
APPLICATION OF ARTIFICIAL INTELLIGENCE IN CATARACTS: GENERAL OVERVIEW

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Abstract

The exploding growth in technology has made things look far less subtle than the way they actually are. For instance, first industrial revolution brought the impediments of mass production, transportation of essentials down to its knees. Today it's the era of Artificial Intelligence that has been enhancing performance, from mathematics and chess to healthcare, it has been astounding everyone's eyes and conquers every field it enters. Biggest challenge today that prevails and haunts many, even ending a few, is the delay in diagnosis and scarce of medical resources. Not everyone is made available to medical resources to the fullest. In fact, many are deprived of it. One among it is, Cataract diagnosis. Artificial Intelligence seems to be very promising in diagnosis of Cataracts disease. The proposed work focuses on the AI applications in cataracts, in the three major areas of early detection and diagnosis, treatment, as well as outcome prediction and prognosis evaluation.

Key words: Artificial Intelligence, Cataracts, Ophthalmology, Deep Learning, Image Processing, Convolutional Neural Network

Introduction

It has always been more than obvious, the two certainties in life are Death and Taxes. If we dredge up human history, a century before, average life expectancy was 40 and a few decades later in 1950s it soared to 65. Today it has reached its zenith, that is, to a value of 78 years. The reason behind this increase in expectancy is because of the rapid progression in health care which resulted in the increase in screening and diagnosing the diseases by the doctors in the earlier stage.

Cataracts is dense cloudy area that if formed in the lens because of accumulation of proteins in the lens. This reduces vision. Cataracts is generally caused because of aging or any injuries that changes the tissue of the lens. It can also be caused because of Diabetes Mellitus In some cases, the severity of Cataracts increases with some genetically inherited disorders.

In this review, we reviewed the application of AI in diagnosis and prediction of cataract.

2. Cataracts

Cataracts is the over-accumulation of proteins in the lens which might be the result of aging or Diabetes Mellitus. We will discuss deep about it in this section.

2.a Symptoms and Risk Factors

2.a.1 Symptoms

There are a wide variety of cataracts that cause different symptoms. Here we will see the general symptoms. [1]

- Colour blindness to a degree
- Increase in myopia

- Loss of contrast sensitivity
- Opacification of vision
- Glare
- Reduced night vision

2.a.2 Risk Factors

Risk factors for cataract development

- Diabetes Mellitus
- Ultraviolet exposure
- Ocular diseases: Retinitis Pigmentosa, Uveitis
- Ocular Trauma
- Steroid use (oral, or inhaled)
- Prior ocular surgery
- Genetic predisposition

2.b Types

There are majorly four types of cataract namely [2].

- **Congenital Cataracts**

Congenital Cataracts are opacity in the lens which in some cases can be present from birth. The severity of this type can cause visual impairment [7, 8]



Figure 1 Congenital cataract

- **Cortical Cataracts**

Cortical Cataracts is hyper sensitivity to ultraviolet rays, caused majorly because of smoking, alcohol, Diabetes, Hypertension and so on. [9, 10]



Figure 2 Cortical Cataracts

- **Posterior Subcapsular Cataract**

Posterior Subcapsular Cataract is a frequent complication in eyes with retinitis pigmentosa which is an inherited disease that causes photoreceptor cell death. [[11](#), [12](#)]

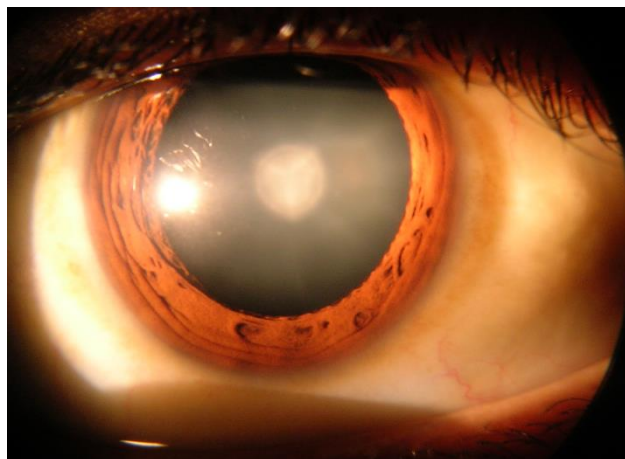


Figure 3 Posterior Subcapsular Cataracts

- **Nuclear Cataract**

Nuclear cataract is caused by gradual hardening and yellowing of central part of lens mainly due to aging. [[13](#), [14](#)]



Figure 4 Nuclear Cataracts

2.c Prevention

Apparently, Doctors doesn't really have concrete proof to prevent cataracts but they insist a few methods that might help., [2].

