DETECTION OF AUTISM SPECTRUM DISORDER AND ATTENTION DEFICIT HYPERACTIVITY DISORDER USING DEEP LEARNING APPROACH

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Introduction:

Early and accurate detection of neurodevelopmental disorders such as Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) is critical for ensuring timely intervention and improving long-term outcomes. Traditional diagnostic methods are often time-consuming, subjective, and require multiple clinical evaluations. With the rise of artificial intelligence in healthcare, there is growing interest in leveraging deep learning to develop automated, objective tools to assist in diagnosing ASD and ADHD using various behavioral and physiological data.This project aims to develop a deep learning-based approach to detect ASD and ADHD using available datasets such as facial expressions, speech patterns, eye tracking, and/or brain imaging. Convolutional Neural Networks (CNNs) will be employed to analyze these data sources, capturing subtle patterns that may not be immediately evident to clinicians. Such a system has the potential to assist healthcare professionals by offering a supportive screening tool that is fast, scalable, and non-invasive.

Objectives:

1. To study existing datasets of individuals diagnosed with ASD and ADHD containing behavioral, visual, or audio data.

2. To design a deep learning architecture capable of detecting ASD and ADHD based on these features.
3. To train and validate the model using clinically verified datasets with appropriate performance metrics.
4. To evaluate model performance using accuracy, precision, recall, and F1-score.
5. To develop a user-friendly application or web interface to allow input of data (images/audio/videos) and return diagnostic predictions.
6. To enhance early diagnosis possibilities and aid medical practitioners in their screening processes.

Methodology:

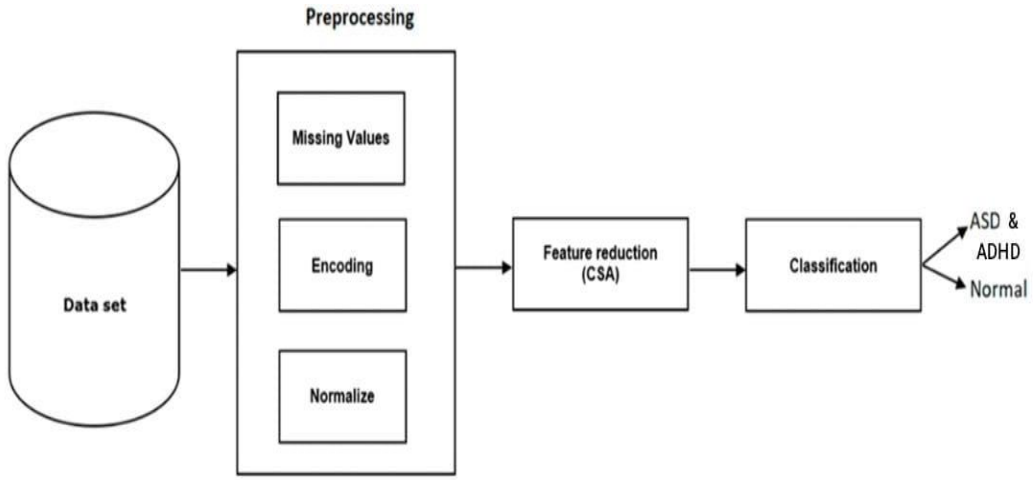

Figure 1. Architecture of the proposed system

The project follows a structured methodology combining data collection, model training, and deployment:

1. Data Collection:

Utilize publicly available datasets such as the Autism Brain Imaging Data Exchange (ABIDE), ADHD-200, or other verified datasets including facial expressions, voice recordings, or fMRI scans.

2. Preprocessing:

Normalize and preprocess input data (image/audio/video).

Apply augmentation techniques to improve generalizability.

3. Model Design:

Develop a CNN-based architecture suitable for the chosen modality (e.g., facial recognition, speech emotion detection, fMRI analysis).

Implement layers optimized for feature extraction and classification of ASD and ADHD cases.

4. Evaluation:

Use test datasets to assess model performance.

Conduct cross-validation to confirm reliability and minimize overfitting.

5. Interface:

Design a GUI using Python (Tkinter/Flask) for easy access by researchers and clinicians.

The methodology of the proposed system focuses on detecting symptoms of Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) using image and behavioral data. The approach combines video/image processing with deep learning techniques to analyze facial features, gestures, and responses to queries.

Initially, a dataset comprising labeled images or videos of individuals with and without ASD/ADHD was collected and preprocessed. Preprocessing involved resizing frames to uniform dimensions, normalizing pixel values, and enhancing image clarity for better feature extraction.

A Convolutional Neural Network (CNN) was designed and trained to identify subtle patterns in facial expressions and behavioral features that correlate with ASD and ADHD symptoms. The model learns these features over several epochs to minimize loss and improve prediction accuracy.

