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Enhanced Detection and Adaptive Learning for Autism

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Abstract

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition affecting social interaction, communication and behavior, requiring specialized interventions. The proposed framework enhances autism detection through multi-level assessment. It begins with the Social Communication Questionnaire (SCQ), a 40-item test evaluating social abilities of children. If results indicate a high likelihood of autism, the system advances to image-based detection using transfer learning with MobileNetV2. Transfer learning is a machine learning technique where a model trained on a large dataset is adapted for a new, smaller dataset. A pre-trained model like MobileNetV2 has already learned features from large-scale datasets and is fine-tuned to detect autism-related patterns, improving accuracy with limited data. The dataset comprises 3,000 images of both autistic and non-autistic individuals, enabling robust detection. By leveraging transfer learning, the system simplifies the process, reducing training time while maintaining high accuracy. Following detection, the Childhood Autism Rating Scale (CARS) is used to assess autism severity. CARS is a 15-item questionnaire that evaluates behaviors commonly associated with autism, with each item scored on a scale of 1 to 4. This step classifies and helps to determine the appropriate level of intervention. The final stage integrates an adaptive learning system, offering interactive, visually engaging tools, as autistic children respond better to dynamic content. Here, the videos will be about how children interact with society, their day-to-day life activities, and how they react to different situations. This comprehensive approach ensures early, precise autism detection while enhancing learning experiences through personalized teaching methods.

Keywords: *Autism Spectrum Disorder (ASD), Social Communication Questionnaire (SCQ), Childhood Autism Rating Scale (CARS), Transfer Learning, MobileNetV2, Adaptive Learning.*

1. Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition that affects an individual's communication, social interactions, and behavior. Early diagnosis is critical for ensuring timely intervention and support, yet many individuals go undiagnosed due to a lack of awareness and the time-consuming nature of traditional screening methods. Existing diagnostic techniques, such as clinical interviews and behavioral assessments, often require professional expertise and are not easily accessible in all settings. To address this challenge, this project presents an automated autism detection system that integrates multiple screening approaches to enhance accuracy and accessibility. The system incorporates the Social Communication Questionnaire (SCQ), a standardized 40-question screening tool that evaluates communication skills and social behaviors to provide an initial risk assessment. Additionally, image-based detection is employed using machine learning techniques to analyze facial and behavioral features, allowing for a more objective evaluation. Furthermore, the Childhood Autism Rating Scale (CARS) is utilized to assess behavioral patterns and classify autism severity based on predefined criteria. Alongside detection, an educational tool has been developed to provide personalized learning resources and interactive support for children diagnosed with ASD, helping them improve cognitive and social skills. By combining questionnaire-based screening, image recognition, and behavioral analysis, this system aims to provide a comprehensive and efficient autism detection tool. The proposed approach leverages artificial intelligence and deep learning techniques to improve accuracy and streamline the diagnosis process. [1-2]This paper details the design, implementation, and evaluation of the autism detection system, covering both the software and analytical methodologies involved. The primary objective is to develop an accessible, AI-driven tool that aids healthcare professionals, educators, and caregivers in identifying autism at an early stage while also offering educational support for individuals with ASD. By reducing reliance on specialized clinical settings, this system has the potential to improve autism screening efficiency and promote inclusive healthcare and learning practices.

2. System Methodology

The proposed autism detection framework integrates questionnaire-based assessment and deep learning-based image classification to ensure a robust and reliable system. The methodology is divided into the following subsections [3]

2.1.Questionnaire-Based Autism Screening

The Social Communication Questionnaire (SCQ) is utilized as the primary screening tool. It consists of 40 binary (yes/no) questions, specifically designed to assess social communication behaviors. Each affirmative response contributes to the cumulative score, with a threshold of 15 indicating a higher probability of autism. Since the SCQ is an established diagnostic tool, its inclusion in this methodology enhances the reliability of initial screening before proceeding to image-based classification [4-5]

