International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Deep Analysis of Autism Spectrum Disorder Detection Techniques

Kaviya.T[1], Spandana[2]

[1,2]Department of CSE, Dr.M.G.R.Education &Research Institute, Chennai

ABSTRACT:
Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by sensory sensitivities, such as unusual responses to sounds, smells, or touch. Traditional autism screening methods are often costly and time-consuming. With the advancement of artificial intelligence, early prediction of autism is becoming more feasible. This project focuses on using deep learning techniques to improve early detection of autism. Specifically, we employ the Mobile Net algorithm, known for its efficiency and accuracy, to build and evaluate a predictive model. Mobile Net's ability to handle complex patterns with reduced computational resources makes it a suitable choice for this task, potentially enhancing early diagnosis and intervention strategies.

KEYWORDS: Autism Spectrum Disorder (ASD), Machine Learning, Deep Learning, MobileNet, Svm, CNN

1. INTRODUCTION

Autism, or autism spectrum disorder (ASD), is a developmental condition that affects how a person perceives the world and interacts with others. It is called a "spectrum" because it includes a range of conditions characterized by challenges with social skills, repetitive behaviours, speech, and nonverbal communication. Each person with autism experiences it differently, with varying degrees of severity

Autism is an integral neurodevelopment disorders that affects the functioning of brain. It can occur at any age but usually occur in childhood; mostly children at the age of 2 or 3 have more chances of having ASD[1].

It occurs due to the combination of both genetic and environmental factors. Autism is not an illness or a disease rather it is a neurological condition in which child is unable to concentrate, think, learn, focus and solve the problems. They find difficulty in explaining things through facial expression or by making Gestures.

The child suffering from ASD faces various challenges like

1. Lack of concentration
2. Repeat the same word again and again
3. Doesn't interact with other people like normal kids of their age/avoid interaction
4. Lack of Understanding in Making Gestures, Facial expression
5. Very sensitive in feel, touch, smell or speech.
6. Abnormal voice tone and body postures
7. they have restricted intrest

Causes of Autism Spectrum Disorder:

The exact cause of autism is not fully understood, but research suggests that it is likely due to a combination of **genetic, environmental, and neurological factors**.

- **GENETICAL FACTORS:**

Autism is strongly inherited, with a 90% chance of occurrence in identical twins. Genetic mutations, such as CHD8, SHANK3, and NRXN1 genes, can disrupt brain development. Genetic predispositions can also interact with environmental factors, increasing the likelihood of ASD. Diagnostic tools are needed to address these challenges, as they are time-consuming and costly.

- **NEUROLOGICAL FACTORS:**

Some children with Autism Spectrum Disorder (ASD) exhibit abnormal brain development patterns, affecting information processing, and neurotransmitter imbalances, such as serotonin and dopamine, which are crucial for neuronal communication.

- **ENVIRONMENTAL FACTORS :**

Prenatal and perinatal factors can increase the risk of Autism Spectrum Disorder (ASD), including advanced parental age, exposure to toxins during pregnancy, maternal infections and immune system irregularities, and complications during birth such as low birth weight, premature birth, or lack of oxygen at birth (hypoxia). These factors can contribute to the development of ASD in both mothers and babies.

There are other reasons such as Immune System Dysfunction, Obesity and Diabetes in Pregnancy, Genetic Syndromes, Epigenetic Changes can also be the cause of ASD.

Machine learning (ML) and deep learning (DL) techniques are being increasingly used for the early detection of autism spectrum disorder (ASD). These models analyse large datasets, such as behavioural data, brain imaging (MRI/EEG), and genetic information, to identify patterns that indicate autism risk.

2. PROBLEM STATEMENT

Early detection is crucial for intervention and support. Traditional screening methods are resource-intensive, requiring specialized personnel and long observation periods. There's a need for more accessible diagnostic tools.

ML and DL models can process complex patterns in large datasets, such as behavioral data, brain imaging, or genetic profiles, to identify subtle indicators of autism. Leveraging techniques like Support Vector Machines (SVM), Convolutional Neural Networks (CNNs), and MobileNet architectures, these models have shown potential in accurately classifying individuals with ASD based on features such as facial expressions, eye gaze, sensory sensitivities, and speech patterns. The integration of ML and DL in ASD detection not only improves diagnostic accuracy but also provides novel insights into the underlying mechanisms of the disorder, paving the way for more personalized and effective treatment strategies.

The research aims to develop a deep learning-based solution using MobileNet architecture to detect Autism Spectrum Disorder based on sensory sensitivities and behavioral patterns. The model will be developed using MobileNet, a lightweight and efficient computational framework, and evaluated on diverse autism-related datasets. The model's accuracy and efficiency will be analyzed, reducing the need for expensive screening processes. The model could be integrated into mobile or web applications for more accessible autism screening and healthcare professional assistance.

