Automatic Screening and Monitoring of Ocular Disease Using a Hybrid Cloud System

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Abstract: - *The maturity of healthcare IoT technology which connects medical devices and applications to healthcare IT systems through internet has driven the rapid growth of healthcare. In recent years, great effort has been spent to improve ocular disease screening and diagnosis using advanced image and data analysis techniques. However, the developed systems are not widely used because they are usually offline and separated from medical devices. In this paper, we introduce a platform that connects medical devices, patients, ophthalmologists, and intelligent ocular disease analysis systems through a cloud-based system. The platform is designed in a hybrid cloud pattern to offer both easy accessibility and enhanced security. The retinal fundus images and patients' personal data can be uploaded to the public cloud tier through multiple channels including retinal fundus cameras, web portals, mobile applications and APIs. The data will be transferred to the private cloud tier where automatic analysis and assessment will be performed using advanced pattern classification algorithms. Subsequently, the analysis report will be made available in the public tier so that patients can access their own report through mobile applications or web portals. Furthermore, patients with high risk of having ocular diseases will be referred to ophthalmologists. The platform helps to form an integrated ecosystem that enables an efficient and cost-effective way of ocular disease screening and monitoring, allowing early disease detection and intervention.*

Keywords: - Internet of Things, healthcare, ocular diseases, disease screening, computer aided diagnosis, cloud computing.

I. INTRODUCTION

Automatic screening and monitoring of ocular disease system enables easy and accurate detection of eye disease. The system detects the disease by performing various image processing steps on an eye image and all this process is performed without any human (expert's) interference. By storing the data on cloud, the patient records can be stored for any further study or analysis purpose.

Internet of Things (IoT) : The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. In our project, we are using IoT to make a virtual network of patient, system and doctor to get effective result in prediction and treatment of disease.

Cloud: The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. Cloud is used in our project for storage purpose. Patient records and ophthalmologist details are stored on cloud.

Image Processing: Image is the input fed to our system, this image further undergoes image processing steps like feature extraction, image segmentation, etc. These image processing steps are performed to get extra information of each pixel of the image which further helps in disease prediction.

The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data. IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer based systems, and resulting in improved efficiency, accuracy and economic benefit.

Internet of Things (IoT) has many applications, healthcare is one of them. IoT has considerably facilitated integrating medical devices and healthcare related applications through internet. Many researches has been done to improve ocular disease screening and diagnosis using advanced image and data analysis techniques. However, the developed systems are not widely used because they are usually offline and separated from medical devices. In this project, we introduce a platform that connects medical devices, patients, ophthalmologists, and intelligent ocular disease analysis systems through a cloud-based system. The platform is designed in a hybrid cloud pattern to offer both easy accessibility and enhanced security. The retinal fundus images and patients' personal data can be uploaded to the public cloud tier through multiple channels including retinal fundus cameras, web portals, mobile applications and APIs. The data will be transferred to the private cloud tier where automatic analysis and assessment will be performed using advanced pattern classification algorithms. Further, the analysis report will be made available in the public tier so that patients can access their own report through mobile applications or web portals. The patients with high risk of having ocular diseases will be referred to ophthalmologists. The platform helps to form an integrated ecosystem that enables an efficient and cost-effective way of ocular disease screening and monitoring, allowing early disease detection and intervention.

II. RELATED WORK

1 Automated Microaneurysm Detection Using Local Contrast Normalization and Local Vessel Detection: Earlier screening programs using retinal photography for thedetection of diabetic eye disease were introduced. Automatic grading of the images is being considered by health boards so that the human grading task is reduced. Microaneurysms (MAs) are the earliest sign of this disease

and so are very important for classifying whether images show signs of retinopathy. This paper describes automatic methods for MA detection and shows how image contrast normalization can improve the ability to distinguish between MAs and other dots that occur on the retina. Various methods for contrast normalization are compared. Watershed transform method was used to derive a region that contains no vessels or other lesions. Dots within vessels were handled successfully using a local vessel detection technique. Results were presented for detection of individual MAs and for detection of images containing MAs.
Limitation:

1. The results for image classification are less clear.
2. The poor performance of method "F" requires some explanation.

2 Automatic Detection of Pathological Myopia using Variational Level Set: Pathological myopiais a condition caused bypathological axial elongation and eyes that deviates from thenormal distribution curve of axial length, resulting in impairedvision. Ocular risks associated withmyopia should not be underestimated, and there is a public health need to prevent the onset or progression of myopia.Peripapillary atrophy (PPA) is one of the clinical indicators forpathological myopia. This paper introduces a method to detect pathological myopia via peripapaillaryatrophy feature by means of variational level set. The proposed method has been tested on 40 images from Singapore CohortStudy Of the Risk factors for Myopia (SCORM), producing a95% accuracy of correct assessment, and a sensitivity and specificity of 0.9 and 1 respectively. The results highlight thepotential of PAMELA as a possible clinical tool for objectivemass screening of pathological myopia.
Limitation:

The accuracy in the boundary location of the optic disc would be compromised.

