A Survey On Smart Autism Support And Detection Hub

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Abstract: The platform helps in detecting early signs of autism with AI assistance and tailors programs to fit every core area of development that has been identified, which may include communication skills, daily living skills and adaptive learning through interactive modules. The integrated chatbot gives conversational support, engagement, answering questions and assisting both users and caregivers in getting the most out of what is available. This AI also aids in the early detection of autism by analyzing the language patterns and styles of interaction for early markers of ASD. With data privacy and ethical use at its core, this platform provides a holistic, supportive environment to all those with autism, helping them build the skills they need and become as independent as possible. The potential of the platform is to cater to the divergent needs of the autism community with a model of continuous, adaptive, and compassionate support that matches personal growth and social integration for people with autism.

Keywords- Autism Spectrum Disorder (ASD), Early Diagnosis of Autism, Machine Learning for Autism Diagnosis, Behavioral Analysis in Autism, sentimental Analysis, Emotion Recognition.

I. INTRODUCTION

Autism Spectrum Disorder is considered a neurodevelopmental disorder with specific challenges that involve difficulties with communication, social interaction, and emotional regulation. Such challenges show a very wide range of variability amongst individuals with ASD, thus warranting an individualized approach when it comes to therapy and help [1]. Of the areas that make up intervention in ASD are speech therapy, emotion recognition, and sentiment analysis-sentiments that are critical towards meaningful communication and understanding. It focuses on using advanced computational techniques to detect sentiments, emotions, and speech patterns in order to assist in autism diagnosis and therapy [2]. It uses multi-modal data such as speech signals, facial expressions, and textual cues to identify emotional states and communication barriers. Through these strategies, the caretakers and the therapist will be capable of understanding much better the necessities of the kids with autism. Research that includes machine learning with NLP capabilities to build devices for sentiment analysis and emotion detectors [16], it also engages speech therapy modules that provide a real-time feed for language growth and communication promotion. It utilizes multimodal data, such as speech signals, facial expressions, or textual cues, to identify emotional states and communication barriers. This would help the caregivers and therapists better understand the needs of those individuals with autism. The work utilizes machine learning and NLP techniques in the building of tools for sentiment analysis and emotion detection. It also incorporates speech therapy modules that offer real-time feedback, supporting language development and enhancing communication. The solution is designed to be adaptive and user-friendly for caregivers and individuals with autism [5]. The paper discusses methodologies, results, and potential applications of the proposed framework. In addressing the core challenges in emotional identification and speech development, this research will add to research that continues to bring quality improvement for people diagnosed with ASD and promotes inclusiveness.

II. LITERATURE REVIEW

2.1 Estimating Autism Severity in Young Children from Speech Signals Using a Deep Neural Network

Autism Spectrum Disorder is a neuro-developmental disorder that is diagnosed by the presence of social communication impairments, repetitive behaviors, and confined interests [1]. The vast majority of children with ASD have speech and expressive language abnormalities that range from total lack of speech (i.e., non-verbal children [17] to those who develop normal vocabulary and syntax, but exhibit difficulties with the use of appropriate prosody and pragmatics [2]. This heterogeneity is evident in the variable scores that children with ASD receive in standardized language assessments [1]. Early studies that have examined speech in children with ASD were based on small samples and manual analysis of short speech recordings. These studies have revealed that a considerable number of children with ASD exhibit expressive language delays often involving a prolonged pre-verbal stage [3]

2.2 A Multimodal Approach for the Early Detection of Autism Spectrum Disorders in Children

ASD is described as a complex neurodevelopmental disorder that affects mainly social interaction, and also poses challenges in communication, including restricted and repetitive behaviors.[1] Generally, ASD develops during early childhood, with effects on cognitive, sensory, motor, and even social-emotional functioning. The prevalence of ASD is growing and is currently estimated at 1 in 54 children in the United States. However, ASD diagnosis is commonly based on behavioural assessments whose interpretation is highly subjective. In addition, few professionals work with ASD [4]. Current studies focus on neuroimaging techniques such as EEG and ET to discover ASD biomarkers. EEG shows abnormalities in neural oscillations and functional connectivity, whereas ET points out atypical gaze patterns, such as reduced eye contact and altered joint attention. However, using these unimodal data sources separately is challenging because of the heterogeneity of ASD. A more promising direction would be that multimodal fusion would have been of potential value in bridging EEG neurophysiology to ET behavioural observations in deriving a complementary perspective in analysis. This paper provides an innovation using a deep-learning framework which is multimodal, aims at diagnosis by integrating data of EEG and ET on 90 children to produce diagnostic information for better ASD recognition and assessment of its complexity on ASD diagnostics.

2.3. Autism Spectrum Disorder Classification Using Machine Learning Classifiers

The diagnosis of autism spectrum disorder is a long and complex process, which may take up to six months to be completed. Involving consultants such as developmental pediatricians, neurologists, psychiatrists or psychologists, it is a comprehensive approach that attempts to capture the complexity of symptoms of ASD.In this slow process which not only adds weight to the emotional burden of families but also delays the much-needed early intervention, Early Intervention is said to greatly enhance the outcomes of any individual on the autism spectrum [2]. The time-consuming diagnostic timeline hinders starting these important interventions in due time. Machine Learning methods appear promising to overcome such problems in healthcare. We use algorithms like Support Vector Machine, Logistic Regression, Random Forest, Boost, and MLP to speed up this ASD diagnosis process several folds. This study emphasizes the transformative potential of Machine Learning in providing faster, more accessible, and accurate diagnoses for ASD, ultimately enhancing the prospects for Early Intervention and improved outcomes for autistic individuals.

