RetinaScan: Dashboard for Diabetic Retinopathy Detection for Ophthalmologists in India

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***Abstract*—Diabetic Retinopathy is one of the leading causes of blindness and eye disease in the working age population of the developed world. This project is an attempt towards finding an automated way to detect this disease in its early phase.**

Keywords—Diabetes, Diabetic Retinopathy, Machine Learning, Data, Disease

I. INTRODUCTION

Diabetic Retinopathy is a condition of blindness which is caused due to long term diabetes. It is an ocular manifestation of diabetes and around 80 percent of the population having diabetes for more than 10 or more years has some stages of the disease [1]. Also, the longer a person has diabetes the higher are the chances of having Diabetic Retinopathy in their visual system. Researches shows that it contributes to around 5% of total cases of blindness [2]. India has an estimated 77 million people with diabetes, which makes it the second most affected in the world. Furthermore, one in six people (17%) in the world with diabetes is from India [3]. Detecting Diabetic Retinopathy is a time-consuming task that requires expert clinicians and can often lead to a delay in treatment due to the slow nature of the process. Without timely treatment, diabetic retinopathy can lead to various complications. In India, there are lots of areas that lack the expertise required to cope up with the rising rate of diabetes. We tried to build an application for the ophthalmologists in India, to automate the system of diagnosis using a machine learning model which is trained using existing dataset of retina images taken using fundus photography under a variety of imaging conditions, to predict the possibility and severity of diabetic retinopathy for patients with diabetes.

II. LITERATURE REVIEW

We looked at past studies to understand how the machine learning model was trained. Lam et al., used the 22 layered GoogleNet architecture to perform transfer learning [4]. Their implementation mainly focused on improving the performance by optimizing and tuning the hyperparameters. Nguyen et al., focused on using VGG-16 and VGG-19 to perform transfer learning [5]. Their implementation focused mainly on using fundus images that had varying illumination and fields of view.

We also looked at studies that researched on the risk factors that affected the DR the most. Liu et.al, found out that longer diabetes duration, higher systolic blood pressure, and higher blood sugar level were the most common factors [6]. The result from this study was used to create a filter that would get all the patients that crossed the threshold for the risk factors.

III. PROJECT DESCRIPTION

Our project comprised of two parts: training the machine learning model, and building a web application that will use this model to predict whether a retina image has diabetic retinopathy or not.

A. Dataset

The dataset was sourced from a Kaggle Competition [7]. The dataset contained 3662 labelled images belonging to 5 different classes, with each class representing the severity of the diabetic retinopathy. A label of 0 indicates No DR, label 1 indicates Mild DR, label 2 indicates Moderate DR, label 3 indicates Severe DR, and label 4 indicates Proliferative DR. The dataset contained 1805 images for label 0, 370 images for label 1, 999 images for label 2, 193 images for label 3, and 295 images for label 4. Some sample images from each class:

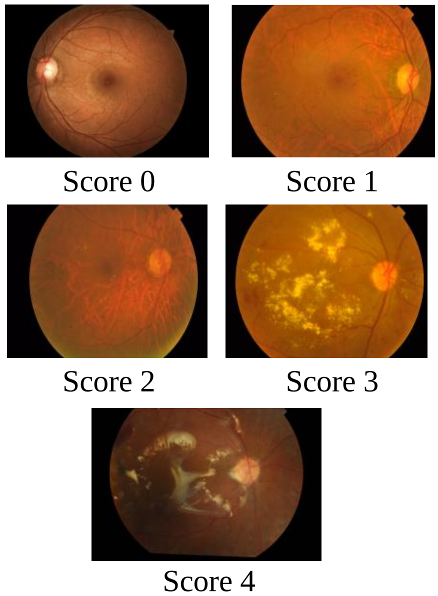

Figure 1: Sample Retina Images

The images were reduced to 224x224 for training. Image augmentation (zoom, horizontal flip, vertical flip) was applied to random images using ImageDataGenerator function from the keras.preprocessing.image class.

B. Machine Learning Model

Deep learning with Convolutional Neural Network (CNN) architectures works well in medical image classification tasks. CNN captures the spatial features from an image. These features correspond to the arrangement of pixels and help detect the relationship between them in an image. Thus, by using a CNN, we can identify the object accurately, the location of an object, and also its relation with other objects in an image.

For this project, we used the DenseNet121 CNN architecture to perform transfer learning and train our dataset. We added a GlobalAveragePooling layer, followed by a Dropout layer (with probability as 0.5), and an output layer with 5 neurons to the end of the DenseNet121 model. We were able to achieve a 95.09% accuracy on the train data and 94.36% on our validation data. After training, we saved the trained model as a '.h5' model which we will use in our application to make predictions on new images.

C. Web Application

We have built an application called RetinaScan that helps ophthalmologists to predict the risk associated with retina images in diabetic patients. The add patient feature helps the doctor to register any new patients whose eyes need to be tested. View patient feature enables to view the patient by patientId and also upload high resolution retina images. Predict button on view patient and all patients page helps to make a prediction using the machine learning model on the scale of 0 - 4. 0 indicating no DR and 4 indicating proliferative DR. All patients page displays all the historic patient details along with the predicted severity scores. We also have a dashboard screen that shows the trends of patients with varying severity scores. It also shows how with severity score 0 the risk factors like cholesterol, systolic/diastolic blood pressure can also cause damage to retina cells. Amazon s3 bucket is being used to save the retina images and the backend interacts with MongoDB atlas to save all the patient and diagnosis related information..

IV. Architecture Diagram

The architecture is a distributed system with both the frontend and backend hosted on separate Amazon EC2 instance. The frontend is written using ReactJS, HTML, and CSS, and backend uses NodeJS, ExpressJS and Python. Patient details is stored on MongoDB Atlas, and the retina images are stored on Amazon S3 bucket.

An ophthalmologist can register a patient, and upload retina scans for that particular patient, using the patientId, on the web page. Once predict is clicked, the webpage sends a request to the backend, which calls the python script and that returns the severity score back to the frontend.

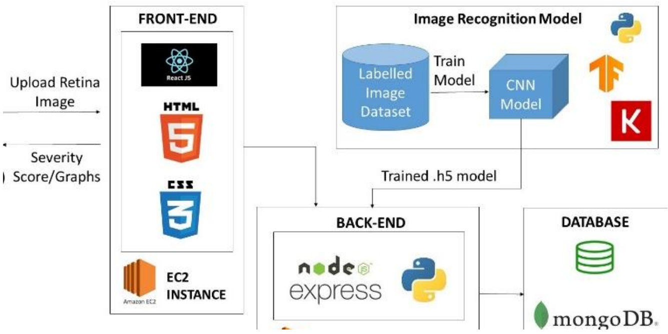

Figure 2: Architecture Diagram

V. Conclusion

We were able to achieve a relatively high prediction accuracy using our current model. Our goal was to create a dashboard that can be used by ophthalmologists in India to get help to patients as quickly as possible. We were able to demonstrate this via a minimum viable product.

In future, we can use a model trained on more images to give an even higher accuracy. We can also add more trends/graphs that would give a deeper insight to help analyze the problem better. Moreover, we can also create a mobile application that would allow us to have a larger market.

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