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# Diabetic Retinopathy Detection by Using SLO Images

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***Abstract:*** *Diabetic retinopathy is a diabetes complication that affects eyes. It is caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina). At first, diabetic retinopathy may cause no symptoms or only mild vision problems. Eventually, it can cause blindness. Scanning laser ophthalmoscopes (SLOs) can be used for early detection of diabetic retinopathy. Scanning Laser Ophthalmoscope is a device, used to view a distinct layer of the living eye at the microscopic level. This paper proposes a novel approach to automatically detect diabetic retinopathy, after detecting true retinal area from an SLO image. Detection of true retinal area from an SLO image, this brings a big challenge on how to exclude artifacts such as eyelashes and eyelids. To reduce the complexity of image processing tasks and provide a convenient primitive image pattern, I have grouped pixels into different regions, that is known as called super-pixels. The framework then calculates some textural features, based on these features it detects true retinal area and classifies diabetic or non-diabetic.*

## 1. Introduction

Eye is a very essential and critical organ of the human body which only gives vision. It is a complex organ next to human brain. There are huge eye diseases spreading nowadays due to improper care. Among those diseases Diabetic Retinopathy (DR) is severe and wide spreading diseases. It has been identified as one of the cause for blindness or vision impairment. Thus there is a much urged need to control and early detection of this disease. Early detection and management of risk factors responsible for diabetic retinopathy could postpone development of diabetic retinopathy or control its progression.

Diabetic retinopathy is a disease, caused by alternation in the retinal blood vessels. It is a strong sign of early blindness and if it is not treated may tend to complete blindness and the vision lost once cannot be restored once again. It is the number one cause of blindness in people between the ages of 20-64 in the United States. Diabetic Retinopathy is major cause for visual loss and visual impaired vision worldwide. A proper detection and treatment of this disease in needed in time. According to recent estimates, approximately 285 million people worldwide in the 20–79 year age group have diabetes in 2010 and by 2030, 438 million people of the adult population, is expected to have diabetes. And one noticeable thing is India at first position of 50.8 million people affected by diabetics by the survey taken on 2010.The likelihood of developing diabetic retinopathy is related to the duration of the disease.

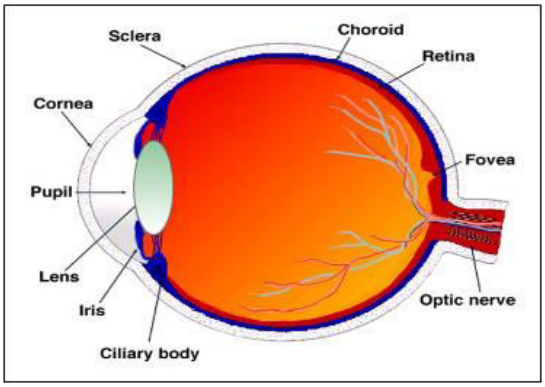


**Figure 1. Anatomy of human eye**

In this paper, retina is the most important part of the work. By examining the retina we can determine diabetic retinopathy which mainly occurs due to the vascular changes of the eye. The symptoms of diabetic retinopathy are blurred vision, seeing black spots in the center of the eye, difficulty to see at night. If it is left untreated it causes complete blindness to the patients.

This paper proposes a novel approach to automatically detect diabetic retinopathy, after detecting true retinal area from an SLO image. So the first part of this project is to detect the true retinal area from an SLO image. Diabetic retinopathy detection is an application of retinal area detection. During the imaging process, artefacts such as eyelashes and eyelids are also imaged along with the retinal area. So we need to exclude the artifacts for better diagnosis of retinal diseases. This brings a big

challenge on how to exclude these artefacts**.** Artificial Nueral Network (ANN) is used to classify true retinal area and artifacts.

Early detection and treatment of retinal eye diseases is critical to avoid preventable vision loss. Conventionally, retinal disease identification techniques are based on manual observations. Optometrists and ophthalmologists often rely on image operations such as change of contrast and zooming to interpret these images and diagnose results based on their own experience and domain knowledge. These diagnostic techniques are time consuming. Automated analysis of retinal images has the potential to reduce the time, which clinicians need to look at the images, which can expect more patients to be screened and more consistent diagnoses can be given in a time efficient manner [1].

Patients usually do not experience symptoms until late in the course of the disease when treatment may be ineffective. Late symptoms of DR vary depending on the cause. Bleeding into the vitreous can cause sudden loss of vision. Macular edema and ischemia are two other mechanisms of decreased vision. The main symptoms of Diabetic Retinopathy

- Blurred vision
- Sudden loss of vision in one eye
- Seeing rings around lights
- Dark spots or flashing lights

Diabetic retinopathy can cause vision loss in two ways:

Macular edema is a condition where the retinal blood vessels develop tiny leaks. When this occurs, blood and fluid leak from the retinal blood vessels and fatty material (called exudate) is deposited in the retina. This causes swelling of the retina and is called diabetic macular edema. When this swelling occurs in the central part of the retina, also known as the macula, then vision will be reduced or blurred.

