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PROACTIVE AUTISM SPECTRUM DISORDER (ASD) SCREENING USING DEEP LEARNING TECHNIQUES

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Abstract: Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by challenges in interaction, communication, and repetitive behaviors. Early and accurate diagnosis is crucial for effective intervention. This paper presents a novel ASD Detection System using deep learning techniques, specifically CNNs, to analyze brain MR images and classify them as either ASD or typical control. The system achieves high accuracy, providing a reliable tool for early ASD diagnosis. Comprehensive testing ensures robustness, performance, and security, making it suitable for clinical use. The system's deployment on a local server enhances data privacy and accessibility for healthcare professionals.

Keywords: Autism Spectrum Disorder, Deep Learning, Convolutional Neural Networks, Medical Imaging, Early Diagnosis, Neurodevelopmental Disorders, Machine Learning, Brain MR Images.

I. INTRODUCTION

ASD affects approximately 1 in 68 children globally.Traditional diagnostic methods are time-consuming and subjective, relying heavily on behavioral observations and assessments by specialists. This delays intervention, which is crucial in the early stages of development.

Advances in deep learning, offer new avenues for improving the speed and accuracy of ASD diagnosis. The burgeoning field of machine learning offers promising solutions to expedite and enhance the diagnostic process. More tangibly, the approaches that are referred to as supervised learning can be used to build models that are highly effective in recognizing ASD.

This paper details the development of an ASD Detection System using CNNs to analyze brain MR images, aiming to provide a faster and accurate tool that can be integrated into clinical workflows.

II. LITERATURE REVIEW

Ko et al. (2023) used functional connectivity metrics from fMRI data to create deep learning models customized to the age and severity of ASD. Their study highlights the importance of considering these factors to enhance diagnostic accuracy. They used a joint attention-based deep learning system, achieving promising results in detecting and assessing the severity of symptoms.

Li et al. (2021): Proposed a deep unrolling-based approach for ASD diagnosis using fMRI data, capturing non-linear relationships in brain networks and significantly improving diagnostic performance (Li, X., Zhou, Y., et al., 2021).

Djemal et al. (2017) introduced a hybrid deep transfer learning approach utilizing scalogram representations of EEG signals for early ASD diagnosis. Their model demonstrated high accuracy and robustness, offering a novel method for non-invasive ASD screening

Ben Bashat et al. (2007) utilized conventional MRI and ADC images to diagnose ASD in children. Their deep learning algorithms showed accelerated white matter maturation in ASD patients, providing a reliable diagnostic marker.

Sandler et al. (2018) developed a video-based deep learning framework to diagnose ASD by analyzing behavioral patterns in recorded videos. This approach provided an innovative and less intrusive method for early detection

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III. PROBLEM STATEMENT

Early and accurate diagnosis of ASD is critical for timely intervention, which can significantly improve developmental outcomes. Current diagnostic methods are labor-intensive, time-consuming, and prone to subjectivity, often leading to delayed diagnosis. This paper addresses the automated, reliable, and efficient diagnostic tool that uses advanced deep learning techniques to analyze brain MR images, providing accurate classifications of ASD and typical controls.

IV. EXISTING SYSTEM

The existing systems for ASD diagnosis predominantly relies on manual assessments by healthcare professionals and specialists. These assessments involve detailed observations of a child's behavior, communication skills, and social interactions over an extended period. Commonly used methods include the Autism Diagnostic Observation Schedule (ADOS) and the Autism Diagnostic Interview-Revised (ADI-R). While these methods are comprehensive, they are also labor-intensive, time-consuming, and subject to the variability in interpretation by different clinicians. Additionally, existing approaches, such as Decision Trees, K-Nearest Neighbor, and Naive Bayes Classifiers, have been explored for ASD diagnosis but have yielded limited accuracy and reliability. These traditional models struggle to handle the complex and high-dimensional nature of brain imaging data, leading to suboptimal performance in differentiating ASD from typical control cases.

V. PROPOSED SYSTEM

The proposed system aims to automate the diagnosis of ASD using CNNs. The system uses brain MR scans to identify patterns associated with ASD. The proposed method involves the following steps:

1.Data gathering and preprocessing: Compile a sizable dataset of brain MR images from both typical control cases and ASD cases. To guarantee quality and consistency, preprocess the photos.

2.CNN Architecture Design: To extract features from the brain images and classify them into ASD and typical control categories, create a CNN model with multiple layers.

3.Training and Validation: Use a subset of the dataset to train the CNN model, and use a different validation set to assess its performance. Aim for high levels of dependability and accuracy.

4. Feature Extraction and Analysis: Examine the differences between ASD and typical control cases by using the trained CNN model to extract pertinent features from the brain images.

