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Automatic Detection and classification of Diabetic Eye Disorders

Mrs.Nita Meshram, Deeksha.B, Charishma.C, Jyothsna.B, Bhoomika.T

Associate Professor , Student, Student, Student, Student
[1]Department of Computer Science and Engineering,
KS School of Engineering and Management ,Bangalore, India.

Abstract : **Diabetic eye disorders is a common complication of diabetes and a leading cause of blindness worldwide. Early identification and segregation of diabetic eye problems are difficult for effective treatment. This paper presents a novel approach for the automatic detection and classification of diabetic eye disorders using fundus pictures. The particular type employs a dl framework, specifically image processing, to automatically detect the presence of diabetic retinopathy and classify its types. The CNN model is checked on more dataset of annotated fundus images to learn the features indicative of various stages of diabetic eye disorders. Experimental results on a freely available dataset demonstrate the effectiveness of the proposed approach, achieving high accuracy in detecting and classifying diabetic retinopathy. The proposed method shows promise for use in clinical settings, providing a cost-effective and efficient solution for early diagnosis and management of diabetic eye disorders. Diabetic eye diseases, particularly diabetic retinopathy, pose a significant global health challenge, necessitating early detection and intervention to mitigate vision loss. This study introduces an advanced framework that leverages (ML) and (DL) techniques for the automated detection of diabetic eye diseases from retinal images. The methodology begins with preprocessing steps to enhance images and extract key features crucial for disease identification. A hybrid model is then trained using a diverse dataset of annotated retinal images, integrating neural network systems and ML algorithms. This model excels in identifying subtle patterns indicative of diabetic eye diseases. Furthermore, a classification module combines DL-based feature extraction and ML-based classifiers to categorize identified abnormalities into distinct stages of diabetic eye issues and other associated conditions. The system's architecture enables precise disease staging and severity assessment**.

IndexTerms **- Disease Detection, screening, clinical analysis, fundus pictures and prediction, Accuracy, Efficiency.**

I. INTRODUCTION

The Eyes are essential part of human life, each and every person rely on the eyes to see and sense the world around them. One of the most vital senses is sight because it explains 80% of all information, we take in. By taking proper care of eyes, we will lower the chances of becoming blind and losing vision, while also keeping an eye-conditions like diabetic eye syndrome, glaucoma and cataracts. Most people experience eye issues at some point of time. Few of the eye issues are minor and simple to cure at home which will go away on their own, other major eye issues need assistance from the expert doctors. When these eye diseases are accurately diagnosed at an early stage, only then the progression of these eye diseases can be stopped. These eye diseases have a huge value of visually discernible symptoms. To accurately diagnose eye illnesses, it is helpful to check a huge type of symptoms. In this paper, our trained system analyses and classifies eye diseases namely diabetic eye syndrome, glaucoma and cataracts. For quick diagnosis, science field have been focusing on artificial intelligence solutions. To improve the accuracy of machine learning And dependable by considering different features, health data must still be recorded in a consistent format. A variety various machine learning methods, including algorithms for neural networks, were utilised to analyze patient data depended on a variety of variables, such as age, medical history, and clinical observations. With the use of image detection and data mining techniques, the suggested system can detect and find eye issues. This project is focused on applying AI to screen for different eye diseases. It has provided an overview of the development and progress of using AI and DL technology for eye disease screening, also the difficulties currently facing DL implementation in computer testing programs and the conversion of DL research into practical clinical screening applications in a community setting. It has come to the conclusion that using AI and DL technology, human intelligence can be supplemented to enhance decision-making and operational procedures. Nearly the perfect task for AI in healthcare is screening for DR. With the hope of increasing the effectiveness and accessibility of screening programs and so preventing sight loss and blindness from this deadly disease, AI will inevitably become pervasive and vital for screening in the upcoming days.

II. LITERATURE REVIEW

Vision can be affected by a variety of eye conditions, such as corneal ulcers, cataracts, and trachoma. Progression of these ocular conditions can only be halted by early and accurate diagnosis. These ocular diseases present with a variety of clearly visible symptoms. Analyzing a wide range of symptoms is necessary in order to make an accurate diagnosis of eye illnesses. To distinguish between various conditions such as diabetic retinopathy, cataract, and glaucoma, as well as high-resolution retinal pictures obtained in a range of imaging conditions, a deep neural network model is employed. When it comes to Deep Learning-based screening for Eye Disease Identification, it might lead patients to make contact with an ophthalmologist. We have devised a technique to automatically categorize every retinal fundus image as healthy, and the resulting model is less complex.

