Cataract Detection using Smartphone

Juyel Rana[1*], Syed Md. Galib[2]
[1]Faculty of Computer Science and Engineering,
Patuakhali Science and Technology University, Bangladesh
[2]Department of Computer and Information Technology,
Patuakhali Science and Technology University, Bangladesh
*mjuyelrana@gmail.com

Abstract— **A cataract could be an evaporation of the ordinarily clear lens of the eye. Those having cataracts may experience seeing through their cloudy lenses which could be a bit like exploring through a frosty a fogged up window. Clouded vision caused by cataracts will create it tougher to browse websites, drive an automobile (especially at night) or see the expression on a friend's face. Most cataracts develop slowly and do not disturb sight early. However, with time, cataracts can eventually interfere with vision. There are some manual techniques to detect a cataract. An ophthalmologist or optometrist diagnoses a cataract by doing a comprehensive eye examination. The ophthalmologist uses a slit lamp camera to diagnose a cataract. By the lacking of ophthalmologist and slit lamp camera in rural areas, especially in developing country like Bangladesh are the main problem of diagnosing a cataract. There also have some automated smartphone based cataract detection techniques that will overcome these problems. In these research, we proposed a methodology that will be implemented on a smartphone (Android, iOS, Windows). This paper presents a proof-of-concept self-screening cataract detecting mobile application. It enables the public to carry out early detecting by using a smartphone with a well focusing front camera that allows self-screening to be performed by almost anyone, anytime, anywhere.**

Keywords— ***Cataract, SDK, NDK, OpenCV, Image Processing, Smartphone.***

I. INTRODUCTION

The expanding evaluation of smartphones with detecting ability is giving developers the chance to plan and create versatile applications. Especially, portable advancements are opening new doors to human services. For example, handheld gadgets and smartphones have significantly changed the present world. With the new era of portable working, applications have been generous expanding improvements and selections of versatile applications. To date, more than 100,000 therapeutic and medicinal services applications are devoted to smartphone and several other handheld gadgets [1].

About 285 million individuals are assessed to be outwardly disabled around the world: 39 million are visually impaired and 246 million have low vision. Around 90% of the world's apparently weakened live in low-wage settings. 82% of individuals living with visual impairment is 50 years old. All inclusive, uncorrected refractive blunders are the fundamental driver of direct and extreme visual impedance; cataract remains the main source of visual deficiency developing countries. The number of individuals apparently weakened from irresistible ailments has lessened over the most recent 20 years as indicated by worldwide assessments work[2].

There are various approaches to screen cataract, for example, utilizing opening light examination, red reflex, and light scrambling techniques. The ophthalmologist will put the ophthalmoscope 30cm/1 foot far from the eye's retina and watch the ruddy orange reflection (red reflex) of light. The red reflex from ophthalmoscope decides the seriousness of the cataract. The red reflex happens on the grounds that the transmission of light from an ophthalmoscope through all the typically straightforward parts of a subject's eye. Any factor that hinders or obstructs this optical pathway will bring about a variation from the norm of the red reflex.

There are few difficulties for consistent screening. Initially, screenings are done by therapeutic professionals, and their accessibility will be a factor. Furthermore, legitimate sorts of hardware are required for the screening, and they are not shabby. The expenses and time required to do eye examination from restorative professionals are likewise conceivable why some are doing the screening as customary as could reasonably be expected. These difficulties are much more troublesome with regards to screening for individuals from the provincial range. For screening cataract, patients ought to be done in the beginning periods as the specialist may require time to plan for the patient's surgery and furthermore patients may require time to get ready mentally.