5. Testing and Implementation: Put the trained model into practice.

VI. MODULE DESCRIPTION AND IMPLEMENTATION

The methodology involves several key steps:

Data Collection: Gather a large dataset of brain MR images from ASD and typical control subjects.

Image Preprocessing: Standardize the images through resizing, noise reduction, and normalization to ensure uniform input for the CNN model.

CNN Model Development: Create and train a multi-layer CNN to reliably categorize and extract features from the preprocessed images.

Model Training and Validation: Use a portion of the dataset for training the CNN and another portion for validation to ensure the model's accuracy and generalization ability.

Implementation: Develop a web-based user interface using Flask to facilitate image upload, processing, and result viewing.

Testing: Conduct unit, integration, system, and user acceptance testing to validate the system's functionality, performance, and security.

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Deployment: Deploy the system on a local server to ensure data privacy and accessibility.

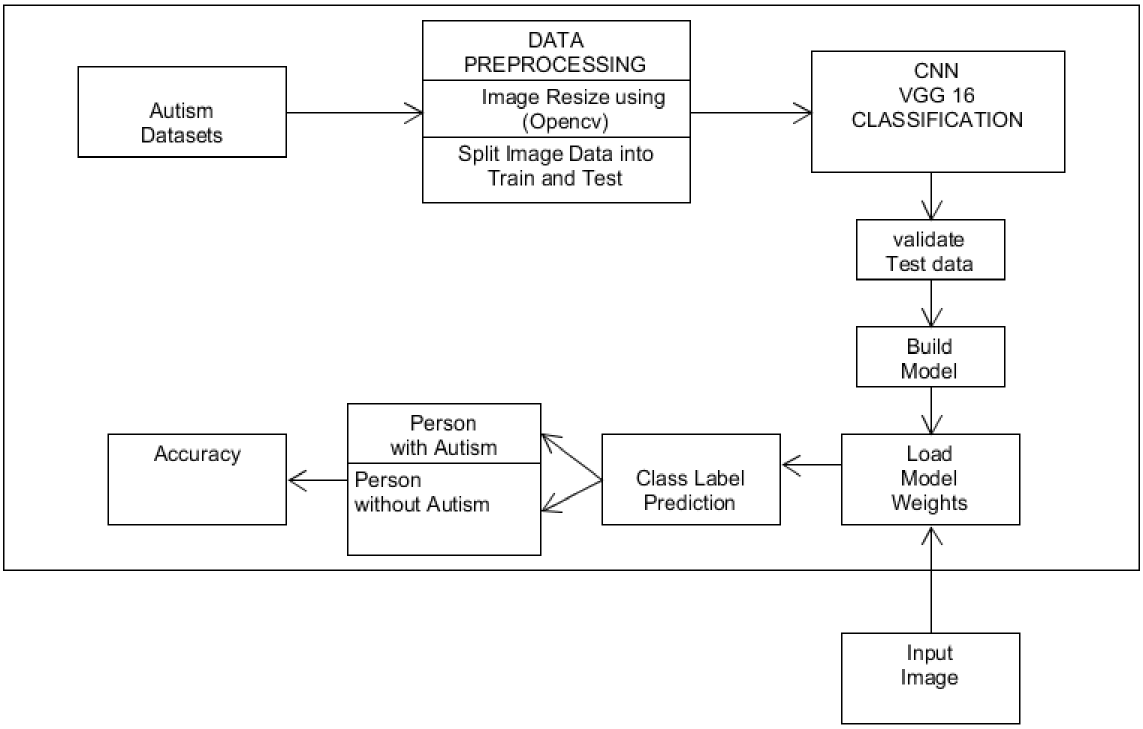

Fig.1 System Architecture

The system architecture of the ASD Detection System is designed using a layered approach to ensure modularity and ease of maintenance. The architecture includes the following layers:

Presentation Layer: This layer is responsible for the user interface, providing interaction capabilities for the users. It includes web-based interfaces for clinicians, researchers, and administrators.

Application Layer: This layer contains the business logic and processing components. It handles image preprocessing, model execution, and result generation. It interacts with both the presentation and data layers to fetch inputs and store outputs.

Data Layer: This layer manages data storage and retrieval. It includes local databases for storing medical images, user data, and diagnostic results. SQLite is used as the database management system because of its simplicity and effectiveness for local storage.

Integration Layer: This layer ensures communication between different components of the system and external systems, such as hospital management systems or other databases.

VII. RESULTS

The ASD Detection System achieved high accuracy in classifying brain MR images into ASD and typical control categories. The system's performance was validated through extensive testing, including unit tests for individual components, integration tests for module interactions, and system tests for end-to-end functionality.

User acceptance testing with clinicians and researchers confirmed the system's usability and effectiveness. The deployment on a local server ensures secure data handling and provides healthcare professionals with a reliable tool for early ASD diagnosis. Future work will relies on incorporating additional data types and refining the model for even greater accuracy and applicability.

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