International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

Early Percentage of Blindness Detection in a Diabetic Person using CNN and Fuzzy Logic

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Abstract - *Diabetic retinopathy is the most common cause of vision loss among people with diabetes and a leading cause of vision loss among working-age adults .Early detection of this condition is critical for good prognosis. In this we will use convolution neural network (CNN) on color fundus images for the recognition task of diabetic retinopathy staging .Fuzzy logic will be used to give the percentage of the blindness.*

***Key Words*: Diabetic Retinopathy, Convolutional Neural Network, Fuzzy Logic.**

1. INTRODUCTION

The ophthalmology is one of the branches of the medicine, which is the combination of application of information technologies and artificial intelligence. Diabetes is a chronic condition which is associated with the high level of sugar in the affected person's blood. Human body's pancreas produce some Insulin which help to reduce the glucose level in the blood. The reduction or absence of this Insulin in the body, or inability to use this Insulin causes diabetes. Every age group of people gets affected by this disease. A variety of diseases can affect the eye and the symptoms from them can be shown in various different ways. One of these diseases is diabetic retinopathy which causes specific changes on the eye retina. It is characterized with different stages (non-proliferative and proliferative) and different anomalies in each of them which affect the blood vessels in the retina. The screening of diabetic patients enables early detection and appropriate treatment. But DR can cause blindness if not treated on time.

2. Problem statement

The condition can lead to blindness if left untreated. Early blindness due to diabetic retinopathy (DR) is usually preventable with routine checks and effective management of the underlying diabetes. Diabetic retinopathy generally starts without any noticeable change in vision. However, an ophthalmologist, or eye specialist, can detect the signs. It is crucial for people with diabetes to have an eye examination at least once or twice annually, or when recommended by a physician. Non-proliferative diabetic retinopathy (NPDR): This is the milder form of diabetic retinopathy and is usually symptomless. Proliferative diabetic retinopathy (PDR): PDR is the most advanced stage of diabetic retinopathy and refers to the formation of new, abnormal blood vessels in the retina. In this we will use convolutional neural network (CNN) on color fundus images for the recognition task of diabetic retinopathy staging .Fuzzy logic will be used to give the percentage of the blindness The project's objective is to build an web application which will detect early blindness at initial stage during diabetes.

3. Analysis

Our study is based on convolutional neural networks and various retinal images.

3.1 Objectives

1. The project's objective is to build an web application which will detect early blindness at initial stage during diabetes.
2. Eyes will be scanned and help to predict and discover the blindness.
3. Accurate percentage of blindness will be shown.
4. It is easy to handle.
5. The application will give results quite early

3.2 Scope

1. The application will be based on python.
2. The concept of CNN is used.
3. Target audience is limited to people who are detected with diabetes.

3.3 Challenges

1. The dataset must contain large number of retinal images so that the system can be trained.
2. The system should be able to handle large dataset.

4. Design

Flowchart

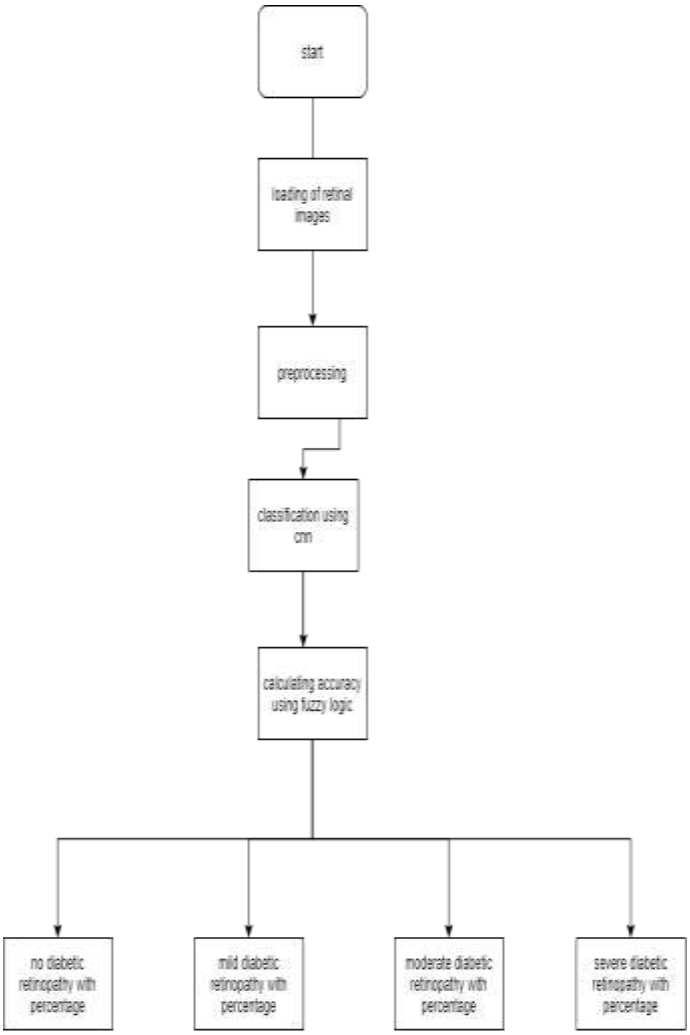

Fig.1. Flowchart

4. Algorithm

4.1 CNN

A CNN uses filters on the raw pixel of an image to learn details pattern compare to global pattern with a traditional neural net. To construct a CNN, we will define:

1. A convolutional layer will Apply n number of filters to the feature map. After the convolution, you need to use a reLU activation function to add non-linearity to the network.
2. Pooling layer will reduce the dimensionality of the feature map to prevent overfitting and improve the computation speed. Max pooling is the conventional technique, which divides the feature maps into subregions (usually with a 2x2 size) and keeps only the maximum values.
3. Fully connected layer takes all neurons from the previous layers are connected to the next layers. The CNN will classify the label according to the features from the convolutional layers and reduced with the pooling layer.