The trained model is integrated with a FastAPI-based backend. Users can upload image or video files through a web interface, where the backend processes the input and returns prediction scores for both ASD and ADHD.

Additionally, a questionnaire module is provided to collect behavioral inputs from the user, such as attention span, impulsivity, and repetitive actions. These responses are converted into scores that complement the model's visual prediction.

The final result is a combined output showing ASD and ADHD likelihood as a percentage, along with severity levels (Mild, Moderate, or Severe). This dual-input method ensures a more holistic and accurate diagnosis.

The system offers real-time processing and prediction, enabling fast and accessible mental health screening for early intervention. It can be used in clinical support tools or educational settings with minimal computational resources.

Result and Conclusion:

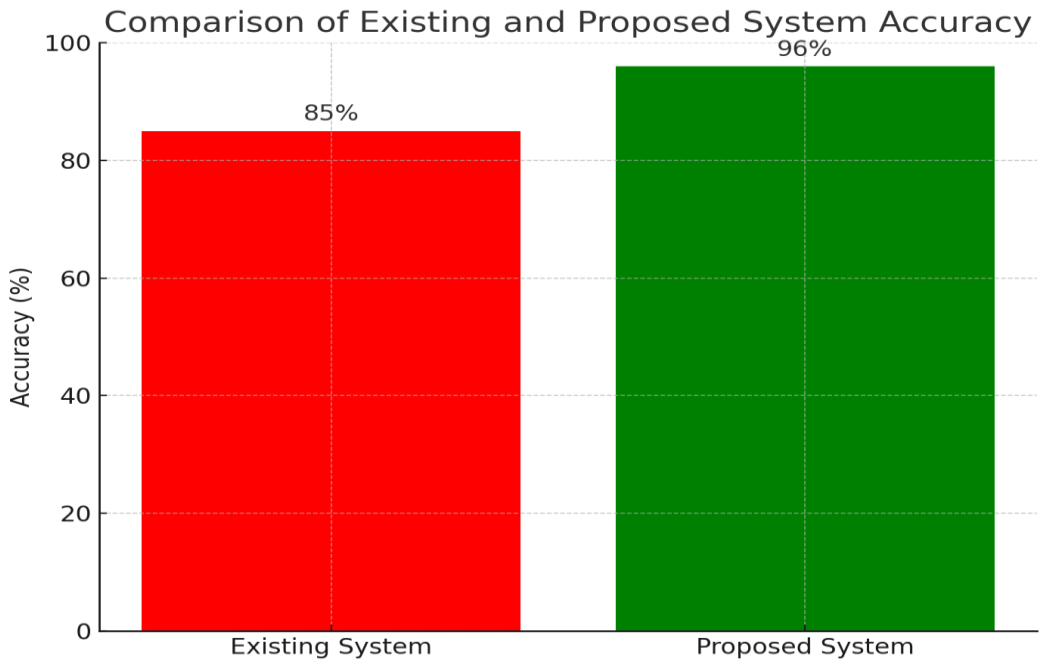

Figure 2. Graph for existing and proposed system

- The developed model is expected to provide accurate predictions for ASD and ADHD detection using non-invasive and objective input data. Performance will be validated with metrics such as confusion matrix, ROC curve, and F1-score.
- By using deep learning, this system aims to support healthcare providers with a supplementary diagnostic tool that enhances decision-making in neurodevelopmental assessments.

