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Artificial intelligence in Autism Spectrum Disorder diagnosis of Visual Attention and Facial Recognition: A Scoping Review

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Abstract
Background: *Autism Spectrum Disorder (ASD) is estimated to affect 1 out of every 100 children globally, with early diagnosis critical for timely intervention. Conventional diagnostic techniques mostly rely on doctor's subjective behavioural observations, which are labor - intensive, resource- intensive and prone to inter-ratter variability. By identifying tiny abnormal patterns in eye gaze and facial expressions, artificial intelligence (AI), in particular visual attention analysis and facial recognition presents intriguing objective alternatives.*
Objectives: *With an emphasis on visual attention (such as eye tracking) and facial recognition technologies, this scoping review maps the scope, variety, and kind of AI applications in ASD diagnosis. It also identifies important techniques, performance measures and research needs.*
Methods: *Using electronic databases from Pubmed, Google Scholar, Web of Science, and Research Gate, a thorough literature analysis was carries out in compliance with PRISMA- ScR guidelines, concentrating on full-text articles published between 2015 and 2025. Analysis was done on eighteen studies that looked at the use of AI in the diagnosis of ASD in areas of visual attention and facial recognition.*
Results: *There were eighteen studies in the records. While visual attention AI used eye-tracking to identify inappropriate gaze fixation with roughly 85% accuracy, facial recognition models detected micro- expressions with about 80% sensitivity.*
Conclusion*: AI exhibits strong promise for scalable ASD diagnosis; however, standardization and varied validation are required. Clinical trials for practical implementation and multimodal integration should be given to priority in future research.*
Keywords*: Artificial Intelligence, Autism Spectrum Disorder, Facial Recognition, Screening, Visual Attention*

1. Introduction
Autism spectrum disorder (ASD) is a multifaceted neurodevelopmental condition characterized by distinct challenges in social interaction, communication, and behavior, with considerable variability across individuals.[1] It is recognized as a functional disorder involving three core domains of persistent impairment: qualitative deficits in social interaction, qualitative impairments in communication, and the presence of restricted, repetitive, and stereotype patterns of behavior, interests and activities. [2] Recent development in technology, especially in machine learning (ML) and artificial intelligence (AL), have encouraged prospects to improve ASD diagnosis and detection. [3] Early diagnosis is crucial for implementing effective interventions; however, identifying ASD at the age of 2-3 years remains challenging due to the limited behavioral repertoire in early childhood, especially in the domain of expressive language. [4] Despite recommendations advocating universal early screening, many family doctors either do not consistently screen or fail to refer those children with positive screening results for further diagnostic evaluation. Conventional diagnostic methods are frequently subjective, difficult and heavily dependent on the knowledge of qualified experts. These techniques mostly depend on clinical judgment and behavioral observations, which might cause delays in diagnosis, especially in environments with limited resources. [5] AI-based advancements in this area

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have the potential to transform the ASD diagnosis and treatment. These technologies have increased the Capacity of health care providers, accelerated diagnostic procedures, and expanded access to early intervention services. AI- driven solutions have a number of advantages over traditional face to face methods, such as enhanced availability for people in neglected and rural areas, lower travel and health check-ups costs and capacity to extend service coverage across boundaries. [6] Early intervention has been demonstrated to greatly reduce the severity of ASD symptoms and impairments in social attention, language skills and cognitive functioning. [7] One of the main areas of interest in current research is the examination of visual attention patterns in children with ASD. Atypical visual behaviors are seen like impaired attention, decreased eye contact and altered gaze fixation. The combination of AI algorithms and eye-tracking technology has made it possible through quantitative study of these patterns, providing possible biomarkers for early detection and diagnosis. [8] Facial recognitions systems employ computer vision algorithms, for analyzing facial features and emotional expressions, and affective responses in children with ASD. These methods help in diagnostic framework by offering non- invasive, and real time way of assessment. Eye tracking techniques additionally, are widely used in variety of fields like education, marketing, entertainment, healthcare and driving, hence proving their adaptability and usefulness in behavioral analysis. [9] This scoping review aims to evaluate application of AI based technologies in detection of ASD, serves as valuable methodological approach to examine broad and complex research areas by facilitating identification of key -concept, theoretical framework and existing evidences which highlights gaps in literature. [6] In spite of rapid expansion in this domain, still existing literature is heterogeneous with variation in study designs, methodologies and outcome measures. There is lack of evidences which address combined application of AI in visual attention and facial recognition of ASD. Therefore there is need of comprehensive mapping of the available evidence to highlight scope and gaps in this field.

1.1.Visual attention

Visual attention refers to attend selective relevant visual stimuli while suppressing irrelevant information. In individual with ASD, atypical visual attention patterns such as more focus on non-social peripheral stimuli, less attention to faces and eyes are well reported. These atypical patterns negatively influence development of social engagement, communication skills and eye tracking. Gaze duration, fixation and scan paths are proven methodologies which significantly objectify these patterns. These patterns are observable and measurable, potential early markers for the identification of ASD. [10, 11, 12]

1.2. Facial recognition

Facial recognition is strongly linked to visual attention processes and is the capacity to recognize and interpret facial features and emotional expressions. Children with autism spectrum conditions often struggle with processing emotional expressions, identifying familiar faces and interpret social cues. There is evidence to suggest that these difficulties could be for abnormal neural processing of facial information, which decreases activation in brain areas which are normally engaged in face perceptions. As a result, children with ASD use feature-based processing rather than holistic processing, when looking at faces. The major cause of social communication problems in ASD is the combined impairments in visual attention and facial recognition. [13, 14]

2. Objective

This review attempts to examine the application of artificial intelligence (AI) and evaluate its efficacy in diagnosis of autism spectrum disorder (ASD), with a focus on facial recognition and visual attention. It also aims to uncover significant methodologies, technical advancements and research trends.

