Automatic Detection of Eye Cataracts and Disease Classification Using Hybrid Techniques

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Abstract— Medical image analysis is the most demanding technology now days. The proposed system performs automatic cataract from the digital eye image and retinal fundus images. The proposed system has developed a new technique with a set of algorithms. Currently, methods available for cataract detection are only based on certain features, but medical images may have heterogeneous feature set; the main motive behind this work is to develop less iterative, effective multi-feature based eye image analysis and cataract detection from the color images of eye and retinal fundus images. An algorithm is proposed for Cataract Screening based on the retinal features, veins, blood vessels, and artery. These features are used to analyze and classify the eye into specific class. To achieve this set of algorithms have proposed. The proposed system performs the pre-processing step initially, and then the feature selection from the preprocessed images is then initially classified using the **Kernel Hyper Support Vector Machine** (KHSVM). The results from the KHSVM, the effective features are applied into the **modified genetic algorithm** named as **IIGA** (Iterative Intensity Genetic Algorithm); this performs a new type of gene selection from the KHSVM features. Instead of selecting the random features, the proposed system gets the features from the KHSVM result. The proposed system achieves better results than the existing works. The proposed system is implemented in Matlab tool with several eye images. The experimented result shows the proposed system achieved better detection than the existing techniques.

Keywords- *Medical Image Processing, Retinal Images, Cataract Detection, Kernel Hyper Support Vector Machine, Genetic Algorithm.*

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I. INTRODUCTION

A technology advances in the medical field gives more opportunity to develop digital image processing techniques. Due to the vast and different types of medical process, it is necessary to develop a perfect method to adopt and perform different medical analysis, diagnosis and prognosis [1]. The digital imaging made this possible to develop and deploy medical image analysis applications in the new revolutionary ways. Automatic medical image analysis [2] may assist the physician to monitor, mine and compare the treatment related decisions. This type of techniques and applications may relieve the physicians of repetitive work in the analysis part. This research develops such medical analysis technique to detect the cataract in the human eyes [3]. The proposed system performs the fundus based cataract classification using image processing techniques. The primary objective of evaluating and detection of eye diseases like cataracts and abnormalities in the human eye is to utilize image processing techniques [4] with higher accuracy. The early detection and accurate detection of eye disease [5][6] may helps to the physician for medical assistant. In medical image processing, for diagnosis of eye diseases, digital color retinal images are becoming increasingly important. Finding the retinal parts for finding cataracts and other diseases from other set of features, which are not only fall on the specific disease feature is more important. In such analysis system, medical image processing techniques are used in order to facilitate and improve diagnosis accuracy with the consideration of the other features. Manual analysis of the images can be improved and problem of detection of eye diseases like cataracts in the earlier stage is difficult. This study aims to detect the cataracts and retinal part from the features of veins, nerves etc. The automatic detection of eye retinal structures and analysis are needed during the mass screening for the detection and diagnosis of cataracts and eye abnormalities. The different retinal structures detection helps in characterizing the detected lesions and in identifying false positives. The deep monitoring using other features is essential for monitoring purpose and to classify the impact of the disease.

II. PROBLEM DEFINITION

Medical image analysis has tremendous growth nowadays; especially the eye disorders and vision oriented disease detection should be treated earlier to avoid the blindness and eye issues. In the literature, there are several approaches and techniques have discussed [7] the cataract detection. The most popular approaches are support Vector Machine (SVM) [8] and neural network (NN) [9] based approaches. These mechanisms have several drawbacks, that the approaches need more training samples and iteration for cataract detection. The existing cataract detection approaches are not suitable for large and fundus image datasets.

III. PROPOSED SYSTEM

An automatic cataract detection system from the digital eye image and retinal fundus images is proposed. The proposed system aims to achieve better results than the existing works by considering several research challenges. The contrast enhancement process is done in the proposed preprocessing stage, which are aimed at altering the images visual appearance that makes an image into a better manner. Usually eye or retinal images acquired using standard clinical protocols often exhibit low contrast and may contain photographic artifacts.

Also, it can be seen that retinal image contrast is decreased as the distance of a pixel from the centre of the image increases. In the current work this preprocessing step is applied to retinal images after the color enhancements and analysis.

A. Research Contributions:

The fast and accurate cataract and eye disease detection is the main aim of the proposed work. To achieve the highest accuracy, the proposed system has the following contributions.

