Instant Detection of Cataracts

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Abstract - Throughout the world more than 20 million people are blind because of cataract. Several surveys say that cataract is responsible for 50-60% of blindness in India. The main reason for this is lack of trained ophthalmologists. According to economic times report, the ratio of ophthalmologists to patients in India is 1:90000. Hence there is a huge gap between the demand and the availability of eye surgeons in this country. This creates a requirement of developing a solution to detect and analyze cataracts in remote areas with least training and educational requirements. There have been several attempts to automate the cataract detection process. This paper contains some details about the present trends in automating cataract detection, theoretical background of some important concepts and the work I propose to do later.

Keywords - Machine Learning, Cataract, SVM algorithm, World Health Organization (WHO), Blindness.

I. INTRODUCTION

Cataract is basically a clouding of the lens in the eye which leads to blurred or decreased vision. There are many causes for the formation of it. Throughout the world approximately 20 million people are blind because of cataract. It is said to be the 60% cause of blindness in parts of Africa and parts of South America. Three out of every four people, aged 60 years or above in India are said to have or had cataract.

II. LITERATURE SURVEY

According to a survey, cataract is responsible for 50-80% of bilateral blindness in India [5]. The report also suggests that the no of cataract blind would increase from 7.41million in 2001 to 8.25 million in 2020 due to a substantial increase in the population of people above the age of 50 years. It is also seen that it contributes to 51% of avoidable blindness in the country. The world health organization made a resolution called ' vision 2020' to eliminate the avoidable blindness, to which India is also an important stake holder. The key to this initiative is to provide sufficient, sustainable and successful cataract services to all the communities [6]. According to its report, it is estimated that by 2020 even with all the attempts by the WHO and other organizations, there would be a huge gap between the surgical requirements and surgical output of India.

The office of registrar general and census commissioner says that 70% of the Indian population lies in the rural areas. But according to the WHO, 70% of the public hospitals are situated in cities. Because of this condition the rural population of India should travel to cities to get good health services. This is said to be one of the main reasons that contributes to the gap in surgical requirement and surgical output of the country. But, providing facilities near to them would mean large investment and low utilization of the infrastructure in smaller communities. Hence there is a requirement of a cheaper alternative for detecting and operating cataracts in remote areas.

III. MOTIVATION

According to an article in the economic times[7], the general ratio of an ophthalmologist to patients in India is 1:90000, which is pretty huge. In United states the ratio is 1:15000.This shows that we have a huge lack of trained personnel in India. This could be one of the major factors in addressing the rural cataract treatment. Hence a solution should be found, which can be implemented in remote and rural areas with minimal educational and training requirements.

IV. PROBLEM DEFINITION

- To design a compact electronic device that can detect the type and stage of a cataract instantly

V. CONVENTIONAL METHODS TO DETECT CATARACTS

To detect a cataract an ophthalmologist performs a test called as visual acuity or a refraction test. This is usually done using a bi microscope or a slit lamp. This instrument is used to view the parts of the eye that bend the light (cornea, iris, lens and vitreous). For getting a clear view, a pupil dilation solution is used. A drop or two of this solution is put in the patient’s eye before examination. The instrument sends out an intense beam of light as it sees the eye. This beam provides a magnified view of the eye through which the technician can visually detect the cataract. The following is an image of a slit lamp:

Fig. 1 Slit lamp

VI. PRESENT TRENDS IN AUTOMATING THE CATARACT DETECTION

Many research works have been conducted to automate the cataract detection. Rafat R. Ansari and Harbans S. Dhadwal [1] proposed a method of using fiber optic probes for detecting the change in molecular weight of the protein molecules present in the lens. The change was detected using the principles of dynamic light scattering. Higher molecular weight of a particular molecule will result in increased opacity of the lens. Jagdish Nayak [2] proposed a method of using image processing and SVM algorithm for feature extraction and classification of extracted features respectively. His setup could classify an image as a normal, cataract and a post cataract lens. The method is said to have achieved 100% of accuracy in detecting cataracts. Sucheta Khole and Shanthi K. Guru [3] proposed a method of detecting the presence and the stage of the cataract by using SVM and MDA algorithms. The presence was detected by the use of SVM algorithm and the MDA algorithm was used to detect the stage of the cataract. The proposed system is expected to give 93% and 77% of accuracy and precision respectively. Retno Suprayanti ,Hitoshi Habe and Masatsugu Kidode [4] proposed a method of detecting cataracts using image processing and the principle of specular reflection analysis. All the methods involving image processing and machine learning are proven to be more accurate and less expensive.

