Comparative Thresholding Analysis for Keratoconus Detection using Probability Density Function

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Abstract: Generally the keratoconus indicates the condition in which the human eye's cornea region unable to hold its round shapes. In cornea, the intensity points around the boundary have drawbacks in predicting the irregular shape. The proposed method uses the techniques of intensity wise classification, edge detection method using the Sobel detector and the density based threholding. The feature vectors like test image and trained image are classified with the Probability Density Function (PDF). The keratoconus parameters to be model using the prediction model and the normal eye, the keratoconus outputs are classified using Probability Density Function. The outputs of the keratoconus are compared with the help of machine learning techniques.

Keywords: Keratoconus, Probability density function,Machine learning approach, Corneal Surface, Thresholding

1. Introduction

A cornea layer covers the outer surface of the human eye. In the human eye structures presents an outer surface for the front portion structure, with the restore cornea properties becomes an important function. It protects the human eyes inner content. An outer layer maintains the eyes shape with the action of light reflection and layer of cell proteins composition in the corneal layers. A most of the portions covers like tissues in the human body and corneal layers doesn't contains the blood vessels , which improves the vision and maintains the proper reflection of light. The corneal layers composition contains the five layers like the epithelium layers, Bowman's layer, the stroma, Descemet's membrane and endothelium. The epithelium layers is the first layers for the cell layers of the cornea , which performs the actions of absorbing oxygen from the tears and send to the remaining portions of the corneal region with free end nerves. The layer disorders may be the keratoconous condition like layers thinness, bend and cornea scaring. A mechanism like pathological for keratoconus has been investigated over a long period of time. In the recent years the factors like genetic with the conditions of environment may create the diseases like keratoconous and some other eye disorders [1]. The tissues based keratoconus detected with a recent image processing techniques. A digital image processing is one kind of the evaluation techniques like threholding, the threholding segmenting the images in an analysis process. A gray scale image threholding might create the binary images.

An analyzing of images from Ultra fast Scheimpflug camera has the individual characteristics in the process, which leads to the problematic samples in the commercial software's without the facilities of devices. Now a day's various methods applied to detect images present in the field. Unluckily original images in the fields of might be revolve out with the unfeasible frequent times and suddenly fails. So the algorithm is adapted in the independently overset with the data. The condition is highly variable from a person's to the persons. A drawbacks limited in the process creates the different registration process, characteristics for the current imaging methods. Similar types of types of harms also appear in the image diagnosis as of the Corvis camera. The ultra-fast Scheimpflug camera might be frequently presents inside the challenging images. Hence the problem mainly focuses on the erroneously detected in the outer corneal edges and the determination factors becomes the essential in acquire the characteristics parameters for the corneal deformation. The detection process involves the special attention which could exist rewarded with the rightness for the detection of corneal contour. The counter discovery for the external edge becomes essential in parameters determinations [2]. The evaluation parameter like Central Corneal Thickness (CCT) becomes the parameters practically important for diagnosing corneal diseases such as keratoconus. The patients having the disorders might be characterized with smaller CCT. A continuous development of the method with support of diagnosing keratoconus that might prevalence rise with the efforts of earlier forms of diseases is detected. A stage by stage development of corneal imaging techniques that might supports the computer aided in the field of corneal image analysis.

The detection of keratoconus diseases early stages becomes the clinical challenges, which is important to avoid complications after the refractive surgery ends [3]. Additional corneal thickness becomes independent for other morpho metric parameters for the human eye in the normal stage significantly for the year 1920, main difference for the present in the thickness of individual corneal values [4]. Sometimes the Corneal parameters measures become significant for both healing and the importance for corneal diseases such as the keratoconus, glaucoma and visual manifestations for diabetes mellitus. The corneal segmentation is the main task for

segmentation becomes separate from the other corneal region. A recognition system for the iris systems to localize and separation using the segmentation process, which improves the collection of texture information stored in the iris region. Therefore the segmentation process involves the iris and pupils study with the help of corneal boundary detection [5]. The proposed method involves the detection of boundaries using threholding method. Next section 2 follows the literature survey and the section 3 explains the proposed method for keratoconus detection and algorithm. The section 4 discusses about the result analysis and section 5 discuss about the conclusion.

