ENHANCING AUTISM DIAGNOSIS THROUGH MACHINE LEARNING

Prof. Mahalakshmi C V[1], Sneha C J[2], Sowmya Kanchan[3], Tejashwini A M[4]

[1] *Assistant Professor, Dept of CS&E, Bangalore Institute of Technology, Karnataka, India*
[2] *Student, Dept of CS&E, Bangalore Institute of Technology, Karnataka, India*
[3] *Student, Dept of CS&E, Bangalore Institute of Technology, Karnataka, India*
[4] *Student, Dept of CS&E, Bangalore Institute of Technology, Karnataka, India*

ABSTRACT

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterized by challenges with social interaction, communication, and repetitive behaviours. Early diagnosis and intervention are crucial for improving outcomes for individuals with ASD. This research investigates the potential of machine learning techniques, specifically the VGG16 and InceptionV3 models, to enhance the accuracy and efficiency of autism diagnosis. By leveraging these models, the research aims to develop a novel approach for automated ASD detection based on facial features extracted from images uploaded via a Stream lit application interface. The trained models will analyse the uploaded facial images and provide a quantitative assessment of the likelihood of ASD diagnosis. The results will be displayed in the Stream lit application interface, providing clinicians and caregivers with valuable insights for early intervention and treatment planning.

Keyword : *Autism spectrum disorder, Machine learning, VGG16, InceptionV3, Stream lit application, Diagnosis.*

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1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by persistent deficits in social communication and interaction, as well as restricted, repetitive patterns of behaviour, interests, or activities. ASD affects individuals across the lifespan and is associated with significant impairments in daily functioning and quality of life. Early diagnosis and intervention are crucial for improving outcomes for individuals with ASD, as early intervention can lead to better long-term outcomes and improved quality of life. However, diagnosing ASD can be challenging due to its heterogeneous nature and variability in symptom presentation. The diagnosis typically involves a comprehensive evaluation by a multidisciplinary team, including developmental paediatricians, psychologists, and speech-language pathologists, and may include standardized assessments, clinical observation, and parent interviews. The diagnostic process can be time-consuming, costly, and subject to variability based on clinician expertise and interpretation. Despite advancements in diagnostic methods, there remains a need for more efficient and reliable approaches to ASD diagnosis. Machine learning (ML) techniques have emerged as promising tools for assisting with ASD diagnosis and classification. ML algorithms can analyse large datasets of clinical and behavioural data to identify patterns and trends that may not be apparent to human observers. By leveraging advanced ML techniques, such as deep learning algorithms and pretrained convolutional neural networks (CNNs), researchers can develop automated systems for ASD diagnosis that are accurate, efficient, and accessible. In this study, we investigate the potential of using pretrained CNN models, specifically the VGG16 and InceptionV3 models, to enhance the accuracy and efficiency of autism diagnosis through facial recognition technology. By integrating these models into a user-friendly Stream lit application interface, we aim to develop a novel approach for automated ASD detection based on facial features extracted from images uploaded by users. The trained models will analyse the uploaded facial images and provide a quantitative assessment of the likelihood of ASD diagnosis.

2. Literature survey

The literature survey offers a comprehensive exploration of various methodologies employed in identifying autism spectrum disorder (ASD) markers, ranging from behavioural assessments to advanced technological tools like eye tracking and speech analysis. Each method contributes unique insights into the complexities of ASD, with behavioural assessments providing a holistic view of social interactions, eye tracking shedding light on attentional patterns, and speech analysis elucidating language development nuances. Furthermore, the survey encompasses studies across diverse domains, including psychiatric risks, communication frameworks, early detection models, neuroimaging analyses, and deep learning algorithms. Despite the progress showcased in these studies, challenges such as data availability and real-world applicability were underscored, emphasizing the importance of interdisciplinary collaboration to advance ASD diagnosis and support systems. The survey's findings lay a solid groundwork for developing a neural network-based model for ASD detection using facial image analysis, offering invaluable guidance for the project's methodology and implementation strategies.