- Usage of eye shades
- Reduce alcohol consumption and smoking
- Periodic eye check ups
- Healthier diets that include fruits and vegetables

2.d Diagnosis

Diagnosis of cataract consist of 3 major steps.

- **Eye visual acuity test**

It is a simple test where a person's eye ability is determined with him/her reading letters from a defined distance. [15]

- **Slit-lamp exam**

Slit-lamp exam is also known as bio-microscopy where microscope with a bright light is used to examine the eye. [16]

- **Retinal exam**

Retinal exam is mainly to exam the retina which is the transparent part inside the eye using Ophthalmoscope. [17, 18]

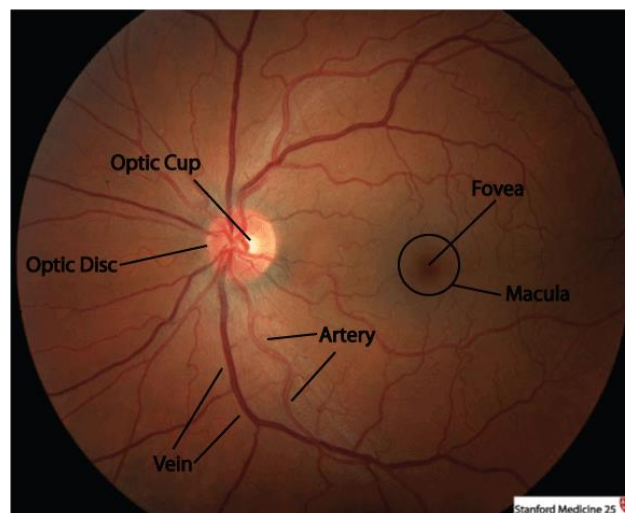


Figure 5 Normal Retina

In this paper we will be concentrating mainly on Retinal exam which is nothing but an exam where doctors view one's back of retina.

2.e Prognosis

Prognosis is a medical course following diagnosis. Generally, prognosis of cataract will include minor surgery where the intraocular lens is replaced. This surgery will be able to improve vision up to 90-95 percent. [19]

Artificial Intelligence

3.a History

It all started with us wondering how human brain works and trying to mimic it with machines. The AI research was first held at Dartmouth Conference ^[3] during summer 1956 and the people who participated in this conference are now the tycoons in the field after decades. Initially the implementation of AI was used in Chess and Checkers. Later, it was used for complex unsolved mathematical equations. Now, it is used in every field, from mimicking human brain to making complex engineering computations.

3.b Types

We can segregate types into two taking ability under consideration. ^[6]

3.b.1 Narrow AI

It is an implementation of single human like task, solely for one task. A few examples one may state are Face recognition, Voice search, Self-driven cars et cetera.

3.b.2 General AI

General AI is generally the attempt to mimic whole human brain with all cognitive thinking. Example, Iron man's Jarvis (Fictional).

AI basically works over a concept named Neural networks. The Neural networks are capable of learning patterns from a data. Hence, it is open to endless possibilities.

3.c AI in Healthcare

As far as healthcare is concerned, it demands meticulous analysis and predictions. The very first implementation of AI is a chatbot in 1965 that helped recreate a conversation between a psychotherapist and a patient. Now it has applications like Symptom predictor, screening of cancer, analysis of radiological scans, digital drug discovery which are hugely contributing to save lives.

AI in Ophthalmology

4.a Ophthalmology

Ophthalmology mainly deals with the study of medical conditions related to eye.

4.b Role of AI

AI based applications are used in Diabetes retinopathy, Glaucoma, retinopathy of prematurity, age-related macular degeneration and so on ^[4].

Walter App (conceptual)

Walter, A Desktop based application, is used for predicting cataracts with a retinal scan using image processing.

