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Early Detection of Autism Spectrum Disorder Using Clinical and Image-Based Data

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ABSTRACT

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by challenges in social communication and the presence of repetitive behaviors, with symptoms typically emerging in early childhood. Accurate and timely diagnosis is critical for effective intervention, yet traditional diagnostic methods often struggle with the heterogeneous presentation of ASD. This paper presents a comprehensive web-based system that integrates both structured clinical behavioral data and image analysis to enhance autism prediction. Machine learning algorithms, including Random Forest, Support Vector Machine, and Decision Tree classifiers, are employed to analyze behavioral assessments and clinical history, while a deep learning-based Convolutional Neural Network processes image data for alternative detection pathways. The platform offers an interactive interface, allowing users to input clinical data or upload images for risk evaluation, and provides immediate, interpretable results. Additionally, the system includes educational resources and administrative tools for user management. By combining conventional machine learning with state-of-the-art deep learning models, this approach delivers a robust, multi-dimensional solution for early ASD screening, supporting timely intervention and improved outcomes for affected individuals and their familie

Keywords: Autism Spectrum Disorder, Machine Learning, Support Vector Machine, Convolutional Neural Network, Random Forest.

I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a multifaceted neurodevelopmental condition that primarily affects social communication, interaction, and behavior patterns. Characterized by a wide range of symptoms and severity, ASD typically becomes evident in early childhood. Early diagnosis is crucial as it enables timely intervention, which can significantly improve the developmental trajectory and quality of life for affected individuals. However, diagnosing ASD remains a complex challenge due to the variability in symptoms and the subjective nature of traditional diagnostic methods, which often rely on clinical observations and standardized behavioral assessments. Moreover, access to specialized diagnostic services may be limited in many regions, leading to delays in identification and intervention.

Recent advances in artificial intelligence, particularly in machine learning (ML) and deep learning (DL), have opened new possibilities for enhancing the accuracy and efficiency of ASD screening and diagnosis. Machine learning algorithms such as Random Forest, Support Vector Machine (SVM), and Decision Tree classifiers have shown promise in analyzing structured clinical data, including behavioral scores, demographic information, and medical history, to predict the likelihood of ASD. Concurrently, deep learning models, especially Convolutional Neural Networks (CNNs), have demonstrated strong capabilities in processing unstructured data like facial images and neuroimaging scans to detect subtle visual and neurological markers associated with autism. These AI- driven approaches can identify complex patterns that may be difficult for human evaluators to discern, enabling earlier and more objective assessments.

Integrating clinical behavioral data with image-based analysis provides a comprehensive, multi-modal approach to ASD prediction. Behavioral assessments capture critical information about social and communicative functioning, while image analysis can reveal phenotypic or neuroanatomical features linked to ASD. Combining these data sources enhances the robustness and reliability of screening tools by leveraging the strengths of both modalities. Hybrid systems that fuse machine learning classifiers with deep learning image analysis have been shown to outperform single-modality models, offering improved sensitivity and specificity in early detection. Such systems are particularly valuable in settings where traditional diagnostic resources are scarce or where rapid screening is needed.

To translate these technological advances into practical tools, accessible and user- friendly platforms are essential. Web-based applications provide an ideal medium for delivering AI-powered ASD screening tools to a broad audience, including caregivers, clinicians, and educators. These platforms enable users to input structured clinical data or upload images for analysis, with real-time feedback provided by the underlying predictive models. Additionally, they can offer educational content and frequently asked questions to support users in understanding autism and the implications of screening results. Secure user registration and administrative functionalities ensure data privacy, user management, and the ongoing maintenance of the platform.

This paper presents the design and implementation of a comprehensive web application that integrates machine learning and deep learning techniques for early ASD prediction. The system analyzes behavioral assessment scores (A1 to A10), demographic factors such as age and gender, medical history including jaundice and family history of autism, and facial images processed through a DenseNet-based CNN model. Machine learning algorithms like Random Forest, SVM, and Decision Tree classifiers evaluate the structured clinical data, while the deep learning model provides an alternative diagnostic pathway through image analysis. The platform's interactive interface allows users to register, log in, and access prediction tools, delivering immediate and interpretable results. It also includes administrative controls for managing user accounts and updating educational resources.

By combining conventional machine learning with cutting-edge deep learning approaches, the proposed system aims to improve the accuracy, reliability, and accessibility of early autism screening. This multi-dimensional solution supports timely diagnosis and intervention, which are critical for optimizing developmental outcomes for individuals with ASD. Furthermore, by making advanced predictive technologies available through an intuitive web interface, the platform empowers families and healthcare providers to make informed decisions and take proactive steps in managing autism. This work contributes to the growing field of AI applications in neurodevelopmental disorders and demonstrates the potential of integrated, AI-driven screening tools to transform autism diagnosis and care.