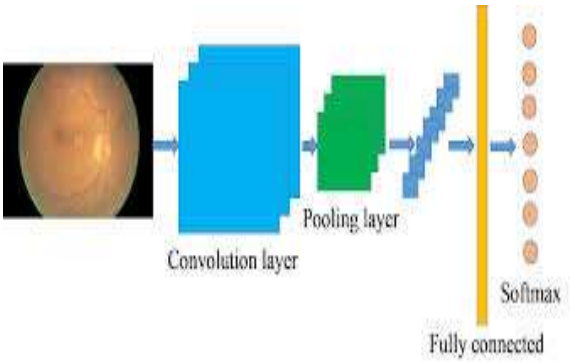

Fig. 2.Cnn Layers

4.2. Diabetic Retinopathy Prediction

4.2.1. Data Preprocessing

The images were captured using different variants of fundus cameras, each having their unique recording method, due to which the exposure and lighting varied. In addition, images were also too large to be trained with CNN directly. The following pre-processing steps were followed:

1. Cropping the image – The images will be cropped by distinguishing the foreground from background.
2. Resizing the image – The images will be resized to 256x256.
3. Normalizing the channels – ZMUV (Zero Mean Unit Variance) was performed on each channel.

4.2.2. Network Training

Deep learning is the process of training a neural network to perform a given task. The deep learning algorithm (CNN) computes DR severity by analyzing the pixel intensities over each channel separately.

1. Input - holds the raw pixel values of the image. Here, an image having the width of 448, height of 448, and three color channels R, G, B (depth = 3).
2. Convolution – computes a dot product between the filter weights and a small region they are connected to in the input volume.
3. Max pool – performs a down sampling operation along the width and height. A max pool of 3x3 will obtain the maximum of the local region of size 3x3.

4. Dropout – used to prevent overfitting. Nodes were randomly dropped with a probability, p= 0.5.
5. Fully connected – each neuron in this layer will be connected to all the inputs from the previous layer.
6. Feature pool – It is an activation function which is the max of the inputs. In our case, we use a pool size of 2.

4.2.3. Fuzzy Logic

The proposed algorithm consists of following six steps. INPUT- Fuzzy set of no, mild, moderate and severe DR are taken as input. OUTPUT- Fuzzy set DM

Step 1: Input crisp values of the diabetic retinopathy.
Step 2: Set the triangular membership function for the fuzzy number.
Step 3: Build the fuzzy numbers.
Step 4: Execute Fuzzy inference method.
Step 4.1: Input the rules and calculate the matching degree of rule with 'OR' fuzzy disjunction for fuzzy input set Step 4.2: Calculate the aggregation of the fired rules for fuzzy output set DM.
Step 5: De-fuzzify into the crisp values.
Step 6: Present the knowledge in the form of human nature language.
Our model was train and converged to an accuracy of about 80%. We took around 35000 images to completely train the model.

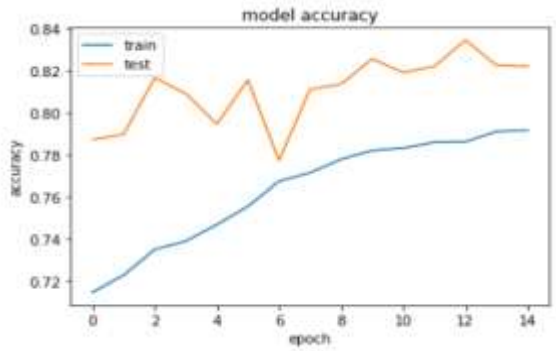

Fig. 3. Model Accuracy

This is how the web application looks like.

Fig. 4.1. Upload image page

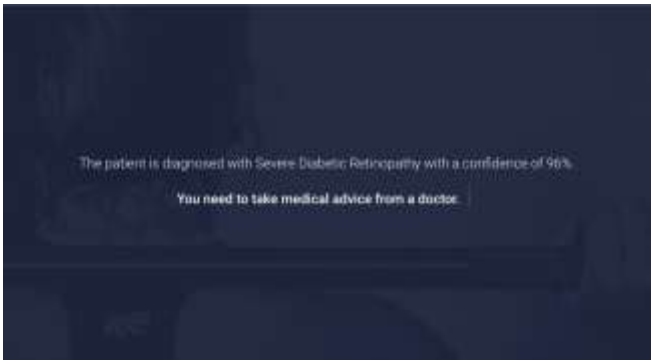

Fig. 4.2. Output Page

5. Conclusion

This study helps in the detection of diabetic retinopathy at an early stage more accurately with the help of fuzzy logic we come to know the exact percentage. Also using advanced architectures like inception v3 will boost up the accuracy and help predicting with minimized True negatives. This work will be useful for technical persons and researchers who need to use this ongoing research in this area.

This can be used in hospitals, labs in future

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