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GENERATIVE AI FOR AUTISM IMAGE DETECTION

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ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by challenges in social communication, repetitive behaviors, and restricted interests. Early diagnosis of ASD is essential for timely intervention and improved developmental outcomes. Traditional screening and diagnostic procedures rely heavily on behavioral observations and clinical assessments, which can be subjective, time-consuming, and resource-intensive. Recent advances in Artificial Intelligence (AI), particularly Generative AI and deep learning, offer new opportunities for developing intelligent diagnostic support systems. This paper presents a Generative AI-based framework for autism image detection using facial image analysis. The proposed approach utilizes deep learning models for feature extraction and classification while employing generative techniques for data augmentation to overcome dataset limitations. The framework aims to enhance the accuracy, robustness, and accessibility of autism screening by identifying subtle facial characteristics associated with ASD. Experimental findings demonstrate the potential of Generative AI to support clinicians in early autism detection while maintaining reliability and scalability.

Keywords: Autism Spectrum Disorder, Generative AI, Deep Learning, Facial Image Analysis, Medical Image Classification, Data Augmentation, Early Diagnosis, Healthcare AI.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) affects millions of individuals worldwide and presents varying degrees of social, cognitive, and behavioral challenges. Early diagnosis and intervention significantly

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improve developmental outcomes and quality of life for affected individuals. However, conventional diagnostic approaches primarily depend on behavioral assessments conducted by trained specialists, often resulting in delayed diagnosis due to limited healthcare resources and subjective interpretations.

Recent developments in computer vision and deep learning have enabled automated analysis of facial images to identify disease-related phenotypic patterns. Studies suggest that certain facial morphological characteristics may exhibit associations with autism, motivating researchers to investigate image-based screening methods.

Generative Artificial Intelligence has emerged as a transformative technology capable of generating realistic synthetic data, enhancing training datasets, and improving model generalization. By leveraging Generative AI for data augmentation and deep learning for image classification, healthcare systems can develop efficient and scalable screening tools.

This research proposes a Generative AI-assisted framework for autism image detection using facial image analysis to support early screening and clinical decision-making.

2. PROBLEM STATEMENT

Early autism diagnosis remains challenging due to dependence on expert behavioral evaluations, variability in symptom presentation, and limited access to specialized healthcare professionals. Existing image-based diagnostic approaches often suffer from insufficient datasets and poor generalization capabilities. Furthermore, medical image datasets related to autism are typically small and imbalanced, reducing the effectiveness of conventional deep learning models. Therefore, there is a need for an intelligent framework that utilizes Generative AI to enhance dataset diversity and improve the accuracy of autism image detection systems.

3. OBJECTIVES

The objectives of this study are:

- To develop an automated framework for autism image detection using facial image analysis.
- To employ Generative AI techniques for synthetic image generation and dataset augmentation.
- To improve classification performance using deep learning models.

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- To identify facial features associated with autism spectrum disorder.
- To evaluate the effectiveness of the proposed approach using standard performance metrics.
- To support clinicians with an efficient and scalable screening tool for early autism detection.

4. LITERATURE REVIEW

Traditional autism diagnosis relies on behavioral screening tools such as the Autism Diagnostic Observation Schedule (ADOS) and Autism Diagnostic Interview-Revised (ADI-R). While clinically effective, these methods require specialized expertise and extensive evaluation periods.

Recent studies have explored machine learning and computer vision techniques for ASD detection using facial images. Convolutional Neural Networks (CNNs) have shown promising performance due to their ability to automatically extract discriminative image features.

However, limited availability of autism-related image datasets remains a major challenge. Generative models such as Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) have demonstrated success in synthesizing realistic medical images to address data scarcity. Integrating generative approaches with classification networks offers opportunities to improve detection accuracy and robustness.

5. PROPOSED METHODOLOGY

The proposed framework consists of the following stages:

5.1 Dataset Collection

Facial image datasets are collected from publicly available repositories and research databases containing images of children diagnosed with ASD and neurotypical individuals. Ethical considerations and privacy regulations are maintained throughout the data acquisition process.

5.2 Data Preprocessing

The preprocessing stage includes:

- Face detection and cropping.
- Image resizing.
- Noise removal.
- Pixel normalization.
- Data labeling.
- Data balancing.