Out of the above models, SVM got the highest accuracy at 92.67%, thereby showing it to be efficient enough in handling complex, non-linear data patterns. On the ROC-AUC axis, Logistic Regression surpassed all with a score of 92.87% hence making it very good in identifying true positive rates. [3] Random Forest balanced accuracy at 91.7%. XGBoost had a competitive performance but that was slightly lower accuracy than the best model at 90.67%. MLP ranked third in terms of accuracy in the list of all models. These results point out the strengths of each classifier. SVM and Logistic Regression were found to be particularly promising for applications where accuracy and sensitivity are the main concerns. Although Logistic Regression is simpler and more interpretable, its inability to handle complex relationships suggests that SVM may be more suitable for data with complex patterns. In general, the study points out the robustness and flexibility of SVM, making it the best choice for reliable performance.

2.4 Autism prediction through convergence of machine learning and internet of things (IOT)

This platform integrates real-time eye-tracking using the Raspberry Pi 0W to enhance the accuracy of predicting risk for the disease of autism. The traditional laptop cameras have low resolutions, lack built-in wireless connectivity (Wi-Fi 802.11n and Bluetooth 4.2), and consume high power with GPIO pin usage for sensor integration[14]. The system generates a ratio for the pupil location depending upon the pupil's gaze direction and some threshold values, on which it shows the gaze direction.[6] In case the value acquired is below 0.40 or above 0.65 then this will produce 30% of the risk to be an autism; otherwise, within the result between 0.40 and 0.65 indicates no risk. This accurate analysis of eye gazing provides this new technology that is the inexpensive yet more reliable method through which early evaluations for autism risk could be executed [14]. Random Forest as well as the Support Vector Machine machine learning algorithm serves as classifier while classifying the input images to the model given, determining the results based on whether a person is autistic or not. Random Forest is an ensemble learning method, which combines the predictions of multiple decision trees for making predictions.[5] It can be applied to autism detection by using its ability to analyze various features and provide accurate predictions. The benefits of using Random Forest in autism detection include accurate predictions, feature importance analysis, and interpretability. However, it is paramount to mention that Random Forest alone should not be a tool for a definitive diagnosis. Instead, they are a significant support in screening and pointing out people to the healthcare experts for follow-up tests regarding autism spectrum disorders. Another image classification algorithm is Support Vector Machine, or SVM.

2.5 Computer Vision-Based Assessment of Autistic Children: Analyzing Interactions, Emotions, Human Pose, and Life Skills

Human Pose Estimation (HPE) is a technique of advanced computer vision that detects and analyzes human body poses in 2D or 3D space, using monocular or depth camera modalities. Though these methods perform well in applications like skeletal joint regression and gesture recognition, they are primarily designed for adults and not adaptable to children, especially those with special needs like ASD.[3] Challenges like data privacy, expensive collection processes, and calibration intricacies do not allow it to have a wider range of application [11]. Current algorithms struggle with fast and random movements of children so they have low efficiency in monitoring different behaviors and social clues [12]. To fill these gaps, this project aims to develop the specialized HPE models optimized for the tracking of head and hand movements, with accurate and reliable performance for both toddlers and adults [15].The intensity and frequency of eye contact and facial expressions can serve to enhance verbal as well as non-verbal communication among individuals. Maintaining eye contact becomes disturbing for some ASD children causing them social anxiety [16]. The ability to mimic and understand facial emotions contributes to the social functioning of any person. ASD children fail to comprehend and respond to nonverbal stimuli and understand and interpret facial expressions and their corresponding emotions [18].

III. FUTURE RESEARCH ASPECTS

Integration of Multimodal Data: EEG, ET, and Human Pose Estimation data may be combined to give a more holistic view of neurophysiological and behavioral patterns in ASD patients. This could increase the diagnostic accuracy and allow for deeper insight into the complexity of the disorder.

i. Advanced Deep Learning Models: The further development of deep learning-based frameworks, tailored specifically for ASD diagnosis, might allow for improved feature extraction and fusion from different modalities, including EEG signals, eye-tracking data, or skeletal movement tracking. Even models such as multimodal transformers might enable the capture of relationships across heterogenous datasets.

ii. IoT Devices for Real-Time Monitoring: IoT-based devices, such as a Raspberry Pi camera for live eye-tracking and pose estimation, can be integrated to make ASD risk assessments accessible, portable, and low-cost. These systems can be used in clinical, educational, or home settings.

iii. Child-Specific Algorithms: Development of algorithms optimized for fast, unpredictable movements of children may help improve the Human Pose Estimation accuracy. Such algorithms may emphasize catching subtle social and behavioural details, which are so vital in the management of ASD.

iv. Ethical and Secure Data Handling: The focus will be on data security and privacy issues, particularly on applications related to children. There will be issues of secure data storage, anonymization techniques, and ethical practices concerning AI.

v. Wearable Technology: Wearable devices that can track real-time gaze and pose will provide non-intrusive, continuous monitoring. Such wearable devices may be integrated with analytics platforms in the cloud, which will allow for ongoing assessments and feedback to caregivers or clinicians.

IV. CONCLUSION

This integration of deep learning, IoT devices, and multimodal data fusion into diagnosis and management represents a great step forward in the treatment and diagnosis of autism spectrum disorder. Tools such as EEG, eye-tracking, and human pose estimation will enable further understanding of the behavioural and neurological patterns that come along with ASD. This notwithstanding, there seem to be bright spots: there have been child-specific algorithms put into development, along with an improvement in cost-effective ways to monitor children's lives.

This development opens quite an avenue to more reachable yet accurate solutions that help bring about change in ASD diagnostics while enabling personal intervention opportunities. Global collaboration, ethical innovation, and a focus on inclusivity will make this field have a meaningful impact on the lives of children and families affected by ASD

IV. REFERENCES

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