2.2.Image-Based Autism Detection

2.2.1. Dataset

The dataset used for this study consists of 3,000 images of autistic and non-autistic children, sourced from Kaggle (Figure 1). The dataset is pre-divided into training and testing sets, ensuring a balanced distribution of both classes. Additionally, ImageNet, a large-scale benchmark dataset with over 14 million images, is used for model pre-training. The knowledge acquired from ImageNet helps the model recognize fundamental image patterns, which are then refined for autism-specific features. (Figure 1)

Figure 1 Sample Images from the Autism Dataset

2.2.2. Transfer Learning Approach

A pre-trained MobileNetV2 model is employed for feature extraction and classification. MobileNetV2 is optimized for mobile and embedded applications, featuring depth wise separable convolutions that reduce computational complexity while maintaining accuracy. [6]

- **Feature Extraction:** The early layers of MobileNetV2 are frozen to retain general image representations learned from ImageNet.
- **Fine-tuning:** The deeper layers are fine-tuned to capture autism-specific characteristics, such as facial expressions, eye contact patterns, and symmetry variations.

2.2.3. Preprocessing and Model Training

To ensure optimal model performance, a series of preprocessing steps are applied to the dataset before feeding it into the MobileNetV2 model. These steps enhance the model's ability to generalize across different images while maintaining efficiency. [7]

2.2.4. Preprocessing Steps

- **Resizing:** All images are resized to match the input dimensions required by MobileNetV2 to ensure consistency in model training.
- **Normalization:** Pixel values are scaled to a standardized range, typically between 0 and 1, to improve convergence during training. [8]
- **Augmentation:** Data augmentation techniques, such as rotation, flipping, contrast adjustments, and brightness variations, are applied. These augmentations help the model learn robust feature representations and

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reduce overfitting. [9]

2.2.5. Model Training

Once the dataset is preprocessed, it is fed into the MobileNetV2 model for training. The early layers of MobileNetV2, which capture low-level image features like edges and textures, are frozen to retain general image representations learned from ImageNet. The deeper layers are fine-tuned to adapt to autism-specific visual features, including facial expressions, eye contact patterns, and symmetry variations. During training, the model undergoes multiple epochs, progressively optimizing its weights to improve classification accuracy. A categorical cross-entropy loss function is used, and the Adam optimizer is applied for efficient learning. The training is monitored using validation accuracy to ensure that the model does not overfit the dataset. By leveraging transfer learning, the training time is significantly reduced, and the need for an extensive labeled dataset is minimized. The final trained model is optimized for real-time autism detection, offering a reliable and scalable solution. [10]

2.3.System Architecture

The overall system architecture is illustrated in Figure 2, representing the flow from data input to autism prediction. (Figure 2)

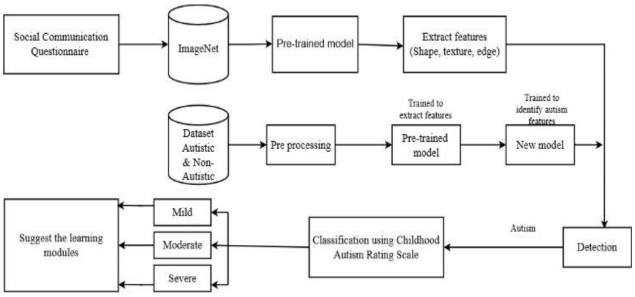

Figure 2 System Architecture for Autism Detection Framework

2.4.Behavioral Rating Assessment

To enhance classification, the Childhood Autism Rating Scale (CARS) is incorporated into the system. CARS evaluates autism severity based on a weighted scoring system. Key aspects assessed include: [11]

- Social Interactions
- Communication Skills
- Sensory Responses

The integration of CARS ensures a comprehensive assessment, combining both visual and behavioral indicators. Based on classification results, personalized learning modules are assigned to children identified with autism. These modules focus on improving cognitive and social skills through targeted interventions. The structure of these learning modules varies based on the severity of autism: (Figure 3) illustrates the modules designed for mild cases, (Figure 4) represents those tailored for moderate cases and (Figure 5) showcases modules specifically structured for severe cases. [12]

