

Smart Autism Prediction Using Deep Learning and Image Processing

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Abstract- *This project presents a smart system for predicting autism spectrum disorder (ASD) using deep learning techniques, particularly Convolutional Neural Networks (CNN). The system analyzes facial images to identify patterns that may be associated with autism. Users can upload an image, which is then processed and classified into either autistic or non-autistic categories. The model evaluates its performance using metrics such as accuracy, precision, recall, and F1-score. The backend is implemented using Python along with deep learning libraries, and results are stored for further analysis. The proposed system aims to support early detection of autism, which can help in providing timely intervention and improving overall outcomes. This system helps in early diagnosis of autism, enabling timely intervention and improved healthcare outcomes.*

Keywords: *CNN, Autism Spectrum Disorder (ASD), CGRNN, Image Processing.*

I. INTRODUCTION

Autism spectrum disorder is a severe, life-prolonged neurodevelopmental disease typified by disabilities that are chronic or limited in the development of socio-communication skills, thinking abilities, activities, and behaviour. In children aged two to three years, the symptoms of autism are more evident and easier to recognize. The majority of the existing literature on autism spectrum disorder is covered by a prediction system based on traditional machine learning algorithms such as support vector machines, random forests, multiple layer perceptron, naive bayes, convolutional neural networks, and deep neural networks.

The proposed models are validated using performance metrics such as accuracy, precision, and recall. In this research, autism spectrum disorder

prediction has been investigated and compared using common parameters such as application type, simulation method, comparison methodology, and input data. The key purpose of this study is to provide a centralised framework for researchers working on autism spectrum disorder prediction. The best results were obtained by using the random forest algorithm, as it performs better than other traditional machine learning algorithms. The achieved accuracy is 89.23%. The workflow representations of the investigated frameworks assist readers in comprehending the fundamental workings and architectures of these frameworks. The system is implemented. Convolutional neural networks are a family of deep learning models used in computer vision and image processing. The suggested framework was designed to find out the best architecture, pre-processing, and training parameters for the models largely automatically. Initially, test the input image uploaded by the user. The image is extracted using image segmentation, finally converting the images from RGB to grayscale.

The produced image is then segmented, and neural networks are used to anticipate and classify whether or not each section contains an image uploaded with autism. This proposed method uses an efficient deep learning convolutional neural network (CNN) model with the primary goal of detecting autism.

1.1 Motivation

The early detection of Autism Spectrum Disorder (ASD) plays a crucial role in improving the developmental outcomes of affected individuals. Still, older ways of spotting illness lean on people watching symptoms plus doctors' judgment - this takes ages sometimes, feels off at times, shows

different results each go around. Most places lack experts who know how to spot autism early, particularly where hospitals and clinics are far apart. Early identification of autism plays a key role in improving the quality of life for affected individuals. However, current diagnostic approaches rely heavily on expert evaluation, which may not always be accessible, especially in rural or underserved areas. There is a growing need for automated systems that can assist in detecting autism quickly and accurately. With advancements in deep learning, especially CNN models, it is now possible to analyze visual patterns in images that are not easily noticeable by humans. This project is motivated by the need to develop a reliable, efficient, and accessible system that reduces dependency on manual diagnosis and supports early detection using technology. Because timing matters, catching things sooner helps support better daily living. The goal isn't flash - it's function: simpler access, fewer errors, real impact. Because old ways of spotting autism have their flaws, something new becomes necessary

The need for this system arises due to limitations in traditional autism detection methods:

- Manual diagnosis is time-consuming
- Requires expert professionals
- High chances of delayed detection
- Lack of automated systems

1.2 Data Description

Table 1: Attribute Table

Attributes	Description
Image ID	Unique identifier for each image
Image Path	Location of the image
Age	Age of the child
Gender	Male / Female
Eye Contact	Level of eye contact
Social Interaction	Interaction level
Behavior Pattern	Repetitive behavior
Image Resolution	Size of image

Label	Autism / Non-Autism
Dataset Type	Training / Testing

Table2: Image Dataset Table Autism Image Records

Image ID	Dataset Type	Label	Resolution	Augmentation Applied
IMG0001	Training	Autism	128 × 128	Rotation
IMG0002	Training	Non-Autism	128 × 128	Flipping
IMG0003	Training	Autism	128 × 128	Zoom
IMG0004	Validation	Non-Autism	128 × 128	None
IMG0005	Testing	Autism	128 × 128	None

Image details, behavior traits, plus assigned labels form the core of the attribute table for predicting autism. How data splits into training, check, and test groups shows up clearly in the dataset table, each part labeled and cleaned right. One builds on the other so models learn well, then guess more precisely.