In recent years, artificial intelligence (AI) has emerged as a promising solution to enhance the early detection of ASD. Machine learning models, particularly deep learning techniques, can analyse complex patterns in behavioural and sensory data, providing a non-invasive and cost-effective alternative to

conventional methods. Among these techniques, convolutional neural networks (CNNs) have demonstrated considerable success in recognizing intricate patterns and have been widely applied in medical image analysis and predictive modelling.

ML and Deep Learning models can identify subtle autism indicators in large datasets using techniques like SVM, CNNs, and MobileNet architectures. These models accurately classify individuals with ASD based on facial expressions, eye gaze, sensory sensitivities, and speech patterns. Integrating ML and DL in ASD detection improves diagnostic accuracy and offers insights into the disorder's underlying mechanisms, enabling personalized treatment strategies.

The main objective of this research paper is to conduct a comprehensive analysis of existing detection techniques for Autism Spectrum Disorder (ASD), with a particular focus on exploring how advanced machine learning and deep learning algorithms can enhance early diagnosis accuracy, improve detection efficiency, and identify key biomarkers associated with ASD. The study aims to evaluate the effectiveness of various methods, compare performance across datasets, and highlight potential improvements for future diagnostic.

3. LITERATURE REVIEW

The literature on autism spectrum disorder (ASD) detection techniques using machine and deep learning highlights significant advancements and challenges in the field. Various studies emphasize the potential of these technologies to enhance early diagnosis and treatment.Some of the related paper works are given bellow using both machine and deep learning techniques

USING ML TECHNIQUE

Analysis and Detection of Autism Spectrum Disorder Using Machine Learning Techniques

The paper reviews the challenges faced by individuals with Autism Spectrum Disorder (ASD) and discusses the development of models for ASD detection[2] using machine learning and deep learning techniques. Techniques used include Naive Bayes, Support Vector Machine, Logistic Regression, K-Nearest Neighbours, Neural Network, and Convolutional Neural Network[3][4]. The study focused on predicting and analyzing ASD problems in different age groups, with CNN-based prediction models outperforming other techniques, achieving high accuracy rates for screening ASD in children, adolescents, and adults[5].

Detection of autism spectrum disorder (ASD) in children and adults using machine learning

The paper explores the detection of Autism Spectrum Disorder (ASD) using Federated Learning (FL) and machine learning (ML) techniques. It employs two classifiers: Support Vector Machine (SVM) and Logistic Regression (LR), trained locally on four ASD datasets. The study achieves high accuracy rates of 98% for children and 81% for adults. The methodology emphasizes data security by keeping data local and minimizing network transmission, addressing privacy concerns in ASD diagnosis .

A Machine Learning Approach to Predict Autism Spectrum Disorder

The study proposes a machine learning model using the AQ-10 dataset to predict autism traits across different age groups, aiming for early detection and cost reduction in diagnosis. It employs Random Forest-CART and Decision Tree-CART algorithms, enhancing accuracy through feature selection and model modifications. A mobile application was developed to facilitate user-friendly screening, addressing a gap in existing tools for diverse age demographics

Detection of Autism Spectrum Disorder in Toddlers using Machine Learning

This study aims to identify toddlers at risk for Autism Spectrum Disorder (ASD) using logistic regression,

a machine learning method. The methodology involves asking carers nominal questions to gather data on social interactions and communication styles, which serve as input features for the model. Rigorous feature selection enhances model accuracy, achieving a notable improvement from 82% to 96%. The approach emphasizes early intervention and provides a quick, cost-effective alternative to traditional clinical testing.

USING DL TECHNIQUES

Deep Analysis of Autism Spectrum Disorder Detection Technique

The literature review discusses the use of Machine Learning (ML) techniques in detecting Autism Spectrum Disorder (ASD). ML approaches like Random Forest Classification, Regression Tree, and Iterative Dichotomise 3 have been used to build prediction models for diagnosing ASD in different age groups, achieving high accuracy rates ranging from 92.26% to 97.10%. Image processing tools have been used to develop mobile applications for identifying autistic children based on eye contact, voice patterns, and quick positive responses. The Autism Diagnostic Observation Schedule (ADOS) method has been used to assess ASD using machine learning algorithms, achieving high accuracy rates of 97.66% and 98.27% for different behaviour subsets in children with or without autism.

