A NOVEL EYE CATARACT DIAGNOSIS AND CLASSIFICATION USING DEEP NEURAL NETWORK

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Abstract -

Eye Cataract is one of the main causes of blindness. It affects mostly people at the age of 60. In India, half of the aged people have cataract or have already treated by a surgery. The cataract identification is highly complicated in an early stage. To achieve this, experts chose the concepts of Deep Learning. In this paper, we proposed Dense-Net and U-Net to detect and classify the eye cataract. Further, we took 200 samples of eye image to determine the presence of cataract with its severity. Finally, the comparison of Dense-Net and U-Net are tabulated in terms of accuracy, sensitivity, and specificity. Hence, it proven that U-Net gives 10% accurate results than Dense Net.

Keywords: Eye Cataract, Deep Learning, Dense-Net and U-Net

1. INTRODUCTION

Eye Cataract is the main reason of blindness. It affects mostly people at the age of 60. In India, half of the aged people have cataract or have already treated by a surgery. According to the survey, in India WHO/NPCI report said that over 12 million people are affected from blindness due to eye cataract. Generally, eye cataracts are classified into three variations: i) nuclear cataract, ii) cortical cataract, and posterior subcapsular cataract. Clinically, the grading of cataracts is performed by comparing the input with real-time cataract and identifying using different cataract severities. It is convenient and cost-effective image acquisition and cataract severity evaluation is urgently needed. Cataract detection and grading based on retinal fundus image will facilitate diagnosis and avoid delayed treatment for patients in less developed regions. The most of proposed methods takes more storage during the network training and implementations. The images are collected from the open sources to verify the proposed method. There are four different retinal image grades: non-cataract, mild, moderate, and severe cataract. Normal image without cataract, the blood vessels and optic disc can be seen very clearly. In mild cataract fundus image, only main vessels and optic disk are visible while choroid and capillary vessels are only faintly visible; As for the image of moderate cataract, only large blood vessels around optic disc are visible; There is hardly any retinal structures can be seen in the severe cataract ones; Ophthalmologists define non-cataract as grade 0 and cataract cases as grades 1 to 3 according to severity of blurriness. It can be detected by comprehensive eye 16 exams like Visual Acuity Tests, Dilated Eye Exam and Tonometry. These tests can prove to be expensive and inaccessible in rural areas which detection using Image Processing techniques cost-effective and efficient. Some other researchers work on classification and diagnosis of specific cataract automatically based on lens image, including nuclear cataract, cortical cataract and posterior sub-capsular cataract. The objective of this paper is to find out a solution using deep neural network U-Net and Dense-Net. Then the dataset are collected through open access to diagnose eye cataract and the proposed method is compared with existing method to analysis the performance.

2. RELATED WORKS

Based on the literature review, we observed that most of the methods are not efficient in boundary marking and not produce high accuracy during diagnosis. The dataset is large in size and takes up much of the memory. The slit-images are difficult to process.

Xi Xu, Linglin Jianqiang Li, et.al, proposes the CNN algorithm to learn the features from input data. and Deconvolution Network (DN) to investigate the characteristics of cataract by each layer. Shenming Hu, et.al, proposes the algorithm for automatic detection of cataract severity in terms of photometric appearance of the crystalline lens of the eyes. This work suggests by the combination of Deep Neural Network, ShuffleNet, and SVM classifier to identify the cataract severity. Xingzhi Qian, et.al. suggest the SqueezeNet model to classify and detect eye cataracts from nuclear cataracts and transparent lens. Also, it implements several techniques like...
cropping and data generation using Image data generator. It classified various cataracts in the accuracy range of 96%. Riyanto Sigit, et.al. proposes the grayscale approach with median filter and canny method used for pre-processing the images. Second, the Hough circular method used for automatic pupil segmentation from cataract images. After the segmentation they use pixel scanning to extract mean intensity and uniformity from the pupil image. After the feature extraction process, classification is done by single perceptron based on the extracted feature.