These procedures ensure consistency and improve learning efficiency.

5.3 Generative AI-Based Data Augmentation

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To overcome dataset limitations, Generative AI techniques are employed to synthesize realistic facial images.

Generative Models Used:

- Generative Adversarial Networks (GANs).
- Deep Convolutional GANs (DCGANs).
- Variational Autoencoders (VAEs).

Synthetic images generated by these models increase dataset diversity and improve model generalization.

5.4 Deep Learning-Based Classification

A Convolutional Neural Network is utilized to classify facial images into:

- ASD Positive.
- ASD Negative.

The CNN architecture includes:

- Convolution Layers.
- ReLU Activation Functions.
- Max Pooling Layers.
- Fully Connected Layers.
- Softmax Classification Layer.

Transfer learning models such as ResNet, VGG16, or EfficientNet may also be employed to improve performance.

5.5 Model Training and Validation

The dataset is divided into training, validation, and testing subsets. Cross-validation techniques are used to prevent overfitting and evaluate model stability.

6. SYSTEM ARCHITECTURE

The proposed architecture consists of:

1. Facial Image Acquisition Module.
2. Image Preprocessing Module.
3. Generative AI Augmentation Module.
4. Feature Extraction Layer.
5. CNN-Based Classification Module.
6. Decision Support System.
7. Performance Evaluation Module.

7. EXPERIMENTAL EVALUATION

The proposed model is evaluated using standard classification metrics.

Evaluation Metrics

- Accuracy.
- Precision.
- Recall (Sensitivity).
- Specificity.
- F1-Score.
- Confusion Matrix.
- Receiver Operating Characteristic (ROC) Curve.

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- Area Under the Curve (AUC).

Experimental analysis indicates that the incorporation of Generative AI significantly improves classification accuracy by reducing overfitting and enhancing the diversity of training samples.

8. RESULTS AND DISCUSSION

The proposed Generative AI-assisted framework demonstrates improved detection performance compared to conventional image classification methods trained on limited datasets. Synthetic image generation enables the classifier to learn robust facial representations while maintaining sensitivity to autism-related characteristics.

The findings suggest that Generative AI can serve as an effective strategy for addressing data scarcity in medical image analysis. However, the generated images should be carefully validated to ensure clinical relevance and avoid introducing biases into the learning process.

Importantly, the proposed system is intended as a clinical decision-support tool and should not replace comprehensive diagnostic evaluations performed by healthcare professionals.

9. APPLICATIONS

The proposed framework can be applied in:

- Early autism screening programs.
- Pediatric healthcare centers.
- Telemedicine platforms.
- Clinical decision-support systems.
- Community health initiatives.
- Mobile healthcare applications.
- Research studies on autism biomarkers.

10. ADVANTAGES

- Supports early autism screening.
- Reduces dependence on limited datasets.
- Improves classification accuracy.
- Enhances model generalization through synthetic data generation.
- Enables scalable and cost-effective screening.
- Facilitates deployment in telehealth environments.
- Assists clinicians in decision-making.

11. LIMITATIONS

- Facial characteristics alone cannot definitively diagnose autism.
- Performance depends on dataset quality and diversity.

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- Generative models may introduce synthetic biases.
- Ethical and privacy concerns must be addressed.
- Clinical validation is required before deployment.
- The system should complement, not replace, professional diagnosis.

12. FUTURE SCOPE

Future work may focus on integrating multimodal information such as behavioral data, speech analysis, and eye-tracking patterns with facial image analysis to improve diagnostic accuracy. Explainable Artificial Intelligence (XAI) techniques can be incorporated to enhance transparency and trust in clinical settings. Federated learning approaches may also be explored to preserve patient privacy while enabling collaborative model development across healthcare institutions.

13. CONCLUSION

This paper presented a Generative AI-based framework for autism image detection using facial image analysis. By combining synthetic data generation with deep learning classification techniques, the proposed approach addresses challenges associated with limited medical datasets and enhances screening performance. The framework offers a promising direction for developing accessible and intelligent healthcare solutions that support early autism identification. Although further clinical validation is necessary, Generative AI has the potential to significantly contribute to next-generation diagnostic support systems for Autism Spectrum Disorder.

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