Utilizing deep learning models in an intelligent eye-tracking system for autism spectrum disorder diagnosis

The study explores the use of deep learning models, specifically MobileNet and VGG19, for diagnosing Autism Spectrum Disorder (ASD) through eye-tracking data. It employs a hybrid model combining these architectures to enhance classification accuracy. The research utilizes a dataset of 547 eye-tracking systems, applying data augmentation techniques to prevent overfitting. The findings indicate that the MobileNet model achieved 100% accuracy, demonstrating the potential of AI in improving ASD diagnostic processes

Deep Learning Approach to Predict Autism Spectrum Disorder(ASD)

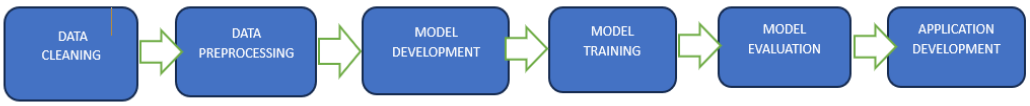
The paper presents a deep learning approach for predicting Autism Spectrum Disorder (ASD) using various advanced techniques. It employs a combination of Convolutional Neural Networks (CNN) and Gated Recurrent Units (GRU) in a model called CGRNN, achieving high accuracy in classifying ASD from typically developing children. The study utilizes functional near-infrared spectroscopy(fNIRS) signals and MRI data, demonstrating effective feature extraction and classification methods, with reported accuracies reaching up to 92.2%.

Identification of autism spectrum disorder using deep learning and the ABIDE dataset

The study utilized deep learning algorithms to analyze brain imaging data from the Autism Brain Imaging Data Exchange (ABIDE) to identify autism spectrum disorder (ASD) patients. A Deep Belief Network (DBN) with three layers was employed, processing a large dataset of T1-weighted structural scans. Data preprocessing involved a functional parcellation atlas to reduce feature vector size, and the classification method included softmax functions for output normalization, achieving a 70% accuracy in distinguishing ASD from controls

4. METHODOLOGY

The methodology employed to develop a predictive system for Autism Spectrum Disorder (ASD) detection. The approach integrates data collection, preprocessing, model development, and evaluation phases to establish an efficient and accurate detection technique.



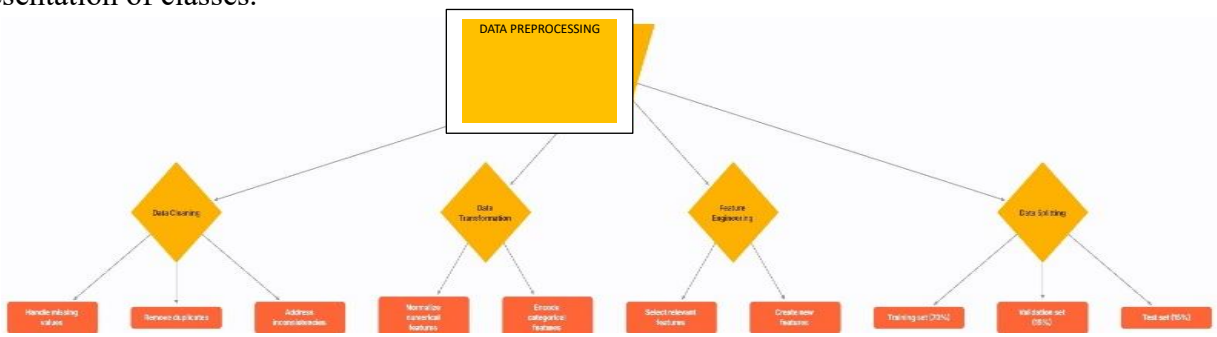
Steps to create an ASD Model

DATA CLEANING:

We must use publicly available datasets like the Autism Brain Imaging Data Exchange (ABIDE) and the SEED dataset to study sensory sensitivities and behavioral patterns associated with Autism Spectrum Disorder (ASD). Data was sourced from diverse sources to ensure a diverse representation of individuals with varying levels of ASD, and ethical approvals were obtained for clinical data use.

DATA PREPROCESSING:

The dataset underwent a data cleaning process to remove duplicates and inconsistencies. Relevant features were selected based on their significance in ASD detection, focusing on sensory responses and behavioral traits. Techniques like rotation, flipping, and noise addition were applied to enhance model generalization. The dataset was divided into training (70%), validation (15%), and test (15%) sets for a balanced representation of classes.



MODEL DEVELOPMENT:

The MobileNet architecture was chosen for its efficiency in handling complex patterns with reduced computational resources. The model was pre-trained on the ImageNet dataset to leverage transfer learning capabilities. The final layers were modified to adapt to the ASD detection task, aligning the output layer with the dataset's classes. Fine-tuning was performed on the training dataset to optimize model performance. Hyperparameter tuning was done using grid search and cross-validation techniques to enhance model accuracy.