Figure 3 Learning Modules Designed for Children with Mild Autism

Figure 4 Learning Modules Designed for Children with Moderate Autism

Figure 5 Learning Modules Designed for Children with Severe Autism

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Results and Discussion

The performance of the MobileNetV2 model was evaluated based on its training and validation accuracy over multiple epochs. Figure 6 illustrates the training vs. validation accuracy, showing a steady improvement in both metrics as the training progresses. Initially, the validation accuracy fluctuates but stabilizes around 78%, indicating that the model effectively learns from the dataset. A comparative analysis was conducted with a standard CNN model, which was implemented for the same classification task. The CNN model achieved a lower validation accuracy of 74% and required a significantly longer training time compared to MobileNetV2. (Figure 6) [13]

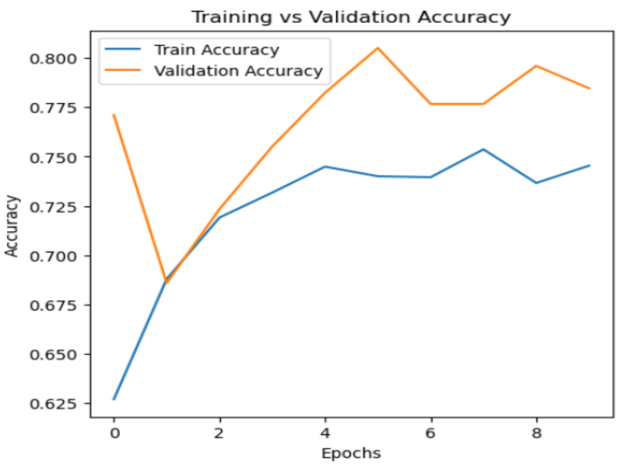

Figure 6 Training Vs. Validation Accuracy for the Mobilenetv2 Model

The increasing trend in validation accuracy suggests that MobileNetV2 generalizes well without significant overfitting. The minimal gap between training and validation accuracy further confirms that the model is stable and well-suited for autism detection. In comparison, the CNN model's lower validation accuracy and higher training time highlight the efficiency of MobileNetV2. The use of depth wise separable convolutions in MobileNetV2 reduces computational cost while maintaining high classification accuracy. This demonstrates the advantages of using a lightweight yet powerful architecture, making it an optimal choice for autism detection applications.

Conclusion

The implementation of MobileNetV2 for autism classification demonstrated improved efficiency and accuracy compared to a standard CNN model. With a validation accuracy of 78%, MobileNetV2 outperformed the CNN model, which achieved 74%, while also requiring less training time. This efficiency makes MobileNetV2 a more suitable choice for real-time applications where faster and more accurate classification is needed. Beyond classification, the system is integrated with interactive learning modules that utilize videos and GIFs to create an engaging educational environment for children with autism. Traditional learning methods often fail to capture and sustain their attention, but visual-based content has been shown to be more effective in helping them focus and retain information. The learning modules are tailored to individual skill levels, ensuring that each child receives appropriately structured content based on their abilities and progress. This personalized approach not only helps in maintaining focus and improving comprehension but also fosters cognitive and behavioral development. By making learning more interactive and adaptive, the system provides a structured yet flexible educational experience, ultimately supporting children with autism in a way that aligns with their unique needs. [14-16]

References

[1]. Charlotte Küpper, Sanna Stroth, Nicole Wolff, Florian Hauck, Natalia Kliewer, Tanja Schad Hansjosten, et al., "Identifying predictive features of autism spectrum disorders in a clinical sample of adolescents and adults using machine learning", Scientific reports, vol. 10, no. 1, pp. 4805, 2020.

[2]. Fadi Thabtah and David Peebles, "A new machine learning model based on induction of rules for autism detection", Health informatics journal, vol. 26, no. 1, pp. 264-286, 2020.