- The disease classification on certain eye images are challenging due to the inadequate images, because the bad positioning and reflections and sometimes the fundus images may collected with poor quality. So, there is a need for effective preprocessing to improve the image quality and this make automatic eye disease and cataract detection accurately. This normalizes the color of the original eye images into a perfect ratio. To enhance the color, local color enhancement method is applied.
- The next step in the disease classification is the feature selection step, which involved detection of the anatomical parts of the images. For the additional improvements of the images, the low pass filters are included. The feature selection from the preprocessed images is then initially classified using the **Kernel Hyper Support Vector Machine** (KHSVM).
- The results from the KHSVM, the effective features are applied into the **modified genetic algorithm** named as **IIGA** (Iterative Intensity Genetic Algorithm); this performs a new type of gene selection from the KHSVM features. Instead of selecting the random features, the proposed system gets the features from the KHSVM result.
- Using the above techniques, the proposed system effectively detects the cataracts and eye diseases. This performs the fast data region detection and segmentation of cataract area, which are taught to deploy in real-time. This application allows the medical expert to diagnose the severity of the eye diseases and cataracts from the fundus images.

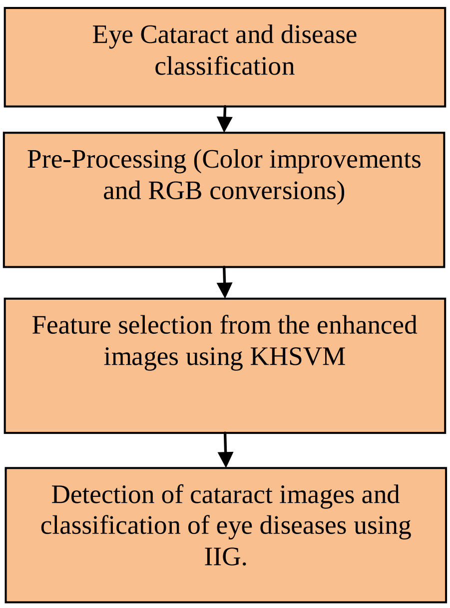

Figure 1.0 overall process of the proposed work

The fig 1.0 shows the steps involved in the proposed system. This initially performs the preprocessing schemes and image color enhancement properties.

IV. METHODOLOGY

A. Preprocessing:

The first step of the proposed system is to improve the image for the further analysis. In any retinal image database, there will be a few images with non uniform brightening and poor in the quality. Likewise there may be contrast in the shade of the fundus cataracts due to the retinal pigmentation and different among various patients. These images are preprocessed before they can be analyzed. Shading standardization is performed to lessen shading varieties in the image by normalizing the shade of the first retinal image against a reference image. With a specific end goal to amend non uniform enlightenment and to enhance differentiation of a image, differentiate constrained versatile histogram adjustment is utilized. On use of this strategy, the image quality is essentially enhanced with the expansion equally. Every fundus cataract camera has a cover of various shape and size as indicated by its settings. Via consequently identifying the fundus cataract cover a sore recognition calculation or vessel identification calculation can process just the pixels of the fundus cataracts forgetting the foundation pixels.

The contrast enhancement process is done in the proposed preprocessing stage, which are aimed at altering the images visual appearance that makes an image into a better manner. Usually eye or retinal images acquired using standard clinical protocols often exhibit low contrast and may contain photographic artifacts. Also, it can be seen that retinal image contrast is decreased as the distance of a pixel from the centre of the image increases. In the current work this preprocessing step is applied to retinal images after the color enhancements and analysis into the feature selection process.

The first step also includes the image denoising steps after the color enhancements. The isotropic Gaussian filter is used as a low-pass filter for image de-noising in the proposed system. The Gaussian functions are used here.

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{x^2+y^2}{2\sigma^2}} \tag{1}$$

where 'σ' is the standard deviation of the distribution and its value has been chosen as 0.5 in this work. At the time of denoising, the edge information will be lost usually. So this is necessary to preserve the edges. The popular approach for edge detection is usually the canny edge detection techniques, which smoothened image is then filtered with a Sobel kernel in both horizontal and vertical direction to get the first derivative (Gx) and (Gy). The pre-processed images are more important for further analysis, because the proposed system improves the accuracy of cataract detection and the diseases analysis using vein and artery information's. So, while pre-processing the edge detection and prevention should be properly done.