II. RELATED WORK

A Machine Learning Framework for Early- Stage Detection of Autism Spectrum Disorders, Authors: S. M. Mahedy Hasan, Md Palash Uddin, Md Al Mamun, Muhammad Imran Sharif, Anwaar Ulhaq, Govind Krishnamoorthy, Author: Anwaar Ulhaq

This study introduces a robust machine learning framework for the early detection of Autism Spectrum Disorder (ASD) using diverse classification and feature-scaling techniques. Four standard ASD datasets— covering various age groups—are used to evaluate combinations of eight classifiers and four feature scaling methods. The framework achieves impressive accuracy levels, with AdaBoost and LDA emerging as top performers. Additionally, the paper performs in-depth feature importance analysis using four selection techniques to identify key ASD indicators. These findings offer valuable guidance for healthcare professionals aiming to enhance early ASD diagnosis and intervention strategies.[1]

Autism Detection Based on MRI Images Using Deep Learning, Authors: Sadab Mostafa, Zihadul Karim, Muhammad Iqbal Hossain.

This study explores a deep learning-based approach for diagnosing Autism Spectrum Disorder (ASD) using functional and structural MRI images. Utilizing the ABIDE dataset, the researchers developed a model that bypasses traditional pre- processing and leverages advanced deep learning architectures to classify ASD- related brain patterns. A custom convolutional block was introduced to enhance the dataset and boost classification accuracy, reaching up to 84%. The findings underscore the potential of MRI-based deep learning methods as a promising alternative to conventional ASD diagnosis, which currently lacks standardized biomarkers.[2]

Detecting Children with Autism Spectrum Disorder Based on Eye-Tracking and Machine Learning, Authors: Hsin-Yi Lu, Yang-Cheng Lin, Chia-Hsin Chen, Chih- Chung Wang, Ia-Wen Han, Wen-Lung Liang.

This study proposes a machine learning- based method to detect Autism Spectrum Disorder (ASD) in children using eye- tracking data. A group of 58 children aged 4 to 6 was assessed using static images while their eye movements were recorded. Features like fixation count and duration were extracted and refined using Principal Component Analysis (PCA). Classifiers including SVM, Random Forest, and XGBoost achieved high accuracy, with XGBoost reaching 94.4% and an AUC of
0.99. The findings demonstrate the effectiveness of combining AI and eye- tracking as a non-invasive, efficient diagnostic tool to support early ASD detection.[3]

Analysis of Brain Imaging Data for the Detection of Early Age Autism Spectrum Disorder Using Transfer Learning Approaches for Internet of Things, Authors: Adnan Ashraf, Zhao Qingjie, Waqas Haider Khan Bangyal, Muddesar Iqbal.

This study explores the use of deep learning, particularly Convolutional Neural Networks (CNN) and transfer learning, to detect early-age Autism Spectrum Disorder (ASD) from brain imaging data using Internet of Things (IoT) frameworks. Using rs-fMRI data from the ABIDE-I and ABIDE-II datasets, the research leverages 4D imaging data to develop biomarkers for ASD diagnosis. The optimized CNN model achieved an accuracy of 81.56%, surpassing earlier approaches. The integration of AI and IoT is highlighted as a transformative approach for real-time, automated ASD detection, with the goal of easing early adaptation for autistic children through intelligent diagnostics.[4]

Detection of Autism Spectrum Disorder (ASD) in Children and Adults Using Machine Learning, Authors: Muhammad Shoaib Farooq, Rabia Tehseen, Maidah Sabir, Zabihullah Atal.

This research introduces a novel federated learning (FL) approach for the early and accurate detection of Autism Spectrum Disorder (ASD) in children and adults. Using FL, logistic regression and support vector machine classifiers are trained locally on separate ASD datasets, and their outputs are merged using a central meta-classifier to determine the most accurate model. The study uses four large ASD datasets, each with over 600 records, and reports impressive classification accuracy—98% for children and 81% for adults. The proposed FL framework ensures data privacy and model efficiency, highlighting its potential for scalable, real- world clinical applications in ASD diagnosis.[5]

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ensures data privacy and model efficiency, highlighting its potential for scalable, real- world clinical applications in ASD diagnosis.[6]

Enhanced Detection of Autism Spectrum Disorder Using ResNet: A Deep Learning Approach, Authors: S. Baghavathi Priya, Priyanga S, Surya Shobith Kamisetty.