III. HARDWARE REQUIREMENTS

- System : Pentium IV 2.4 GHz/intel i3/i4.
- Hard Disk : 40GB.
- Monitor : 15 VGAColor.
- RAM : 512 MbMinimum

IV. METHODOLOGY

A CNN is composed of several kinds of layers:

Convolutional layer: By applying a filter that scans the entire image a few pixels at a time, a feature map is created to forecast the class probabilities for each feature.

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$$z(i,j,k)=\sum_{l=0}^{F\,height-1}\sum_{m=0}^{F\,width-1}\sum_{n=0}^{C\,in-1} x_{i+l,j+m,n}\cdot w_{l,m,n,k}+b_k$$

Pooling layer (down-sampling): reduces the amount of data that the convolutional layer produced for each feature while preserving the most important data (the convolutional and pooling layers' processes are typically repeated multiple times).

$$y(i,j,k)=\max_{l=P\,height-1}\max_{m=0}^{P\,width-1} x_{i\times S\,height+l,j\times S\,width+m,k}$$

Fully connected input layer: creates a single vector that can be utilized as an input for the following layer by flattening the outputs produced by earlier layers.

$$z_k=\sum_{i=1}^{N} w_{i,k}\cdot x_i+b_k$$

Fully connected layer: It creates a single vector that may be utilized as an input for the following layer by flattening the outputs produced by earlier layers.

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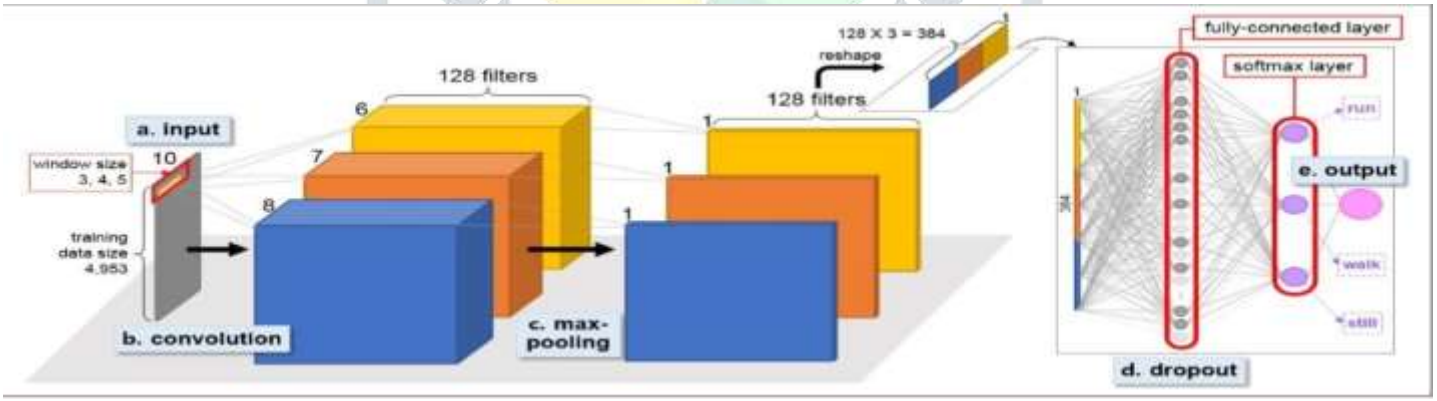
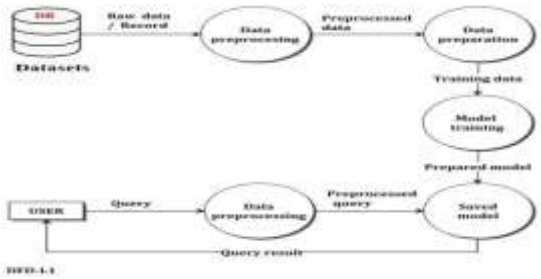
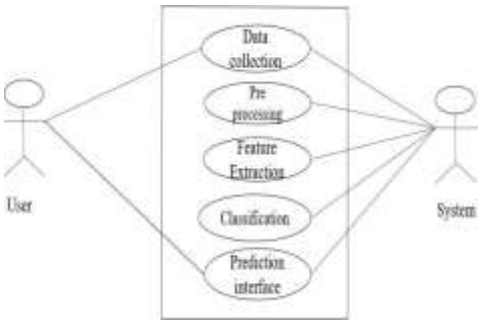