2. Literature Survey

Xu Chen et al.,[6] proposed an anatomy- regularized the presentation for learning approach for segmentation action relates with the cross- modality image synthesis. The method learns the common features encoding across different modalities can be shared with latent spacing. Hence the input and synthesis present anatomical structure information. The transformation between the two images in one domain can be preserved syntheses in the other domain. Shumao Pang et al., [7] proposed a two stage frame –work refers with the Spine Parse Net to achieve automated spine with parsing characters for the volumetric MR images. The Spine Parse Net consists with a 3D graph convolutional segmentation networks (GCSN) with the 3D graph convolutional segmentation network (GCSN) for 3D coarse segmentation and the 2D residual U-Net (ResUNet) for 3D coarse segmentation refinement.

Xinghuo Ye et al., [8] proposed segmentation method using active contour models compared lengthy. The method solves the problems of local binary fitting model and Gaussian distribution increases in terms of energy increases and initiated. The methods able increases the technology of computer graphics and image processing techniques speeds up the training and professional capacity. Li Tao et al.,[9] proposed a deep learning techniques refers the MR based attenuation correction (MRAC) process for the PET/MR system model, that focus on the human brain region parts. A generative adversarial network (GAN) facilitate the focus for a blocks in the residual conditions for the setting the task. An author studied the design performance for the network for an image translation and segmentation task, which must be essential for the MRAC. Yi Lu et al.,[10] discussed about the pixel - level, the problem might regards the classification for each pixel present in an image. Currently the image segmentation problem takes the pixels from the image set. The input values and output values are category for each pixel. The pixels relate with gray values present among the same area might approximately similar values but the different areas are significantly different. The image segmentation quality might directly affect the stability and reliability for the feature extraction and object recognition techniques [11]. The common methods for image segmentation includes the processes like threholding, region-based, edge – based, clustering and graph based techniques. The threholding based method widely used to solve the image segmentation problems.

3. Proposed Methodology

A keratoconus is a type non- inflammatory material for the cornea link with the etiology, characteristics like the thinning and the type of conical deformation. General type of corneal degradation may involve the changes present in the corneal thickness and posterior corneal surface might increases the irregular myopic astigmatism. Therefore the unpredictable progressive nature for keratoconus, refractive surgery, specifically the laser in suitable keratomileusis might not be recommended [12]. The threholding process include in the presents of keratoconus pattern might chosen to 0.45 increases specifically with high sensitivity. The keratoconus detection is not easy for the binary classification task.

The keratoconus segmentation is the simplest detection method among the segmentation process. The processes easily change the pixels of an image in easier way [13]. An analyzing limitations for the anterior corneal surface features linked with the keratoconus and the recognition techniques for corneal topography system. The topography systems not able to measures the anterior corneal surface features. The threholding techniques like the Histogram shape- base methods like the peak valleys and the curvatures for smoothed histogram are analyzed. The clustering methods for gray scale level samples are clustered into the two parts such as the background and foreground (object).

An alternative modeled are mixtures of two Gaussians. Therefore entropy based methods results in the algorithm uses the entropy for the regions in the foreground and background regions. The cross entropy between the images like the binary and original images etc. An object attribute – based methods search for a measure similarity between the gray-level and binary images like the fuzzy shape similarity, edge coincidence etc. A spatial method uses the higher order probability distribution or correlation between the pixels. Similar local methods adapt the threshold value for an individual pixel with local characteristics of an image. The methods has a different T is selected for individual pixels in an image. A part of corneal sensitivity the threshold values near the tear solution or the unpleasant correlated keratoconus severity. An age demonstration for the case of keratoconus corneal hypoesthesia founded abnormality in sensory input with the abnormal selection depends early in the diseases and remains same independently of age [14]. The Figure 1 shows the proposed methodology for the keratoconus.