Proliferative retinopathy refers to the changes that occur when new, abnormal blood vessels begin to grow on the surface of the retina. This abnormal growth is called neovascularization. If these abnormal blood vessels grow around the pupil, glaucoma can result from the increasing pressure within your eye. These new blood vessels have weaker walls and may break and bleed, or cause scar tissue to grow that can pull the retina away from the back of your eye. When the retina is pulled away it is called a retinal detachment and, if left untreated, it can cause severe vision loss, including blindness. Leaking blood can cloud the vitreous the clear, jelly-like substance that fills the back of the eye and block the light passing through the pupil to the retina, causing blurred and distorted images. In more advanced proliferative retinopathy, diabetic fibrous or scar tissue can form on the retina.

## 2. Methodology

To detect diabetic retinopathy by using SLO images, after detecting retinal area. Implement a system to detect diabetic retinopathy efficiently after detecting retinal area. Retinal area detection will make the system more efficient to detect retinal diseases. The framework has been divided into four stages, namely training stage, testing and evaluation stage, deployment stage and DR detection.

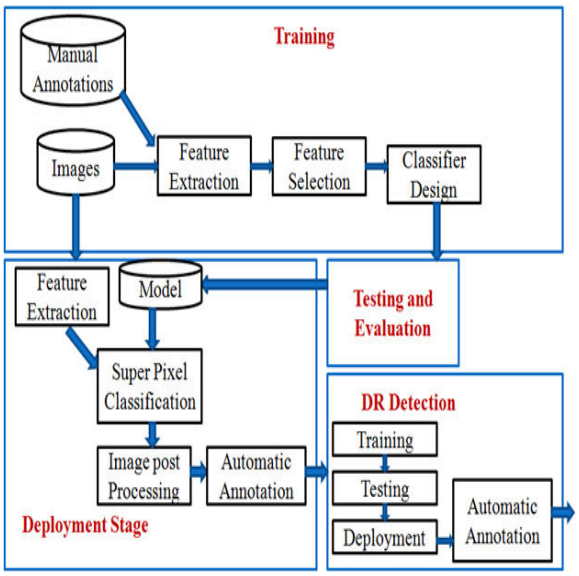


**Figure 2. Proposed System Architecture**

### 2.1. Feature extraction

Feature extraction consists of three processes, namely image pre-processing, super-pixel generation and feature generation.[1]

**2.1.1. Image preprocessing** Images are then preprocessed in order to bring the intensity values of each image into a particular range. Images were normalized by applying a Gamma ($\gamma$) adjustment to bring the mean image intensity to a target value.

**2.1.2. Super-pixel Generation** The training images after preprocessing are represented by small regions called super-pixels. The generation of the feature vector for each super-pixel makes the process computationally efficient as compared to feature vector generation for each pixel. The super-pixel algorithm groups pixels into different regions, which can be used to calculate image features while reducing the complexity of subsequent image processing tasks.

**2.1.3. Feature Generation** Generate image-based features which are used to distinguish between the retinal area and the artefacts. The image-based features reflect textural, grayscale, or regional information and they were calculated for each superpixel of the image present in the training set. In testing stage, only those features will be generated which are selected by feature selection process. After the generation of superpixels, the next step is to determine their features. There is a need to differentiate between the retinal area and artefacts using textural, grayscale gradient, and regional based features.[1]

### 2.2. Feature selection

The main purposes for feature selection are reducing execution time, determination of features most relevant to the classification and dimensionality reduction. For feature selection, I have selected sequential forward selection (SFS) approach. In the "SFS approach," the interaction among features is taken into account.

### 2.3. Classifier design

The classifier is constructed in order to determine the different classes in a test image. In our case, it is a two class problem: true retinal area and artefacts. We have applied Artificial Neural Networks (ANNs). The ANN is the classification algorithm that is inspired by human and animal brain. It is composed of many interconnected units called artificial neurons. ANN takes training samples as input and determines the model that best fits to the training samples using nonlinear regression.

### 2.4. Super-pixel classification

Based on the selected features classifier classified the given input image as true retinal area and artefacts such as eyelashes and eyelids. Classification is performed on the super pixels which representing the true retinal area and artefacts.

### 2.5. Image post processing

Image post-processing is performed by morphological filtering so as to determine the retinal area boundary using super-pixels classified by the classification model. After classification of the test image, the super-pixels are refined using morphological operation, so as to remove misclassified isolated super-pixels. The morphological closing was performed so as to remove small gaps among super-pixels. The size of disk structuring element can be a smaller value, say 10.For better results, perform area opening so as to remove one or two misclassified isolated super-pixels.