3. Method

Literature search methodology: A comprehensive literature search was conducted using electronic databases in PubMed, Google Scholar, Science Direct and Research Gate. The search focused on full-text articles published in English between 2015 till 2025. Relevant keywords used in search included: “Artificial Intelligence”, “Autism Spectrum

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Disorder" OR ''ASD'' OR ''Autism'' OR ''AUTISTIC'' shortlisted studies focused on Autism Spectrum Disorder, "Facial Recognition", "Visual Attention", ''Diagnosis'' OR ''Screening'' OR ''Identification'' to ensure shortlisted studies focused on screening diagnosis, detection and identification of ASD.

- Eligibility criteria:

Articles that fulfilled the following inclusion criteria were included: a) Research with subjects between the ages of one to seventeen years, b) randomized controlled trials (RCTs), cross sectional studies, and case studies, c) studies using Artificial Intelligence (AI) techniques for diagnosing ASD. Reviews and meta-analyses, books, notes, theses or dissertations, conference proceedings or abstracts were all excluded. The PRISMA-SCR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews) flowchart was utilized in the study's selection process. A total of 18 articles that met the study criteria were selected for this scoping review, as represented in Figure 1.

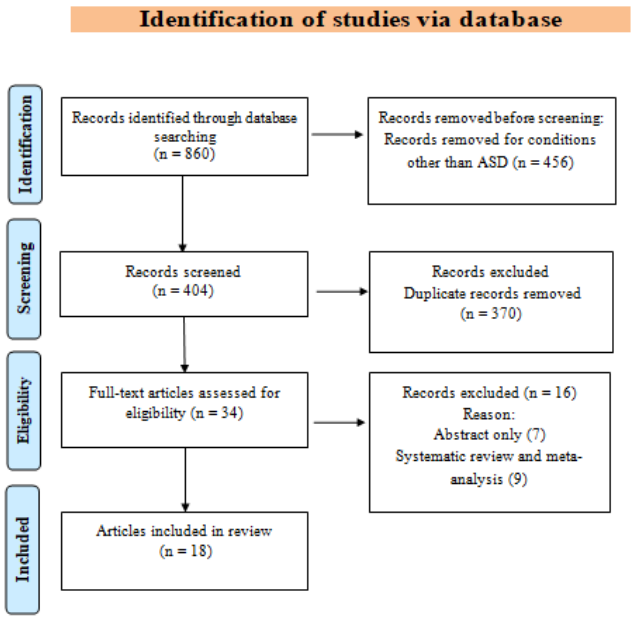

Figure 1 Prisma SCR- Flowchart

4. Results And Discussion

4.1. Results

The results from 18 articles demonstrated that the use of Artificial Intelligence techniques like Visual Attention and Facial Recognition helped in screening and diagnosing a child with ASD. While some studies favored AI alone, others found combined approaches were more effective than AI alone. Broadly, the use of AI like Visual Attention and Facial Recognition was shown to be beneficial techniques for screening children with Autism Spectrum Disorder.

4.2. Discussion

The usefulness of AI in diagnosing ASD is examined in this scoping review, with a particular emphasis on facial recognition and visual attention. Findings suggest that the techniques like Visual Attention and Facial Recognition may contribute in diagnosing features of ASD. The findings are consistent with growing evidence and significant benefits of AI, particularly in screening in ASD populations. The study incorporates various Haibin Cai et al. (2019) conducted an experimental study employing various artificial intelligence techniques including face alignment algorithms, eye gaze estimation and facial expression recognition and demonstrated their effectiveness in interpreting assessment components in children with Autism Spectrum Disorder (ASD). [15] Similarly a study by Sijun Zhang et al. (2025) integrated artificial intelligence with machine learning approaches, such as intelligent education platforms and developed smart monitoring systems to track and assess children with autism spectrum disorder. [16] Seyed Reza et al. (2020) employed machine learning and deep learning techniques to develop a new autism detection system, referred to as 'Autism AI'. This system utilized behavioral questionnaire data derived from screening tools such as Q-CHAT-10 and AQ-10, thereby facilitating effective screening for ASD. [17] In an experimental study, Jin Xie et al. (2019) used 700 images and matching eye movement patterns as a dataset from children with Autism Spectrum Disorder (ASD) and Typically Developing (TD) groups to create deep learning network for recognition. A Tobii eye-tracking equipment was used to gather data on eye movements. This advanced AI's ability to analyze children with ASD's eye-tracking habits and visual attention. [18] Two approaches in a face-based attention recognition model in a similar experimental study by Bilikis Banire et al. (2021) were done.

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Methods included geometric features transformation and conversion of time-domain spatial features into two-dimensional spatial representations. The results demonstrated that these techniques worked well for identifying and evaluate attention behaviors in children with ASD. [13]

Conclusion

The available data suggests the use of artificial intelligence (AI), helps in screening and diagnosis of children with autism spectrum disorder (ASD), especially in areas of visual attention and facial recognition. The advantages of AI-based methods have been highlighted in various publications, particularly in early- intervention. More research is necessary to determine the efficacy, validate results and investigate usefulness of different AI approaches across different ASD populations.

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