3.1 Database Image characteristics

Spectral Domain Optical Coherence Tomography (SDOCT) is one kind of the new spectral domain (SD) devices. The device includes a spectrometer present in the receiver side analyses. The spectrum for the

reflected lights for the retina and transforms it into the information about the depth of the structures works with the Fourier principle. The SD- OCT is defined as the Fourier domain OCT, which becomes the distances are encoded with the Fourier Transforms of the frequencies for the light reflected. The SD-OCT presents systematic structures for an SD-OCT system. An Optical Coherence Tomography (OCT) is the normally perform with the diagnostics test design for the help the doctor identify for the diseases like retinal, age factor and diabetic retinopathy. The database image contains more than 200 images.

3.2 Gray scale Image

The image threholding is the simplest and effective way of partitioning the current image into the two types namely foregrounds an back ground division. One kind of image analysis be the image segmentation techniques that separates objects from the grayscale image that converts the gray into binary image.

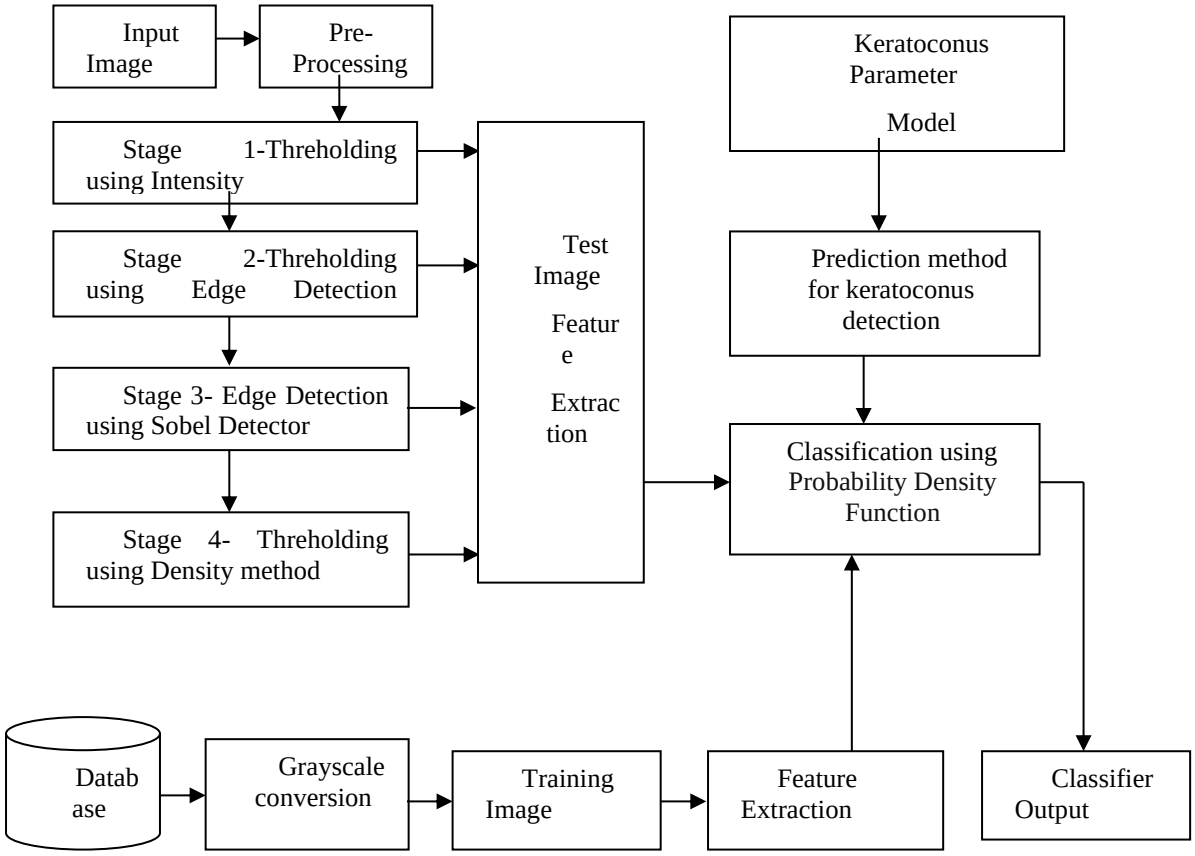


Figure 1. Keratoconus detection using Intensity threholding

3.3 Probability Density Function (PDF)

In probability hypothesis, a probability density function (pdf), or density of a continuous random variable, is a function whose esteem at some random example (or point) in the example space (the arrangement of potential qualities taken by the random variable) can be deciphered as giving a relative likelihood that the estimation of the random variable would approach that sample.[2] as such, while the total likelihood for a continuous random variable to take on a specific worth is 0 (since there are a boundless arrangement of potential qualities in any case), the estimation of the pdf at two distinct examples can be utilized to induce, in a specific draw of the random variable, the amount almost certain it is that the random variable would rise to one example contrasted with the other example.

