iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XII **Month of publication:** December 2023

DOI: https://doi.org/10.22214/ijraset.2023.56797

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XII Dec 2023- Available at www.ijraset.com

ASD Detection System

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Abstract: ***Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition that presents a wide range of challenges for affected individuals and their families. Early detection and intervention are crucial in improving outcomes for individuals with ASD. This abstract introduces the development of an innovative ASD detection system, which combines advanced technology and machine learning techniques to assist in early diagnosis. The ASD detection system leverages various data sources, including behavioral observations, medical records, and genetic information, to create a comprehensive profile of individuals at risk for ASD. It utilizes sophisticated machine learning algorithms to analyze and interpret this data, aiming to identify subtle patterns and markers associated with ASD. The system's user-friendly interface allows healthcare professionals to input and access data easily, streamlining the diagnostic process.***

Key Terms: Autism Spectrum Disorder, Machine Learning, Convolutional Neural Network (CNN), k-nearest neighbors (KNN), Artificial Intelligence, Support Vector Machine, Multilayer Perceptron

I. INTRODUCTION

Autism Spectrum Disorder occurs in the developmental stages of an individual and is a serious disorder which can impair the ability to interact or communicate with others. Generally caused by genetics or environmental factors, it impacts the nervous system, as a result of which the overall cognitive, social, emotional, and physical health of the individual is affected. There is a wide variance in the range as well as the severity of its symptoms. A few of the common symptoms the individual faces are difficulties in communication, especially in social settings, obsessive interests, and mannerisms, which take a repetitive form. To identify ASD, an extensive examination is required. This also includes an extensive evaluation and a variety of assessments by psychologists for children and various certified professionals. Conventional methods of diagnosing include Autism Diagnostic Interview Revised (ADI-R) and Autism Diagnostic Observation Schedule Revised (ADOS-R). However, these are lengthy and cumbersome, taking up a large amount of time as well as efforts.

A significant portion of the pediatric population suffers from ASD. In most cases, it can usually be identified in its preliminary stages, but the major bottleneck lies in the subjective and tedious nature of existing diagnosis procedures. As a result, there is a waiting time of at least 13 months from the initial suspicion to the actual diagnosis. The diagnosis takes many hours, and the continuously growing demand for appointments is much greater than the peak capacity of the country's pediatric clinics.

II. LITERATURE SURVEY

Autism Spectrum Disorder is a neurological disorder which needs to be detected at an early stage in order to reduce its symptoms. Various development in the field of machine learning is helping more innovations and development in this medical area. Various researchers have utilized various machine learning algorithms in order to detect Autism at an early stage. Some deep learning- based methods such as CNN have also been used to detect autism in kids using image classification of MRI images.

In the work by Raj et al. "Analysis and Detection of Autism Spectrum Disorder Using Machine Learning Techniques" the authors have proposed the use of methods like- CNN, Support Vector Machine (SVM) and Artificial neural network (ANN). In this work, the missing values were handled first. Later, the authors have used CNN based classifier instead of SVM by including all its features attributes. Here, both the SVM and CNN based models showed the same accuracy of prediction of about 98.30 % for ASD Child dataset. They have used Adam optimizer to optimize and handle loss functions.

Another researcher M. S. Mythili et al. have used classification techniques in order to detect Autism. In Neural Network methods, Support Vector Machine and Fuzzy Logic was used to analyze Autism in students. The dataset utilized in this research work consists of various attributes such as Language data, social skill data, Behavior data, etc.

In another work by Omar et al. the authors have proposed effective prediction of autism using various machine learning techniques. Here, the authors have also developed a mobile application for predicting autism in people of any age. In this work, the authors have performed predictions based on Tree-CART classifier. At the beginning, the tree root consists of the whole dataset. Later on, the dataset is split based on feature selection.

They have also performed prediction using Random Forest-CART method. They have claimed that the Random Forest Method performs better than another classifier. J.A. Kosmicki et al. have proposed to search least set of features to detect autism. They have used machine learning based approach to detect autism. They have employed 8 different machine learning algorithms.

III. METHODOLOGY

A. *Data Preprocessing*

Various dataset has been collected in this research area. One of the datasets has been collected from the UCI Machine learning Repository which is available publicly. This dataset contains data for Adults, Children and Adolescent. This dataset contains 20 attributes in order to predict Autism Spectrum Disorder. Table 1 shows the attributes that the dataset contains.

Recently MRI data is also being utilized to detect autism. Various functional and structural brain imaging datasets have been provided by Autism Brain Imagining Data Exchange (ABIDE). These images were collected from several brain imaging centers around the world. Preprocessed connectomes project (PCP) from the ABIDE has openly released 539 individuals who have ASD and 573 TD to the public. All these 1112 dataset consists of structured and pre-processed resting state functional MRI data along with phenotypic information. Many researchers have provided insight on using facial morphology to detect autism. Some of these methods involved physical measurement of facial features and then its data analysis in order correlate these measurements with the presence of Autism. One of the researchers released dataset containing images of children with Autism and without Autism. The images in the dataset were gathered through various online sources. This data set contains 1667 images of Autistic children and 1667 images of Non-Autistic children. Facial features were used in order to perform Autism detection among kids. Fig 1 shows the images contained in the dataset.