5.a Required Concepts

Image processing can be achieved with Convolutional Neural Network (CNN). This network works based on the concept of deep learning, a machine learning concept. ^[20]

5.b Working

Walter App will use CNN algorithm for processing the retinal scan and predicting cataract. The CNN algorithm basically divides the picture into segments and will take values for each segment based on colours and contrast. Then the values are passed in into the algorithm where it undergoes a series of differential equations and the algorithm will finally give a value between 0 and 1 where if the value is closer to 0, then the person is normal. If the value is closer to 1, then the person is likely to have cataracts in his eye. [The eye of normal person and a

person with a cataract can be seen in [Figure 9](#)]. First the CNN model is created and is trained with datasets of retinal image. Following that, the trained model will be merged with an application-based program eventually becoming an app. [A detailed view of the working can be seen in [Figure 10](#)]. The UI of the app will be kept simple, so that a normal person could understand it and wouldn't have to wait for a technician to operate.

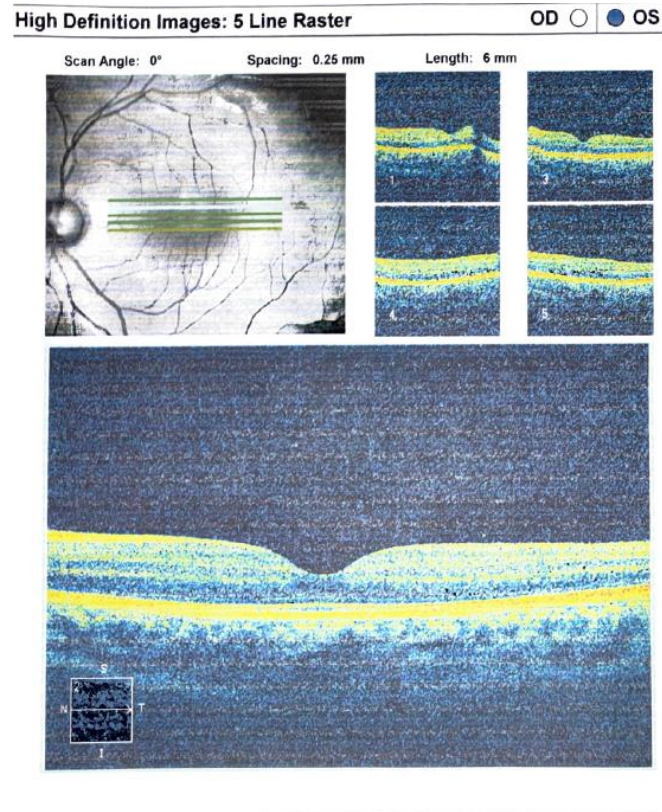


Figure 6 – Retinal scan

5.c Technological stack

Walter app will be implemented with CNN using Tensor flow and will be merge along with Java script in order to make it an application with user interface.

