Chapter 7

Eye Tracker: An Assistive Tool in Diagnosis of Autism Spectrum Disorder

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ABSTRACT

The high prevalence of autism spectrum disorder (ASD) has provided a spectrum of diagnostic methodologies ranging from screening scales to technological techniques. The technology-based techniques, especially eye trackers, are shifting the traditional subjective approaches to objective, leading to early ASD screening and intervention. The eye gaze deficits marked by eye trackers are the valid biomarkers of ASD, but the trackers are not clinically available. Another reason for non-availability is the limited number of methodologies which can meaningfully analyze gaze data. The assistance of new technologies into eye tracker system explored here can (1) detect gaze patterns and cognitive abilities of individuals at the single platform and (2) analyze eye movements and events automatically using deep learning system rather than manual interpretation of raw data. These types of systems, if implemented, have the potential to assist clinicians for better ASD diagnosis and intervention approaches.

INTRODUCTION

Recently, International Clinical Epidemiology Network Trust (INCLEN) statistics reported that the number of Autism Spectrum Disorder (ASD) affected children has crossed 10 million in India or roughly it is 23 after 10,000 (Rudra, Belmonte, Soni, Banerjee, Mukerji, & Chakrabarti, 2017). ASD is a neuro-developmental disorder principally classified by impairments in the three core domains viz. social interaction, communication, and restricted-repeated behaviors (Bölte & Hallmayer, 2011). It occurs in the early developmental phase of an individual with the appearance of the spectrum of deficits which differentiates them from typically developed individuals. The failure in maintaining proper eye

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contacts, recognizing vocal effects (Bekele, Wade, Bian, Fan, Swanson, Warren, & Sarkar, 2016), judging and reading other’s facial expressions and intentions are the factors leading to poor interaction and communication in ASD (American Psychiatric Association, 2013). The reason for the same is that the neural networks of ASD individuals use different methodologies in monitoring the social information as compared to controls (Wang, Dapretto, Hariri, Sigman, & Bookheimer, 2004). In addition, the attention deficits, imitation and perception deficits co-occur with the disorder. These deficits are generally common in all individuals but their appearance varies from individual to individual (Bekele, Wade, Bian, Fan, Swanson, Warren, & Sarkar, 2016). The heterogeneity in ASD is not only because it has a wide range of symptoms but also due to variations in disorder onset (Ozonoff, Iosif, Young, Hepburn, Thompson, Colombi, & Rogers, 2011). The fact complicating the situation further is that no universally effective ASD diagnostic approach has been found yet. Therefore, ASD detection is based on the identification of visually appealing atypical behavioral traits and the cognitive mechanisms underlying these behaviors. The process of behavior tracing cannot be a robust diagnostic methodology since some individuals may show symptoms in infancy period or some may show in late childhood. The delay in diagnosis period can lead to delay in treatment process resulting in poor growth of ASD individual as compared to normal with the same age-group. The early diagnosis is not only mandatory for the early treatment but also to enhance their IQ so that they can also get involved in regular activities viz. education and social activities similar to normal individuals.

In literature, dozens of techniques have been proposed not only to diagnose ASD but also to help in identifying more cases. It is found that in ASD the behavioral impairments become very much complex with growth so follow-up screenings of the individual are required. The screening of individual from time to time can keep a track of the impairments. The clinicians and experts have invented different screening tools involving screening scales, interview methods, clinical observations, behavioral measures for evaluation and differential diagnosis of disorder (Matson, Nebel-Schwalm, & Matson, 2007). These primary screening techniques play their role after the onset of disorder making them inappropriate in early diagnosis or prognosis of the disorder. Along with this, there are some other limitations reducing the suitability of these techniques:

1. Age-specific as the scales are designed using different age groups and periods involving infants, childhood, and adult.
2. Rater biasing while measuring and diagnosing disorder sometimes shows symptoms of some other problem from the spectrum of disorder which reduces the effectiveness of this approach (Frazier, Klingemier, Beukemann, Speer, Markowitz, Parikh, & Ahuja, 2016).
3. Time-consuming as the expert need to design many questionnaires and to take responses from children as well as parents is a long-lasting process.
4. Subjective in nature as the disorder description is highly dependent on parent’s interview and clinician/expert observations (Frazier, Klingemier, Beukemann, Speer, Markowitz, Parikh, & Ahuja, 2016).
5. The administrator whether parents or clinician needs a proper training of tools or scales before applying the same to the children (Frazier, Klingemier, Beukemann, Speer, Markowitz, Parikh, & Ahuja, 2016). Sometimes, only trained administrators or experts/professionals are hired that further poses a restriction.
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