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B. KHSVM

The support vector machine is a well known supervised learning algorithm, which is used to classify the objects into the desired class. At the time of initial analysis and features selection, the most appropriate results. The proposed system performs an iterative way to find the cataracts and eye diseases using kernel hyper SVM techniques. The KHSVM initially classifies the image into two classes, such as normal or abnormal. This can be validated by the basic functionalities from the training samples. To improve the accuracy of the detection, the IIGA will be applied and verified. This section describes the basic functions of the SVM and the modification done on the KHSVM.

The standard SVM is a completely supervised binary classifier. The SVM classified is an extensively used in pattern recognition problems. The pattern reorganization problems such as image and, handwriting recognition, medical analysis, security like intrusion detections, audio recognition and so on. The support vector machine is treated for eye disease classification. There are three properties that usually performed in the SVM process, which makes the results more effective. The SVMs make a maximum margin separator. The separator or the hyper plane is referred as a decision boundary with the largest possible distance to example points. So, the proposed system utilizes the SVM to perform the initial classification with several performance improvements.

KHSVMs make a straight isolating hyper plane, however they can insert the information into a higher-dimensional space, utilizing the supposed piece trap. Regularly, information that are not directly divisible in the first info space are effectively distinct in the higher dimensional space. The high-dimensional linear separator is really nonlinear in the first space. This implies the hypothesis space is incredibly extended over strategies that utilization entirely direct description. KHSVMs are a non parametric technique they hold training illustrations and conceivably need to store them all. Then again, by and by they regularly wind up holding just a little part of the quantity of cases, here and there as few as a little steady time the quantity of measurements. In this manner KHSVMs consolidate the benefits of non parametric and parametric models: They have the adaptability to speak to complex capacities, yet they are impervious to over fitting. The information indicates are mapped a high dimensional feature space, where an isolating hyperplane can be found. The calculation is picked so as to expand the separation from the nearest designs, an amount which is known as the edge. KHSVMs are learning frameworks intended to consequently exchange off precision and multifaceted nature by limiting an upper bound on the speculation blunder. In an assortment of classification issues, KHSVMs have demonstrated an execution which can decrease training and testing mistakes, in this manner getting higher acknowledgment exactness. KHSVMs can be connected to high dimensional information without changing their detailing.

The proposed KHSVM reduces the hyperplane size by selecting an optimal threshold. This threshold used to verify the values of other objects to classify the images. The cataract detection and other eye abnormality detections are performed using the kernel hyper. This selects the maximum appropriated hyper kernel split up to perform the classification.

Algorithm for KHSVM:

The steps involved in the development of the eye cataract and eye classification system are presented below:

Step 1: Get the input retinal fundus image with cataract (I)

Step 2: Obtain the Green component of the image (G) from the original RGB image

Step 3: Apply image enhancement using the preprocessing steps and the adaptive histogram equalization to the green component of the image.

Step 4: perform KHSVM

1. Initiate the hyperplane
2. Detect the threshold T.
3. Use the polynomial function for the kernel $k(\mathbf{x_i}, \mathbf{x_j}) = (\mathbf{x_i} \cdot \mathbf{x_j} + 1)^d$, here the d is represented as the degree of the kernel
4. Selects the optimal hyperplan with the degree.
5. Classify I into different classes C .

Step 5: return the results

To acquire the feature set values for the KHSVM, the first step is calculating the statistical with the mean and standard deviation (Sd) are calculated and these values are used as initial features for the classification. The support vector values are calculated using these two features and plotted in hyperplane rejoin with the kernel values. The two feature sets are stored in feature list T1 , T2. the sample image features are stored in feature library (T1 , T2). Features of test images are in (Te1 , Te2). The Euclidian distance D is calculated,

$D= [(Te1-T1)^2 + (Te2-T2)^2]^{1/2}$

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An image is preprocessed, the important features are extracted in the initial step, and the extracted features are passed to KHSVM classifier. Support vector machine is primarily the method of classification task by constructing hyper plane in multi dimensional space that separates cases of different class labels, in the KHSVM, . It is compared with the points of SVM plane by calculating the highest degree value and distance as to on which side of the plane, the points are in, determines the type of class. The overall detection rate of the proposed KHSVM is 96%. To improve the detection and classification accuracy, the proposed system utilizes the next iteration to achieve this.

