Prediction of Ophthalmic Disease Using Image Processing and Machine Learning

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***Abstract*:**

Many researches have been done to improve ophthalmic disease screening and diagnosis using advanced image and data analysis techniques. However, the developed systems are not widely used because they are usually offline and separated from medical devices. Here, we introduce a platform that connects medical devices, ophthalmologists, and intelligent ophthalmic disease analysis systems through a cloud-based system. The retinal fundus images and patients' personal data can be uploaded to the system and automatic analysis and assessment will be performed using advanced pattern classification algorithms such as CNN and SVM. Further, the analysis report will be made available so that patients can access their own report through mobile applications or web portal.

Keywords

Age-related Macular Degeneration (AMD), Computer Aided Diagnosis (CAD), Diabetic Retinopathy (DR), Pathological myopia (PM).

I. INTRODUCTION

The most important sense which greatly impact on individual's quality of life is vision. From the survey we came to know that many of the major causes of vision impairment and blindness worldwide are absolute and hard be cured [1].we introduce a platform that does Automatic screening and monitoring of ophthalmic disease which provide enables easy and accurate detection of eye disease[8]. The system detects the disease by performing various image processing steps on an eye image and all this process is performed without any human (expert's) interference [2]. From the ratio of global population we found many of these diseases have been diagnosed in old age people. For example, Age-Related Macular Degeneration (AMD), Glaucoma, pathological myopia (PM) and diabetic retinopathy (DR) are the main causes for vision impairment [16]. Currently, ophthalmic diseases are detected only when a person experiences symptoms such as pain or blurred vision [12]. Until late stage, people suffering from these diseases don't come across any symptoms. Therefore, early detection and timely intervention is the only way to prevent visual impairment or blindness [9].

1.1 Image Processing:

The input fed to our system is in the form of fundus image, further the fundus image goes through steps like feature extraction, image segmentation, etc that are involved in image processing. Through these steps we are getting in detail information of each pixel of the image which later helps in disease prediction.

Studies have been done to enhance ophthalmic disease screening and detection using advanced image and data analysis techniques [8]. The existing systems are usually offline and separated from medical devices so they are not widely used. In this project, we introduce a platform that connects medical devices, patients, ophthalmologists, and intelligent ophthalmic disease analysis system. The fundus image of retina and patient's personal data can be uploaded to the web portal. The image and data will be processed and automatic analysis and assessment will be performed using advanced pattern classification algorithms. On the basis of predication report will be generated and will be available on the web portal so that the patient can easily access it anywhere.

2. Existing System:

To the date researchers have proposed many computer aided detection (CAD) system that are listed below for detection of multiple diseases with individual systems.

1. Automated Micro aneurysm Detection Using Local Contrast Normalization and Local Vessel Detection
2. Automatic Detection of Pathological Myopia using Variational Level Set
3. Early Age-Related Macular Degeneration Detection by Focal Biologically Inspired Feature:
4. Level-Set Based Automatic Cup-To-Disc Ratio Determination Using Retinal Fundus Images in Argali
5. Model-based Optic Nerve Head Segmentation on Retinal Fundus Images:

3. Proposed System:

The proposed System is able to detect and handle multiple diseases using multiple informatics domain via algorithms like CNN and SVM. Here the patient will access the system by giving login credentials and will provide personal details with retinal fundus image as input. The uploaded image will be processed and feature will be extracted through CNN and prediction of the disease on the uploaded image will be done via SVM. After prediction a report will be generated on the basis of that report a proper medication will be provided to the patient. After early detection of disease certain home remedies will be suggested.

3.1 Proposed System flow:

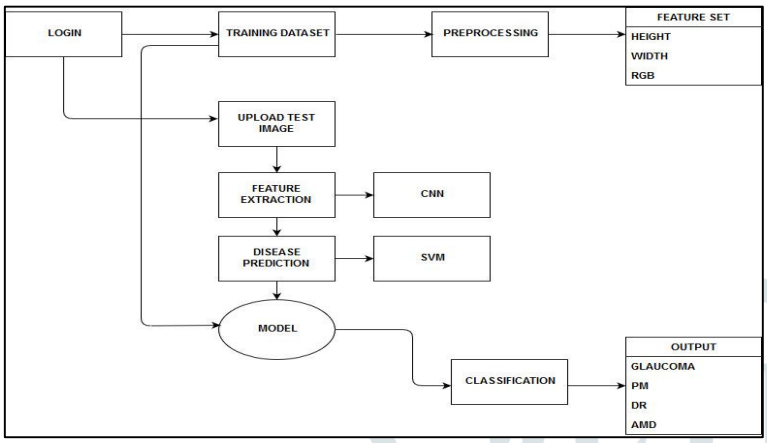


Fig. System flow

Following are the proposed system steps:

A. User will login in and preprocessing will be done on training data and define a feature set such as height, width, RGB.
B. Testing image will be uploaded and processed using cnn algorithm and feature will be extracted.
C. The extracted image will be classified using svm algorithm.
D. Model will be built which will compare test image with training dataset and prediction will be done.