3. MATERIALS AND METHODS

3.1 Datasets:
The existing samples are downloaded from the open access dataset.

![Fig. 1 Sample image of Datasets](image)

3.2 Methods:
The major contribution of proposed work is to implement the densely connected CNN for semantic segmentation. It highly utilizes of features extraction and enhances the segmentation results also with low level of training samples.

Further, we proposed U-Net and Dense-Net to evaluate the eye cataract diagnosis and compared with traditional CNN. In U-Net, many additional layers are located in between the each pair of convolutional layers with same output size. For both Dense-net and U-Net, each layer consists of feature-maps with its preceding layers as input data.

4. PROPOSED WORK

Dense – Net:
Dense – Net is a conventional feed-forward neural network. After applying composite operations it connects the output layer to the next layer. In Dense – Net each layer add into the existing layer with 32 feature maps. Whereas, these layers are gain from 64 to 256 feature maps after 6 layers. In addition, transition block performs 1x1 convolutions with 128 filters which followed by 2x2 pooling with a stride of 2, it results by dividing the size of the volume and the number of feature maps on half as shown in Fig. 2.

![Fig. 2 Dense Net Architecture](image)

U – Net:
U-Net is an efficient method than conventional approach, in terms of architecture and pixel-based image segmentation. It is an effective method with limited datasets. This network consists of both contracting and expansive path. The contracting path involves in repeated application of convolutional layers, then each layers followed by ReLU and max pooling operation. The spatial information are reduced due to contraction and information of feature may increased. In expansive pathway, there is a combination of both feature and spatial information via sequence of up-convolutions with high resolution from the contracting path.
Fig. 3 U-Net Architecture

Block Diagram:

Input Image → Pre-Processing → Top Hat & Bottom Hat Filter → Hough Transform for Segmentation → Classification → Normal, Mild, Severe

Fig. 4 Proposed Block Diagram
Our proposed undergoes into three folds: i). Pre – Processing, ii). Applying filters, iii). Classification.

Step: 1 Insert the input image in the Matlab Software.
Step: 2 Pre-Processing has done using given input image.
Step: 3 Then apply the top hat and bottom hat filter in the processed images
Step: 4 Hough transform has been used to segment the eye image.
Step: 5 Finally, the classification done through U – Net and Dense Net to indentify the eye cataract as normal, mild, and severe.

5. RESULTS AND DISCUSSION

In our proposed work, we use Dense-Net and U-Net for cataract classification. The experimental analysis of feature extraction achieves better results than single layer feature extarction. The propagation strategies prevent over fitting. Dense-Net and U- Net has been proposed to detect and classify the eye cataract as normal, mild and severe. The proposed method identifies the mild cases also which helps to identify cataract at the starting stages. No need skillful person to diagnosis and classify the cataract and various information like contrast, correlation, energy and homogeneity is also calculated, which is helpful for the ophthalmologists to treat cataract. Thus the proposed method is easy to handle and classification is done accurately as shown in Fig. 5

| Algorithm | Accuracy | Sensitivity | Specificity |
|-----------|----------|-------------|-------------|
| Dense Net | 89.5     | 75          | 82          |
| U Net     | 93.5     | 80          | 86          |

Table. 1 Performance Analysis of Dense Net and U Net
Fig. 5 (a). Mild Cataract, (b). Medium Cataract, (c). Severe Cataract
6. CONCLUSION

Eye Cataract is a cause of blindness which affects mostly people at the age of 60. In this paper, we proposed Dense-Net and U-Net to detect and classify the eye cataract. Further, we took 200 samples of eye image to identify the stages of cataract with severity. Finally, the comparison of Dense-Net and U-Net are tabulated in terms of accuracy, sensitivity, and specificity. Hence, it is proven that U-Net gives 10% accurate results than Dense Net.

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