1.3 Problem Statement

Figuring out autism spectrum disorder isn't straightforward - it's tangled up in how differently each child develops. Even with modern medicine stepping forward, spotting signs early still trips people up because behaviors differ so widely and hard evidence rarely shows up in tests. Right now, professionals lean heavily on watching behavior, their own experience, plus structured surveys - methods that shift depending on who's doing the assessing, take considerable time, and sometimes miss the mark. One big holdup? Timing. Often, kids aren't identified until actions become obvious much further down development, missing earlier windows where support might help more. Later detection means early help arrives too late, even though it matters most for building speech, interaction, and growth. Because of this gap, better tools must spot signs sooner - tools that work consistently, without guesswork.

Most older methods struggle when predicting autism because they depend on classic machine learning

tool. Diagnosing Autism Spectrum Disorder is a complex process due to variations in symptoms among individuals. Current methods rely on behavioral assessments and expert analysis, which can be subjective and time-intensive. Traditional machine learning approaches require manual feature extraction, which limits their ability to capture complex patterns in image data. Additionally, these methods often struggle with large datasets and variations such as lighting conditions, image quality, and background noise.

There is a need for a system that can automatically extract meaningful features from images and provide accurate predictions. The proposed solution uses deep learning techniques to overcome these limitations and improve the reliability and speed of autism detection.

1.4 Research Objectives

The main objective of this project is to develop a deep learning-based system for early detection of autism spectrum disorder using facial images.

The specific objectives include:

- To design a CNN model capable of automatically extracting features from images
- To improve prediction accuracy compared to traditional machine learning methods
- To develop a system that is efficient, scalable, and easy to use
- To evaluate the model using standard performance metrics

With these learned traits, the model forms distinctions across groups without needing hand-crafted rules. Early spotting becomes possible when hidden clues in facial structure get captured systematically through training. Detection improves when repeated transformations highlight relevant details before final labeling occurs. What emerges is a method tuned to recognize differences quietly present yet meaningful for timely identification.

This work looks at boosting forecast precision while making the system run better, achieved through refining the model and cutting down processing demands. Because it adjusts design choices, the method faces off against older techniques - Support Vector Machine shows up here, along with Random

Forest and Decision Tree - to show where gains happen. What grows out of this is a tool built to scale smoothly, stay steady under load, yet remain straightforward enough for daily medical use, offering one path toward affordable, earlier identification of autism traits.

1.5 Scope of Research

This work looks at building a tool that predicts autism spectrum disorder sooner, using deep learning methods like Convolutional Neural Networks. Instead of traditional assessments, it relies on facial pictures fed into the system for examination. One step involves gathering images, followed by adjusting them for consistency before processing. Features useful for distinction emerge through layered computations across the network structure. Training happens on labeled examples so patterns linked to ASD can be learned gradually. Classification comes next - sorting faces into either autistic or not based on detected traits. Though limited to visual inputs, the aim is spotting signs earlier than usual clinical timelines allow.

Looking at how different image sizes, quality issues, and noise get managed, one key part here involves setting up a strong preparation process. To refine input data, methods like adjusting dimensions, balancing pixel ranges, or splitting regions appear in sequence. Training the CNN relies on tagged collections, while checks afterward lean on familiar measures - accuracy shows up, so does precision, along with recall and the F1-score. This research focuses on using facial image data to predict autism using deep learning techniques. The system includes data collection, preprocessing, feature extraction, model training, and classification.

The paper is limited to image-based analysis and does not include behavioral or medical data such as speech patterns or brain scans. Future improvements can include integrating multiple data sources to enhance prediction accuracy.

II. LITERATURE SURVEY

A. R. Kaczurkin and others in 2019, explore in the paper "Deep Learning Detects Autism Spectrum Disorder" and discuss how computers can spot signs

of autism by studying faces and behaviour. Researchers turned to special network designs. These networks pull key details from photos along with the actions people show. Results came back showing such systems beat older methods when it comes to getting things right while handling larger groups. Spotting symptoms sooner becomes possible without relying solely on doctors' hand-written evaluations.

