DETECTION OF DIABETIC RETINOPATHY USING RETINAL FUNDUS PHOTOGRAPHS BASED ON DEEP LEARNING ALGORITHM

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ABSTRACT
In this modern world, diagnosis of disease by using advanced technology plays a vital role in the medical field. Medical imaging techniques are used to detect diseases by visualizing the image. A better way to detect the disease is using Deep learning (DL) algorithm. DL is the subset of artificial intelligence (AI) which thus a subset of computerized reasoning(AI). In deep learning technique, the features are picked out by the neural network without human intervention. Diabetic retinopathy is caused by high sugar level in the blood which damages the back part of the eye called retina. Ineffectively controlled glucose is one of the danger factors to cause diabetic retinopathy. Early symptoms include floaters, blurriness, micro-aneurysms and difficulty in perceiving colours. In severe cases, blindness can occur. Due to this reason, the early detection of retinopathy is of critical importance. The retinal fundus photographs will be processed with the help of a deep learning algorithm called “Convolutional Neural Network” which helps in classifying the image by learning distinctive features of the retinal image by itself. Diabetic retinopathy can be recognized a lot quicker and more exact outcomes will be normal with the assistance of CNN calculation. Since, it is more efficient by identifying the features accurately as well as its relation with other features in an image. This paper proposes the solution for diabetic retinopathy detection in eyes using deep learning.

Keywords: Convolutional Neural Network, Fundus photographs

I. INTRODUCTION
One of the powerful senses in our body is eye vision. As lifestyle gets changed step by step, food habits for individuals additionally get adjusted. So, the people tend to choose a tastier and fast food which is deprived of nutrition and fiber. Hence the people used to suffer from diseases and therefore various organs in our human body get affected. Due to obesity, polycystic ovarian syndromes (PCO’s), smoking, alcohol, genetic problems, aging, improper diet many diseases like diabetes invaded against peoples. One of the threatening complications of diabetes is diabetic retinopathy. Diabetes is a metabolic disorder. The food molecules are broken down by stomach and digestive system into glucose or blood sugar. This glucose is the main source of energy which is then absorbed by the blood stream and is supplied to various organs in the body. The master metabolic hormone (insulin) of our body is released from the beta cells of pancreas. With the help of insulin, glucose enters into the cell and is converted to energy. When insulin in our body is not sufficient, glucose stays in the blood, as it was unable to enter into the cells without the help of insulin bind receptors on the cell membrane. Due to this blood sugar levels rises while the cells are lacking with nutrition [7]. Surplus sugar in the blood causes devastation of blood vessels along with various parts of our body.

Diabetes that effects on retina of the eyes is called diabetic retinopathy (DR). Diabetic retinopathy affects eyes by growth of abnormal blood vessels, by developing lesions and tiny haemorrhages in early stage. If not properly diagnosed it might eventually block the light entering into the retina of eye and hence lead to vision impairment. Over 90% of the new patients can be minimized with appropriate monitoring and treatment of the eyes. Ophthalmologists found that early detection and proper treatment is the best way to eliminate severe causes of diabetic retinopathy.
Clinicians sometimes find it hard to examine the eye manually and to detect the disease. This can be accomplished with the help of medical imaging techniques and artificial intelligence (AI). High quality healthcare and more detailed knowledge of the disease can be provided with the help of AI [5]. Artificial intelligence is capable of performing tasks such as decision making, solving complex problems, detection of objects etc., by using computer systems. The imaging techniques provide the visual representation of an anatomy of an eye [8]. Usually the medical photographs are taken with higher dimensions for better clinical analysis. Depending on the field of view of retinal photographs, the analyses by the doctors are distinct, time consuming and with high error rates.

AI aids in identifying the disease easier and quicker through its high level computation. With larger availability of medical datasets and development of complex algorithms, the impact of AI in the field of healthcare is increasing these days. The deep learning approach of AI is used to process the data and detect the disease by learning itself without the use of feedback from humans. One of the deep learning algorithms used for detecting the diabetic retinopathy is Convolutional Neural Network (CNN). It is a feed forward network to process and recognize image data with the grid version [3]. CNN is an organization of complex interconnected cycles, coordinated in layers. With every single layer, the CNN can spot more significant level and more conceptual highlights of the fundus photographs using filters. A clinical picture in radiology or ophthalmology or dermatology is described by neighborhood structure, which incorporates surfaces, edges, bends and corners. CNN algorithm learns by itself to extract features through various hidden layers and these models will be used to detect the diabetic retinopathy very efficiently. The CNN algorithm can be designed with the help of high-level programming language called Python. Python is an open source, object oriented, portable and interpreted programming language. It has an extensive set of libraries for processing the image. Improved healthcare with deep learning leads to earlier diagnosis of diabetic retinopathy and significantly prevent vision impairment.

