Detecting Autism Spectrum Disorder in Children Using Deep Learning

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Abstract

Autism Spectrum Disorder (ASD) is a complex, neurological disorder and enduring condition characterized by challenges related to communication and behavior with the outside world. While it is feasible to detect autism symptoms at any stage of an individual's life, there is a greater likelihood of detection within the first two years after birth, as differences in typical activities, communication gaps, or a lack of understanding typically become more noticeable during this early developmental period. This paper aims to identify children on the autism spectrum using various AI techniques, and image processing techniques involving Convolutional neural networks (VGG16, VGG19, Efficient NETB3, and Logistic Regression). Early autism detection provides numerous benefits by preparing for the future and increasing awareness of medical conditions. Our objective is to utilize data sets from the ASD Tests program as a primary data source involving different modern algorithms. Autistic children often display unique patterns of facial features that distinguish them distinctly from neurotypical children, so we want to utilize a deep learning-based web application for the detection of autism. We have acquired facial images from a publicly available dataset, from a platform called Kaggle. Our primary goal is to improve the accuracy of autism detection or contribute to research by developing a comprehensive research paper. This paper seeks to enhance model comparisons and streamline autism detection using contemporary AI techniques.

Research Objective

The research objective of our project is to identify autism in children accurately from facial images of children.Some of the objectives are-

- **Early Identification** can help in identifying if a child has autism early on so that he/she can receive proper care.
- **Objective Diagnosis** can assist doctors to make a proper diagnosis with help of pictures.
- **Understanding Behavoirs** can aid in learning how children with autism behave and express themselves based on their facial expression.
- **Tracking Progress** can help us in understanding how a child's expressing changes with time.
- **Raising Awareness** about different medical conditions in surrounding.

Methodology

The proposed deep learning-based autism detection model suggests tech- niques that employ facial analysis to diagnose autism in children. The main steps are broken down as follows:

1.1 we Identify relevant Data Sources to determine which data sources are relevant and pick ones that include pictures of patients with and without autism.

1.2 To train and test the model, create a dataset that includes pictures of people with and without autism.

1.3 we use Preprocessing Methods to Standardize the dataset by using preprocessing methods to ensure consistent image sizes and lower noise. 1.4 we make three subsets out of the dataset: 300 for testing, 100 for validation, and 2,540 for training.

2. To process input photos, learn weights and biases, and build predictive models, we select deep learning algorithms such as VGG16, VGG19, EfficientNetB3, and ASD LR.

3. We make use of the learned models to forecast if a picture input represents an autistic or non-autistic condition. To assess each model's performance, compute and contrast its accuracy in relation to its predictions.

Data Preprocessing

In our paper, we used four models with consistent preprocessing on a Kaggle dataset (2940 images: 2540 for training, 300 for testing). The data underwent organization, splitting, resizing, validation, augmentation, and array conversion. Uniform steps included reading images in RGB or converting them to grayscale, resizing to a target size, and flattening into arrays. Pixel values were normalized to [0, 1]. This process ensures data readiness for testing with diverse algorithms.

Literature Review

A research (Gaddal, 2023) looked into a number of deep learning models, such as DNNs, for the purpose of detecting ASD using face features. Although their results point to the possibility of increased accuracy, the study's lack of information on dataset size and ethical issues, as well as the opaque nature of deep learning, raise questions regarding interpretability. Our proposed hybrid model, while incorporating LR, targets to better model interpretability by offering perceptions into the process of making decisions. Furthermore, another paper (Tamilarasi) improved accuracy (76.2 percent) and provided interpretability by combining CNN features with XGBoost and Random Forest algorithms. Nevertheless, the study lacked a thorough examination of the particular facial traits that contribute to the prediction of ASD, and their dataset size was likewise somewhat limited. Our larger dataset can provide higher statistical power and possibly more broadly applicable results can be obtained. Also, since we are combining pre-trained CNNs (VGG16, VGG19 and EfficientNetB3) we can make in-depth use of CNN's feature extraction capabilities. Also, another study (Bauer, 2015) got an accuracy of 84 percent utilizing VGG16 and VGG19 (focusing solely on CNNs). We can improve the overall functionality of such approaches by incorporating LR. By combining multiple CNNs and Logistic Regression and utilizing a larger dataset, our hybrid model seeks to overcome the aforementioned drawbacks by improving interpretability and making use of pre-trained CNNs' feature extraction powers.

Study Pipeline

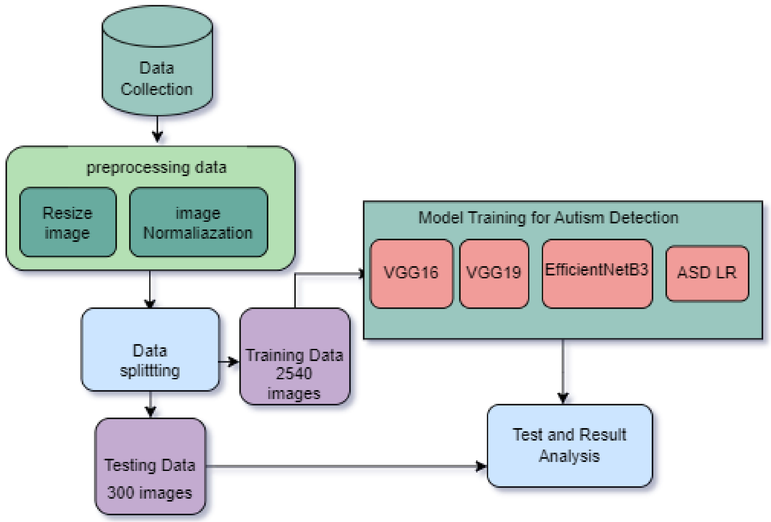
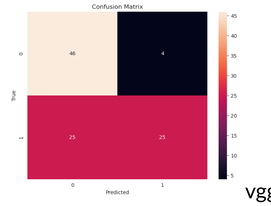
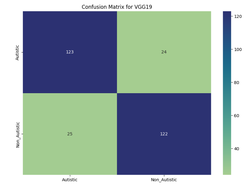


Figure 1. Step by step work plan of the proposed autism detection model.

Visualization



vgg16 confusion matrix



vgg19 confusion matrix

EfficientNetB3 confusion matrix

Analysis

Among all the models Efficient NetB3 gave us the highest accuracy of 87 percent. It is clear that logistic regression is bad for image data. All three CNN models gave us accuracy above 70 percent. VGG16 is the most commonly used model for our dataset and it has accuracy of 71.33 percent. Better version VGG19 has accuracy around 80 percent and Efficient NetB3 has the best accuracy of 87 percent.

Models	VGG16	VGG19	Efficient NetB3	ASD LR
Accuracy	71.33	80	87	61

Table 1. Result Comparison

CNN models(VGG16, VGG19, Efficient NetB3) autistic classification report are given below:

Model	VGG16	VGG19	Efficient NetB3
Precision	0.66	0.83	0.92
Recall	0.88	0.84	0.81
f1 score	0.75	0.83	0.86

Table 2. Autistic Classification Report

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