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Early Detection of Diabetic Retinopathy

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Abstract: Diabetic retinopathy is one of the prevalent reasons of sight impairment in this day and age According to an epidemiology study, diabetic retinopathy affects one out of every three diabetics. In today's world, disease diagnosis is an essential part of medical imaging. In medical imaging, machine learning gives a greater vision for detecting disease. The objective is to detect diabetic retinopathy using ML. Machine learning in medical imaging could speed up and enhance the detection of sight caused by sugar. In order to detect diabetic retinopathy quickly and support the health-care system, this study will look at several machine learning methodologies, algorithms, and simulations. CNN is used to train the model.
Keywords: Convolution Neural Network (CNN), Diabetic Retinopathy, Machine Learning, Iris detection, Image detection

I. INTRODUCTION

Diabetes mellitus (DM), also called diabetes, is combination of collective diseases characterized by a high blood sugar level that persists. Symptoms include frequent bathroom visits, increased need to drink water, and increased hunger. It causes a plethora of health problems if left untreated. Diabetic retinopathy, often known as diabetic eye disease (DED), is a medical condition that occurs when diabetes affects the retina. It is the leading cause of vision impairment in developed countries. Diabetic retinopathy affects up to 80% of diabetics who have been diagnosed for further than two decades. At least 90% of future occurrences might be avoided with diligent therapy and eye supervision. Those who do have diabetes for a long time are more prone to develop diabetic retinopathy.12% of vision impairment is caused by DR in U.S. annually. As a result of various advances in Deep Learning, computer vision technologies have evolved considerably, spanning from authenticating our smartphones with our facial features to smarter self-driving automobiles. The majority of modern deep learning models involve artificial neural networks, particularly CNN & RNN.

Diabetic Retinopathy (DR) began to progress globally, and it is still the primary cause of visual loss. We present a Deep Learning (DL) method for predicting DR progression utilizing Color Fundus Photos (CFPs) taken in as source from doctor consultancy. DR causes eye functionality failure if treaded lightly. Computer-Aided Diagnostic (CAD) strategy depends on optic disc is an effective and successful approach for diagnostic and helping others. It works by detecting, segmenting, and categorizing abnormalities in fundus images. Several basic methods using features have been reported. Researchers have suggested many DL-based methods for DR diagnosis as a result of deep learning's recent progress and obvious triumph over traditional ML approaches for several purposes. Diabetic-induced retinopathy remains a threat to the stability of individuals diagnosed with diabetes of any kind, spite of the fact that healthcare centers and equipment are getting more contemporary and made widely accessible population on a regular basis. This is a serious issue, since the annual rate of diabetics is increasing by leaps, owing to a variety of causes extending from dietary changes to COVID-19 confinement. Because any clinic meant to reduce COVID-19 has found it difficult to focus on those other ill aliments, giving an alternative and much more user-friendly examination for such a critical problem must be given a lot of thought. Developing an automated technique for detecting diabetes-induced cataracts is important in this circumstance. Due to the efficiency of machine learning architectures in investigation, CNNs have garnered a lot of attention for photo classification. Furthermore, characteristics learned by pre-trained CNN models on huge data sets help considerably with picture classification tasks. The effectiveness of pre-trained.

II. LITERATURE REVIEW

There are numerous amounts of studies carried out on the detection of diabetic retinopathy patients in various possible ways. In 2016, Bhatia *et al.* [1] proposed a classifying algorithm based on different retinal image processing algorithm like diameter of optic disk and prediction of presence of diabetic retinopathy was performed using altering decision tree, adaBoost, Naïve Bayes and SVM. Followed by Chen *et al.* [2] in 2017 who used streamline machine learning algorithms for effective prediction of chronic disease outbreak in disease-frequent communities. They proposed a convolutional neural network based multimodal disease risk prediction algorithm by using structured and unstructured data collected from different hospitals.

Further research is conducted in the upcoming years and the effective solutions and conclusions are drawn from all the available information along with the other research conditions. In 2019, F.Arcadu *et al.* [3] proposed an algorithm to detect the disease using

Color Fundus Photographs (CFPs). The proposed DR models were designed to predict future DR progression defined as a 2-step worsening on the Early Treatment Diabetic Retinopathy Severity Scale.

In 2019, Asiri *et al.* [4] proposed a Computer-Aided Diagnosis system based on retinal fundus images in an efficient and effective method for DR diagnosis which involves various stages like detection, segmentation and classification of lesions in fundus images. Bellemo *et al.* [5] provided an integrated overview of the current state of knowledge of emerging techniques using artificial intelligence integration in national screening programs around the world.