II. LITERATURE REVIEW

As lifestyle of people changes rapidly, technologies nowadays become highly advanced. The procedures and practices for curing the disease also get changed. Doctors usually consult the patients and prescribe appropriate medicine for a normal disease. But in case of severe conditions, they struggle to take quick decisions without proper analysis of the internal organs. Both the 2-dimensional and 3-dimensional constructions of an organ being examined are significant to recognize what is ordinary versus strange [3]. In order to visualize internal organs of the human body, various medical imaging techniques are used. The medical imaging assists doctors in further process of treatment without any delay. Few medical diagnoses are very hard to examine by the clinicians in photographs as the view of every people is different. Hence accurate analysis and classification should be done.

Different methods have been evolved to avoid manual detection of diabetic retinopathy. Hamood Ali Hamood Al shamaly make use of MATLAB based system to detect the various symptoms associated with diabetic retinopathy. This MATLAB based system learns the fundus images pixel positioning pattern by preprocessing the fundus image and image segmentation. Though the attainment of accuracy is relatively high, there are further possibilities in improving the detection rate of the system [2]. As a result, Artificial Intelligence (AI) takes part in human life. AI aids in reducing various factors like time consumption, classification errors, problem solving and manual computations. AI is the branch of computer science which deals with the machine intelligence and maximizing chances of success and accuracy [5]. A review by Luteshna Bishnol, Shailendra Narayan Singh found that medical diagnosis would be tougher for clinicians without the help of machines that has powerful intelligence, high computational efficiency and accuracy in predicting the diseases. Kavitha et al., have stated that monitoring the patients while the doctors are away [15].

The AI system can be developed with the help of machine learning and deep learning techniques. Machine learning (ML) is a subset of AI that learns data itself with least human mediation to order classes or foresee future or unsure conditions [9]. ML tasks include regression, classification, detection, segmentation, etc. It takes in qualities of information from the preparation informational index and approves the look in attributes from the approval informational collection[10]. Since ML is information driven learning. It is categorized into non-symbolic AI and can predict from unseen data. Koushik U M S, Nithin T N R, Subhasini R had employed diabetic retinopathy detection with image processing (GUI). This GUI based system dealt with image processing and machine learning techniques. Dissimilar to the solid fundus images, mobile captured images can have restrictions associated with them like absence of clarity that may prompt misclassification [4]. Even though the system has faster processing time, it is not helpful for non-technical persons in the medical field. A system proposed by Mohamed Chetoui, Moulay A Akhloufi, Mustanha Kardouchi extract different texture features...
of diabetic retinopathy with machine learning techniques. Support Vector Machine (SVM) algorithm is used for the classification extracted histogram features [6]. The machine learning techniques produce less accuracy when large numbers of datasets were used. Vein extraction in sclera for human identification is done in [13]. Brain Tumor is detected using intelligent method of high grade moment invariant features[14].

Hence, the profound learning calculation gets a great deal of consideration these days to tackle different issues in clinical imaging fields. The deep neural networks provide higher accuracy level even with the big data.Haiquan Chen, Wenbin Ye, Xianglong Zeng, Yuan Luo utilized a novel convolutional neural network model with the Siamese-like architecture is trained with a transfer learning technique to detect diabetic retinopathy [1]. In their proposed work, a binocular fundus images is applied to the system. These binocular images are harder to train the system in-addition to that paired fundus images are not available. The International of Advanced Science and Technology journal is based on signal processing in VLSI design. The main focus of this journal is to implement the design for reduce the power, area and delay with the help of VLSI Design to analyze the signal efficiency in signal processing [11].The Journal of Medical Imaging and Health Informatics, is based on signal processing in VLSI design. The main focus of this journal is to implement the FILTER for improving SNR and the signal strength with the help of VLSI Design [12].

III. In this paper, a proposed model is designed with the help of Convolutional Neural Network (CNN) algorithm of deep learning. CNN's usually have higher prediction results than machine learning techniques because of its neural system with invisible layers between them. The fundus image datasets are used to detect the diabetic retinopathy. The CNN model is implemented using Python programming. Since Python is user friendly and easily understandable, we adopted it to design our proposed CNN model.

IV. PRINCIPLE OF OPERATION

In our paper, we use a deep learning-based CNN method for the problem of classifying Diabetic Retinopathy in fundus imagery. This is a medical imaging task with increasing diagnostic relevance. Neural network is a computer system that replicates the human brain and the nervous system. There are different types of CNN deals with the study of DNN and is used to analyze the visual image. This system is employed with a method called convolution. This convolution technique normally iterate rather than normal multiplication. The hidden layers regularly comprise of a progression of convolutional layer that convolve with an augmentation or other dot products. Therefore, it processes every pixel matrix with series of other pixel matrices.