This study presents a deep learning-based method using the ResNet50 architecture for early and accurate detection of Autism Spectrum Disorder (ASD) through eye- tracking data. A total of 547 eye movement images (219 ASD, 328 non-ASD) were analyzed using a fine-tuned ResNet50 model with transfer learning and data augmentation. The system achieved an impressive 95% validation accuracy and AUC of 0.95, indicating strong predictive capabilities. The research highlights the effectiveness of convolutional neural networks, particularly ResNet, in medical imaging tasks related to neurodevelopmental disorders like ASD, offering significant potential for clinical screening and early intervention.[7]

Computer Vision-based Interactive Autism Detection System using Deep Learning, Authors: Badhon Parvej, Sikder Md Mahbub Alam, Faizul Islam Fahim, Md. Naimul Pathan, Muhammad Aminur Rahaman.

This research proposes a deep learning- based system for early autism detection through facial image analysis. Utilizing a dataset of 2,940 facial images, the study employed enhanced versions of VGG16 and VGG19 convolutional neural networks (CNNs) to identify ASD-related features. By tuning training parameters and evaluating key performance metrics, the VGG19 model achieved an accuracy of 88%, outperforming the modified VGG16 model. The system demonstrates the effectiveness of computer vision and transfer learning techniques for automated ASD diagnosis, emphasizing the value of facial asymmetry and visual cues as early indicators of autism.[8]

Automatic Classification of Autism Spectrum Disorder (ASD) from Brain MR Images Based on Feature Optimization and Machine Learning, Authors: Mamata Lohar, Suvarna Chorage.

This study presents a machine learning- based framework for the automatic classification of Autism Spectrum Disorder (ASD) using brain MR images. Utilizing structural and functional MRI data from the ABIDE dataset, the authors employed feature extraction via GLCM, and feature selection using PCA and forward selection methods. The model classified ASD and typical control (TC) subjects, achieving a maximum accuracy of 66.66% for sMRI using an SVM classifier and 56.66% for fMRI with a Decision Tree. This approach demonstrates the potential of optimized feature selection and ML for early ASD diagnosis, although further accuracy improvements are needed for clinical application.[9]

EEG Based Autism Detection Using CNN Through Correlation Based Transformation of Channels' Data, Authors: Zahrul Jannat Peya, M.A.H. Akhand, Jannatul Ferdous Srabonee, N. Siddique.

This study introduces a deep learning approach for early detection of Autism Spectrum

Disorder (ASD) using EEG data. The EEG signals were transformed into 2D matrices using Pearson's Correlation Coefficient to capture the inter-channel relationships, which were then classified using a residual CNN model. Conducted on clinical EEG data, the proposed method achieved an exceptional classification accuracy of 100%, showcasing the strong potential of correlation-based EEG feature transformation combined with CNN for accurate ASD diagnosis. This approach underscores the viability of non-invasive, signal-based early screening techniques for autism.[10]

III. METHODOLOGY

The methodology for the proposed autism prediction system involves a multi-stage process that integrates both machine learning and deep learning techniques to analyze structured clinical data and image inputs for early and accurate ASD screening. The process begins with comprehensive data collection and preprocessing, followed by feature selection, model training and evaluation, and culminates in the deployment of these models within a user-friendly web application. This systematic approach ensures that both behavioral and visual indicators of autism are leveraged to enhance prediction accuracy and accessibility.

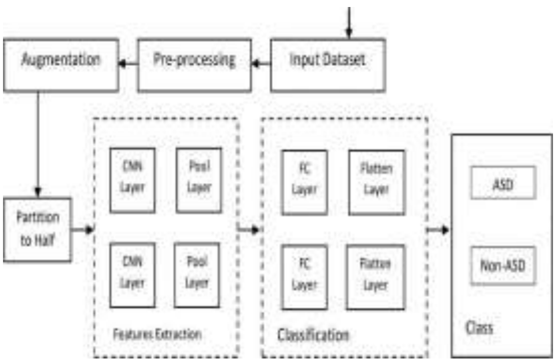


Fig 3.1.1 Proposed Methodology

1. Data Collection and Preprocessing:

Initially, structured clinical data—including behavioral assessment scores (A1 to A10), demographic details (age, gender), and medical history (such as jaundice and family history of autism)—are collected from validated sources and standardized questionnaires. For the image-based component, facial images are gathered with strict adherence to privacy and ethical guidelines. Preprocessing of structured data involves handling missing values, normalization, encoding categorical variables, and outlier removal to ensure data quality and consistency. Image data undergoes resizing, normalization, and augmentation to prepare it for deep learning analysis.