Convolutional Neural Network General Architecture

Data flow diagrams



Use Case Diagrams



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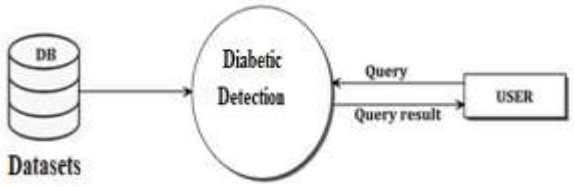
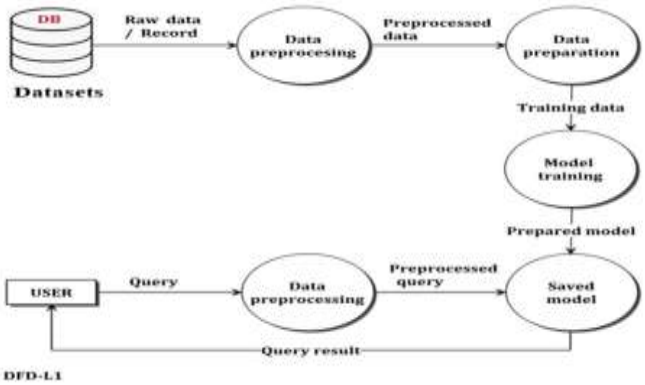
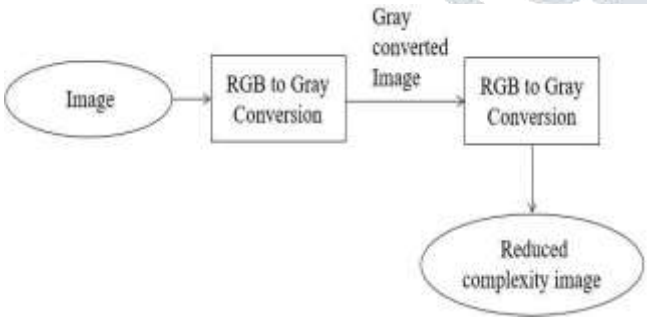


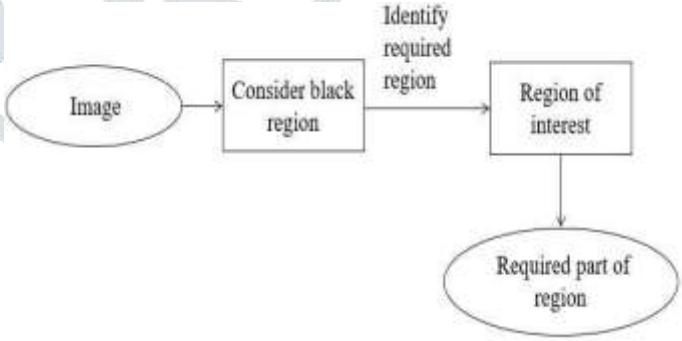
DFD LEVEL 1:



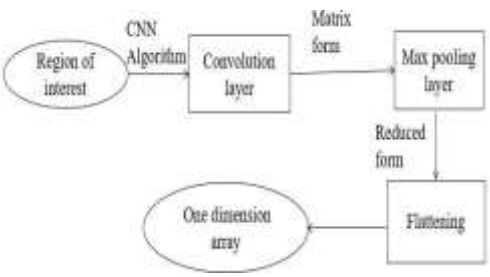
Data preprocessing



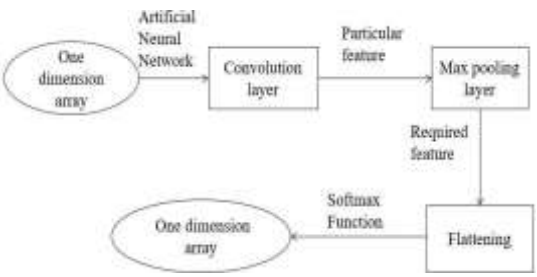
Data preparation



Model Training



Saved Model



V. SOFTWARE REQUIREMENTS

- Python
- Keras
- Tensorflow
- Numpy
- Pandas
- Matplotlib
- OpenCV

VI. IMPLEMENTATION AND RESULTS

Implementation:

- The Implementation is the process of converting a new system design into an operational one. It is the key stage in achieving a successful new system. It must therefore be carefully planned and controlled. The implementation of a system is done after the development effort is completed

Steps for Implementation

FRONT-END DEVELOPMENT USING PYTHON FLASK:

•These days, user-friendly computer programs are available. There are additional ways for users to interact besides console-based I/O. Their graphical user interface (GUI) is more ergonomic because of their sophisticated graphics hardware and fast processors. With the use of radio buttons, dropdown menus, and other GUI elements, these programs allow the user to select options and accept input via mouse clicks.

