A Project Work (Phase -1) with seminar on

Detecting Autism using Deep Learning

Submitted in partial fulfilment of the requirements for the award of the

Bachelor of Technology

in

Department of Computer Science and Engineering

(Data Science)

by

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CERTIFICATE

This is to certify that the project work (phase -1) entitled **“Detecting Autism using Deep Learning”** submitted by **Palreddy Nithin Sai (20241A6742), Krishna Shastry Rushi Hari Haran (20241A6731) , Kourikanti Koushik (20241A6730)** is in partial fulfillment of the award of the degree in Bachelor of Technology in Computer Science Engineering [DS] during the academic year 2023-2024.

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DECLARATION

We hereby declare that the mini project titled **“Detecting Autism using Deep Learning”** is the work done during the period from **17th Jul 2023 to 18th Nov 2023** and is submitted in the partial fulfillment of the requirements for the award of degree of Bachelor of Technology in Computer Science and Engineering [Data Science] from Gokaraju Rangaraju Institute of Engineering and Technology (Autonomous under Jawaharlal Nehru Technology University, Hyderabad). The results embodied in this project have not been submitted to any other University or Institution for the award of any degree or diploma.

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ABSTRACT

Autism Spectrum Disorder (ASD) is a pervasive neurodevelopmental condition characterized by challenges in social interaction, communication difficulties, and restricted, repetitive patterns of behavior. Early diagnosis and intervention are critical for improving outcomes and quality of life for individuals with ASD. However, the current diagnostic process often relies on subjective assessments and extensive clinical evaluations, leading to delays in diagnosis and potential variability in accuracy.The existing diagnostic methods primarily rely on behavioral observations, parent and caregiver interviews, and standardized assessments, which can be time-consuming, costly, and subject to inter-rater variability.Furthermore, there is a growing need for more objective and quantifiable measures to complement traditional diagnostic tools. The incorporation of advanced technologies and data-driven approaches, such as machine learning algorithms and deep learning algorithms.These presents an opportunity to leverage multimodal data (including text,image, video, and clinical information) for a more accurate and efficient ASD diagnosis.

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CHAPTER 1

1. INTRODUCTION

Autism spectrum disorder (ASD) is a neurological and developmental disorder that affects how people interact with others, communicate, learn, and behave. Autism is classified as a "developmental disorder" even though a diagnosis can be made at any age. This is because the majority of symptoms usually manifest in the first two years of life. People with ASD frequently have the following symptoms, which are listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), an American Psychiatric Association manual used by medical professionals to diagnose mental disorders: Difficulty interacting and communicating with others, limited interests and recurrent actions, signs that impair their capacity to learn, work, and lead normal lives. Autism is described as a "spectrum" condition because the types and degree of symptoms people experience vary greatly. ASD can be diagnosed in people of all sexes, races, ethnicities, and socioeconomic statuses. Although ASD is a lifelong illness, therapies and programmes can help people with their symptoms and everyday functioning. All children should be screened for autism, according to the American Academy of Paediatrics. About ASD screening or evaluation, carers should speak with their child's medical professional.

Fig 1.1 Autism

Signs and Symptoms :

It's important to note that every individual with ASD is unique, and not everyone will exhibit all of these signs. Additionally, some traits may become more noticeable over time, or they may change as a person develops and learns coping mechanisms. Here are some common **Signs and Symptoms of ASD:**

1. Social Challenges:

- Difficulty with social interactions and forming relationships.
- Limited or unusual eye contact.
- Difficulty understanding and using nonverbal cues like facial expressions, gestures, and body language.

2 . Communication Difficulties:

- Delayed speech or language development.
- Limited or atypical use of verbal and nonverbal communication (e.g., gestures, facial expressions, tone of voice).
- Repetitive or unusual language patterns, such as echolalia (repeating words or phrases).

3. Repetitive Behaviors and Interests:

- a) Engaging in repetitive movements or activities (e.g., hand-flapping, rocking).
- b) Having very specific and intense interests in particular topics, often to the exclusion of other activities.
- c) Insistence on sameness or routines, becoming distressed by changes in routine.

4. Sensory Sensitivities or Sensory Processing Differences:

- Overreacting or underreacting to sensory stimuli (e.g., lights, sounds, textures).
- Preference for specific sensory experiences (e.g., seeking out certain textures or tastes).

5. Difficulty with Empathy and Understanding Others' Perspectives:

- Challenges in understanding and respoing to the emotions and needs of others.
- Difficulty with taking another person's point of view.

