ASD PREDICTION

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ABSTRACT

The proposed system uses multiple AI-based methods to develop a complete Autism Spectrum Disorder (ASD) prediction system which helps doctors identify autism early and make better diagnoses and provide better care for children with autism. The neurodevelopmental disorder ASD presents doctors with difficulties when they need to diagnose it because the condition shows wide variations in behavioral and cognitive and physiological symptoms. The system includes three connected modules which focus on specific age ranges and information categories to fill this knowledge deficiency. The first module uses machine learning models to study 0–3 year old infants and toddlers by analyzing their developmental milestones and social behaviors and sensory reactions and interaction methods which serve as essential signs for developing ASD characteristics. The second module examines children between 4 and 11 years old by studying their speech habits and mental abilities and social skills and adaptive responses to monitor their behavior development across different ages. The system uses Convolutional Neural Networks (CNNs) to run a deep-learning image classification model which evaluates facial expressions and gaze patterns and visual behavioral cues that show hidden ASD characteristics which standard assessment tools cannot detect. The system uses behavioral data together with developmental information and visual evidence to create an advanced prediction system which delivers precise results while eliminating human judgment errors that produce incorrect positive or negative results. The platform operates with scalability while providing easy access to users who need to use it in areas with restricted access to specialized diagnostic facilities. The system updates its knowledge base through new data entries to stay relevant with current research findings about ASD. The system provides users with two main functions which include prediction and individualized recommendations for starting treatment and developing therapy plans and caring for their children. The project works to enhance autism detection at an early stage while providing ongoing developmental assistance which results in better life quality for people with autism.

Keyword: *Autism Spectrum Disorder (ASD), Machine Learning, Deep Learning, Early Diagnosis, Behavioral Analysis, Convolutional Neural Networks (CNN), Predictive Modeling*

1. INTRODUCTION

Autism Spectrum Disorder (ASD) represents a complex neurodevelopmental condition which produces various social and communication and behavioral difficulties in individuals. The process of detecting ASD at an early stage followed by proper intervention helps people with ASD achieve better results. The research aims to create a new method for ASD prediction through the combination of advanced machine learning methods with a systematic evaluation system. Our research combines behavioral pattern analysis of children from birth through three years with older people and CNN-based image classification to develop a complete system which identifies ASD at its earliest stages.

Early Behavioral Analysis: The first part of our project uses machine learning algorithms to study behavioral information which researchers collect from children during their first three years of life. The first stage of development requires immediate action because it creates opportunities to stop ASD from causing permanent damage to child development. The model examines multiple behavioral indicators which include social behavior and speech and body language signals and sensory perception patterns to detect early warning indicators for ASD development. The new method will create an essential resource which helps parents and caregivers and healthcare providers to develop early intervention techniques.

The second part of our project uses behavioral analysis to study people who belong to different age groups starting from four years old and extending to eleven years.

The project uses Convolutional Neural Networks (CNNs) for image-based Autism Spectrum Disorder (ASD) classification alongside behavioral analysis. By analyzing visual data, we can identify patterns that are not visible when we look at behavior alone. This new approach allows for better prediction of ASD through improved identification methods that yield more accurate results. Our team focuses on boosting the prediction system with CNN integration, creating an effective way to detect medical conditions early.

1.1 Literature review

Research on diagnosing Autism Spectrum Disorder (ASD) has improved, but scientists still find significant knowledge gaps. The foundational paper indicates that ASD can be predicted using a few medical and background characteristics, showing that simple screening methods exist for affordable and non-invasive testing. Studies show that diagnostic accuracy increases when using behavioral assessments along with neuroimaging, genetic screening, machine learning, and deep learning models. Current systems have limited capabilities because they rely on a single measurement method, require human judgment, and do not assess children before they turn three. The existing research lacks a unified predictive system that combines behavioral data with minimal feature information and imaging results to assist autistic individuals and their caregivers with real-time tools. The identified research gaps highlight the need for a complete system that predicts ASD in early development through multiple detection methods and provides actionable support for children. This system should merge basic machine learning algorithms with advanced imaging technology and interactive support tools.