### 2.6. DR Detection

This phase is used to detect Diabetic Retinopathy by using ANN. It consists of three stages such as Training, Testing and evaluation, and Deployment. Training stage includes Feature extraction, Feature selection and Classifier design. In feature extraction, extracting features from SLO images for classification. Images are then preprocessed in order to bring the intensity values of each image into a particular range. That is known as image pre-processing. The training images after preprocessing are represented by small regions called super-pixels. The generation of the feature vector for each super-pixel makes the process computationally efficient as compared to feature vector generation for each pixel. After generate image-based features which are used to distinguish between the retinal area and the artefacts. The image-based features reflect textural, grayscale, or regional information and they were calculated for each superpixel of the image present in the training set. In testing stage, only those features will be generated which are selected by feature selection process.

In the testing and evaluation stages, the automatic annotations are performed on the "test set" of images and the classifier performance is evaluated against the manual annotations for the determination of accuracy.15 percentage of images are set as test set. Testing and evaluation is performed by system itself by using test set of images. The result of such a classifier is the superpixel representing either the "true retinal area" or the "artefacts." Image post-processing is performed by morphological filtering so as to determine the retinal area boundary using super-pixels classified by the classification model.[1]

## 3. Performance Analysis

Classification was carried out using Artificial Neural Network. In the proposed work, a binary classifier is used to divide the images as diabetic or non-diabetic. ROC and Mean Square Error are used for performance analysis. Mean Square Error is the error difference between the target output and actual output. Classification performance can be detected with the help of receiver operating characteristics (ROC). ROC can be represented by plotting false positive and true positive as shown in figure4.

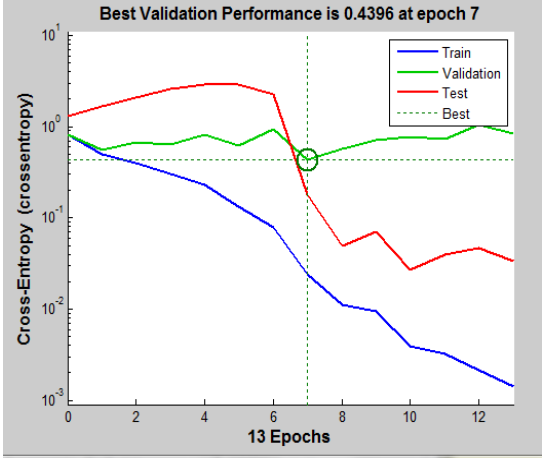


**Figure 3. Performance of the DR detection System**

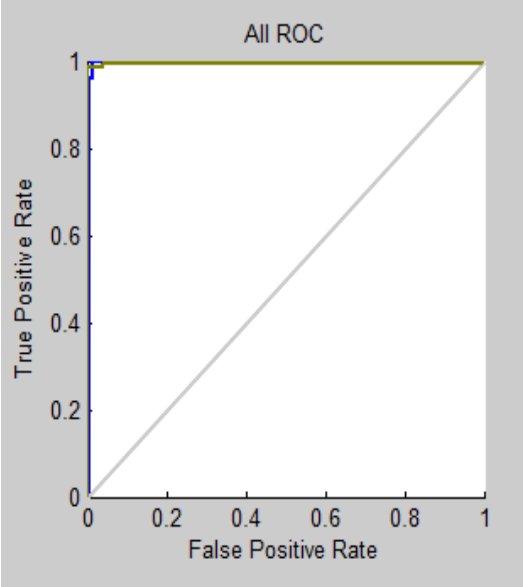


**Figure 4. ROC Representation**

True-Positive (TP): Healthy retina that is correctly detected by the classifier.
False-Positive (FP): Diabetic retina that is wrongly detected as healthy retina by the classifier.
True-Negative (TN): Diabetic retina that is correctly detected by the classifier.
False-Negative (FN): Healthy retina that is wrongly detected as diabetic retina by the classifier.

## 4. Conclusion

Distinguishing Diabetic affected retina and healthy retina area in SLO images is a challenging task, which is also the first important step toward computer-aided disease diagnosis. In this study, we have proposed a novel framework for automatic detection of Diabetic Retinopathy in SLO images. I have used superpixel to represent different irregular regions in a compact way and reduce the computing cost. Feature selection enables the most significant features to be selected and, thus, reduces computing cost too. A classifier has been built based on selected features to extract out the retina area. Feature selection is necessary so as to reduce computational time during training and classification. This Diabetic detection framework serves as the first step toward the processing of ultrawidefield SLO images.

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