VII. THEORETICAL BACKGROUND

Cataract is a medical condition where the lens of the eyes becomes progressively opaque, which leads to blurring of vision. The normal eye is made up of the sclera, cornea, pupil, aqueous humor, iris, conjunctiva, lens, vitreous humour, ciliary body, macula, retina, fovea and the optic verve. Lens is the clear part of the eye behind the iris that helps to focus light on the retina. The lens helps to focus on both far and near objects so that they are perceived clearly and sharply. The ciliary muscle helps to change the shape of the lens. This changing of the lens shape is called accommodation. It is said that the diameter of the lens is 10 mm, and basically there are three types of cataracts. They are discussed in the following section.

A. Nuclear Sclerotic Cataracts

This is the most common age related cataract. Sclerosis is a medical term for hardening. The lens of the eye gets hardened and gets a yellowish shade. It starts gradually clouding from the centre. The clouding and hardening occurs only in the nucleus of the lens. Because of this property the term nuclear is added. The hardening of the lens causes the loss in focus and the cloudy yellow shade makes the lens opaque. In this condition the complete lens has to be replaced with an artificial one.

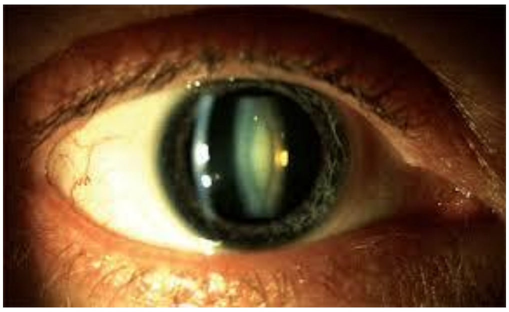

Fig. 2 Nuclear sclerotic cataracts

B. Cortical cataracts

White opacities or cloudy areas develop at the edge of lens. This region is called as cortex. The variation in the water content of the lens fibres create a spooky kind of a structure that begins from the edge and ends at the centre. These structures cause scattering of light which in turn causes blurred vision, glaring, higher contrast and depth perception. People having type 2 diabetes are prone to have this cataract.

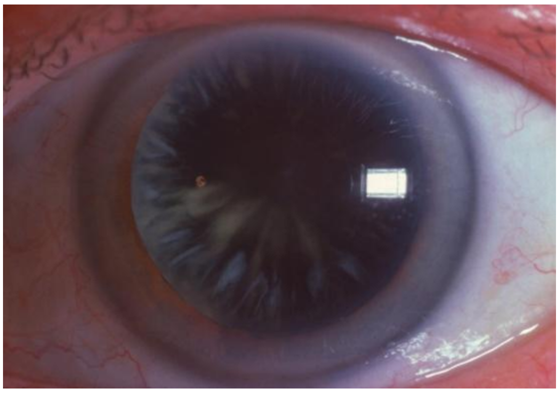

Fig. 3 Cortical cataracts

C. Posterior subcapsular cataracts

These are the cataracts where the opaqueness or cloudiness occurs at the back of the lens or posterior to the lens. People with diabetes or those taking high doses of steroid medications have a greater risk of developing a subcapsular cataract.

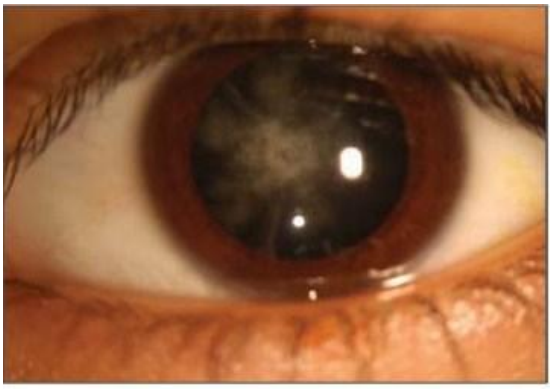

Fig. 4 Posterior subcapsular cataracts

D. Image processing

The science of extracting data form an image can be defined as image processing. Image processing is basically used to extract particular features from an image. Based on these extracted features we classify the image into different types using different machine learning algorithms.

E. Machine Learning

Machine learning is the science of making the computers act in certain situations without human intervention. It is a tool using which one can train the computers to act in certain ways without actually programming it.

F. SVM algorithm

The support vector algorithm is an algorithm designed for classification and regression of patterns. This algorithm can be implemented by initially plotting the data items on a two dimensional graph. The graph mainly consists of two types of data items. Let me take an example to explain this. Consider an analysis of different types of roads. We will use the machine learning algorithm to understand which road is better to drive. We take two different properties of roads to classify the type of terrain. For simplicity let us consider only two types of terrains here(tough and easy).If the road is bumpy and the slope is uphill , we consider the terrain to be tough and if the road is smooth and slope is straight/ downhill, we consider it to be an easy terrain to drive. We first plot a graph where the x axis defines the bumpiness of the road and the y axis defines the slope of the road.