Gradekallu *et al.* [6] normalized the DR dataset using the standard scalar technique and then Principal Component Analysis (PCA) is used to extract the most significant features from the images. Further, Firefly algorithm is implemented for dimensionality reduction. Also, various other researches have been conducted to favor the analysis and detection of Diabetic Retinopathy using all possible learning and classification algorithms.

III. IMAGE CLASSIFICATION

Image classification is an important issue in which a system trained to recognize a collection of training instances (things to classify in pictures) using labelled sample snapshots. The source of the first image processing algorithms was local texture information. Texture analysis information, on the other hand, does not provide a coherent depiction of an asset's numerous variations captured in a photograph. The location of the article, the landscape behind the image, ambient lighting, camera angle, and lens focus may all impact raw pixel data; these variations are substantial enough that weighted means of pixel RGB values cannot correct for them.

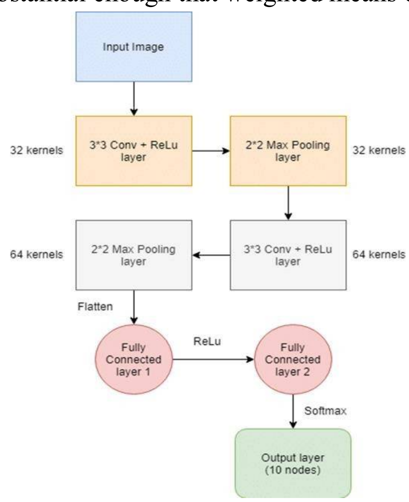

Fig 3.1 Architecture of Image Classification model

IV. CONVOLUTION NEURAL NETWORKS

The convolution neural network method is a multilayer perceptron with a unique architecture for recognizing two- dimensional sensory input. The convolution layer and sample layer in a deep network design may contain a large number of events. It's a form of deep learning model that is used to analyze visual images. A hidden layer, and also an inlet and outletlayer, are present. It captures an input as user data & generates a number of mappings based on feature as result. The input image may have many layers, such as color, wings, eyes, & avian beaks, indicating that the convolution operation does a 3D volume projection. 3D volumes' width, height, and depth are all taken into consideration. The CNN is divided into two sections:

1) *Extraction of Feature:* Characteristics are identified when the network performs a series of convolutional and pooling processes.
2) *Classification:* The collected attributes are passed to a completed connection that acts as a classifier.

CNN is made up of 4 layers as mentioned below. The convolutional layer allows for the retrieval of very small amounts of visual data from a photograph. Pooling is a method of decreasing the number of cells in a prior convolution operation while preserving the information. A value is sent from the activation layer to a procedure that collapses it into a spectrum. In a completed model, a synapse through a layer connects to every neuron in the next level. Because CNN identifies each neuron in great detail, it is more precise.

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A. Convolution Layer

This is the base structure for CNN. It contains collection of free feature detectors.

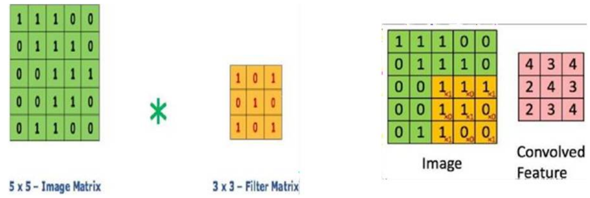

Fig 4.1 Convolution Layer

B. Pooling Layer

It reduces the represented space or computed parameters in the connection web. It independently operates on feature maps.

Methods implemented in pooling are:

1) Pooling by Max
2) Mean Pooling
3) Sum Pooling

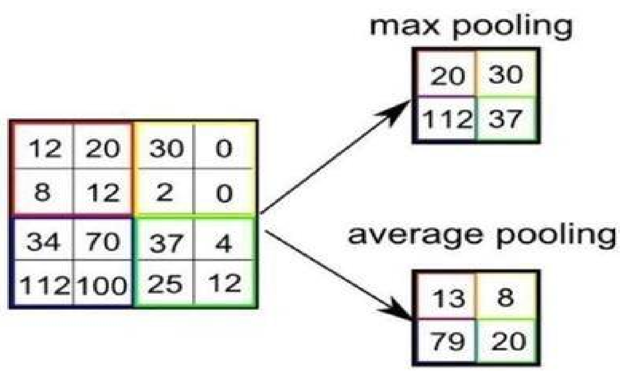

Fig 4.2 Pooling

C. Fully Connected Layer

In the completely connected approach, all activations in the previous layer are entirely linked to neurons. The max pooling result is converted to a 1D array, which is utilized as the input nodes, and the operation is continued as the ANN model. For picture classification, we choose deep learning approaches over machine learning techniques because data mining techniques like CNN and RNN reduce overfitting. For large datasets, accuracy is also higher when compared to ML techniques. Accuracy improves as the number of epochs is increased. The activation functions used in this research are relu and softmax.