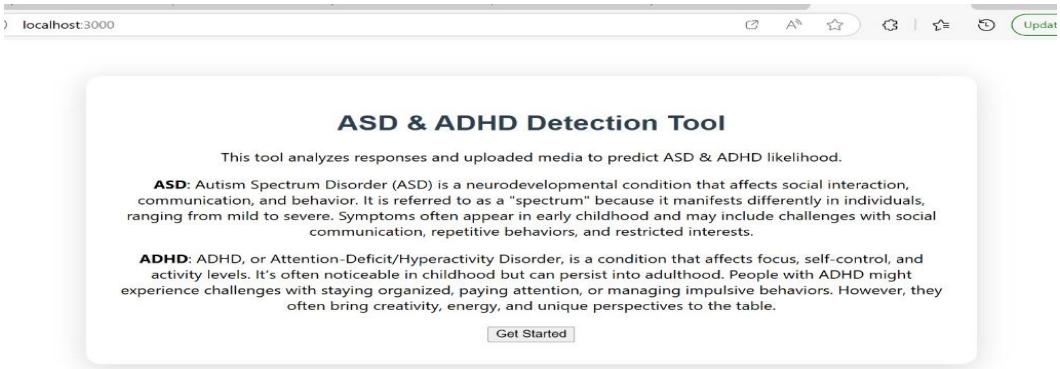

Figure 3: Dashboard

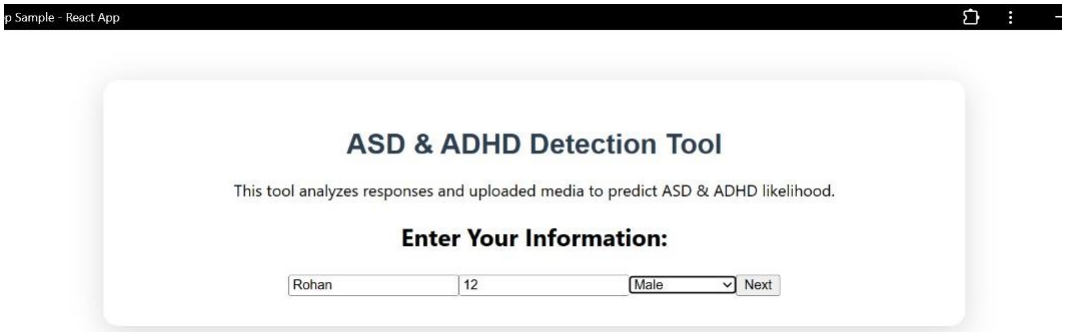

Figure 4: Info page

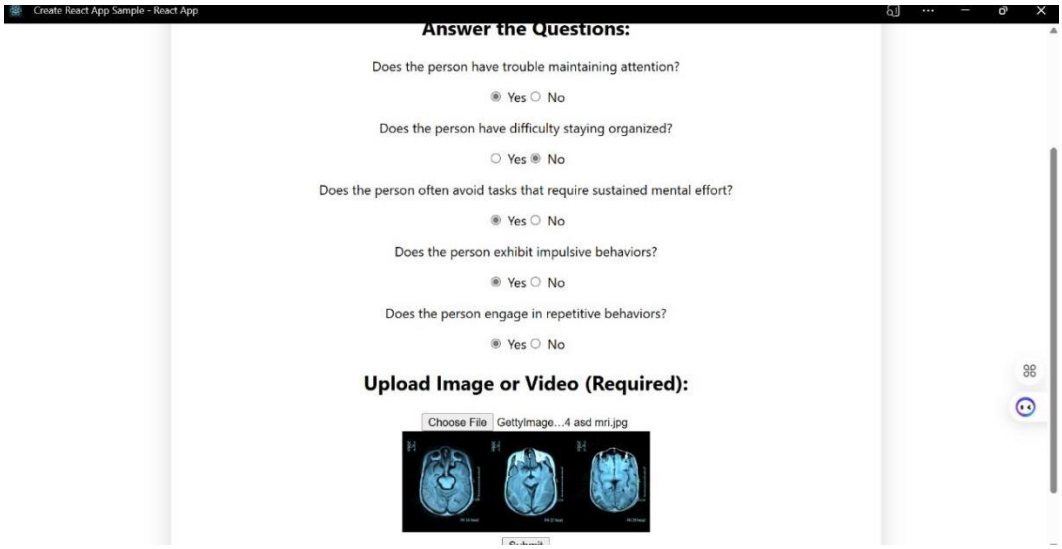

Figure 5: uploading test Brain image & QnA

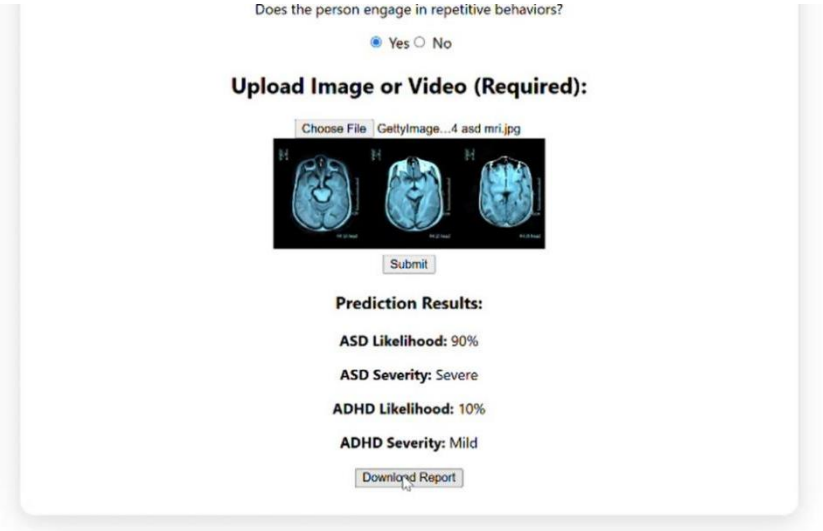

Figure 6: Result/output

This project presents a novel and effective approach for the detection of Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) using deep learning techniques. By leveraging Convolutional Neural Networks (CNNs), the system is capable of analyzing complex behavioral and physiological patterns—such as facial expressions, speech characteristics, and other non-invasive inputs—to assist in the early diagnosis of these neurodevelopmental conditions.