3.2 Scope:

System will predict four ophthalmic diseases such as Age-related Macular Degeneration(AMD),Diabetic Retinopathy(DR), Glaucoma, Pathological Myopia(PM). Proper information regarding the diseases would be provided such as its symptoms, causes etc. Report will be generated in which local medications will be provided and user can download the report.

3.3 System Architecture:

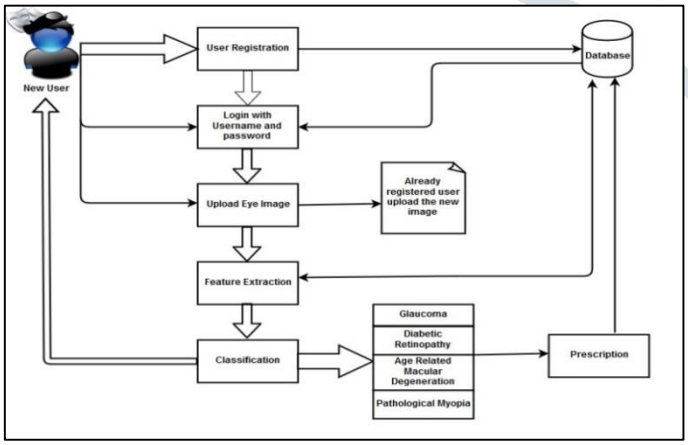


Fig. System architecture

Above fig shows system architecture. User enters personal credential's for login into web portal. After that user provides personal details, medical history (if any), and upload the eye image as input. The system accepts the input image and performs feature extraction. Then the disease diagnosis is being performed and prediction of disease is done. In-addition, report will be generated and medication will be included in it.

4. Methods and Material:

We are using two algorithms CNN and SVM one for extracting the features of given input image and other for prediction of disease.

4.1 Algorithm used

A. Convolution neural network(CNN)

Convolution neural network is one of the main category for image classification. It takes an input image, process it and classify it under certain categories.

There are three main layers in CNN:

1. Convolution Layer
2. Pooling layer
3. Fully-Connected layer

1. Convolution Layer:

This is the first layer that extract feature from input image. Convolution is a process where the network tries to label the input signal. It takes two inputs such as image matrix and a filter. The layer computes the output by performing the dot product between the filter and image patch. layer holds the raw input of image with width 32, height 32 and depth 3.

- Image matrix dimension(h*w*d)
- A filter Matrix dimension(f_h*f_w*d)
- Output dimension(h-f_h+1)*(w-f_w_1)*1

1A. Activation Function:

Here we are using ReLu activation function. ReLU stands for Rectified Linear Unit for a non-linear operation. ReLu is important because it introduce non-linearity in our system. The output is

$$f(x) = max(0,x) \quad (1)$$

2. Pooling Layer:

The main function of this layer is to reduce the number of parameters when the image is too large and makes the computation faster and also prevent the overfitting. Two common types of pooling layers are max pooling and average pooling. If we use a max pool with 2 x 2 filters and stride 2, the resultant volume will be of dimension 16x16x12.

3. Fully-Connected Layer:

This layer is regular neural network layer which takes input from the previous layer and computes the class scores and outputs the 1-D array of size equal to the number of classes. we flattened our matrix into vector and feed it into a fully connected layer like neural network. Finally, we have an activation function such as softmax or sigmoid to classify the outputs. Softmax function is use to classify an object with probabilistic values between 0 and 1.

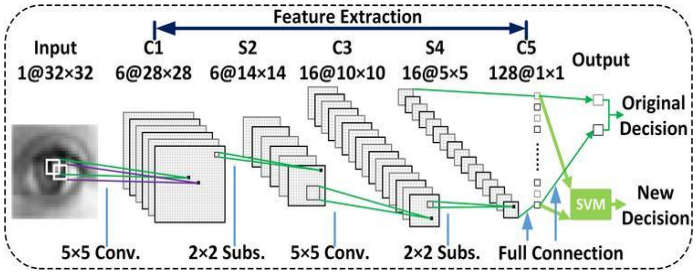


Fig. Convolutional neural network

B. Support Vector Machine (SVM):

SVM is a supervised machine learning algorithm which is used for classification in the system. In this step we compare the training and the test set image with each other in order to get a prediction. In this we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate.