In probability theory, contingent probability is a proportion of the probability of an occasion happening, given that another occasion (by supposition, assumption, declaration or proof) has just happened. On the off chance that the occasion of interest is An and the occasion B is known or accepted to have happened, "the restrictive probability of A given B", or "the probability of An under the condition B",", is usually written as P($A|B$), or sometimes $P_B(A)$ or P(A/B), as the probability of a conditional event.

The conditional probability might be represent as the probability of a provisional event The Goodman–Nguyen–van Fraassen conditional defined as the

$$A_B = \bigcup_{i\geq 1}\left(\bigcap_{j<i}\overline{B}_j, A_i B_i\right). \quad (1)$$

It represents like

$$P(A_B) = \frac{P(A \cap B)}{P(B)} \quad (2)$$

It indicates the Kolmogoro with the conditional probability

3.4 Feature selection algorithm

Feature selection determination is a significant advance in AI since it might fundamentally affect the precision of learning models. This is a significant assignment in clinical medication also. Distinguishing which boundaries force a higher risk of developing a specific sickness has been of high interest in medication. The algorithm as follows:

- Select the input image
- Removal of noise using pre-processing techniques
- Intensity points are calculated using the stage –I Threholding using intensity process.
- The edge points of the image are detected using the Sobel Detector
- Density based boundary methods are detected using the stage 4 process.
- The test features are selected using the intensity, edge detection density in boundary detection.
- The test features able to detect the characteristics of human eye cornea.
- Keratoconus test parameters helps to evaluate the test features.
- Finally the probability classifiers are able to detect the keratoconus stage of the input image.

4. Result Analysis

In the proposed system implemented using the Matlab software R2014a. The sample of test results was shown below. The Figure 2 shows the input image taken for the process. Then the image is pre-processed using the noise removal filter. The input image may contain the Speckle noise indicates the multiplicative noise; having a coarse model it is the intrinsic property of SAR image. This noise may remove using the wiener filter.