We propose to build up an answer utilizing versatile innovation that explains the above difficulties. The thought is to use a smartphone with a fitting application as an options screen instrument. This device ought to be intended for the use by overall population. As it were, nearly anybody ought to have the capacity to work the application and do cataract screening without the help of a therapeutic professional. This paper displays the thought and an original model to show the believability of the thought. The proposition does not mean to supplant the expert screening method. The application should fill in as a non-therapeutic self-screening administration so that with early discovery, the patient would then be able to look for proficient screening to affirm and thus ready to avoid potential risk ventures by having early treatment. As smartphone turns out to be practically universal in most urban spots since the earlier years, cataract self-screening with smartphone expels the boundaries like screening cost and travel/time bothers for patients who are associated with having a cataract. As cataract

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event increments with age, visit self-screening can distinguish cataract right in time to decrease preventable visual impairment. Our proposed method is to detect cataract using a smartphone like Android, iOS, Windows. First developed customize camera using Open CV, Java Camera View which give real-time camera application. When the patients or users launch the application its open the customize camera. The camera detects two eyes, crop eyes on running time and shows the different layout in the camera view. When cropping the pupil from two eyes on running time, then two pupils are stored in a matrix. Analyze two matrices using the help of NDK, which provide C/C++ coding on android platform. Some color detection method is applied to detect the pupils color then take the decision, eyes are a cataract or not.

II. RECENT WORKS

Cataracts are the most common cause of vision loss in people over age 40 and are the principal cause of blindness in the world. In fact, there are more cases of cataracts worldwide than there are of glaucoma, macular degeneration and diabetic retinopathy combined, according to Prevent Blindness America (PBA). Today, cataracts affect more than 22 million Americans age 40 and older. And as the U.S population ages, more than 30 million Americans are expected to have cataracts by the year 2020 [3].

Several research works have been performed to detect cataract using retinal images. Some related reviews have been presented here under the following sub-heads. A Bourouis, M. Feham, M.A. Hossain and L. Zhang (2014) proposed a retinal disease diagnosis using a Feedforward Neural Network (NN). The NN used to break down patient's retinal images and perform infection determination. The Neural Network is at first prepared with solid and tainted retinal pictures on a PCs and after that installed in an Android domain. After retinal pictures are caught by the minuscule focal point joined with a smartphone, a progression of Android's picture handling API's is likewise used to investigate the crude pictures. The exploration is composed and created to find anomalous retinal from typical cases. They used two therapeutic picture databases DIARETBO and STARE, for the assessment of the savvy versatile based conclusion framework. The assessment comes about prove that the framework indicates focused retinal sickness identification exactness (>87 %) [1].

Jaspreet kaur and Ravinder kaur (2015) proposed low-cost cataract detection system using smartphones. The authors proposed a minimal effort cell phone based keen framework mix and miniaturized scale focal points enable patients in remote zones to have standard eye checks and inventive advancement of ailment determination. The official portable demonstrative framework for the investigation of retinal pictures taken by minuscule focal point to recognize retinal infection conditions. The neural system constructs approach can be kept running in light of both desktop PC strange/typical retina picture characterization for Android-based cell phones. Feedforward neural system calculation ready to carry out ongoing proficient arrangements, as a matter of first importance the sound and tainted stages. At that point utilizes the dataset of the retina, on a desktop PC testing neural system INA cell phone introduced Android in the ready framework (OS). Testing stage, utilizing miniaturized scale focal point and gather clients, which is utilizing retinal pictures, indicative, Android smartphone, is joined. The advantages of utilizing magnifying instrument focal point, execution for the conclusion of enabling the framework to take clear retinal pictures. To give shrewd answers for portable based proficient to do different streamlining strategies, continuous determination, considered their examination. Coordination of the outer magnifying lens by utilizing an industrially accessible smartphone introduced to clever portable based retinal infection discovery technique. The proposed technique was produced for the Android working stage. The application is anything but difficult to work with any portable clients could be used remotely as a productive minimal effort versatile for wellbeing checking framework when [4].

