How Can Artificial Intelligence Be Used to Diagnose Autism Spectrum Disorder?

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ABSTRACT:

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by difficulties in social interaction and repetitive patterns of behavior. As ASD cases increase worldwide, there is an increased need for innovative and effective interventions. This literature review aims to assess the potential of Artificial Intelligence (AI) to diagnose ASD. I searched Google Scholar and PubMed using the key search terms Autism Spectrum Disorder diagnosis, MRI, facial recognition, emotion in speech, and fMRI to identify four relevant studies, excluding any studies before 2017. The results of the four reviewed articles revealed that AI has a strong potential in improving the assessment of ASD. However, data limitations, differing views, and lack of collaboration between clinicians, must be addressed before AI can be used to effectively diagnose ASD.

INTRODUCTION:

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects people's behavior and the way they function, ranging from mild to severe. ASD affects social communication and interaction. Challenges include not understanding sarcasm, taking things literally without understanding abstract concepts, and having difficulty processing information [1]. Signs of ASD also include repetitive and restrictive behavior. According to the CDC, nearly 1 of 36 children in the US have been diagnosed with ASDas of 2023 [1]. ASD is four times more commonly seen in males compared to females and has occurred in all racial, ethnic, and socioeconomic groups [1]. Globally, an estimate of 75 million people were reported to have ASD [1]. The diagnosis of ASD is difficult due to the lack of any specific medical tests or blood tests [1]. Currently, the diagnosis of ASD mainly depends on behavioral, parent-report, and interview assessments,which are very subjective, and time-consuming [1]. Two common tools used by medical specialists to diagnose ASD are MCHAT-R and ADOS [2]. However, these tools often miss the diagnosis or overdiagnose the case due to multiple barriers such as language barriers. Using this screening (check) tool, ASD could be detected as early as 18-months-old, but diagnosis has shown to be more reliable at age 2-years-old and up. However, many children do not receive their final diagnosis until they are much older due to the shorter availability of psychologists, psychiatrists, and developmental pediatricians [3]. Early diagnosis may lead to early intervention which could be beneficial to both patient and family.

As technology advances, medical professionals continue to see artificial intelligence (AI) as a potential tool for the diagnosis of ASD. AI is a machine or software that performs and mimics human intelligence to perform cognitive functions. AI could assist in the diagnosis of ASD efficiently using the algorithm to analyze large datasets of developmental milestones, behavioral

patterns, and medical records. These can lead to early screening, diagnosis, and intervention, which is crucial in order to improve the outcomes of individuals with autism. Although AI has shown promising potential in assisting the diagnosis of ASD, it does not replace the expertise of trained professionals. The purpose of this paper is to assess the combination of currently used screening tools and how AI could possibly speed the process of the diagnosis of ASD and increase the accuracy, leading to early intervention.

METHODS:

The inclusion criteria included AI being used to diagnose ASD. The articles stated the AI algorithms used to conduct the study such as using brain imaging using fMRI, emotion detection in speech, facial expression detection, and behavioral observation using skeletal movement. The articles also stated how participants of different gender and ethnicity were used in the studies conducted.

Articles that used specifically AI algorithms such as brain imaging using fMRI, emotion detection in speech, facial expression detection, and behavioral observation using skeletal movement were also included. Finally, The article/study includes that they tested both males and females as well as all ethnicity groups in order to determine the prevalence rate in gender and ethnicity groups.

The exclusion criteria of this study states the study must not be earlier than 2017. This is because AI was not implemented at the time therefore there is no data available. The study must also not test patients diagnosed with chronic conditions such as seizure disorder or hearing impairment. It may interfere with the AI algorithm result interpretation due to similar behavior. Finally, case reviews were excluded from this scopus review.

Based on the inclusion and exclusion criteria, four articles were reviewed from databases such as PubMed, Google Scholar using the key search terms: AI, Autism Spectrum Disorder diagnosis, MRI, facial recognition, emotion in speech, and fMRI. Using these keywords, four articles were chosen for this Scoping review amongst all others.