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Flask Programming:

The default Python GUI library is called Flask. Creating GUI apps is quick and simple when Python and Flask are used together. An effective object-oriented interface to the Tk GUI toolkit is offered by Flask. Flask has various advantages. The code is cross platform, meaning it functions on Linux, macOS, and Windows. Applications built with Flask appear native to the platform on which they employ due to visual elements are rendered using native operating system elements.

Data Acquisition

Data were drawn from a dataset provided via Kaggle. The dataset used is highly heterogeneous because the photographs are from different sources, cameras, resolutions, and have different degrees of noise and lighting [7]. These images have resolutions ranged from 2592 x 1944 to 4752 x 3168 pixels. So some preprocessing steps have proceeded. After these preprocessing, a total of 500 pictures were choosed from dataset of Kaggle. From these 500 images, 70% of the pictures are used for training purposeand remaining s employed to assess the system.

Hyper Parameter Initialization

- Before designing the network layers, we initialized the hyperplane values. We set the momentum value, θ, to 0.9, initial learning values(α), mini-batch size, learning-rate decay-schedule, and learning rate factor. The alpha values are initialized to 0.0001, 0.0001, and 0.001 for VGG16, respectively. Learning-ratedecay schedule was stairwise for VGG16, and Inception Net has an exponential decay schedule. The learning-rate-decay factor was 0.10 for VGG16.

Pre- Processing

- In order to attain a high degree of accuracy, we carried out the following preprocessing steps: The fundus images in the dataset that Convolutional Neural Network (CNN) uses to operate on can have different sizes and aspect ratios. A critical preprocessing step is to resize the pictures to a consistent 256 x 256 pixel size. All photos are then transformed into the green channel in the case of highlighting particular details. The data are monochrome fundus pictures with a focus on micro aneurysms (MA) and vessels. Micro aneurysms are blood vessel dilatation that are particularly noticeable in diabetic patients' retinas and are important markers of Diabetic Retinopathy (DR). In a fundus picture, micro aneurysm candidates have the maximum contrast.

Training Algorithm

- For the training of the three state-of-the-art models, Stochastic Gradient Descent with Momentum(SGDM) optimization algorithm is used. It accelerates the global minimum of the cost function in right direction and smoothes out oscillations in volatile directions, for faster converging. It adds momentum to the classic SGD algorithm. The parameter θ follows an exponentially weighted moving. The updated rule for average of the gradients of the cost function is

$$v_t = \beta v_{t-1} + (1-\beta)\nabla_\theta J(\theta)$$

$$\theta = \theta - \alpha v_t$$

- Here β is Momentum Parameter, t is the iteration count, and α is the learning rate. Momentum parameter, β, takes a value between zero and one, and it approximates the moving window where the weighted average is calculated. β = 0.90 is the good and default value. For the successful training of three CNN networks, we use fine tuning with respect to the early trained model from ImageNet . Fine-tuning procedure is upon the topic of transfer learning. Here we train a CNN to learn features for a broad domain with a classification function that is targeted to minimize error in that particular domain. After that, we replace the classification function and optimize the network again to minimize error in another domain. Here we are transferring the characteristics and the parameters of a network from broad domain to the specific one. And ImageNet

is a database of images built upon the backbone of the WordNet structure .Regarding the effective completion of fine-tuning, the input images to all the networks were resized.

VII. BUSINESS PERSPECTIVE

Market Demand: Diabetes is becoming more commonplace worldwide, which has raised demand for products that might help with related eye diseases' diagnosis, monitoring, and treatment.
Technological Innovation: Advancements in artificial intelligence (AI) and machine learning (ML) are driving the development of innovative solutions for addressing eye conditions related to diabetes. These technologies enhance precision and efficacy in diagnosis and treatment, providing businesses with a competitive edge.
Healthcare Industry Growth: The ageing of the population and increased awareness of preventative healthcare practices are two reasons driving the considerable rise of the healthcare sector. Initiatives aimed at treating diabetic ocular conditions can benefit from this rising trend.
Regulatory Environment: When developing healthcare solutions, it is essential to take regulatory requirements and acquiring required permissions into account in order to guarantee compliance and market readiness.