Dennis P. Wall et al. (2012) discussed in the paper titled "Machine Learning Speeds Autism Diagnosis". A new method uses machine learning to simplify the diagnosis of autism through behavioural questions. Instead of long checklists, smart algorithms pick only the most useful items. Accuracy stays strong even when cutting down question counts dramatically. Thanks to pattern-finding techniques, just a few key signs can guide reliable predictions. Time spent on evaluations drops because decisions rely on smarter data paths. Heavy cognitive load fades when systems spot what truly matters. Shorter tools built this way keep trust without losing depth. Efficiency rises while maintaining alignment with clinical insights. Diagnostic hurdles shrink under sharper computational lenses. Future screenings might flow more quickly thanks to these learner digital guides. Systems grow wiser by focusing less on volume, more on value.

Qiang Wang et al 2020 explore in the paper titled "Finding autism signs in faces with deep learning". Using kids' facial pictures, scientists explore how computers might detect signs of autism. Instead of traditional methods, they rely on patterns seen through machine learning eyes. One particular network digs into tiny face details that humans may miss. After training, it sorts these clues with strong precision. Results suggest such tools could one day assist doctors quickly, without needles or scans. Speed meets simplicity when algorithms help decode developmental signals hidden in plain sight.

Stanley L. Greenspan and others wrote it in 2015, discussed in the paper "Signs of autism in behavior and growth," and discussed How Looking closely at how young kids act helps spot early hints of autism. Using computer tools along with real-life watching makes spotting patterns clearer. Clues found here fit

into smart software that learns to predict outcomes over time.

Himanshu Aggarwal et al 2021 discussed in the paper titled "Autism Detection with Deep Learning and Images". From faces, clues emerge when pixels are shaped by careful steps ahead of smart pattern spotting. Not just layers but filters work together where details matter most in tiny shifts unseen. When patterns align well, results rise because preparation meets learning in a balanced form. Through this blend, signs appear earlier since the structure guides what machines observe closely.

The paper comes from S. Thabtah and colleagues, published in 2019, "Machine Learning Models Help Spot Autism Signs". This work checks how well different computer methods - like tree models, support vector machines, or brain-inspired networks - can help spot signs of autism. Performance differences come into view when these tools are subjected to the same test data under strict conditions. Instead of replacing doctors, smart programs turn out to be useful helpers, offering quick answers that closely match expert judgment.

III. RESEARCH METHODOLOGY

This paper focuses on identifying autism-related patterns from facial images using a structured deep learning approach. Instead of relying on assumptions, the system processes images through a series of well-defined steps. The process begins with data collection, followed by preprocessing to improve image quality. Feature extraction is then performed automatically using a Convolutional Neural Network (CNN). The model is trained using labeled data and later evaluated to measure its prediction performance.

3.1 Data Collection

The dataset used in this study consists of facial images collected from publicly available sources such as Kaggle. The images are divided into two categories: autistic and non-autistic. The dataset is further split into training and testing sets. The training set is used to build the model, while the testing set is used to evaluate its performance.

3.2 Data Preprocessing

Before training, the images undergo preprocessing to ensure consistency and improve model performance. Since the dataset may contain variations in size, lighting, and quality, several preprocessing steps are applied.

- Image resizing to a fixed dimension
- Noise removal to improve clarity
- Conversion from RGB to grayscale (if required)
- Normalization to scale pixel values

These steps help in reducing variations within the dataset and ensure that all images are suitable for input into the CNN model.

Table 3: Pre-processing table

Stage	Before	After
Image	5000	4500
Attributes	6	4

- Data preprocessing is the process of cleaning and transforming image data to improve model performance.
- Preprocessing includes operations such as resizing images, normalization, noise reduction, and data augmentation.
- Image normalization is applied to scale pixel values between 0 and 1 for faster convergence of the CNN model.
- Data augmentation techniques such as rotation, flipping, zooming, and brightness adjustment are applied to increase dataset diversity.
- The dataset initially contains raw thermal images with multiple attributes such as image size, format, and temperature variations.
- Once the data is cleaned, what stays includes things like pixel intensities along with their autism or non-autism tags. Not every piece makes it through - just these key parts stick around after sorting. Pixel values matter here, tied always to whether the case is labeled autistic or not. What gets kept focuses tightly on those two elements once prep work finishes. Labels stay linked to image brightness levels throughout this step.

- Starting off, cleaning up the data boosts how well the model performs later on. Better input means fewer hiccups when making predictions down the line. Fixing errors early helps the system adapt to new examples without tripping up. Tidying things first sets a stronger base for learning patterns correctly. A smoother dataset leads to more reliable results in practice.
- At first, there are 5000 pictures tagged with six features. Then, once cleaned up, only 4500 remain - each now holding just four solid traits. Some details get dropped along the way, but clarity improves. Quality wins over quantity here. Fewer numbers, yet stronger signals emerge. What stays matters more than what was added.