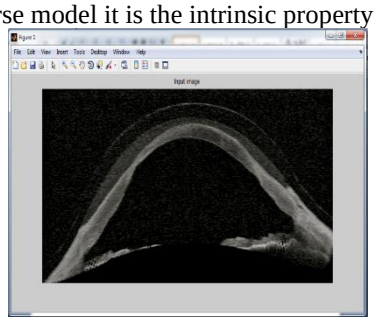


Figure 2. Input Image

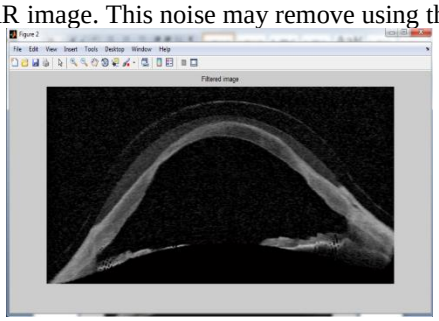


Figure 3 Filtered image

The Figure 3 shows the results of wiener filters, which reduces the speckles and the signal to noise ratio increases in preserving edges. The reduction of speckles with the filters and compared with angular compounding. The Wiener filter is the one type of filters helps in estimation to target range of liner time invariant (LTI) filter with random process. It filters the noise present in the image like stationary signal , noise , spectral and additive noise.

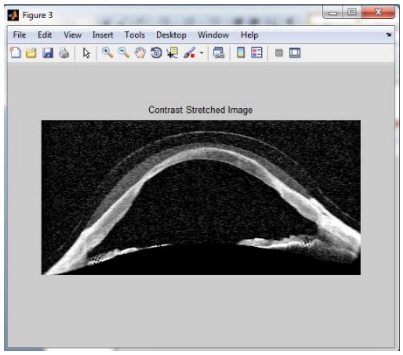


Figure 4. Contrast stretched image.

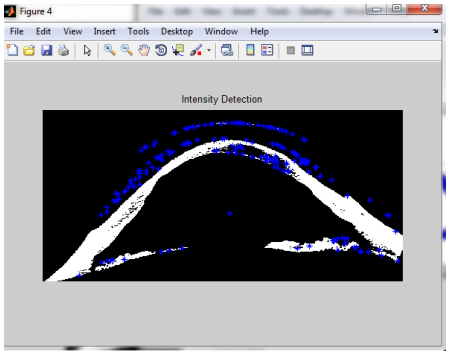


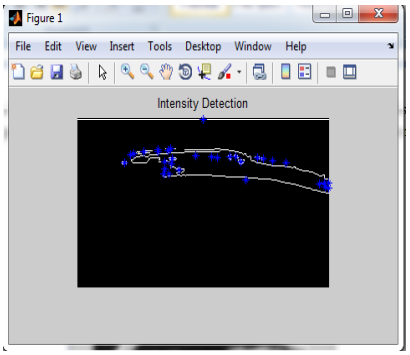
Figure 5. Intensity Detection

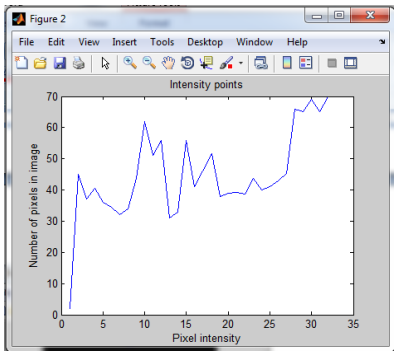
The Figure4 shows the contrast stretching indicates normalization becomes the simplest method for image enhancement. This method improves the contrast in the current image and increases the stretching values in the desired range. The Figure 5 shows the setting of picture handling and PC vision, each shape is made of pixels, and the centroids are basically the weighted normal of the relative multitude of pixels establishing the shape.

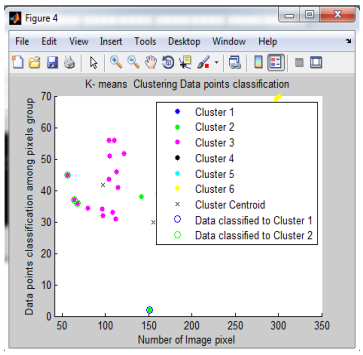
Table 1. Comparative analysis for the RNN algorithm, morpho geometrics, and hybrid supervised techniques and Intensity based thresholding