C. Iterative Intensity Genetic Algorithm (IIGA):

The implementation of the IIGA with the selected feature set from the previous steps will improve the detection accuracy. The proposed system finds multiple features and feature dataset for accurate detection. Due to the detection issues of eye cataracts, this is necessary to obtain an optimal method for performing more anatomical medical image classification. The proposed work concentrated on the cataract detection from the retinal fundus images with other eye disorders. This considers the veins, nerves and other anatomical features for accurate result obtaining.

The usual genetic algorithm contains three steps, selection, cross over and mutation. The modified IIGA performs the selection process from the result of previous section. Ie the feature used by the KHSVM is applied into the selection process and reduces the redundancy in the detection. The proposed system finds the veins, nerves and the cataract features simultaneously with every iteration . due to the huge process, it is necessary to develop an optimal technique to support all type of detection. The following fig 2.0 shows the process of IIGA.

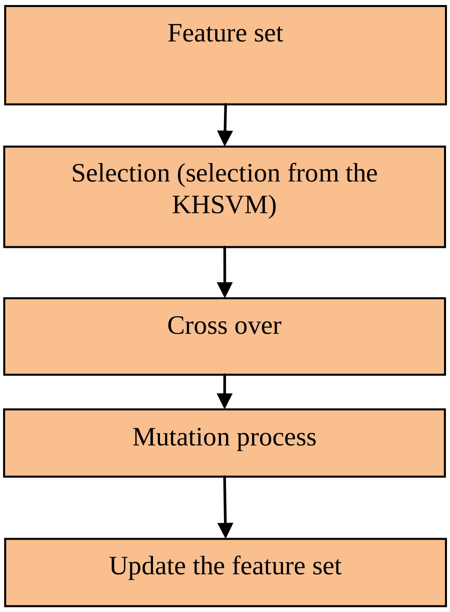

Figure 2.0 the steps of IIGA.

The members of the features set are selected for reproduction at the selection process is updated based on the fitness value calculated. A method with optimal accepts a large number of solutions, while high selectivity will allow a few or even one to dominate.

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V. IMPLEMENTATION RESULTS

To prove the effect of proposed system, the experiments used MATLAB tool. The experiments are performed on an Intel Dual Core with a RAM capacity 2GB. The algorithms are implemented in Matlab Tool are run under Windows 7. The retinal images from the synthetic database and real time data collection are used for evaluating the performance of the cataract detection method. The manually detected cataract results are compared to assess the proposed system. the comparison is made with two different algorithms such as SVM, and NN.

Table 1.0 accuracy comparison table

Techniques	Accuracy (%)
SVM	98%
NN	86.69%
KHSVM_IIGA	98.23%

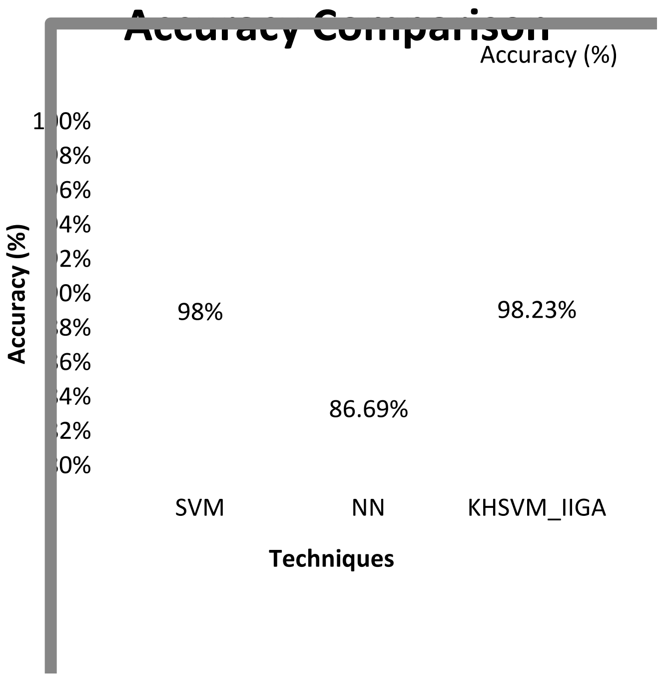

Figure 3.0 Accuracy comparison chart

The figure 3.0 shows the accuracy achieved in the existing and proposed system. The result shows the proposed system improves the existing SVM based cataract eye image classification accuracy. The least accuracy is NN based approach.