3 Early Age-Related Macular Degeneration Detection By Focal Biologically Inspired Feature: Age-related macular degeneration (AMD) is a leading cause of vision loss. The presence of drusen are often associated to AMD. Drusen are tiny yellowish-white extracellular buildup present around the macular region of the retina. Clinically, ophthalmologists examine the area around the macula to determine the presence and severity of drusen. However, manual identification and recognition of drusen is subjective, time consuming and expensive. To reduce manual workload and facilitate large-scale early AMD screening, it is essential to detect drusen automatically. In this paper, we propose to use biologically inspired features (BIF) for the purpose of AMD detection. The optic disc and macula are detected to determine a focal region around macula for feature extraction. The extracted features are then classified using support vector machines (SVM).
Limitation:

Need to improve the accuracy as well as to compute the severity of the drusen.

4Level-Set Based Automatic Cup-To-Disc RatioDetermination Using Retinal Fundus Images in Argali: Glaucoma is a leading cause of permanent blindness. However, disease progression can be limited if detected early. The optic cup-to-disc ratio (CDR) is one of the main clinical indicators of glaucoma, and is currently determined manually, limiting its potential in mass screening. In this paper, we propose an automatic CDR determination method using a variational level-set approach to segment the optic disc and cup from retinal fundus images. The method is a core component of ARGALI, a system for automated glaucoma risk assessment. Threshold analysis is used in preprocessing to estimate the initial contour. Due to the presence of retinal vasculature traversing the disc and cup boundaries which can cause inaccuracies in the detected contours, an ellipse-fitting post-processing step is also introduced.
Limitation:

Proposed method has an error for glaucomatous retinal images.

5 Model-based Optic Nerve Head Segmentation on Retinal Fundus Images

The optic nerve head (optic disc) plays an important role in the diagnosis of retinal diseases. Automatic localization and segmentation of the optic disc is critical towards a good computer-aided diagnosis (CAD) system. In this paper, a method is proposed that combines edge detection, the Circular Hough Transform and a statistical deformable model to detect the optic disc from retinal fundus images.
Limitation:

Results of proposed method can be much worse for discs with non-circular shapes

III. PROPOSED SYSTEM

Product Perspective

Now-a-days, ocular diseases are increasing in the aged group of population. Lack of awareness, inadequate medical facilities and other such issues lead to patient inconvenience and even loss of vision. To overcome this scenario, early and accurate diagnosis of the ocular disease is necessary so as to provide the required and proper medical assistance to the patient. The system proposed in the project enables the accurate detection of the ocular disease by analyzing the eye image of the patient. If the system detects that the disease is at initial stage than a medical prescription is given to the patient. And if the patient is at high risk, an opthamologist (eye expert) is being consulted for expert advice and further medical treatment. This system also helps to reduce the inconvenience caused to the patient while taking a medical appointment, reduces load on urban infrastructure by efficiently managing the expert and patient appointment.

Fig.4.1. Eye image for Age-related Macular Degeneration (AMD)

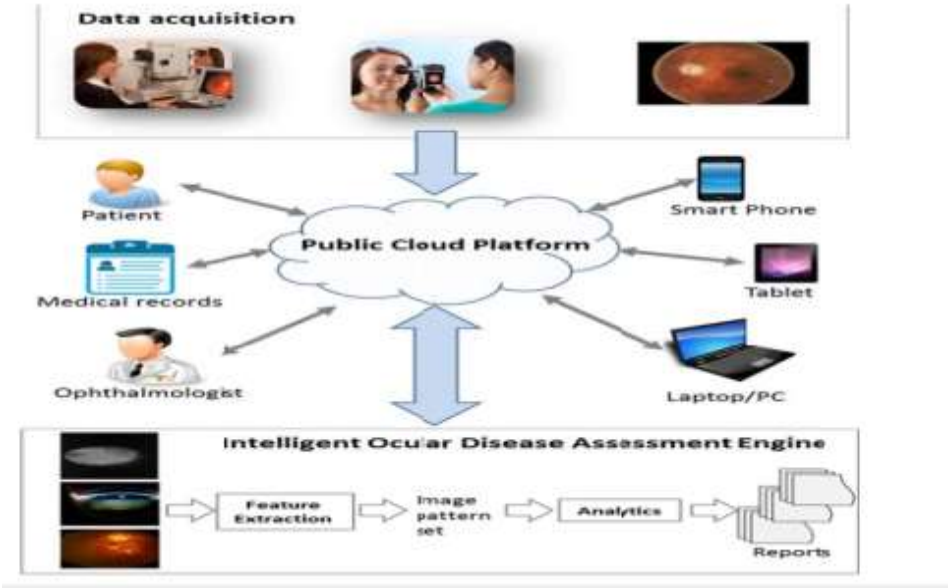

Figure 1: Architecture Diagram

Product Function

This project proposes a hybrid cloud-based system for automatic ocular disease screening and monitoring. Here the patient visits clinic for an eye check-up and his/her eye images are captured so as to detect the disorder and provide proper medical treatment. (In our project, we will be considering the eye images that are already available over cloud.) The captured images will be forwarded to cloud and by analysing those images, proper assessment and reporting on ocular diseases will be sent to the patient. In case of serious situation, the patient will be informed about it and an expert is consulted for further treatment that should be taken.

IV. CONCLUSION

In this work, we present an online cloud-based service platform for automatic ocular disease screening through the use of medical image based pattern classification technologies Leveraging on the fast development of intelligent analysis algorithms for glaucoma, age-related macular degeneration pathological myopia and diabetic retinopathy , the system can detect ocular diseases in an objective and consistent way.

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