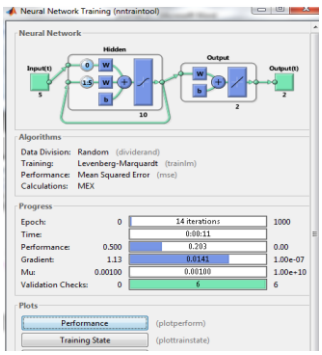
Sl.No.	Layer Thickness	List of Parameter	RNN algorithm Values	Parameters for morpho-geometric metrics	Values	Hybrid Supervising and Unsupervised Model			Intensity based threholding		
						Range	Obtained Value	Prediction	Range	Obtained Value	Prediction
1	Stroma SR	Corneal volume	0.01	Apex of the anterior surface-mm	2.236	2.5mm	2.3mm	Lesser than the normal value	~450 µm thick	301µm	Less than the range
2	Epithelium Layer EL:	Corneal Thickness	105	Apex of the posterior surface-mm	0.16	20µm	18.84 µm	Lesser than normal value	~50 µm thick	22.6µm.	Normal in the range
3	Cornea region	Thinnest corneal thickness	1	Anterior corneal surface area-mm	0.376	540-560 µm	680 µm	Greater than normal value	1.5-2.5 µm.	3.1µm.	Greater than the range
4	Tear Film TF	Corneal Area	343	Post corneal corneal thickness-mm	0.5	1.98mm	1.734 mm	Lesser than normal value	~4-10 µm thick	5.88µm.	Normal in the range
5	Bowman's layer BL	Corneal perimeter	671.53	Total corneal volume	43.9183	10 µm	9.36 µm	Lesser than normal value.	~17 µm thick	66µm.	Greater than the range
6	Accuracy	76.6.6677%		90.10%		99.52%			99.85%		
7	Sensitivity	65.71%		60.15%		98%			98.50%		
8	Specificity	0		1		98.70%			99.89%		
9	Keratoconus Detection	Yes		Yes		Yes			Yes		

One of the estimations given by locale props is 'Centroid'. Here's an illustration of naming parallel articles, registering the centroids of each item, and plotting the centroids area on top of the picture. To process the intensity weighted centroids. In this manner each named district compares to a locale in a gray scale picture and the centroids weighted by the gray scale pixel values utilizing pixel rundown and file properties. The pixels are plotted utilizing the beneath table 1.









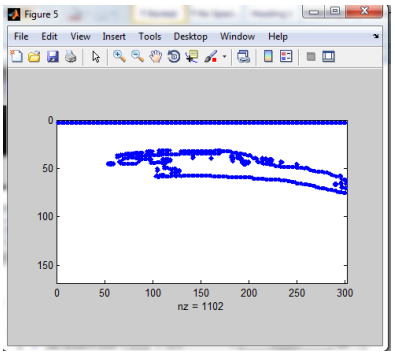


Figure 6. Sample output for keratoconous detection

The Table 1 shows the comparative result for the keratoconus detection. The parameters of the detection methods along with the accuracy are given in the table 1. The accuracy from the different method increases from 76%, then 90% , then 99.58 % and finally 99.85%.

5. Conclusion

In OCT pictures, ophthalmologist face issue in effectively identifying sickness because of the clamor. It is likewise an obstruction for programmed division of biomedical picture for determination of keratoconus diseases. The proposed framework recognizes the issues present in the corneal surface the outcome values are obtained in the lower level contrasted and the standard area. The density of the layer and intensity pixel points are obtained using k-implies various leveled clustering and the probability density function. The five layers of cornea recognized and contrasted and the standard values. The proposed calculation identifies the unpredictable states of cornea in request to distinguish keratoconus diseases. All in all, the proposed calculation has a solid potential to improve the finding of significant corneal diseases by thickness estimation of the portioned corneal microlayers interfaces. Our calculation may possibly permit the utilization of corneal microlayers tomography in clinical preliminaries to make way for its introduction to regular clinic stream. The future work upgrades to classify different diseases in cornea.

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