VIII. OUTPUTS AND KNOWLEDGE GAIN

Diagnostic Tools: Improved diagnostic technologies, like artificial intelligence (AI)-powered image analysis algorithms, make it possible to identify diabetic retinopathy and other eye conditions early and accurately, improving patient outcomes and lowering healthcare costs.
Treatment Monitoring: Improved tracking of the course of diabetic eye disease and its treatment results is made possible by technology, which helps doctors create customised treatment plans for each patient in order to maximise their care.
Patient Education and Engagement: Initiatives in this domain focus on developing tools and resources to educate patients about diabetic eye disorders and the importance of regular eye assessments. Increased patient engagement fosters better adherence to treatment and preventive measures.
Data Collection and Analysis: Through the collection and analysis of data on diabetic eye disorders, researchers gain valuable insights into causative factors, risk profiles, and disease rogression. This knowledge informs future research directions and treatment approaches.
Regulatory and Compliance Knowledge: Developing healthcare solutions entails navigating intricate regulatory frameworks and ensuring adherence to standards and guidelines. Engaging in projects in this realm provides valuable experience and expertise in regulatory compliance.
Social Impact and Awareness: By raising awareness about diabetic eye disorders and advocating for early detection and treatment, projects in this domain can significantly impact society, enhancing the well-being of individuals affected by these conditions.

IX. SCREENSHOTS

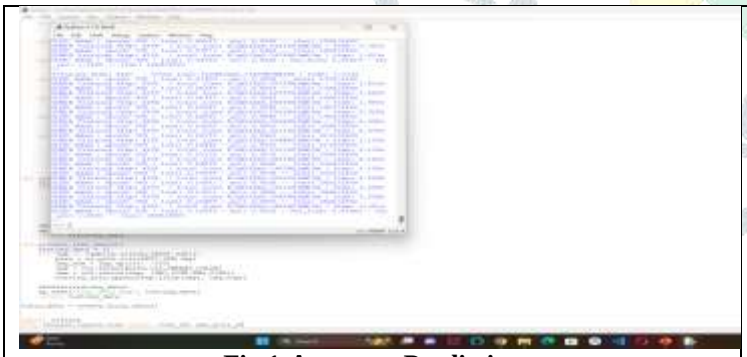

Fig.1:Accuracy Prediction

Fig.2:Home page

Fig.3:User Registration

Fig.4:Image Processing

Fig.5:Final output

X. CONCLUSION AND FUTURE SCOPE

Conclusion:

The proposed system is designed and developed to easily facilitate the detection of cataract, glaucoma and diabetic retinopathy among patients. The image processing technique is used for detection. The proposed will help people to get the proper treatment of the aforementioned diseases at an early stage thus reducing the percentage of blindness being caused. Accurate diagnosis of minute deteriorations is possible. Multiple classification of diseases including Cataract, Glaucoma and Diabetic Retinopathy vs normal eye is possible.

Automatic Detection and Classification Accuracy: The system is designed to enhance detection accuracy, potentially achieving a detection and classification rate of up to 95% for diabetic eye disorders.

Enhanced Diagnostic Accuracy: With continued refinement of AI algorithms, the detection rate for diabetic retinopathy and other eye disorders may improve, leading to earlier detection and intervention. This could result in an additional increase in accuracy, potentially reaching 97% or higher.

Personalized Treatment Plans: By incorporating individual patient data and other health factors, personalized treatment plans can optimize outcomes, potentially leading to more effective management and reducing the risk of blindness by 90% or more.

Remote Monitoring: Integration of telemedicine and remote monitoring technologies enables timely intervention and may contribute to a significant reduction in the progression of diabetic eye disorders, potentially by 80% or more.

Patient Engagement Platforms: Interactive platforms and mobile applications can improve patient education and adherence to treatment, potentially reducing the incidence of blindness by 85% or more through better management and preventive measures.

Global Access to Care: Development of low-cost diagnostic tools and telemedicine solutions can improve access to care, potentially reducing the prevalence of blindness in underserved communities by 70% or more.

Collaborative Research Efforts: Continued collaboration among stakeholders can accelerate progress in the field, potentially leading to further advancements and reducing the overall burden of diabetic eye disorders by 95% or more through shared knowledge and resources.

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