Different Techniques for Cataract Detection

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Abstract - *Cataract is an eye disease that caused by opacity of lens. This will leads to complete loss of vision. Mostly cataracts are affected to aged peoples. In this modern era, so many techniques are used for detecting cataract. In this paper, various techniques for the diagnosis of cataract are focused.*

Key Words: Cataract, Feature extraction, Thresholding, Classification

1. INTRODUCTION

Cataracts are very general in older people.The main causes of cataracts are diabetes, optic nerve damage, and macular degeneration and it can occur in either or both eyes.

It cannot spread from one eye to the other. It is mainly affected to lens of retina. The lens is a clear part of the eye that helps to focus light, or an image, on the retina. In a normal eye, light passes through the transparent lens to the retina. Range of affected people is depicted in figure 1.

Fig -1: Range of cataract affected people

1.1 Types of Cataract

Cataracts classified based on cause:-

- Secondary cataract: Cataracts also can develop in people who have other health problems, such as diabetes.
- Traumatic cataract: It can develop after an eye injury, sometimes years later.
- Congenital cataract: Some times cataracts develop in childhood, often in both eyes. It may be so small that they do not affect vision.
- Radiation cataract: It can develop after exposure to some types of radiation.

Cataracts classified based on age:-

- Congenital and acquired

Cataracts classified based on location:-

- Cortical, nuclear, sub-capsular

Cataracts classified based on shape:-

- Dot-like, coronary, lamellar

Cataracts classified based on degree:-

- Immature, intumescent, mature, hypermature

1.2 Symptoms

The most common symptoms of a cataract are:

- Cloudy or blurry vision and poor night vision
- Glare headlights, sunlight or lamps
- Double vision or multiple images in one eye
- Frequent prescription changes in your eyeglasses

1.3 Causes

Most common causes for cataract are:

- Lifestyle, age, and diet
- Previous eye injury [1]
- Limit overexposure to sunlight
- High altitude can also contribute to cataracts
- Diabetes, obesity, or high blood pressure [2][3]
- Smoking or drinking too much alcohol[4]

Difference between normal eye and cataract eye are shown in figure 2.

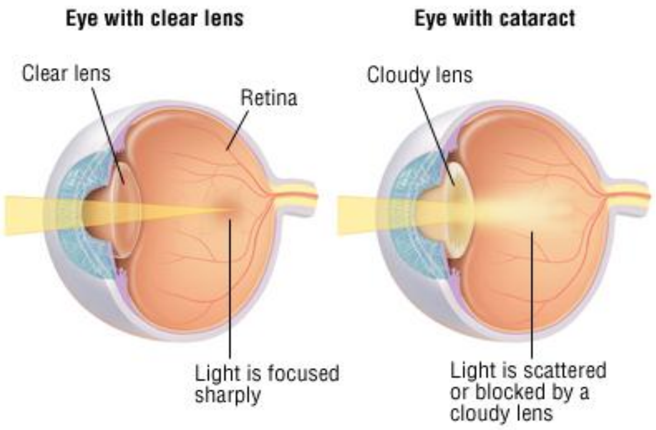

Fig -2: Normal eye and eye with cataract

Cataracts can be not easy to detect. The opacity of the lens of eye may be obvious to many people; it may not be noticeable to others.

2.CATARACT TESTS AND TREATMENTS

The existing tests and treatments for cataract detection are shown below:

2.1 CATARACT TESTS

The amount of visual deterioration, representing the asperity of the cataract, can be obtained by an eye examination which may contain the following investigations.

Refraction test: This test will finds whether glasses can help to enhance the vision.

Visual acuity test: A visual awareness eye test is identical to the routine eye test done throughout life by an ophthalmologist. Both eyes are tested individually by using a viewing device or an eye chart in order to determine the ability to see letters of gradually reduced sizes. Using this method, the doctor can understand what extent the vision has been affected by the cataract. Visual acumen is measurement of how well a person can see.

Contrast sensitivity testing: Test is similar to visual acumen testing but it shows more definitely the reduced image contrast caused by a cataract, as result of light glare and scattering caused by the cataract. The capability to distinguish between various shades of gray forms the basis of this test since this ability may be blocked in the existence of a cataract.

Color vision testing: Helps to detect obtained color vision defects that can be seen in cataract patients.

Glare Testing: Vision may be changed based upon different lighting conditions, such as at night and in brilliant sunshine. These marks may be found out with various types of lighting by having a patient read the chart twice, once with and without bright lights.

Potential acuity testing: Test that can give an almost idea about the vision following cataract removal and taken as the eye's vision power if there was no cataract.