Yunendah Nur Fuadah, Agung W. Setiawan, Tati L.R. Mengko and Budiman (2015) proposed mobile cataract detection using the ideal combination of texture analysis. The authors proposed optimal combination candidate of statistical texture features that provides the highest accuracy for cataract detection. They use K-Nearest Neighbor (KNN) as grouping technique that is actualized on Android telephone. The principal procedure of the framework consists of preparing and testing process. Both of the preparation and testing process have the means, specifically, reprocessing, highlight extraction and order. They utilize the factual surface examination highlight extraction to distinguish waterfall and K-NN as grouping technique. The framework configuration is executed in MATLAB and dissect the execution of factual surface components (Uniformity, Contrast, Dissimilarity, Correlation, and Homogeneity), at that point find the ideal estimation of K-NN. After the surface components and the ideal k esteem, execute the framework on Android Smartphone. The most astounding exactness of their proposed framework is 97.5% [5].

Stewart Jordan et al., (2014) proposed a smartphone based ophthalmoscope. A minimal effort contrasting option to the immediate ophthalmoscope, a straightforward optical connector for a cell phone. It can beat a large part of the specialized difficulties of fundus duplicate, giving a high determination perspective of the retina through an unengaged student. Correlation of optic nerve pictures from business retina screening cameras with the cell phone connector exhibits solid confirmation for no distinction in execution in glaucomatous plate evaluating [6].

Prateek Prasanna, Shubham Jain, Neelkshi Bhagat and Anant Madabhushi (2013) proposed decision support system for diabetic retinopathy using smartphones. The authors proposed model needs a smartphone to be attached to a direct hand-held ophthalmoscope. The phone is used to capture fundus images as seen through the direct ophthalmoscope. The algorithm performance is characterized by testing an existing database. The system has been designed to be used by Ophthalmologist, general practitioners, emergency room physicians, and other healthcare people alike. They able to diagnose conditions with an average sensitivity of 86% [7].

S. Pathak and B. Kumar (2016) proposed a robust automated cataract detection algorithm using diagnostic opinion based factor threshold for telemedicine application. The authors proposed an algorithm to automatically detect cataracts from color images in adult human subjects. The main motive behind their research work is to develop an inexpensive, robust and convenient algorithm which in conjugation with suitable devices will be able to diagnose the presence of cataract from the true color images of an eye. An algorithm is proposed for cataract screening based on texture features: uniformity, intensity and standard deviation. These features are first computed and mapped with a diagnostic opinion by the eye expert to define the basic threshold of screening system and later tested on real subjects in an eye clinic. Finally, a teleophthalmology model using their proposed system has been suggested, which confirms the telemedicine application of the proposed system [8].

A large number of works have been done to estimate the detection of cataract using digital image processing. Also, some algorithm has been implemented for feature choice. The goal of my research is to develop an Android Application Software for detecting cataract on running time camera.

III. METHOD

In our proposed model, we want to develop an Android Application. Today's Google's Android provides better features for developers. Every day's programmer builds some library to make the development works easy. Our research work, we used Android Studio, SDK, NDK, and OpenCV.