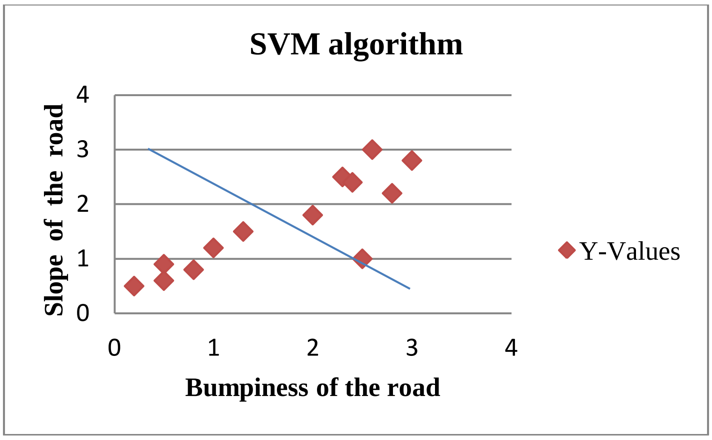

Fig. 5 Graph

VIII. PROPOSED WORK

From all the research works I have studied, I could observe that most the solutions proposed could perform the following functions:

- Detect the presence of cataract
- Detect the stage of cataract

But none of the methods had the ability of detecting the type of cataract. Removal of cataracts is not a must in all the cases. The necessity of operation can be decided by the speed of development of the cataract and the position of the cataract formation. Most of the research works focused on detecting cataracts from acquired images of patients. In my project I would also like to focus on the image acquisition of the eye and the rate of cataract growth. In my research work I aim to include the following features in the device:

1) Real time acquisition of image
2) Instant detection of cataract presence
3) Detection of stage of cataract
4) Detection of type of cataract
5) Detection of the speed of cataract growth
6) Detection of position of cataract
7) Compact size of device
8) Minimal complexity of operation
9) Cheap in cost
10) High accuracy

G. Methodology

Following is the block diagram of the proposed project:

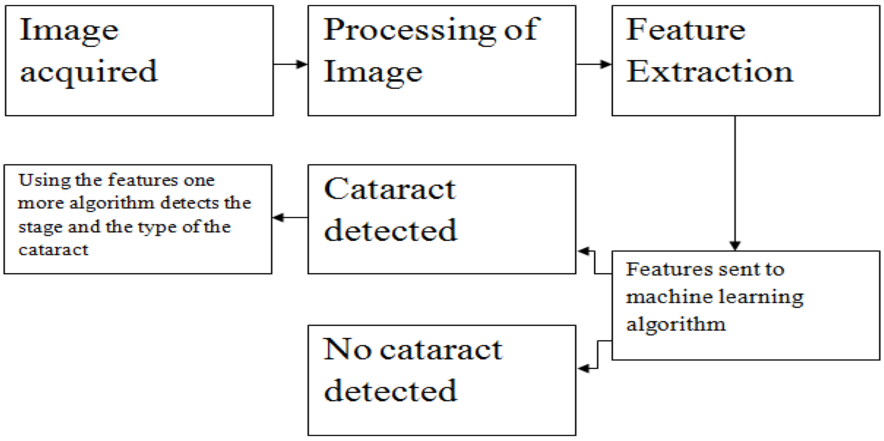

Fig. 6 Block diagram

Image is acquired through a camera. The acquired image is then processed to extract features from it. The extracted features are fed to an algorithm. The machine is already trained with several pictures of positive and negative samples.

Based on the trained data it classifies the given picture into a category. In this case it classifies weather the eye has cataract. If the cataract test is negative then it terminates the process and displays the result. If the test turns out to be positive then it further sends the features to another algorithm to check the type, stage and position of the formation. The data is stored in a database. Again after a month or two the patient is retested with this system. The features are fed to an algorithm to get the growth rate of the cataract in the lens. Based on the results obtained, the system will suggest weather there is a requirement of a surgical removal of the lens.

IX. CONCLUSION

In this paper we have discussed about the present trends in automating the detection cataracts and the requirement of developing a system to make the detection more specific. We also saw the necessity of detecting the position of cataract to help us decide whether there is a requirement of surgical replacement of lens. Hence my aim is to develop a device that is able to detect the presence, type, stage and position of the cataract

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