Spectacular photographic microscopy: To take a photograph of the endothelial layer of the cornea, a specialized microscope is used. This is usually done previous to cataract surgery to find out the health of the endothelium, which is likely to affect the outcome of surgery.

Retinal examination: Before this examination, the pupils are dilated with eye drops so that the retina may be better visualized. An ophthalmoscope or slit-lamp is used to look for signs of cataract, as well as signs of macular degeneration, glaucoma, and other problems related to the optic nerves and retina which could be the cause of vision impairment.

Slit-lamp examination: Done with a special microscope known as the slit-lamp, which projects an intense, thin beam of light into the eye to give an amplified three-dimensional view of the interior of the eye. Manual detection is able to examine in section the structures at the front of the eye, including the iris, cornea and lens, as well as the area between the cornea and iris and look for any disorders.

Tonometry: Test may be done to calculate the pressure within the eye, or intraocular pressure (IOP), by a special instrument. Eye drops may be injected before doing the test. Raised IOP may represent glaucoma.

2.2 CATARACT TREATMENTS

Treatment in the early stages may be simple, such as the use of alternative lenses, eyeglasses, alternative lenses, anti-glare sunglasses, aalternative lenses or just an adjustment in environmental lighting.

Medication: Drug therapy cannot heal a cataract. Mydriatic eye drops which dilate the pupils may help in some cases for a short span of time by raising the amount of light entering the eye. Ssometimes recommended for young children who are waiting for cataract surgery so as to avoid vision loss in the interim.

Surgery: It is only effective treatment option in the case of more severe cataracts, especially when it affects daily actions or when it is combined with other problems. Removal of cataract surgery is safe and highly accurate in enhancing vision. And is not damaged significantly then surgery may not necessary once a cataract is detected. During surgery, the cloudy lens is removed and is replaced with an artificial lens. Whether there are cataracts in both the eyes which require treatment, surgery is usually done one at a time with an interval of four to eight weeks between the two processes. Phacoemulsification is the general process for cataract extraction, the cloudy lens is destroyed up by a probe which emits ultrasonic vibrations and the particles are then removed by suction. Other surgical method is called extra-capsular cataract surgery, where the cloudy lens is removed as a whole. Intracapsular cataract surgery is rarely done nowadays, where the lens, along with its capsule, is removed. Surgery is gradually done on an outpatient basis. The different surgical procedures are discussed in detail under cataract lens removal and replacement surgery.

3.CATARACT DETECTION TECHNIQUES

Rafat et.al [5], the technique of DLS or dynamic light scattering is used for detection of cataract at molecular level. However, the victory of this system in experimental use depends upon the exact control of the dispersal volume inside a patient's eye and particularly during patient's replicate visits. This is significant because the dispersal volume within the eye in a high-quality DLS set-up is very less. A corneal analyzer was customized by introducing a DLS fiber optic imaging probe within its cone. Figure 3 is a schematic illustration of the optical system.

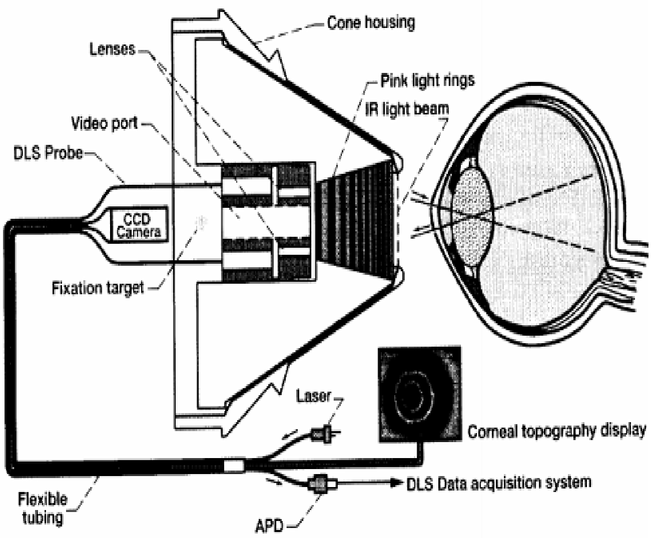

Fig -3: Diagram of the optical system

The unmistakable data obtained in this study is significant in planning a longitudinal study of anti-cataract drug screening.

