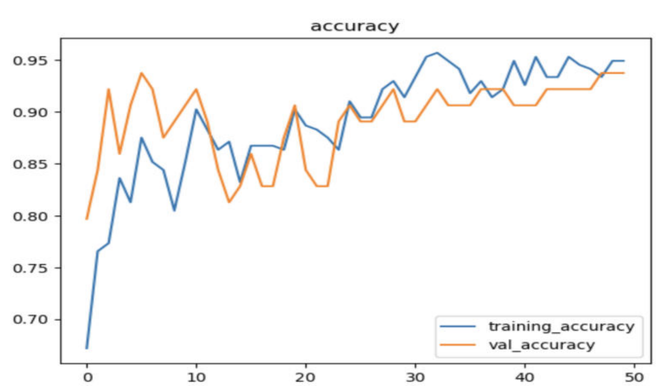

Fig 3: Accuracy graph of the DenseNet Model

Our model's binary accuracy on the training set was 94%, and its accuracy on the validation set was 93%, demonstrating its excellent efficiency in correctly identifying cataract.

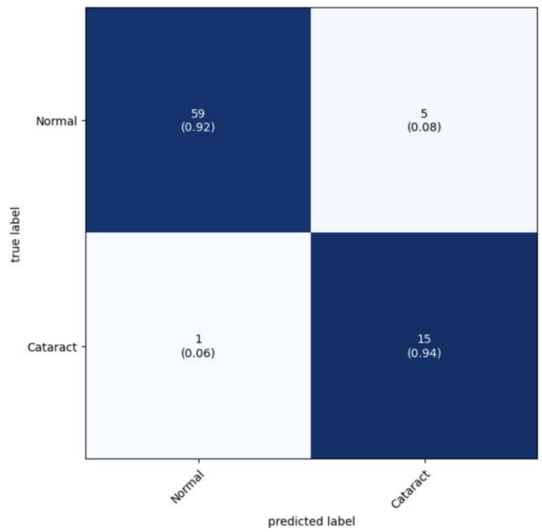

Fig 4: Confusion matrix

The above figure shows us the confusion matrix, this the table that summarises the performance of the binary accuracy. Here the matrix shows the model made a total of 80 predictions. The first row represents the actual normal eye samples and the second row represents the actual cataract samples. These results are promising for the potential use of our model in clinical settings, where accurate and timely diagnosis of cataract is crucial for proper treatment and management.

V.CONCLUSION

Automatic cataract detection systems are a new development in the field of ophthalmology that use computer vision algorithms to detect cataracts in medical images. By automating the screening procedure, these devices can reliably identify cataracts with high sensitivity and specificity, which can lighten the workload of ophthalmologists and save time. Furthermore, automated cataract screening can result in early cataract detection, enabling prompt treatment and improved results. The current work for cataract detection using DenseNet has achieved a binary accuracy of 94% and a validation binary accuracy of 93%, indicating its effectiveness in detecting cataract in the given dataset.The current work demonstrates the promise of deep learning models for cataract diagnosis, and future research can examine various architectures or improve the suggested approach's performance.

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