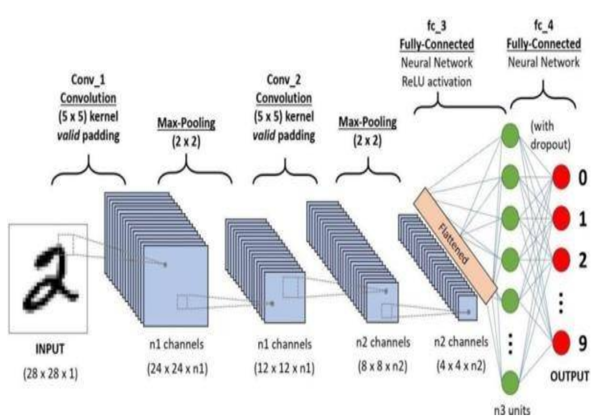

Fig 4.3 Fully Connected Layer

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D. ReLu

ReLu transform working triggers a node when the input exceeds a specific threshold; while the intake is <0, output=0; however, feed beyond a limit results in a proportionality with dependent. It is implemented particularly CNNs. y=max is the mathematical formula (0,x). The Rectified Linear Unit transform function triggers a node whenever the input exceeds a certain threshold; whereas the input is less than zero, the result is zero; however, so when input is over a certain criterion, the result isas above. When a neuron engages, Relu is crucial because it does not exhaust and the gradients is constantly high. Repeated updates are fairly confident that the results even as synapse is not dead. Relu is also a lightning-fast analyzer.

Fig 4.4 ReLu activation Function

E. Softmax

The softmax operational amplifier can handle issue of occurrence of a class whenever count of potential higher than 2 while creating a multi - class classification in neural networks. This function is used as the last layer's final output in most neural network models. It's also known as soft argmax or the normalized exponential function. Over a collection of n occurrences, the Softmax function predicts the probability distribution of the event. To put it another way, this function determines theprobability of every class among all. Results obtained subsequently would help define it for the provided data. It's advantage is the outlet probability range. It lies between 0 to 1, with one being the summation of possibilities. These are returned when the softmax function is applied to a multi-classification framework, with the personal involvement having one of the highest likelihoods. The method calculates each input value's exponent (e-power) as well as the sigma of all values. Softmax function returns the ratio.

V. IMPLEMENTATION

The convolutional neural network (CNN) would be developed using the following steps:

Data Collection	Image dataset
Data pre-processing	Augment, standardize and split the images to a training and testing dataset
Training the CNN model	Using the training dataset
Testing the CNN model	Using the testing dataset

A. Data Collection

Because thousands of pictures are necessary to successfully train the CNN, the training samples will be critical, as one of deep learning's strengths is its ability to perform well when trained with big data sets. While searching the internet, the photos ofthe eyes were discovered. JPG or PNG image files were used to collect the photographs.

B. Data Preprocessing

1) *Standardization:* The images were shrunk down to 128 pixels by 128 pixels and saved in JPG format.
2) *Folder Structure:* The learning dataset comprises about 80% of the images, while the testing dataset contains the remaining 20%. Based on the photographs to be kept in them, the photos were organized into dataset files and subfolders. The subfolder name dictated the label that will be applied to each image.

C. Training the CNN model:

1) *Importing the packages*
2) *Adding Layers*
   a) *Convolution Layer*
   b) *Max Pooling Layer*
3) *Flatten*
4) *Dense – ReLu*
5) *Dense – Softmax*
6) *Compile Keras Model*

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D. Training the Model

1) *Data Preparation:* For the project, we will be using the dataset that includes 2 different categories of infected eye images and normaleye images. Some of the images like Diabetic induced blindness eyes are:

Fig: 5.1: Stages of Diabetic Retinopathy

VI. RESULTS & DISCUSSION

The output is seen through user interface which it consists the area to upload the image it shows the output by considering theinput as uploaded image that is if we give the image then it predicts the respective output of an image as diabetic infected or not.Result of the some of the instant images is as:

Fig 6.1: User interface greeting the first-time user.

Fig 6.2: System diagnosing level-4 diabetic retinopathy.

Fig 6.3: System diagnosing level-2 to 3 diabetic retinopathy.

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Fig 6.4: System diagnosing level-2 diabetic retinopathy.

Fig 6.5: System diagnosing level-3 diabetic retinopathy.

VII. CONCLUSIONS

The current study examined an approach for detecting diabetes blindness and assessing its severity using a Deep learning algorithm on a dataset for picture classification. The user interface that has been designed allows the user to upload an eye image for identification and then receive the required result. As a result, it is more advantageous for people with diabetes or facilities with limited resources. The study looked at a variety of image recognition machine learning algorithms before settling on transfer learning and CNN, that are well-suited to feature extraction approaches. This research showed that advances in digital imaging have facilitated the identification of artificial neural networks that can reliably and quickly conduct fine-grained categorization. The proposed method works by implementing CNN to recognize patterns that are already trained by the system. These gathered attributes and classification is used to categorize them. Based on the data, the technique has provided the highestlevel of accuracy in forecasting the probability of diabetic blindness.