6.Unusual Play Patterns:

- Engaging in repetitive or idiosyncratic play, such as lining up toys or focusing on one aspect of a toy.

7.Intense Focus and Attention to Detail:

- Showing an unusually high level of attention to detail.

It's important to remember that not all individuals with ASD will exhibit all of these traits, and the severity of symptoms can vary widely. Additionally, some individuals may have strengths and abilities that are not captured by this list. If you suspect that someone may have ASD, it is important to seek a professional evaluation from a qualified healthcare provider or specialist in autism diagnosis and treatment. They can provide a thorough assessment and, if necessary, offer recommendations for support and intervention.

Fig 1.2 Autism signs

1.1 Working of CNN

Convolutional Neural Networks (CNNs) have revolutionized the field of computer vision and image analysis, reshaping the way we perceive and interact with visual data. Inspired by the intricacies of the human visual system, CNNs have emerged as a cornerstone of deep learning, and they have played a pivotal role in the development of artificial intelligence. Their ability to automatically learn and extract features from grid-like data, such as images and videos, has redefined the landscape of image recognition, enabling remarkable advancements in object recognition, image classification, and facial identification.

At the core of CNNs is a sophisticated workflow that guides their operation. This workflow, characterized by the progressive transformation of input data through layers of convolution, non-linear activation, pooling, and fully connected layers, is a testament to the network's capacity for hierarchical feature extraction. This intricate process unfolds step by step, ultimately yielding accurate and nuanced predictions. The training of CNNs involves iterative refinement of internal parameters through backpropagation and optimization, leading to highly sophisticated models capable of discerning intricate patterns.

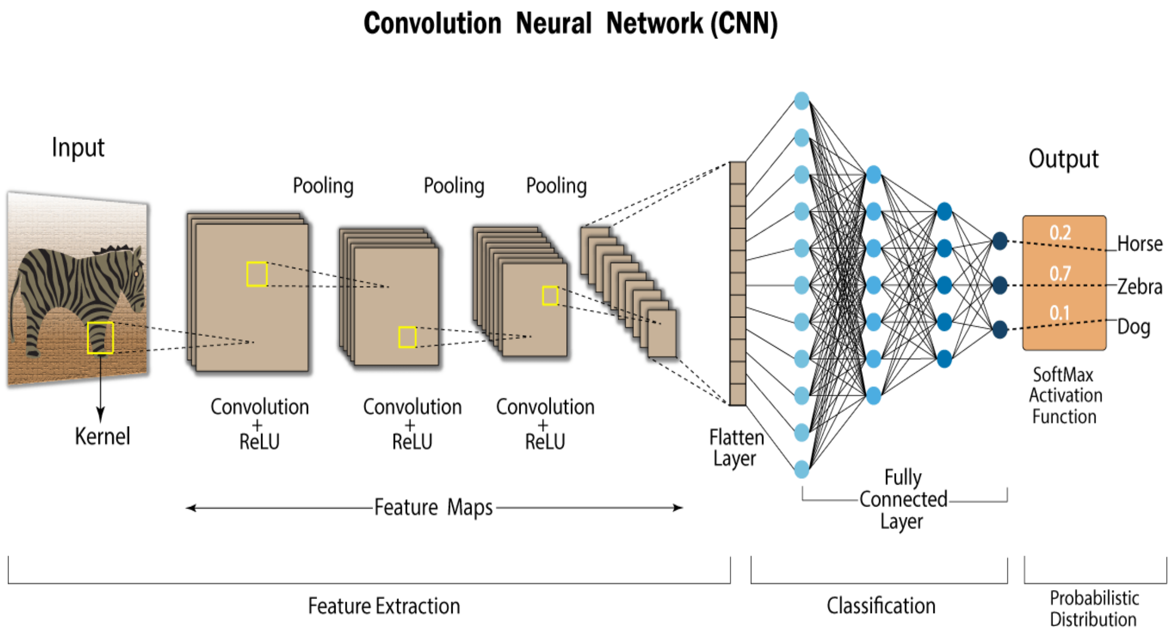

Fig 1.3 CNN

Underpinning the success of CNNs is a harmonious marriage of statistical and mathematical principles. Convolutional layers employ filters to scan input data, capturing local information that forms the basis of feature extraction. Non-linear activation functions, notably Rectified Linear Units (ReLU), introduce non-linearity and enable the network to capture complex relationships within the data. This mathematical foundation, supported by concepts from linear algebra, calculus, and probability theory, forms the bedrock of CNNs, making them an elegant blend of statistical reasoning and mathematical precision.