Table 1 Various attributes in dataset

Attribute ID	Attribute Description
1	Patient Age
2	Sex
3	Nationality
4	The patient suffered from Jaundice problem by birth
5	Any family Member suffered from pervasive development disorders
6	Who is fulfilment the experiment
7	The Country in which the user lives
8	Screening application used by user or not?
9	Screening test type
10-19	Based on the screening method answers of 10 questions
20	Screening Score

B. *Working Model*

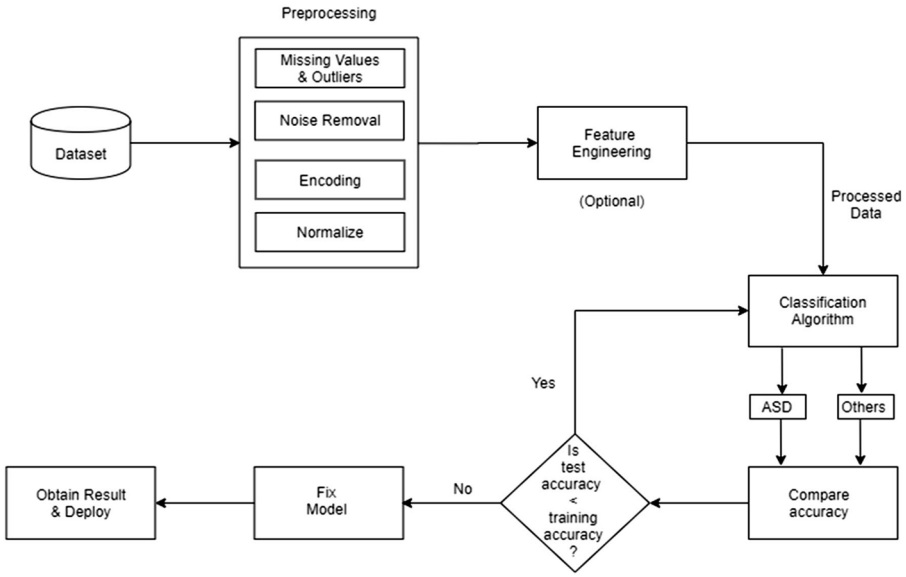

Figure 1 Architecture

Figure 1 demonstrates the general working and flow of our system We begin by preprocessing the dataset to eliminate missing values and outliers, remove noise, and encode categorical attributes. We also employ feature engineering to choose the most beneficial features out of all the features present in the data set. This reduces data dimensionality to improve speed and efficiency during training. Once the data set has been preprocessed, classification algorithms like Logistic Regression, Naïve Bayes, Support Vector Machine, K-Nearest Neighbors, and Random Forest Classifiers are used to predict the output label (ASD or no ASD). The accuracy of each classifier is observed and compared. Furthermore, metrics like the F1 score and precision-recall values have also been computed for better evaluation of each classifier. If the classifier performs well, then the training accuracy will be higher than its test accuracy. This model can then be deemed to be the best model and hence be used for further training and classification.

IV. PROPOSED SYSTEM

1) *Data Integration and Analysis:* The proposed system will integrate data from multiple sources, including behavioral observations, medical history, genetic markers, and cognitive assessments. This comprehensive dataset will be analyzed using advanced machine learning algorithms to identify patterns and markers associated with ASD.
2) *Early Detection:* Early diagnosis is critical for effective intervention. The system will focus on identifying ASD in children at a young age by analyzing developmental milestones and behaviors, aiding in timely support and therapies.
3) *Predictive Modeling:* Machine learning models will be developed to predict an individual's likelihood of having ASD based on their data profile. These models will continually improve as more data becomes available and will assist healthcare professionals in making accurate assessments.
4) *User-Friendly Interface:* The system will feature an intuitive and user-friendly interface, making it accessible for healthcare professionals and reducing the time and effort required for data input and interpretation.
5) *Customized Intervention Plans:* Based on the system's assessments, customized intervention plans can be developed for individuals with ASD, ensuring that their specific needs are addressed effectively.
6) *Data Security and Privacy:* The system will prioritize data security and privacy to protect sensitive information, adhering to relevant regulations and ethical considerations.
7) *Ongoing Research and Validation:* Continuous research and validation will be essential to refine and enhance the system's accuracy and effectiveness in ASD detection.