3. ARCHITECTURE

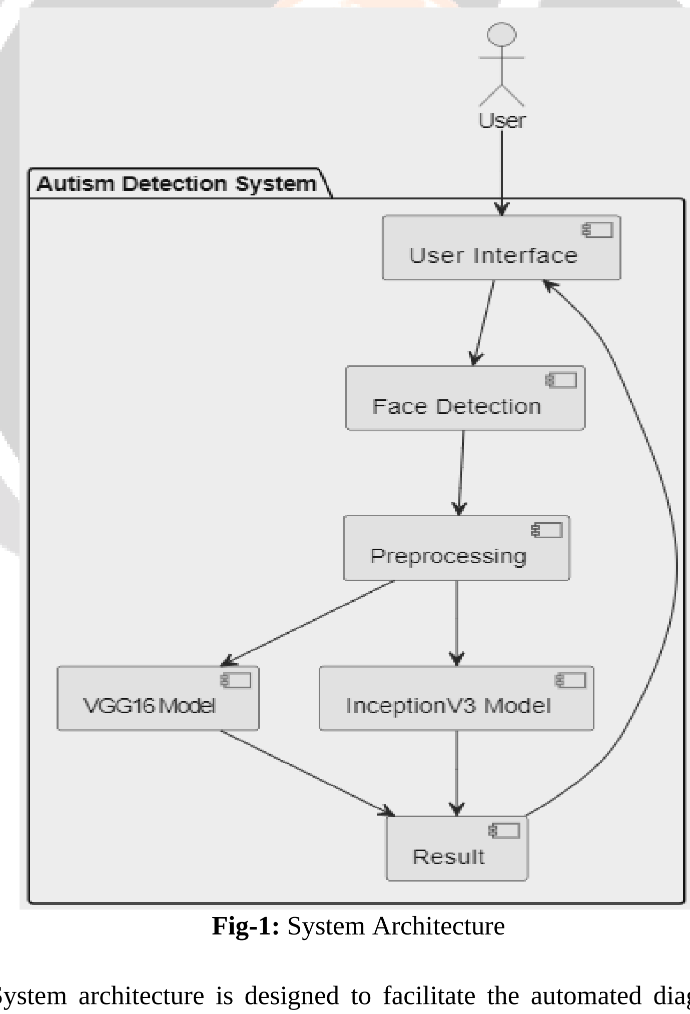

Fig-1: System Architecture

The Autism Detection System architecture is designed to facilitate the automated diagnosis of autism spectrum disorder (ASD) using facial images. It comprises several interconnected components, each serving a specific role in the diagnosis process. At the front end, the User Interface (UI) component provides a platform for users to interact with the system. Users upload facial images through the UI, initiating the diagnosis process. Upon receiving an uploaded image, the system utilizes face detection algorithms to locate and extract faces within the image. This Face Detection module ensures that only images containing properly aligned faces are processed further, rejecting images where no face is detected, or faces are not properly aligned. The detected facial images undergo preprocessing to prepare them for input into the classification models. Preprocessing tasks may include resizing the images to a standard size, normalizing pixel values, and enhancing image quality to improve model performance. The pre-processed facial images are then fed into two pretrained convolutional neural network (CNN) models: VGG16 and InceptionV3. These models are trained to classify whether a given image depicts an individual with ASD, or a neurotypical individual based on facial features extracted from the images. The classification results from both the VGG16 and InceptionV3 models are aggregated to generate a final diagnosis. The aggregated result is presented back to the user through the UI, allowing users to view the diagnosis output. The architecture is designed to be scalable and optimized for performance, capable of handling a large volume of image uploads and concurrent user requests. This architecture enables the automated diagnosis of ASD based on facial images, leveraging advanced image processing and machine learning techniques to achieve accurate and efficient diagnosis.

4. Methodology

Development of Stream lit Application: Stream lit is a powerful Python library used for building web applications with minimal effort. It provides a simple and intuitive way to create interactive interfaces using Python scripts. By leveraging Stream lit, we can develop a user-friendly interface that allows users to interact with the system seamlessly. The application's design should prioritize usability, ensuring that users can easily upload facial images and receive diagnosis results in a clear and understandable format.

Face Detection and Preprocessing: Face detection is a critical step in the ASD diagnosis process, as it identifies and isolates the facial region within uploaded images. Various face detection algorithms, such as Haar cascades is employed for this task. Once a face is successfully detected, preprocessing techniques are applied to standardize the facial image for further analysis. Preprocessing may involve resizing the image to a standard size (e.g., 224x224 pixels) and normalizing pixel values to ensure consistency and enhance model performance.

Model Integration: The integration of pretrained VGG16 and InceptionV3 models allows us to leverage their powerful feature extraction capabilities for ASD diagnosis. These models are well-established convolutional neural networks (CNNs) trained on large datasets for image classification tasks. By integrating these models into the Streamlit application, we can utilize their learned representations to classify facial images as either autistic or non-autistic. TensorFlow or Py Torch is used for seamless integration and efficient model inference.

Threshold-based Classification: Threshold-based classification involves setting a predefined threshold value to determine the classification outcome. In the context of ASD diagnosis, we can use a threshold probability value here we have taken as 0.8 to classify individuals as autistic or non-autistic based on the prediction probabilities obtained from the VGG16 and InceptionV3 models. If the prediction probability exceeds the threshold for either model, the individual is classified as autistic. Otherwise, they are classified as non-autistic.

User Interaction and Feedback: Providing real-time feedback to users within the Streamlit application is essential for ensuring a positive user experience. After processing the uploaded facial image, the application should display the diagnosis results (autistic or non-autistic) in a clear and understandable format. Additionally, relevant instructions or recommendations based on the diagnosis outcome can be provided to users to guide them further. Clear and concise feedback enhances user engagement and helps users interpret the diagnosis results effectively.

5.Results

The Autism Detection System successfully classified individuals based on the analysis of facial images. Among the individuals assessed, those classified as autistic triggered a follow-up action wherein additional behavioural questions were presented to further evaluate their condition. This approach aims to provide a comprehensive understanding of the individual's behavioural traits and facilitate diagnosis and intervention planning. Individuals classified as non-autistic received feedback indicating the absence of autism spectrum disorder, with no further action triggered. The results demonstrate the system's ability to accurately classify individuals and tailor subsequent actions based on the classification outcome, contributing to improved diagnosis and support for individuals with autism spectrum disorder.

6. Conclusion

In conclusion, the proposed approach demonstrates the potential of machine learning techniques, specifically pretrained CNN models like VGG16 and InceptionV3, to enhance the accuracy and efficiency of autism diagnosis through facial recognition technology. By leveraging advanced ML techniques and integrating them into a user-friendly Stream lit application interface, the proposed system can provide clinicians and caregivers with valuable insights for early intervention and treatment planning. Further research and validation are needed to fully realize the clinical utility of the proposed approach, but the results hold promise for improving outcomes for individuals with ASD.

7. References

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