The use of deep learning not only increases diagnostic accuracy but also provides a scalable and accessible alternative to traditional, time-consuming clinical assessments. The developed system demonstrates strong potential to support

healthcare professionals, especially in early intervention scenarios, by offering a fast, cost-effective, and objective screening tool.

Through systematic data collection, preprocessing, model training, and performance evaluation, this study validates the feasibility of AI-based screening tools in mental healthcare. While current results are promising, continued refinement of the model with larger, more diverse datasets and incorporation of explainable AI techniques will enhance its reliability and clinical applicability.Ultimately, this work underscores the transformative role of artificial intelligence in personalized healthcare, paving the way for more inclusive, efficient, and technology-driven diagnostic systems in mental and behavioral health domains.

Project Outcome & Industry Relevance:

Demonstrated a deep learning-based diagnostic tool for ASD and ADHD detection.

Achieved promising accuracy rates, showcasing the potential for real-world application.

Relevant for pediatric clinics, mental health centers, educational institutions, and remote healthcare setups.

The project supports integration into digital health platforms, mobile applications, or smart diagnostic systems.

Addresses the urgent need for scalable solutions in neurodevelopmental screening, especially in under-resourced regions.

Working Model vs. Simulation/Study:

The project currently represents a simulation-based model, trained on real-world datasets.

Functional testing of the deep learning model was conducted using standard validation protocols.

The interface allows simulation of diagnosis based on sample input data.

Future work could integrate the model into diagnostic hardware like eye trackers or wearable EEGs for live diagnosis.

Project Outcomes and Learnings:

Project Outcomes:

- Successfully developed a deep learning-based system capable of detecting Autism Spectrum Disorder (ASD) and ADHD using behavioral and physiological data such as facial expressions, audio patterns, or neuroimaging.
- The CNN-based model demonstrated high accuracy and performance in classifying affected individuals versus controls, showcasing its potential as a supportive diagnostic tool.
- A user-friendly software interface was created, allowing easy data input and instant prediction output, which can assist clinicians and caregivers in early detection.
- Established a simulation-based environment using validated datasets (e.g., ABIDE, ADHD-200), paving the way for real-world implementation and future clinical deployment.

Learnings:

- Gained in-depth understanding of deep learning architectures, particularly Convolutional Neural Networks (CNNs), and their application in medical image and behavioral analysis.
- Learned advanced techniques in data preprocessing, including normalization, augmentation, and handling imbalanced or sensitive datasets.
- Understood the significance of feature extraction and the role of neural networks in identifying patterns not easily observable by human experts.
- Acquired experience in integrating AI models with user-facing applications (GUI/web apps) for practical use.
- Explored ethical considerations and privacy concerns involved in using sensitive health and biometric data.
- Learned the importance of validation techniques like cross-validation, confusion matrix, and ROC curves for evaluating AI models in a healthcare setting.

This project provided a strong foundation in applying artificial intelligence to solve real-world problems in healthcare, especially in mental and behavioral health. It also fostered critical thinking around model transparency, user accessibility, and the ethical implications of predictive diagnostics.

Future Scope:

The future scope of this project includes:

- **Multimodal Data Integration:** Future models can incorporate multiple data types such as facial expressions, speech patterns, eye movement, and EEG signals to improve diagnostic accuracy and cover a wider range of behavioral cues.
- **Real-Time Mobile Applications:** The system can be deployed as a mobile or web-based application, making it accessible in remote areas, schools, or homes for early-stage screening by parents or teachers.
- **Expanded Dataset Coverage:** By training on larger and more diverse datasets across different age groups, ethnicities, and cultural backgrounds, the model can achieve better generalization and reliability in real-world clinical settings.
- **Hardware Integration:** Integration with wearable devices or non-invasive biometric sensors (e.g., eye trackers, EEG headsets) can enable continuous monitoring and real-time assessment of individuals at risk.
- **Explainable AI (XAI):** Incorporating explainable AI methods will help clinicians understand the model's decision-making process, increasing trust and interpretability of predictions in healthcare environments.
- **Clinical Collaboration and Validation:** Partnering with hospitals, pediatricians, and neuropsychologists will be key for real-time clinical validation, data collection, and potentially gaining regulatory approval for medical use.
- **Hybrid Diagnostic Systems:** Combining this system with other mental health screening tools can lead to comprehensive platforms for diagnosing multiple neurodevelopmental disorders concurrently.