The CNN contains an arrangement of layers namely input, max pool, convolutional, flatten, dense and output layers respectively. In the input layer the fundus images are fed to the system. These images are preprocessed to 512 x 512 dimensions. Since it has poor clarity and an improper dimension as it is difficult to train the model. From the preprocessed images, the convolution network starts to learn features from the image with the help of in-between hidden layers. The image fed to the system is 0’s and 1’s. The max-pool layers process every matrix in the image and took a highest value in the respected pixel matrix. The convolutional layer uses a gaussian filter to convolute the matrix. The results of each neuron are connected to every other neuron in neural network. Each matrix is convoluted with filter and the output of the layer is converted to single series of convolutional matrix with the help of flatten layer. The dense layer is applied to allocate memory space for the input datasets and processed images. Similarly, each image data is trained with the model. Numerous datasets are trained and the model tends to learn by itself by extracting various features. Around 2050 fundus image datasets have been used in our proposed work. These model during designing, we followed an 80 – 20 principle in testing and validation. So, the model learns to extract the features with these fundus images. This CNN algorithm is designed with Python 3.7.3 using TensorFlow 2.4.1 and Keras 2.0.8 installation. The CPU of the system 4GB RAM is used as a memory for the overall proposed work. As a result, whenever a new data is given to the system, the model pre-process the image. It compares the result of pre trained datasets with the loaded test model and produces the result as affected or normal retinal image with better accuracy in detection.
A ARCHITECTURE

![Architecture Diagram]

**Figure 1: Architecture of Diabetic Retinopathy Detection**

From figure 1 the input images are trained and classified automatically to detect diabetic retinopathy is affected the human retina or it is a normal retina which is unaffected.

B DATASETS

Datasets plays a vital role in this paper. Datasets are feeded as an input for predicting diabetic retinopathy. The retinal fundus photographs are available in eye hospitals. These images have better clarity, higher dimensions. With advancements in technology, the data gets stored over internet. Hence, people can easily access datasets in many websites like Kaggle, Roboflow, Quandl and so on. Here, we have used around 2050 images for training the CNN model. Following are the few datasets which we have used in our paper.

![Retinal Fundus Photographs]

**Figure 2: Retinal fundus photographs**

V. ALGORITHM

The main role of the Convolutional Network is to minimize the size of the fundus images to an easier. Thus, it helps for better prediction of diabetic retinopathy without dropping any features of a fundus photograph. The input photograph that we supplied to the system is a colour fundus image. It is a combination of Red, Green, Blue colour (RGB). The convolutional neural network model can be developed by importing layers in the Keras libraries. Keras and Tensorflow contain libraries that are useful for digital image processing.
The syntax “from keras.layers import layer_name” is used to import the required layers and to make it use in the algorithm. The layers used in this project are Max pooling, Convolutional, Flatten and Dense. In order to use all the four layers, sequential layer is to be initialized. These are the layers which are hidden between the input and output layers. The datasets available can be blurred, different in sizes and dimensions. Feeding this kind of datasets makes the model unreliable. Hence, pre-processing is done to avoid these factors. With the help of preprocessing, the original fundus photographs are resized to 512 x 512. The data pre-processing is mainly done to eliminate data lag. For building the model, here we are making the CNN model to learn via 32 total filters initially and then Max Pooling is applied to reduce spatial dimensions. The convolution layer uses Gaussian filtering technique. Each 2 x 2 matrix in 3 kernels are convoluted and the output of this layer is provided to max pool layer. Similarly, the max pool layer of CNN slides every 2 x 2 matrix in the past output matrix and pick the highest value in the matrix. This process continues for up to 512 filters to increase accuracy. The filters increased step by step as a power of 2 such as 32, 64, 128, 256, and 512 respectively.

The activation function of the neural network is used to find the result of the neural network as 1 or 0. Before training the CNN model, the compile method is used to configure the model’s learning process. In order to make some of the training data, we are using “keras.preprocessing.image. ImageDataGenerator class” to augment the original data. This prevent model overfitting. For training the model, the data directory must be set. Accordingly, validation directory should also be provided to the algorithm. During training of the CNN model, validation takes place. For example: whenever 80 images get trained 20 images are validated to check the performance of the model. For every epoch, 120 images are trained from the total datasets. After training, the trained images should fit to the model. The architecture of the model and trained weights are saved to the disk as .json file. The final results are binary classified as 1 for an affected data and 0 for a normal data.

VI. RESULTS AND DISCUSSION

A INPUT
The retinal fundus images given are detected accurately as affected and normal retina. The six input images are placed in test folder of a system. The following figure 10 displays the result for our diabetic retinopathy detection system for the retinal fundus image 1, fundus image 2, fundus image 3, fundus image 4, fundus image 5, fundus image 6 respectively. These results can be used for making further clinical decisions and initiating treatment procedures.

**VII. CONCLUSION AND FUTURE WORK**

In this paper, convolutional neural networks (CNN) are proposed to recognize the existence of diabetic retinopathy. In this neural network, the neurons communicate with one another in feed forward direction and backward propagation technique. Hence, CNN will produce high accuracy rate compared to all other algorithms. In addition, python is opted because it is an open source programming language. Python has numerous inbuilt...
modules for processing the image. The accuracy rate will be still higher even with big data. To handle large amount of datasets simultaneously, this system is very useful. The manual methods are replaced by the neural networks. So, investment is very economical and it yields quicker results. Also, it minimizes the time consumption in diagnosis process. Therefore, this diabetic retinopathy detection system increases the surveillance on patient’s eye. In future, this framework can be extended to employ detecting various diseases with improved high accuracy rate. This paper can also be implemented with real time fundus cameras than by using fundus photographs.

VIII. REFERENCES