Table 2.0 Time comparison table

Techniques	Time (ms)
SVM	2300
NN	3200
KHSVM_IIGA	1980

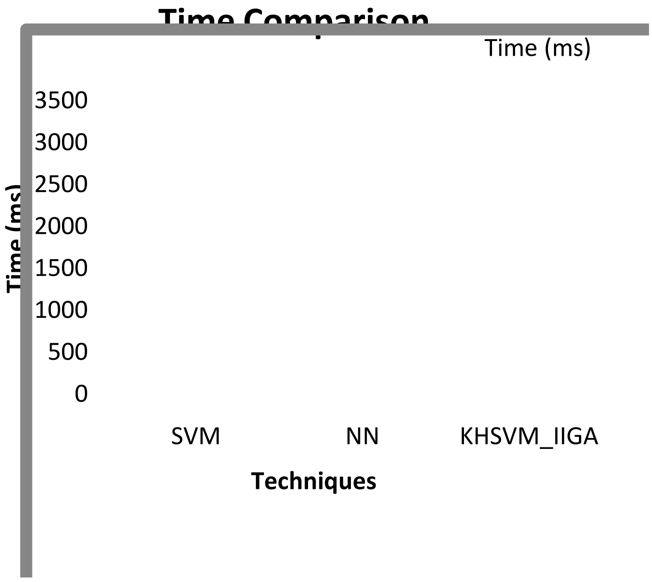

Figure 4.0 time comparison

From the experiments, the detection time is calculated and compared with the existing systems. The proposed KHSVM with the IIGA techniques allows less iteration by adapting various important features. This approach is effective in terms of accuracy and time than the existing SVM and NN based cataract detection methods.

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CONCLUSIONS

The proposed system developed a new algorithm for improving the cataract detection and other eye disease detection from the retinal fundus images. The accuracy of the proposed system is improved using the genetic algorithm. This thesis presented an analysis on various cataract detection techniques of cataract. It was observed that inclusion several features for cataract detection improved the detection accuracy. The features such as blood vessels, veins etc. With the help of digital image processing techniques and tools, the eye disease diagnosis process became easier and effective. The results experiment shows the use of KHSVM and IIGA improved the detection ratio in the retinal images with fundus features. The proposed method gave very good results with close to 98.3% accuracy.

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REFERENCES

[1]. Zhou, Xiao-Hua, Donna K. McClish, and Nancy A. Obuchowski. *Statistical methods in diagnostic medicine*. Vol. 569. John Wiley & Sons, 2009.

[2]. McAuliffe, Matthew J., Francois M. Lalonde, Delia McGarry, William Gandler, Karl Csaky, and Benes L. Trus. "Medical image processing, analysis and visualization in clinical research." In *Computer-Based Medical Systems, 2001. CBMS 2001. Proceedings. 14th IEEE Symposium on*, pp. 381-386. IEEE, 2001.

[3]. Guo, Liye, Ji-Jiang Yang, Lihui Peng, Jianqiang Li, and Qingfeng Liang. "A computer-aided healthcare system for cataract classification and grading based on fundus image analysis." *Computers in Industry* 69 (2015): 72-80.

[4]. Keerthana, S., and K. Sathiyakumari. "A Brief Study of Image Processing and Techniques." *Digital Image Processing* 9, no. 1 (2017): 11-13.

[5]. Kumar, B. N., Chauhan, R. P., & Dahiya, N. (2016, January). Detection of Glaucoma using image processing techniques: A review. In *Microelectronics, Computing and Communications (MicroCom), 2016 International Conference on* (pp. 1-6). IEEE.

[6]. Sinthanayothin, Chanjira, James F. Boyce, Tom H. Williamson, Helen L. Cook, Evelyn Mensah, Shantanu Lal, and David Usher. "Automated detection of diabetic retinopathy on digital fundus images." *Diabetic medicine* 19, no. 2 (2002): 105-112.

[7]. Kumar, B. Ramesh, and M. P. Shimna. "Recent Approaches for Automatic Cataract Detection Analysis Using Image Processing." *Journal of Network Communications and Emerging Technologies (JNCET) www. jncet. org* 7, no. 10 (2017).

[8]. Nayak, Jagadish. "Automated classification of normal, cataract and post cataract optical eye images using SVM classifier." Proceedings of the World Congress on Engineering and Computer Science. Vol. 1. 2013.

[9]. Linglin Zhang, Jianqiang Lia, He Han ." Automatic Cataract Detection And Grading Using Deep Convolutional Neural Network" cResearch Institute of Information Technology, Tsinghua University, Beijing, China.