VIII. ACKNOWLEDGMENT

CNN is a highly effective image classification and object identification method that is frequently utilized. CNN is a fairly robust method for different image and object identification applications because to its hierarchical structure and excellent feature extraction capabilities from a picture. Because it has minimal latency and requires fewer computing resources while retaining high accuracy, the depth-wise separable CN network model developed in this study is well suited for mobile devices. Finally, a security visor map was added in the created system. The major gain of CNN over its followers is that it recognizes significant characteristics without the need for human intervention. Among all the methods, CNN has the best picture classification accuracy.

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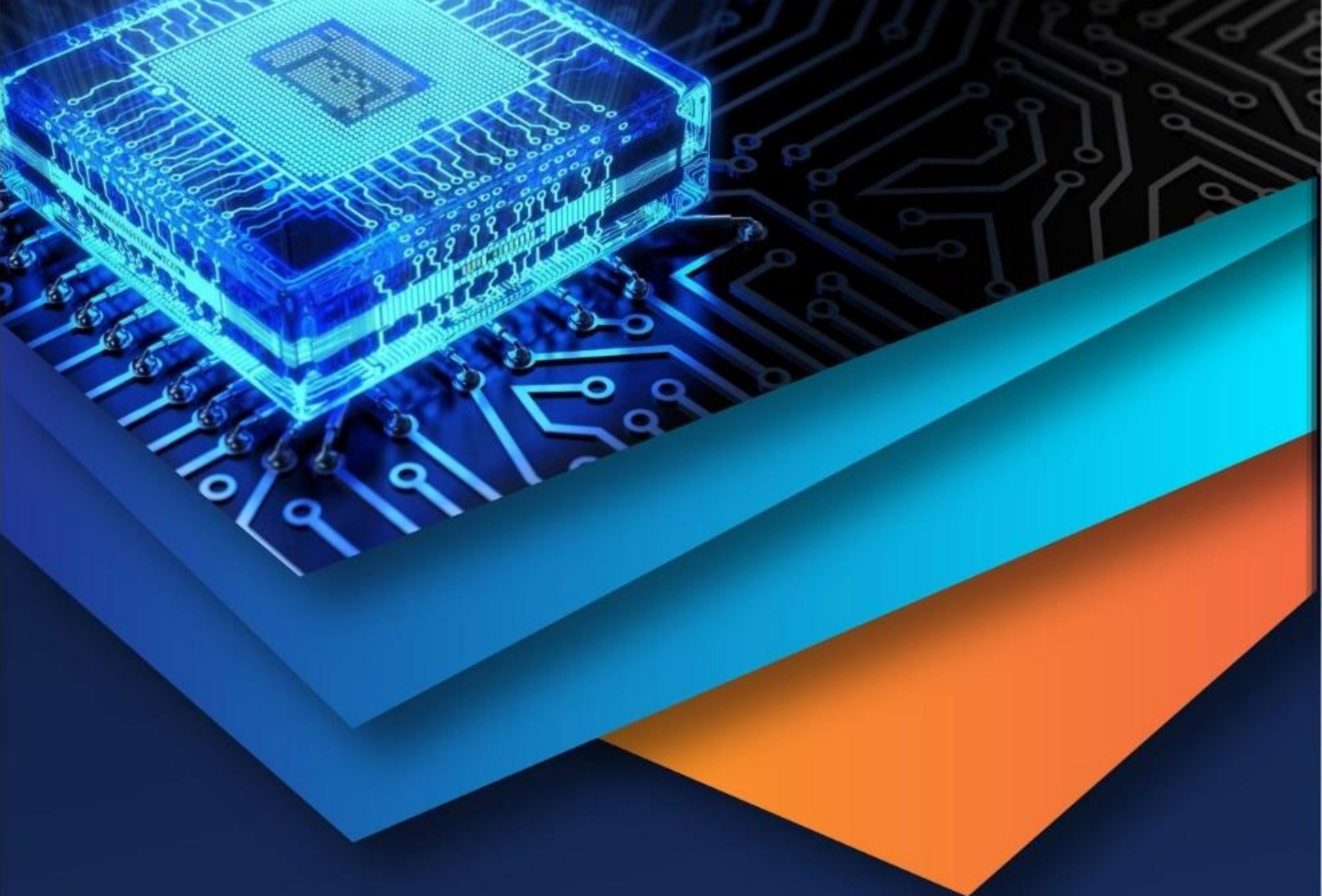

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