[3]. Fawaz Waselallah Alsaade and Mohammed Saeed Alzahrani, "Classification and detection of autism spectrum disorder based on deep learning algorithms", Computational Intelligence and Neuroscience 2022.

[4]. Jonathan T. Megerian, Sangeeta Dey, Raun D. Melmed, Daniel L. Coury, Marc Lerner, Christopher J. Nicholls, et al., "Evaluation of an artificial intelligence-based medical device for diagnosis of autism spectrum disorder", NPJ digital medicine, vol. 5, no. 1, pp. 57, 2022.

[5]. Khosla Yukti, Prerana Ramachandra and N. Chaitra, "Detection of autistic individuals using facial images and deep learning", 2021 IEEE International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS), pp. 1-5, 2021.

[6]. Lonnie Zwaigenbaum, Jessica A. Brian and Ip Angie, "Early detection for autism spectrum disorder in young children", Paediatrics & Child Health, vol. 24, no. 7, pp. 424-432, 2019.

[7]. Madison Beary, Alex Hadsell, Ryan Messersmith and Mohammad-Parsa Hosseini, Diagnosis of autism in children using facial analysis and deep learning, 2020.Musser Mikian, "Detecting autism spectrum disorder in children with computer vision", Medium, vol. 24, Aug 2020.

[8]. Parisa Moridian, Navid Ghassemi, Mahboobeh Jafari, Salam Salloum-Asfar, Delaram Sadeghi, Marjane Khodatars, et al., "Automatic autism spectrum disorder detection using artificial intelligence methods with MRI neuroimaging: a review", Frontiers in Molecular Neuroscience, vol. 15, pp. 999605, 2022.

[9]. R. Sujatha, S. L. Aarthy, Jyotir Chatterjee, A. Alaboudi and N. Z. Jhanjhi, "A machine learning way to classify autism spectrum disorder", International Journal of Emerging Technologies in Learning (iJET), vol. 16, no. 6, pp. 182-200, 2021.

[10]. Shaik Jahanara and Shobana Padmanabhan, "Detecting autism from facial image", International Journal of Advance Research Ideas and Innovations in Technology, vol. 7, no. 2, pp. 219-225, 2021.

[11]. Shu Lih Oh, V. Jahmunah, N. Arunkumar, Enas W. Abdulhay, Raj Gururajan, Nahrizul Adib, et al., "A novel automated autism spectrum disorder detection system", Complex & Intelligent Systems, vol. 7, no. 5, pp. 2399-2413, 2021.

[12]. Suman Raj and Sarfaraz Masood, "Analysis and detection of autism spectrum disorder using machine learning techniques", Procedia sComputer Science, vol. 167, pp. 994-1004, 2020.

[13]. Ugur Erkan and Dang Nh Thanh, "Autism spectrum disorder detection with machine learning methods", Current Psychiatry Research and Reviews Formerly: Current Psychiatry Reviews, vol. 15, no. 4, pp. 297-308, 2019.

[14]. Yukti Khosla, Prerana Ramachandra and N. Chaitra, "Detection of autistic individuals using facial images and deep learning", 2021 IEEE International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS), pp. 1-5, 2021.

[15]. Zeinab Sherkatghanad, Mohammadsadegh Akhondzadeh, Soorena Salari, Mariam ZomorodiMoghadam, Moloud Abdar, U. Rajendra Acharya, et al., "Automated detection of autism spectrum disorder using a convolutional neural network", Frontiers in neuroscience, vol. 13, pp. 1325, 2020.

[16]. Zeyad At Ahmed, Theyazn Hh Aldhyani, Mukti E. Jadhav, Mohammed Y. Alzahrani, Mohammad Eid Alzahrani, Maha M. Althobaiti, et al., "Facial features detection system to identify children with autism spectrum disorder: deep learning models", Computational and Mathematical Methods in Medicine 2022, 2022.