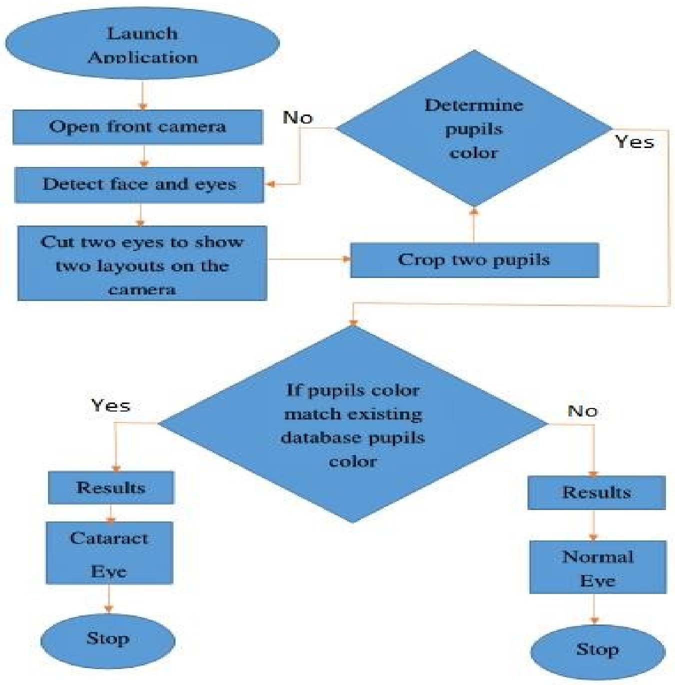

Figure 1: Flow diagram of proposed model

At first, the patient launches the application. When the app is launched, it opens a customized camera which provides OpenCv an image processing library. The phone is placed in front of the eye with the maximum distance of 30 cm. The camera first detects the patient's face with a colored rectangle. The two eyes are also shown in two different rectangular views. Here only two eyes are shown clearly so that the patient can see his own eyes problem. Now the two frame detect and cut the pupil using Cascade Classifier.

Cascade Classifier is a library that has some functionality to detect pupil. Then the pupil image is stored in a temporal matrix. The matrix stored the values as RGB format. Now the two frame detect the pupil using Cascade Classifier. Then the pupil image is stored in a temporal matrix as an RGB value.

Algorithm 1. Pseudo code for detecting cataract

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start

1. Launch application, open front camera and detect face and eyes
2. Cut two eyes and show two different layouts on the camera screen.
3. Detect two pupils from two different layouts and crop only pupils region.
4. Determine pupils color;
5. repeat

{

5.1 if (determine pupil color)

{

- Check pupils color on existing database pupil color
- If pupils color match then classify the into three stages- Cataract stage 1, Cataract stage 2 and Cataract stage 3.
- If doesn't match pupil color, it classify to normal eye.

}

else {

- GOTO step 3

}

until (stop the application)

}

end

IV. RESULTS AND DISCUSSION

After pupil detection and crop automatically it will send to OpenCv C++ coding part. OpenCv provide some methodology to determine the pupil color. In the following section, described the pupil color detection.

```
cv: Mat img   = cv::imgread("pupliImage")
int pixelValue = 0, int m = 0;        for ( int j =
0;  j <=  img.rows; j++){
            for( int I = 0;  I <= img.cols; i++){
```

```
                pixelValue = (int) img.at<uchar>(i,j);
                n++;
            }
    }
int pupilColor = 
```

$$\frac{pixelValue}{n*255}$$

Now we can determine the four stages of cataract detection.

Stage 1: If pupilColor is less than OR equal to databaseCataractPupilColor AND less than OR equal to 50. This is dark gray and Normal eye.
Stage 2: If pupilColor is less than OR equal to databaseCataractPupilColor AND the pupilColor is greater than 50 AND pupilColor less than 120. This is medium gray and Cataract stage-1.
Stage 3: If pupilColor is less than OR equal to databaseCataractPupilColor AND the pupilColor is greater than 120 AND pupilColor less than 200. This is light gray and Cataract stage-2.
Stage 4: If pupilColor is less than OR equal to databaseCataractPupilColor AND the pupilColor is greater than 200. This is light gray and Cataract Stage-3 (Glucoma).

We presented an experiment using 50 people. Those are 20 having cataract and 30 are normal. The evaluation results indicate that the system shows competitive retinal disease detection accuracy rates greater than 90%.

V. CONCLUSION

The cataract is the leading cause of blindness and affecting people age 40 and older. Multiple studies have also been shown that cataract increases changes in automobile crashes and also accidental injuries sustained to the elderly. This research work presents a proof-of-concept self-screening cataract mobile application. It enables the general public to carry out early detection by using a smartphone with a camera and flash. This is not only allows self-screening to be performed by almost anyone, anytime, anywhere, it also can be used as a portable screening solution in places with limited medical facilities or professional. The research has shown that such the approach is possible.

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