RESULTS:

Four articles were chosen to investigate the results of the different studies conducted [4-7]. Several computer aided design systems (CADS) were used based on AI techniques such as Machine Learning and Deep Learning (ML and DL methods) by using MRI modalities (sMRI and fMRI) which was less time consuming. Among various MRI modalities data sets Autism Brain Imaging Data Exchange (ABIDE) was the most complete and freely available database for MRI. Different pipelines methods were used for preprocessing of data sets, ABIDE was found to be the most popular pipeline. The most common method used for feature reduction/selection was principal component analysis (PCA) due to its ability to find a minimal number of features required for classification. For classification, which is the final step, support vector machines (SVM) have been widely used with AUC of 62%-99.52%. Random Forest (RF) classification method had the highest accuracy rate of100% and had 100% sensitivity and specificity followed

by LR. (Linear Regression). ML method is more time consuming and complex to design than DL method, because DL method automatically performs the steps from deep layers feature extraction to classification and requires little human intervention to function properly. Combination of both techniques may give more accurate results in diagnosing ASD.

A study by Song, et. al. reviewed thirteen studies using ML techniques and different classification methods used for multiple behavioral observation in ASD and typically developing (TD group) of children [4]. Among all behavioral symptoms eye tracking was the most important characteristic with accuracy of 88.51% when compared to other behaviors. Typically the developing group spent more time looking at the right eye while the ASD group spent more time on the left eye. This paper reviewed the eye tracking scan path in diagnosing ASD by using ML technique where 59 children participated that included both normal and ASD children. They watched a set of photography and age appropriate video. Eye tracking scan paths were converted to visual representation as a set of images when convolutional neural network (CNN) was used to classify the image. Results showed that an eye tracking scan path was able to differentiate children from ASD to non ASD groups.

CNN model can provide prediction accuracy of 90%. In this study eye movement velocity was compared with CARS (Childhood Autism rating Scale) scores which revealed possible correlation between the level of autism and eye motion velocity [5]. Individuals with high autistic traits tend to have shorter and less frequent saccades compared to low autistic traits. The comparison between eye movement velocity with CARS helped to mitigate the effect of outliers in eye tracking experiments.

Source	Machine Learning Model	Outcome
Megerian et al.	Gradient boosted decision tree machine learning algorithm	The algorithm enabled timely diagnostic evaluation with a high degree of accuracy for a third of the primary care sample
Song et al.	Support Vector Machines (SVM)	SVM has the highest accuracy in analyzing behavioral symptoms.this study also showed this classification method were able to exclude duplicate items to reduce the amount of time and effort needed in the assessment process.
Cillia et al.	Machine Learning - scan paths system used to	Eye tracking could be an objective tool for diagnosis of

	transform eye tracking into a set of visual images and then the CNN model used to perform image classification	ASD, CNN model could provide prediction accuracy close to 90%, study also revealed that individuals with high autistic traits have shorter and less frequent saccades compared to others with low autistic trait.
Parikh et al.	Neural Network Model	Personal characteristics data plus neuroimaging provided the highest sensitivity and specificity for neural network models to predict ASD diagnoses.

DISCUSSION:

The results of the reviewed papers showed the use of AI in the diagnosis of ASD has shown promising results [4-7]. ABIDE was the most popular method to retrieve data sets [4-7]. DL technique was proven to be superior to ML technique [4-7]. SVM classification was the most commonly used method among all other methods [4-7]. Eye tracking characteristics were proven to be the best method compared to other behaviors [4-7]. It was also well accepted by both clinicians and parents because of the ease of administration [4-7]. The biggest challenges of each of these studies was gathering standardized data sets, data complexity and use of a wide variety of classification methods [4-7]. These challenges required collaboration between AI researchers, clinicians and individuals with ASD to develop effective and responsible AI based diagnostic tools.

These findings suggest that AI has the potential to improve the accuracy and efficiency of ASD diagnosis leading to earlier interventions and support for individuals with the conditions. Based on the study reviewed, I would recommend that clinicians should implement AI for the diagnosis of ASD in addition to standard screening methods for earlier diagnosis and intervention. Future study can focus on the development of more accurate and reliable AI algorithms for early detection and diagnosis of ASD. Another area of exploration could be the integration of AI in the existing diagnostic tools. This could involve the development of AI powered screening tools and interactive systems that can assist clinicians in making more accurate and efficient diagnosis in the clinics.

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