A. *Element of Confusion Matrix*

Specificity ratio measures the ability of the test to correctly generate negative results for people who don't have conditions for which the person is being tested (known as True Negative). Sensitivity ratio measures the ability of the test to correctly generate a positive result for people who have the condition for which the person is being tested (known as True Positive). Following are the formulas for Specificity, Sensitivity and Accuracy.

$$\text{Specificity} = \frac{TN}{TN + TP}$$

$$\text{Sensitivity} = \frac{TN}{TN + FN}$$

$$\text{Accuracy} = \frac{TN+TP}{TN + TP + FN + FP}$$

Accuracy gives a measurement to identify the accurate predictions made based on the overall number of tests. These are some of the common evaluation metrics utilized in the field of Autism Spectrum Disorder.
These were some of the datasets and evaluation metrics used in the field of Autism Spectrum Disorder.

V. CONCLUSION

In conclusion, the development of an Autism Spectrum Disorder (ASD) detection system represents a significant advancement in the field of autism research and healthcare. This system offers a comprehensive, data-driven approach to early detection and diagnosis, with the potential to positively impact the lives of individuals on the autism spectrum and their families. By integrating data from various sources, employing advanced machine learning algorithms, and focusing on early intervention, the system holds great promise for enhancing developmental outcomes and improving the quality of life for those with ASD.

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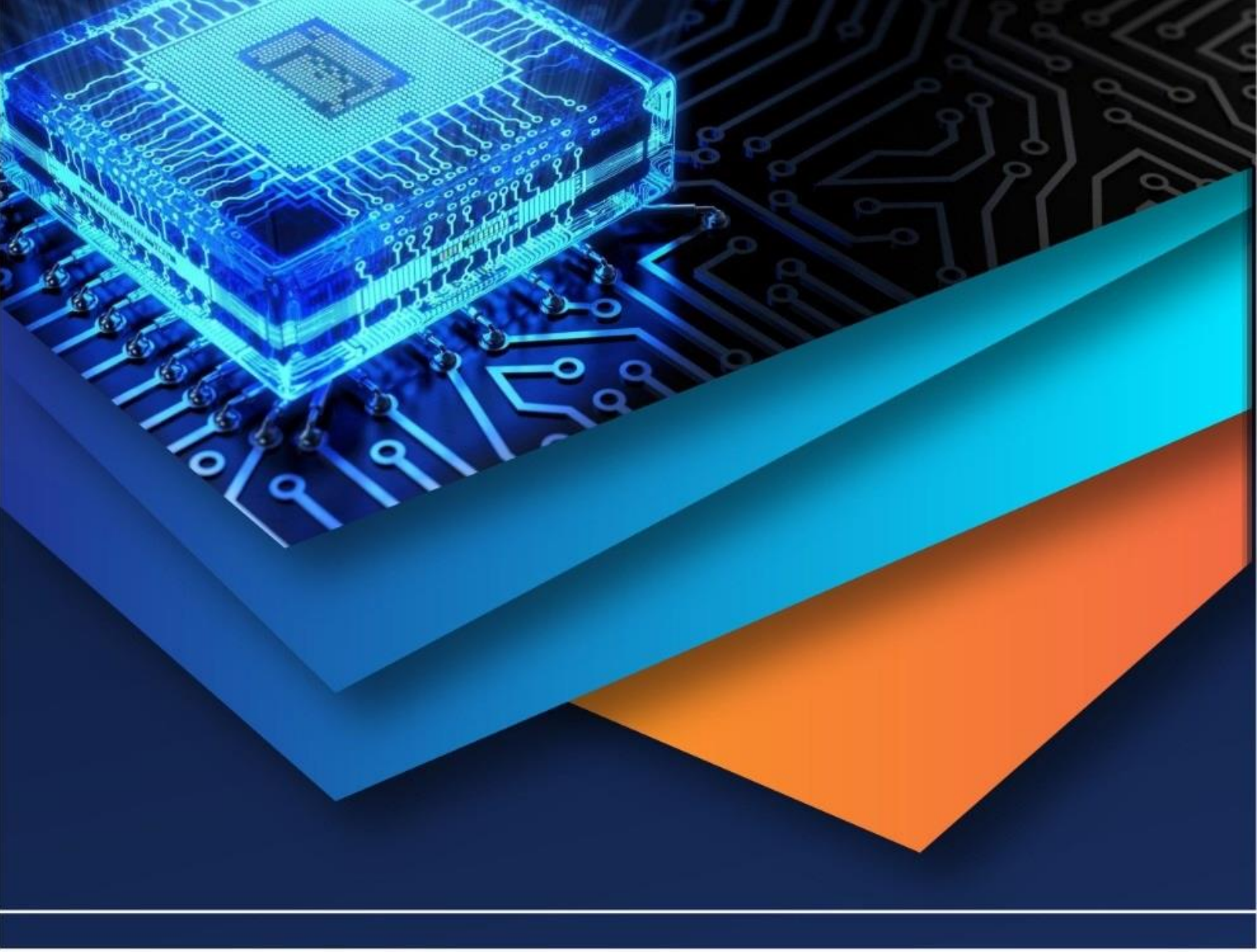

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