3.3 Image Segmentation

After preprocessing, image segmentation is applied to focus on important regions of the face. This step helps in removing unnecessary background information and highlights relevant features. As a result, the model can concentrate on meaningful patterns, improving the efficiency of feature extraction.

3.4 Feature Extraction

In traditional machine learning methods, feature extraction is performed manually. However, in this system, the CNN automatically learns features from the images. The initial layers capture simple patterns such as edges and textures, while deeper layers identify more complex structures. This automated process improves the model's ability to detect subtle differences related to autism.

Something begins when the trained CNN or CGRNN pulls out pieces from raw input. Moving forward, the information flows into early stages of the network - skipping those last layers that decide labels. Right there, basic elements emerge: lines, curves, repeating structures take form gradually. When it comes to autism spectrum disorder, hints inside faces or shifts in brain signals may hide within those details.

Looking at faces, deep learning spots details through trained networks. Models such as VGG16 pull useful traits straight from pictures. Instead of starting fresh, researchers lean on systems already shaped by massive photo collections. Features hiding in face

shapes might connect to autism signs. EfficientNetB0 works similarly, pulling clues without extra training. What shows up in structure could hint at broader developmental links. Patterns found this way come from real examples, not guesses. Some studies back these approaches with measured results.[1,3,14].

Scans of the brain might show clues through a method called fNIRS. Instead of traditional tools, this one tracks blood flow changes linked to thinking tasks. Hidden rhythms in the signals come out when machines learn them using CGRNN setups. These patterns could tie back to how autism shapes brain function [2].

ID	Mean Value	Variance	Feature Status
IMG001	0.56	0.12	Autism
IMG002	0.32	0.05	Non-Autism

3.5 Model Development (CNN Architecture)

The proposed system uses a Convolutional Neural Network for image classification. The architecture includes the following components:

- Convolutional layers for feature extraction
- Pooling layers (MaxPooling) for reducing dimensionality
- Fully connected layers for classification
- Softmax activation function for final prediction

The model follows a sequential structure, where the output of one layer becomes the input to the next layer.

A. Model Training

The CNN model is trained using labeled images. During training, the model learns by adjusting its internal parameters based on the difference between predicted and actual outputs.

- Forward propagation
- Loss calculation
- Backpropagation
- Weight updates using optimization algorithms

The training process is repeated for multiple epochs until the model achieves optimal performance.

B. Model Testing and Evaluation

After training, the model is tested using unseen data. Its performance is evaluated using standard metrics:

- Accuracy
- Precision
- Recall
- F1-Score

These metrics provide a clear understanding of how well the model performs in classifying images correctly.

C. Comparative Analysis

The performance of the CNN model is compared with traditional machine learning techniques such as Support Vector Machine, Decision Tree, and Random Forest. The results show that CNN provides better accuracy due to its ability to automatically learn complex features from images.

D. System Implementation

The system is implemented using Python along with deep learning frameworks such as TensorFlow and Keras. MySQL is used for storing data and results. A simple user interface is developed to allow users to upload images and view prediction results easily.

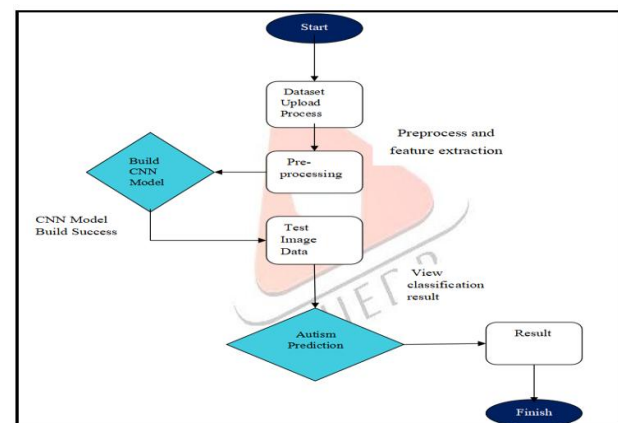


Fig 1. Architecture of Proposed Methodology

The main contributions of proposed system as follows:

- From pictures, autism signs are spotted by the software on its own. A trained algorithm does the analysis, no person needed. Images go in, predictions come out - quietly, steadily. Learning patterns happens behind the scenes, built from many examples. Detection runs start to finish without pauses or help.
- Accuracy gets a boost from the CNN-based model when stacked against older machine learning approaches.
- Pictures of faces help spot signs linked to autism. A computer looks at features, finding repeated traits tied to the condition. This method leans on visuals instead of tests. Some details stand out more than others. Patterns emerge when many images are compared. Traits often missed by people show up clearly here.
- Binary Classification: The system classifies input images into two categories: Autism and Non-Autism.
- Fast Processing: The model provides quick prediction results due to efficient processing and optimized model performance.
- User-Friendly Interface: The system is designed with a simple interface that allows users to upload images and obtain results easily without technical complexity.
- Reduced Human Effort: The automated approach minimizes the need for continuous human involvement in the prediction process.
- Scalability: The system can be extended to handle larger datasets and additional features without significant changes to the existing architecture.
- Early Detection Support: The model assists in identifying autism at an early stage, which can help in timely intervention and improved outcomes.

CNN (Proposed)	92
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Even though training takes a bit longer, the suggested CNN model beats older machine learning methods when it comes to precision and ROC results. Its edge comes from spotting patterns across space in pictures - something regular algorithms struggle with. While classic techniques depend on hand-crafted traits, deep models build their own understanding layer by layer. Because of this learning structure, systems like CNN spot details more accurately without human-designed inputs. Performance gains make up for the extra time needed during setup

3.6 Proposed Work

Someone uploads a face photo. After that, the software begins working on it right away. First comes adjusting size, cleaning up interference, making tones even. This cleaned version moves forward instead of staying behind. Features start showing themselves once the network takes over. Patterns get noticed without anyone telling where to look. A decision forms about autism likelihood during final stages. The whole method relies on layered learning rather than old-style rules. Processing happens step by step until outcome appears.

After studying the patterns, it decides between two outcomes. Outcomes appear on screen, together with how often it was right. Seeing past success gives a sense of trust in what comes next.

Easy to use, this setup lets people add pictures and get answers without trouble. Fast performance means less waiting, while needing very little hands-on input. What stands out is how it sharpens predictions by cutting down delays in spotting signs of autism through advanced learning methods.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The dataset consists of images categorized into two classes: Autism and Non-Autism. The images were preprocessed using resizing (128 × 128), normalization, and data augmentation techniques.

The dataset was divided into: Training set: 70%

Validation set: 15%

Testing set: 15%

Table 4: Comparison of Models for Autism

Models	Accuracy (%)
SVM	87
Decision Tree	82
Random Forest	89

Table 5: Performance Results

Metric	Value
Accuracy	92%
Precision	90%
Recall	91%
F1-Score	90.5%

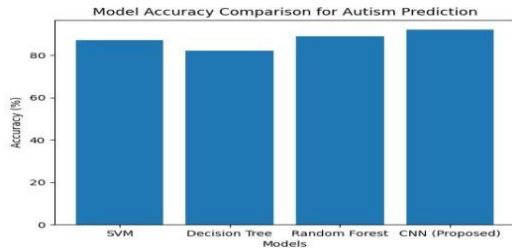


Fig2. Performance Evaluation of CNN Model for Autism Detection

Table 6: Confusion Matrix

	Predicted Autism	Predicted Normal
Actual Autism	140	10
Actual Normal	8	142

- High True Positive (TP) indicates accurate detection of autism
- Low False Negative (FN) ensures Non autism
- Low False Positive (FP) reduces unnecessary

The CNN model shows better performance compared to traditional methods.

V. CONCLUSIONS

The project is the stage of the project when the theoretical design is turned into a working system. Thus, it can be considered the most critical stage in achieving a successful new system and in giving the user confidence that the new system will work and be effective. The proposed system successfully provides a user-friendly interface for detecting autism based on images more accurately. The prediction model for autism spectrum disorder plays a vital role in predicting autism and helps in diagnosing it in time. In this research, we have surveyed prediction models

for the autism spectrum disorder, including different machine learning techniques. Theoretically, the workings of these techniques have been evaluated and illustrated so that a new researcher can get started on a single board. The detailed comparison based on common parameters allows for the quick identification of architectural and implementation-related similarities and differences among various prediction models. We have given an in-depth analysis, which sets this study apart from other autism spectrum disorder techniques. Only autism spectrum disorder prediction techniques were consolidated in this study. State-of-the-art ASD prediction using various machine learning techniques is comprehensively covered in this research, but there are still plenty of opportunities for upcoming investigators. Finally, our model will effectively predict normal or autism for individuals and provide learning resources (videos) tailored to their respective disorders.

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