5. Result:

The outcome of our system is that it gives the prediction of the disease of the eye image that is given as input to the system. The time to calculate the exact prediction is negligible. The system is trained by dataset of images for all the disease that are to be predicted, viz. glaucoma, diabetic retinopathy, pathological myopia and age-related macular degeneration. After training the system by these images, the test image (input eye image) is given input and then the system will give an accurate diagnosis.

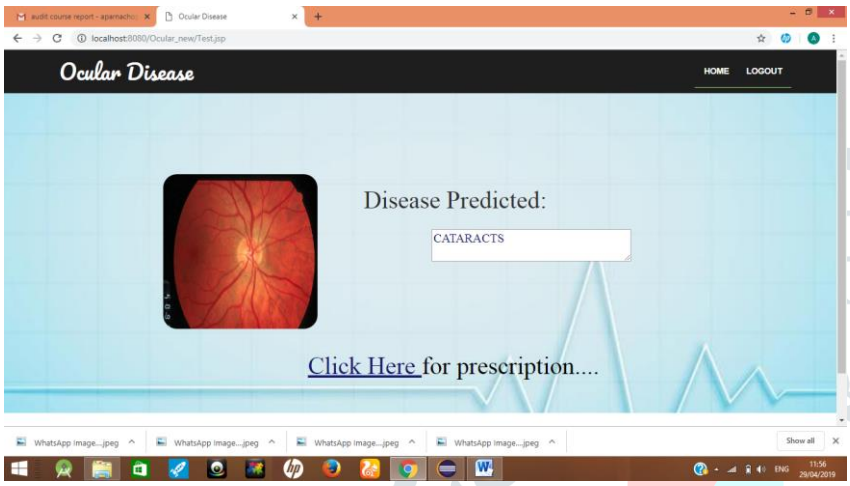
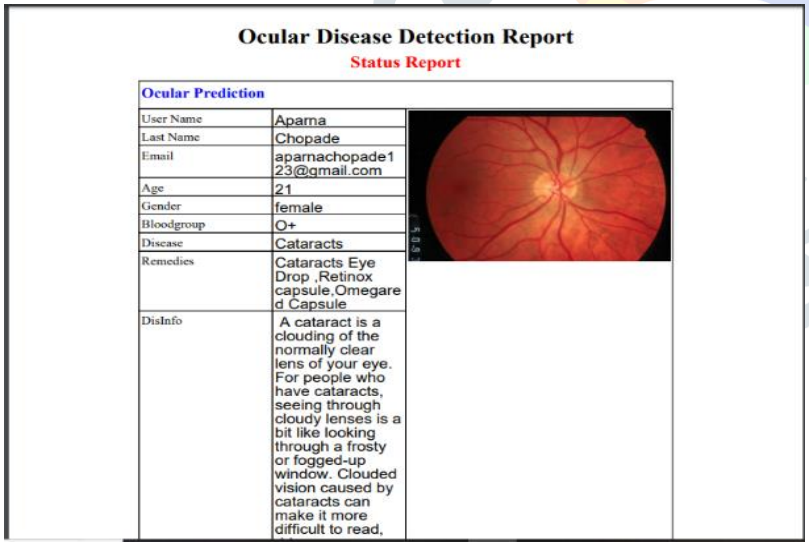


Fig. Disease prediction



Ocular Disease Detection Report

Status Report

Ocular Prediction

User Name	Aparna
Last Name	Chopade
Email	aparnachopade123@gmail.com
Age	21
Gender	female
Bloodgroup	O+
Disease	Cataracts
Remedies	Cataracts Eye Drop ,Retinox capsule,Omegared Capsule
DisInfo	A cataract is a clouding of the normally clear lens of your eye. For people who have cataracts, seeing through cloudy lenses is a bit like looking through a frosty or fogged-up window. Clouded vision caused by cataracts can make it more difficult to read,

Fig. Report generation

6. Applications:

- The proposed system is very beneficial especially for the areas where there is lack of ophthalmologists, as the system will predict the disease that a patient is affected with. This saves the time of both the patient (user) and the ophthalmologist.
- The system also provides basic medicinal suggestion to the patient according to the disease (s)he is affected with.

7. Future scope:

To link patients, ophthalmologists and intelligent ophthalmic disease analysis system through a cloud based system so that we can access the system and the data anywhere and we can get immediate help online as well as offline through a quick prediction of result.

8. Conclusion:

An automatic screening mechanism for ophthalmic disease is done, where the images of eye are trained in the system initially so that to diagnosis the disease. The system is trained in a way to predict the diseases after extracting the features from an image. Thus, in negligible time and more accurately our system can predict the disease easily and efficiently. The proposed system is very beneficial especially for the areas where there is lack of ophthalmologists, as the system will predict the disease that a patient is affected with. This saves the time of both the patient (user) and the ophthalmologist. The system also provides basic medicinal suggestion to the patient according to the disease (s)he is affected with.

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