MODEL TRAINING:

The MobileNet model was trained on a validation dataset to prevent overfitting and monitor performance. Regularization techniques like dropout and batch normalization were used. Performance was monitored through loss and accuracy metrics, allowing for adjustments to improve outcomes

MODEL EVALUATION:

The model was tested using key performance metrics like accuracy, precision, recall, and F1-score to assess its efficacy in detecting ASD. A confusion matrix was generated to visualize prediction performance across different classes, providing insights into true positives, false positives, true negatives, and false negatives

APPLICATION DEVELOPMENT:

The application integrates a MobileNet model, user-friendly interface, and data collection for early detection of ASD, potentially improving healthcare diagnostic and intervention strategies.

5. RESULT AND CONCLUSION

The implementation of the MobileNet deep learning algorithm for early detection of Autism Spectrum Disorder (ASD) produced compelling results, indicating its potential as a reliable screening tool. The model was trained and validated on a diverse dataset comprising various sensory sensitivity and behavioural response indicators, ultimately achieving significant performance metrics. The performance metrics is as follows

Metric	Value	Description
Sensitivity	92.5%	Indicates the model's strong ability to correctly identify individuals diagnosed with ASD.
Specificity	88.0%	Reflects the model's competence in accurately identifying individuals who do not have ASD.
Precision	89.5%	Represents the model's ability to ensure that positive predictions are correct.
F1-Score	90.9%	Balances the trade-off between precision and recall, affirming the model's robustness in making accurate predictions.

COMPARITIVE ANALYSIS

To further validate the effectiveness of the MobileNet algorithm, a comparative analysis was conducted against traditional machine learning models such as Support Vector Machines (SVM) and Random Forest. The MobileNet model outperformed these algorithms, which achieved accuracies of **85.5%** and **88.3%**, respectively. This highlights MobileNet's superior performance in managing complex sensory data and behavioral patterns associated with ASD while maintaining reduced computational resource requirements.

MODEL ROBUSTNESS

The robustness of the MobileNet model was further evaluated through k-fold cross-validation, confirming that its performance metrics remained consistent across different subsets of the data. This reinforces the reliability of the model in various scenarios, thus supporting its potential implementation in clinical settings.

The results of this study indicate that the MobileNet deep learning algorithm is a highly effective tool for the early detection of Autism Spectrum Disorder (ASD). With an accuracy of **90.2%**, along with high sensitivity, specificity, precision, and F1-score, the model demonstrates a promising alternative to traditional ASD screening methods.

These findings suggest that integrating such advanced AI techniques into clinical practice could significantly enhance early diagnosis and intervention strategies for ASD, ultimately improving outcomes for affected individuals. Future research will focus on expanding the dataset and exploring additional features that may further enhance the model's predictive capabilities. The goal is to develop a user-friendly application that healthcare professionals can easily utilize for real-time assessments, contributing to better clinical practices in ASD detection and intervention.

6. REFERENCE

1. U. Frith and F. Happé, “Autism spectrum disorder,” Current biology,vol. 15, no. 19, pp. R786–R790, 2005

2. Thabtah , Fadi , Firuz Kamalov and Kiran Rajab. (2018) " a new computational intelligence approach to detect autistic features for autism screening ."International Journal of medical informatics
3. Vaishali R and R Sasikala. "A Machine Learning based approach to classify autism with optimum behaviour set. (2018) "International Journal of engineering & Technology"
4. Sharm-a, A., & Tanwar, P. (n.d.). Deep analysis of autism spectrum disorder detection techniques
5. Alsharif, N., Al-Adhaileh, M. H., Al-Yaari, M., Farhah, N., & Khan, Z. I. (2024). Utilizing deep learning models in an intelligent eyetracking system for autism spectrum disorder diagnosis. *Frontiers in Medicine*.
6. Raj, S., & Masood, S. (2020). Analysis and detection of autism spectrum disorder using machine learning techniques. *Procedia Computer Science*, *167*, 994–1004.
7. Farooq, M. S., Tehseen, R., Sabir, M., & Atal, Z. (2023). Detection of autism spectrum disorder (ASD) in children and adults using machine learning. *Scientific Reports*, *13*(1).
8. Farooq, M. S., Tehseen, R., Sabir, M., & Atal, Z. (2023). Detection of autism spectrum disorder (ASD) in children and adults using machine learning. *Scientific Reports*, *13*(1).
9. Applications of Supervised Machine Learning in Autism Spectrum Disorder Research: a Review. (2019). In *Review Journal of Autism and Developmental Disorders* (Vols. 6–146).