2. Feature Selection:

Feature selection is performed on the structured dataset to identify the most informative variables for ASD prediction. Statistical techniques and domain knowledge are used to select features that have the highest correlation with ASD risk, thereby improving model performance and interpretability[5]. For image data, feature extraction is handled automatically by the convolutional neural network during the training phase.

3. Model Training and Evaluation:

Multiple machine learning algorithms—including Random Forest, Support Vector Machine (SVM), and Decision Tree classifiers—are trained on the processed clinical dataset. Hyperparameter tuning and cross-validation are employed to optimize each model's predictive capabilities. For the image-based analysis, a deep learning model based on DenseNet architecture is implemented, which learns to extract and analyze visual features relevant to ASD detection. The models are evaluated using metrics such as accuracy, precision, recall, and area under the ROC curve (AUC) to ensure robust and reliable performance.

4. Hybrid Prediction and Integration:

The system supports both independent and integrated prediction modes. Users can submit either structured data, images, or both. When both types of data are available, ensemble or fusion strategies are used to combine the outputs from machine learning and deep learning models, leveraging the strengths of each modality to improve overall prediction accuracy.

Web Application Deployment:

All predictive models are deployed within an interactive web application. The platform features separate interfaces for structured data entry and image upload, providing immediate, interpretable results to users. Additional functionalities include user registration, secure account management, and access to educational resources and FAQs. Administrative tools allow for the management of user accounts and updating of informational content, ensuring the system remains current and user-focused.

This methodology ensures a scalable, accessible, and accurate ASD screening solution that combines the interpretability of clinical data analysis with the advanced feature extraction capabilities of deep learning on image data, supporting timely intervention and improved outcomes for individuals at risk of autism.

IV. TECHNOLOGIES USED

The technologies used for the proposed autism prediction system are a combination of advanced machine learning, deep learning, and web development tools, designed to process both structured clinical data and image inputs for early and accurate ASD screening. The core technologies include:

Machine Learning Algorithms: The system utilizes widely adopted algorithms such as Random Forest, Support Vector Machine (SVM), and Decision Tree classifiers to analyze structured clinical and behavioral data. These algorithms are known for their robustness and effectiveness in classification tasks related to ASD prediction.

Deep Learning (CNN): For image-based analysis, Convolutional Neural Networks (CNNs), particularly DenseNet architectures, are employed to automatically extract and analyze visual features from facial images that may be indicative of ASD. CNNs have demonstrated high accuracy in detecting subtle patterns in image data that are difficult to discern manually.

Data Preprocessing and Feature Engineering: The system incorporates data cleaning, normalization, encoding of categorical variables, and feature selection techniques to ensure high-quality input for the models and to enhance prediction accuracy.

Web Application Frameworks: The user interface and backend functionalities are developed using modern web technologies, enabling users to input clinical data, upload images, and receive predictions. This typically involves frameworks such as Django or Flask for the backend, and HTML, CSS, and JavaScript for the frontend (based on standard practices for similar systems).

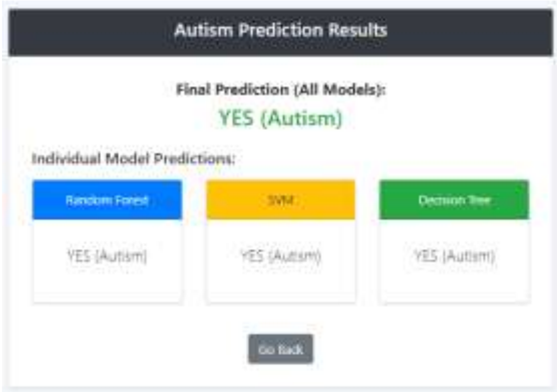
Performance Evaluation Tools: The models are validated using metrics such as accuracy, precision, recall, and ROC-AUC to ensure reliability and effectiveness in real-world scenarios.

Database Management: Secure storage and management of user data and prediction results are handled using relational databases, ensuring data integrity and privacy (as seen in comparable web-based ASD prediction systems).

This integrated technology stack allows the system to deliver a scalable, accessible, and accurate autism screening solution that leverages both clinical and image data for comprehensive ASD risk assessment.

V Result

Autism predicted by clinical behavioural data.



Autism prediction by Image

Autism predicted by image.