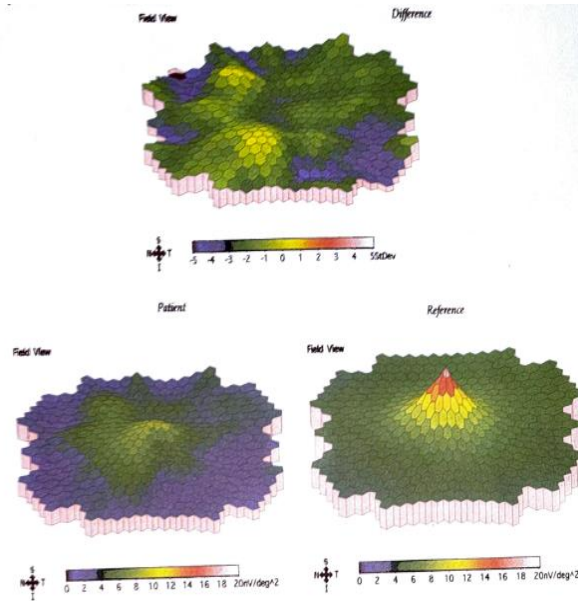


Figure 7 – Retinal scan

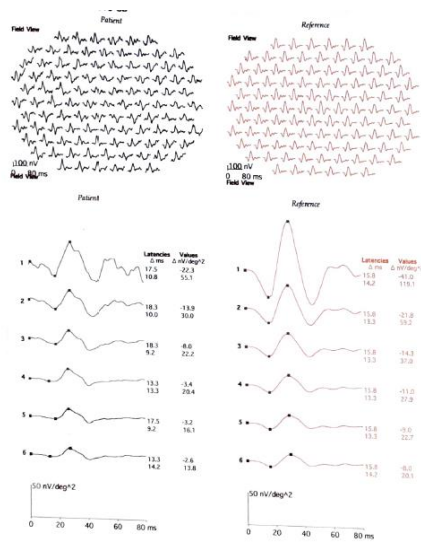


Figure 8 – Retinal scan

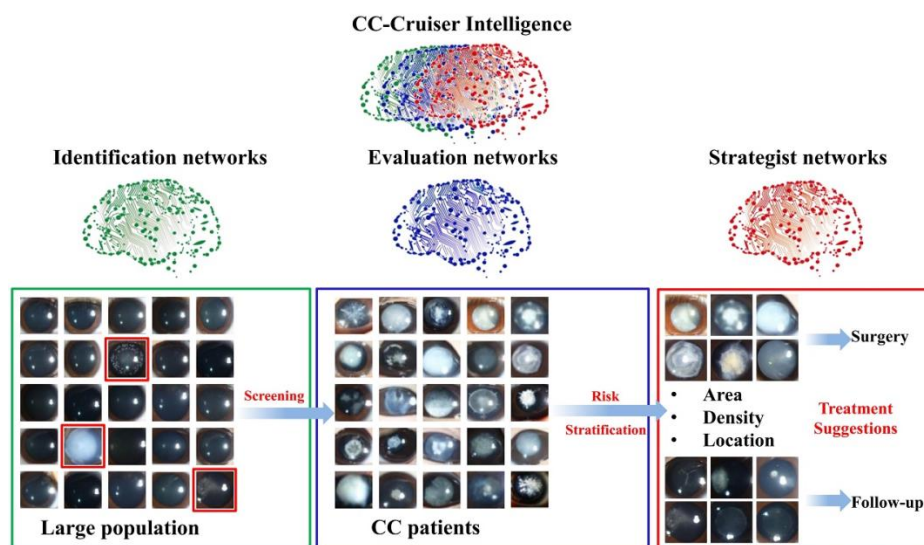


Figure 9 sample data

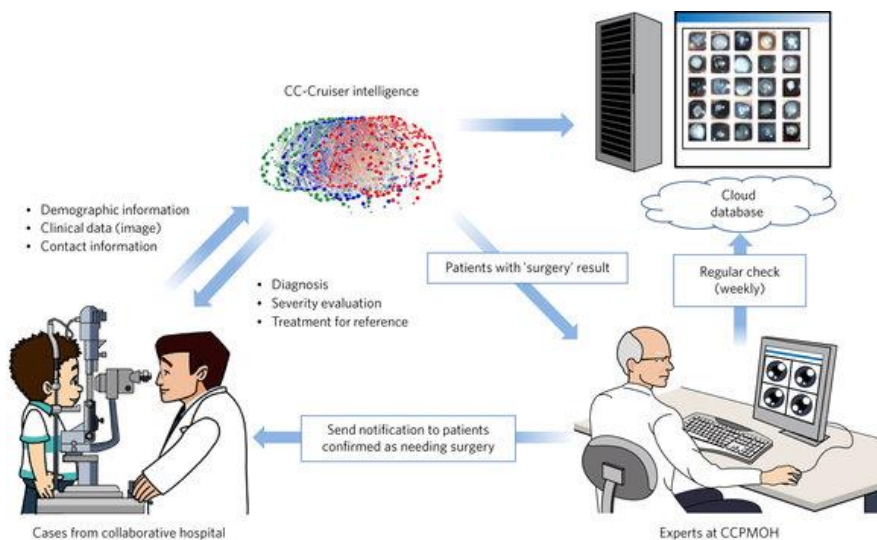


Figure 10 Process of identifying pediatric Cataract

Conclusion

The application of AI in the medical field facilitates the interpretation of results with higher accuracy and speed. Artificial Intelligence and machine learning can save lives by helping each and every individual patient beat the odds and live their life happily.

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