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Future diagnostic in Glaucoma using eye tracking technology

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Abstract- Glaucoma is one of the main causes of irreversible blindness in developed countries including India. It will be important to identify people affected by Glaucoma and to treat them before their condition progresses. This effort is especially important for among the people with glaucoma as a leading cause of blindness. Here, we discuss how eye tracker data may help us detect early glaucomatous changes in high-risk groups. This paper presents the use of eye tracker data to improve our ability to assess the risk of glaucoma in different populations. Eye movements are a continuous part of sensory perception of a scene. Whenever we interact with the visual environment we generate saccadic eye movements. Saccades move the eyes in a ballistic manner from one point to another, interspersed by fixations where the eye is stable. Scan paths describe the sequence of fixations and saccades. This eye movement signature data can be collected as a part of a person's daily activities and can be analyzed to detect eye diseases like Glaucoma.

Keywords- Glaucoma, Eye tracker, Saccades, scanpaths

I. INTRODUCTION

Glaucoma is a wide spread ophthalmic disease leading to progressive loss of visual field function. The death of retinal ganglion cells culminates in the loss of visual acuity, making glaucoma one of the main causes of irreversible blindness in industrialized nations and worldwide.[1,2] Elevated intraocular pressure (IOP) is a major risk factor for the onset of glaucoma.[3,4] In addition to IOP, other risk factors are well known, such as age, family history, and race.[5] Primary open angle glaucoma (POAG) and primary angle-closure glaucoma (PACG) are the main forms of the disease. Pseudoexfoliation (PEX) glaucoma is the main cause of secondary open-angle glaucoma. By the time the loss of retinal ganglion cells is clinically detected, extensive and irreversible damage has already occurred. [6,7] Since effective therapy can inhibit the progress of glaucoma, early diagnosis is one of the main goals in the treatment of this disease. It is strongly believed that the thinning of the retinal nerve fiber layer (RNFL) correlates highly with, or even precedes, visual field loss in glaucoma.[8] Therefore, establishing reliable methods of RNFL measurement could be one key step in early diagnosis and treatment of glaucoma.

Using optical coherence tomography (OCT), Huang [9] were the first to present a noncontact, noninvasive method of using low-coherence interferometry to determine the echo time delay and magnitude of backscattered light reflected off different layers of a structured tissue sample. The unique optic free pathway through the eye made OCT highly applicable to the visualization of retina layers. In 1995, time domain OCT (TD-OCT) was introduced as an imaging technique for glaucoma diagnosis. In spectral domain (SD)-OCT (Fourier domain OCT), a moving reference mirror, as used in TD-OCT, is no longer needed.[10,11] SD-OCT provides higher resolution at faster scanning speeds. Another invention available in recent OCT devices is the implementation of specific algorithms and software to further enhance scanning resolution and decrease motion artifacts.

In 2006, Spectralis SD-OCT (Heidelberg Engineering GmbH, Heidelberg, Germany) was introduced for retinal imaging. This instrument features two different options to enhance reproducibility. An online eye-tracking device (eye tracker) compensates for involuntary eye movements during the scanning process, and a retest function assures that follow-up measurements are taken from the same area of the retina as the baseline examination.

II. OVERVIEW

Glaucoma is a generic term for age-related disease of the optic nerve which can lead to irreversible loss of the visual field : the area which can be seen when the eye is directed forward, including both central and peripheral vision. Medical treatment to control the condition is largely successful, but once diagnosed all patients with glaucoma normally need life long treatment, and lifelong monitoring within hospitals and clinics, so that any worsening of visual damage can be detected. Therefore, people with glaucoma represent a major workload of eye services,

In humans, eye movement recordings are extensively used in behavioural and cognitive neuropsychological experiments. Eye movement recordings are also an important and sensitive tool to diagnose neurologic, ophthalmologic, and vestibular disorders. It is used by psychologists to determine the patient's focus or interest level.[15] There are different systems available that can be used to track eye movement.

III. MOTIVATION AND AIM

Glaucoma is one of the main causes of irreversible blindness in developed countries including India. It will be important to identify people affected by Glaucoma and to treat them before their condition progresses. This effort is especially important for among the people with glaucoma as a leading cause of blindness. once diagnosed all patients with glaucoma normally need life long treatment, and lifelong monitoring within hospitals and clinics, so that any worsening of visual damage can be detected. Therefore, people with glaucoma represent a major workload of eye services,

IV. METHODOLOGY

The pathogenesis of glaucoma shares many features with other chronic age-related neurode generative disease: there is, for example, ample evidence linking the etiology and disease process in glaucoma to Alzheimer's disease (AD) (Bayer et al., 2002; Sivak, 2013). The epidemiology and impact of glaucoma is well known but the pathogenesis of the disease is multifaceted and not well understood. Optic neuropathy is characterized in the clinic by changes in the optic nerve head (ONH) and thinning of the nerve fiber layer. This is almost certainly a result of a non-specific gradual reactive change of glial cells resulting in chronic retinal ganglion cell death and then loss of visual function (Tezel and Fourth ARVO/Pfizer Ophthalmics Research Institute Conference Working Group, 2009; Sivak, 2013). There are at least two theories to explain eye gaze. In short, eye movement can be driven by factors that purposely direct fixations toward task-driven locations or in the absence of such task demands eyes are likely directed to salient regions. Investigators have already used scanpaths to gain insights into what an observer is doing or their mental state. For example, a large variety of stud- ies have confirmed that eye movements contain rich signatures about an observer. An excellent up-to-date review of the literature is given elsewhere (Borji and Itti, 2014). Investigators have revealed data showing that simple view- ing patterns in controlled experiments can detect eye-movement abnormalities that can discriminate schizophrenia cases from control subjects with good accuracy (Benson et al., 2012). Other workers, extracting salient features from a series of films, have used eye movements to classify patients with attention deficit hyperactivity disorder and Parkinson's disease (Tseng et al., 2013). The work of this type has attempted to demonstrate the classi- fication of clinical populations from natural viewing. Errors in the ability to make anti-saccades (an eye movement purposely directed in the opposite direction from a target) has been repeat- edly implicated in AD (Crawford et al., 2013) and patients with AD have also been shown to display irregular eye movements when reading and in other tasks (Lueck et al., 2000; Mosimann et al., 2004).

Other research regarding the nature and consistency of the types of eye movement patterns shown by groups of individuals as they view scenes have been considered (Castelhano and Henderson, 2008; Cristino and Baddeley, 2009; Dorr et al., 2010). Data analyses in these studies typically, and inadequately, rely on simple counts and averages of, for exam- ple, number of fixations, saccade amplitude, and region of interest measures. We propose computational approaches to analyze eye-tracking data not used before, considering sequences of saccades within the scanpaths.

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V. CONCLUSION

To help physicians in the diagnostic of Glaucoma, recent research has looked into the development of computer aided diagnostic tools. Various techniques have been widely used for Glaucoma diagnostics. It will be important to identify people affected by Glaucoma and to treat them before their condition progresses. This effort is especially important for among the people with glaucoma as a leading cause of blindness. Here, we discuss how eye tracker data may help us detect early glaucomatous changes in high-risk groups. This paper presents the use of eye tracker data to improve our ability to assess the risk of glaucoma in different populations.

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