VI. CONCLUSION

In conclusion, the integration of machine learning and deep learning techniques within a web-based platform offers a powerful, accessible, and multi-dimensional approach to early autism spectrum disorder prediction. By leveraging both structured clinical data and image analysis, the proposed system enhances the accuracy and reliability of ASD screening, supporting timely intervention and better outcomes for affected individuals. This innovative solution not only streamlines the diagnostic process for healthcare professionals and families but also demonstrates the transformative potential of artificial intelligence in advancing neurodevelopmental disorder assessment and care.

VII. REFERENCES

[1]. A Machine Learning Framework for Early-Stage Detection of Autism Spectrum Disorders, Authors: S. M. Mahedy Hasan, Md Palash Uddin, Md Al Mamun, Muhammad Imran Sharif, Anwaar Ulhaq, Govind Krishnamoorthy, Author: Anwaar Ulhaq, Publisher: IEEE

[2]. Autism Detection Based on MRI Images Using Deep Learning, Authors: Sadab Mostafa, Zihadul Karim, Muhammad Iqbal Hossain, DOI: 10.1109/ICCIT60459.2023.10441006, Publisher: IEEE, Conference:, 2023 26th International Conference on Computer and Information Technology (ICCIT), Conference Location: Cox's Bazar, Bangladesh, Date: 13–15 December 2023

[3]. Detecting Children with Autism Spectrum Disorder Based on Eye-Tracking and Machine Learning, Authors: Hsin-Yi Lu, Yang-Cheng Lin, Chia-Hsin Chen, Chih-Chung Wang, Ia-Wen Han, Wen-Lung Liang,DOI:10.1109/ICKII58656.2023.10332630, Publisher: IEEE, Conference: 2023 IEEE 6th International Conference on Knowledge Innovation and Invention (ICKII), Conference Location: Sapporo,

Japan, Date: 11–13 August 2023

[4]. Analysis of Brain Imaging Data for the Detection of Early Age Autism Spectrum Disorder Using Transfer Learning Approaches for Internet of Things, Authors: Adnan Ashraf, Zhao Qingjie, Waqas Haider Khan Bangyal, Muddesar Iqbal, DOI: 10.1109/TCE.2023.3328479, Publisher:
IEEE – IEEE Transactions on Consumer Electronics, Published Date: 30 October 2023 (Current Version: 26 April 2024)

[5]. Detection of Autism Spectrum Disorder (ASD) in Children and Adults Using Machine Learning, Authors: Muhammad Shoaib Farooq, Rabia Tehseen, Maidah Sabir, Zabihullah Atal, DOI: 10.1038/s41598-023-36499-z, Publisher: Nature Portfolio – Scientific Reports, Volume 13, Article number: 9605 (2023)

[6]. Detection of Autism Spectrum Disorder (ASD) in Children and Adults Using Machine Learning, Authors: Muhammad Shoaib Farooq, Rabia Tehseen, Maidah Sabir, Zabihullah Atal, DOI: 10.1038/s41598-023-36499-z, Publisher: Nature Portfolio – Scientific Reports, Volume 13, Article number: 9605 (2023)

[7]. Enhanced Detection of Autism Spectrum Disorder Using ResNet: A Deep Learning Approach, Authors: S. Baghavathi Priya, Priyanga S, Surya Shobith Kamisetty, DOI: 10.1109/ICDSNS62112.2024.10690847,Publisher: IEEE – 2024 International Conference on Data Science and Network Security (ICDSNS), Conference Location: Tiptur, India, Conference Date: 26–27 July 2024

[8]. Computer Vision-based Interactive Autism Detection System using Deep Learning, Authors: Badhon Parvej, Sikder Md Mahbub Alam, Faizul Islam Fahim, Md. Naimul Pathan, Muhammad Aminur Rahaman, DOI: 10.1109/COMPAS60761.2024.10796046, Publisher: IEEE – 2024 IEEE International Conference on Computing, Applications and

Systems (COMPAS), Conference Location: Cox's Bazar, Bangladesh, Conference Date: 25–26 September 2024

[9]. Automatic Classification of Autism Spectrum Disorder (ASD) from Brain MR Images Based on Feature Optimization and 10.1109/SMARTGENCON51891.2021.96

45785, Publisher: IEEE – 2021 International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON), Conference Location: Pune, India, Conference Date: 29–30 October 2021

[10]. EEG Based Autism Detection Using CNN Through Correlation Based

Transformation of Channels' Data, Authors: Zahrul Jannat Peya, M.A.H. Akhand, Jannatul Ferdous Srabonee, N. Siddique, DOI: 10.1109/TENSYMP50017.2020.9230928, Publisher: IEEE – 2020 IEEE Region 10 Symposium (TENSYMP), Conference Location: Dhaka, Bangladesh, Conference Date: 05–07 June 2020