Nayak et.al [6], pre-processing is made to diminish the contrast and to regulate the mean intensity. Intensities of the three colour bands were altered to an intensity-hue saturation representation [7]. It allows the intensity to be processed without affecting the professed relative colour values of the pixels. Mainly the features of the optical eye image such as small ring area, big ring area, object perimeter and edge pixel count are extracted. The inner surface of the cornea images is more whitish relative to that of normal and post-cataract images. It is the origin for manipulating small ring area. Colour at the external surface of the cornea is not the equivalent in all the three classes. The outer surface of the cornea images is bright in colour as compared to that of the normal and post-cataract images. It is origin of discovering big ring area. Using Cannys edge detection method edge pixel count (EPC) is computed and by the computation of EPC, the number of white pixels in the output of the edge detection is found out. For normal image, the count is very less and in post cataract image it is more than the normal where as in the cataract image it is very large. Object perimeter feature performed erosion. The normal, cataract and post-cataract images have a lot of unexpected changes in the gray levels. SVM classifier is used for classification.

Gao et.al [8], during pre-processing step the images are transformed into gray channel, so as to facilitate feature extraction. Texture, homogeneity and intensity features are extracted. Intensity histogram serves as a key feature to differentiate transparency from opacity. The histogram of a lens with cataracts has wider width and the tail extends to the darker side while, histogram of an obvious lens normally has slim thickness at clear intensity level. The other feature extracted is combined texture information. Here the wavelet coefficients are capable to describe such texture information. Results from both anterior and posterior images, representing a combined wavelet map shall be more appropriate to illustrate cortical and PSC cataracts. Spatial distribution of intensity and texture features are also extracted. One confront of automatic cataract detection is the diversity of the variance and the opacities of the illuminations in the images. Information of the total lens image may demonstrate analogous values for lens images with severe cataracts and clear lens images. Lens is equally separated into twenty-four subfields to portray the diverse spatial variance between them. Then, extract the wavelet statistics and intensity inside each subfield. SVR classifier is used to classify the cortical and PSC cataract which is supervised learning technique, used to train the regression model.

Xu et.al [9], each lens image is separated into three sections: nucleus, anterior cortex, and posterior cortex. Features are extracted from each of the resized sections. BOF or Bag-of-features extraction is performed. This is also called as the bag-of words model [10]. BOF model gives a location-independent global representation of local character in which properties such as rotation, intensity, scale or affine invariance can be conserved. Here, the local features in BOF model are image patches that characterize texture and intensity information. The local patches from a set of training images, k-means clustering is used to create the codebook from arbitrarily selected samples, and the BOF is obtained in a binning method. A regression model is used to grade nuclear cataract. A regression model is trained for the nuclear cataract grading task with the image feature representation. A condensed representation could potentially be used, but it is uncertain which colour channels are most instructive for each section of the lens, and how many bins is finest for a given channel. A group sparsity constraint in the regression is applied to choose a successful subset of the extracted features for nuclear cataract grading.

Li et.al [11], two computer-aided diagnosis systems for cataract grading is used. It is based on the landmark detection using ASM method. Features were extracted using formerly available clinical work [12, 13]. Six-dimensional feature was selected and they are: mean intensity of sulcus, mean intensity inside lens, intensity ratio between anterior lentils to posterior lentil and colour on posterior reflex. The last two features were obtained by visual axis profile analysis and it is the intensity distribution on a horizontal line through central posterior reflex. Spoke-like features were used to differentiate cortical opacities from the posterior sub-capsular opacities to identify the cortical opacities in ROI in automatic grading system for cortical. An original image is renewed to polar coordinate first. Edge detection and local thresholding were applied in both angular and radial directions. Region mounting was then applied to detect the cortical opacities. Angular opacities were subtracted from radial opacities to maintain only the cortical opacities as cortical seeds. To eliminate noises as a post-processing step, size and spatial filters were used. SVM or Support vector machines regression was employed to train a grading model and calculate the grade for a testing image.

Table -1: Comparison of cataract detection techniques

Authors	Methods	Success rate (%)
Rafat. R et.al [5]	Dynamic light scattering and corneal topography	Not reported
Nayak et.al[6]	Cannys edge detection method	94
Gao et.al [8]	Five-fold cross validation	51-62
Xu et.al [9]	Group sparsity-based constraint	69
Li et.al [11]	Model- based approach, Thresholding	89.3

3.CONCLUSIONS

Cataract is a familiar crisis in an aging people. Decreased vision due to cataract can very much influence the patient's capability to carry out usual actions. Most of the automatic cataract detection systems are based on retro illumination images or slit lamp direct images. But exceptions cannot be handled by using these techniques while this can be used for mass screening. This work mainly focused on cataract and its screening methods.

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