1.2 Problem statement

Early detection of Autism Spectrum Disorder (ASD) requires swift and accurate identification. However, current assessment methods are slow, costly, and depend heavily on human judgment, resulting in poor outcomes across different age groups. The initial behavioral signs that appear in infants and young children are often subtle, and medical professionals need to look for visual signs that behavior alone may not reveal. This research project addresses these knowledge gaps by using machine learning-based behavioral assessments in early development. It evaluates various age groups and employs CNN-based image classification to improve the precision, accessibility, and speed of ASD predictions.

2.Methodology

The research design for this ASD prediction study involves collecting behavioral data alongside minimal medical information and neuroimaging data from subjects at different developmental stages. This occurs before the preprocessing steps, which include normalization, encoding, and image augmentation. The system uses key features to reduce data dimensions while training machine learning models, including SVM, Random Forest, and Bernoulli Naive Bayes, on behavioral and medical information, with CNNs for image prediction tasks. The two models generate predictions that are combined using ensemble or multi-input methods to arrive at the final medical diagnosis. The system tests its accuracy across different age groups before it becomes accessible through an easy-to-use interface that provides quick and reliable ASD diagnoses.

3. RESULTS AND DISCUSSION

The performance analysis of the ASD prediction system demonstrates the effectiveness of combining behavioral and neuroimaging data. The behavioral Random Forest model achieved 89.5% accuracy with high recall (91%), indicating strong detection of ASD cases, while the CNN-based MRI model reached 92.5% accuracy and 94% precision, effectively identifying non-ASD individuals and capturing structural brain features. The proposed fusion model outperformed both, achieving 93.2% accuracy, 92.5% precision, and 90.1% recall, highlighting the advantage of integrating behavioral and MRI inputs for more reliable diagnosis. Compared to existing systems, which rely on single modalities and have lower accuracy or subjective limitations, the fusion model provides higher diagnostic confidence, reduces misclassification risk, and supports early intervention. Key findings emphasize the multimodal advantage, the clinical importance of behavioral features like social interaction and communication deficits, and the neuroimaging confirmation of atypical brain patterns, offering practical insights for clinicians and caregivers in enhancing early detection and prioritizing interventions.

3.1 Challenges and solutions

During the development of the ASD Detection System, several technical challenges were encountered and addressed. Class imbalance in the dataset was handled through data augmentation, oversampling, and class weighting to improve model generalization. Variations in image quality were mitigated via standardized preprocessing, including resizing, normalization, noise reduction, and ROI extraction. CNN overfitting due to limited data was controlled with dropout, regularization, reduced depth, early stopping, and augmented datasets. Slow local training was resolved by migrating to GPU-enabled environments like Google Colab. Integration with Flask was optimized by globally loading the model, separating preprocessing functions, and organizing routes for responsiveness. Library compatibility issues were addressed by maintaining fixed package versions, and user image upload errors were prevented through format validation, file-size checks, and error handling. Collectively, these solutions enhanced model accuracy, efficiency, robustness, and usability.

Challenge	Solution
Model overfitting during training	Dropout layers, reduced depth, early stopping, L2 regularization, augmented data
Slow model training on local machine	Moved training to Google Colab with GPU acceleration and larger batch sizes
Integrating trained model with Flask	Global model loading, separate preprocessing functions, organized routes, proper output mapping
Compatibility issues between libraries	Maintained fixed library versions, updated incompatible packages, reinstalled environment
Handling user image upload errors	File format and size validation, try–except handling, user-friendly error messages

Chart -1: Challenges and their solutions

4. CONCLUSIONS

The Autism Prediction System successfully integrated machine learning–based behavioral analysis with a CNN-powered MRI image classification model to enhance the early identification of Autism Spectrum Disorder (ASD). The Random Forest behavioral model achieved an accuracy of 89.5%, while the CNN model reached 92.5%, demonstrating strong performance in detecting both behavioral and neurological patterns associated with ASD. The final fusion model, which combined predictions from both approaches, achieved an overall accuracy of 93.2%, outperforming traditional single-modality diagnostic systems.
This multimodal approach produced more reliable, comprehensive, and clinically relevant insights, supporting early detection and intervention. Additionally, the project identified key behavioral features—such as social interaction difficulties, communication delays, and repetitive actions—and confirmed MRI-based patterns typically associated with ASD, enhancing the explanatory power of the system.

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