Using CNNs in image detection has transformed a myriad of domains, from healthcare to autonomous vehicles. The process begins with data preprocessing, including resizing and normalization, to prepare images for analysis. A well-crafted CNN architecture is then designed, consisting of convolutional layers for feature extraction, followed by fully connected layers for classification. Training the model involves fine-tuning internal parameters through the principles of backpropagation and gradient descent. The model's performance is rigorously evaluated, ensuring it generalizes well on unseen data. In practical applications, CNNs have been deployed for a spectrum of image detection tasks, including object detection, facial recognition, and the interpretation of medical images.

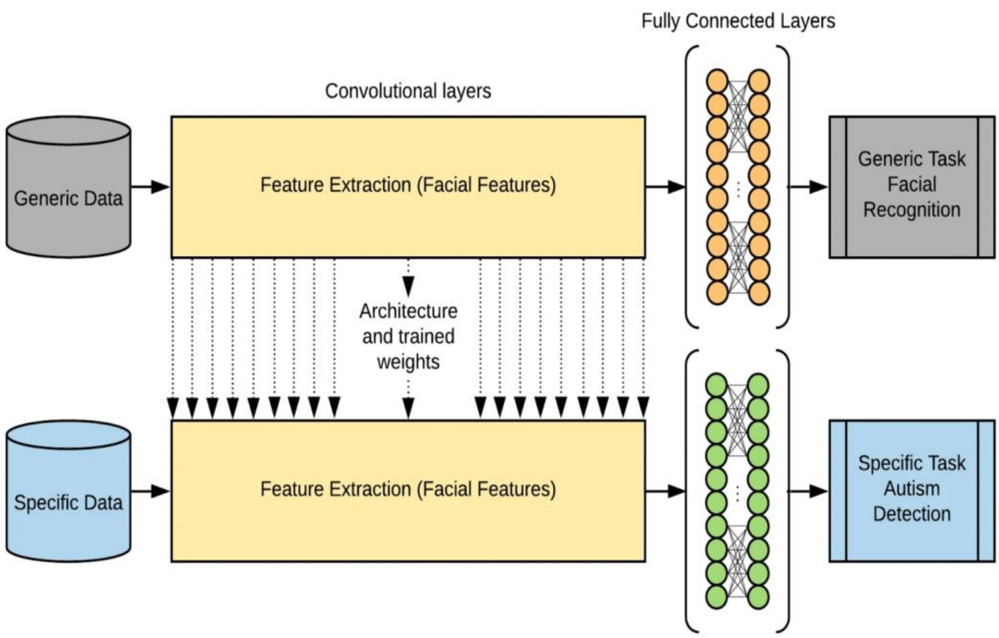

Fig 1.4 CNN Layers

1.2 Objective of project

The aim of the project is to Develop methods that can reliably detect signs of ASD in early childhood,ideally before the age of two years , to enable timely intervention and support and to Integrate advanced technologies and data-driven approaches to provide more objective and quantifiable assessments of ASD, reducing reliance on subjective observations. Also to Create models and algorithms that are robust, reliable across different age groups, severity levels, and demographic backgrounds, enhancing the reliability of ASD detection.

1.3 Methodology

Module 1: *Data Preprocessing.* This module will handle tasks such as loading and preparing the dataset for training. It may include tasks like data augmentation, normalization, and splitting into training and testing sets.

Module 2: *Training and Evaluation.* This module will contain functions or classes for training the deep learning model on the prepared dataset. It will include functions for evaluating the model's performance using metrics like accuracy, precision, recall, etc.

Module 3: *Autism Detection* . This module will utilize OpenCV to perform actual autism detection. It will handle tasks like image preprocessing, feeding images to the trained model, and interpreting the results.

Module 4: *User Interface* . This module will use Streamlit to create a user-friendly interface for interacting with the application. It will allow users to upload images, initiate the autism detection process, and view the results.

Module 5 : *Visualization*.This module will include functions to generate visualizations like plots or images that help in understanding the model's performance or the process of autism detection.

Module 6: *Main Application.* This is the main script that brings everything together. It will contain the high-level flow of the application, including initializing the UI, calling the necessary functions from the other modules, and displaying results to the user.

1.4 Architecture Diagram

The Architecture Diagram outlines the flow of information and processes involved in the system. It showcases how user inputs are processed, analyzed, and transformed into detecting and classifying autism positive and negative users , which are then presented back to the user through the web interface.

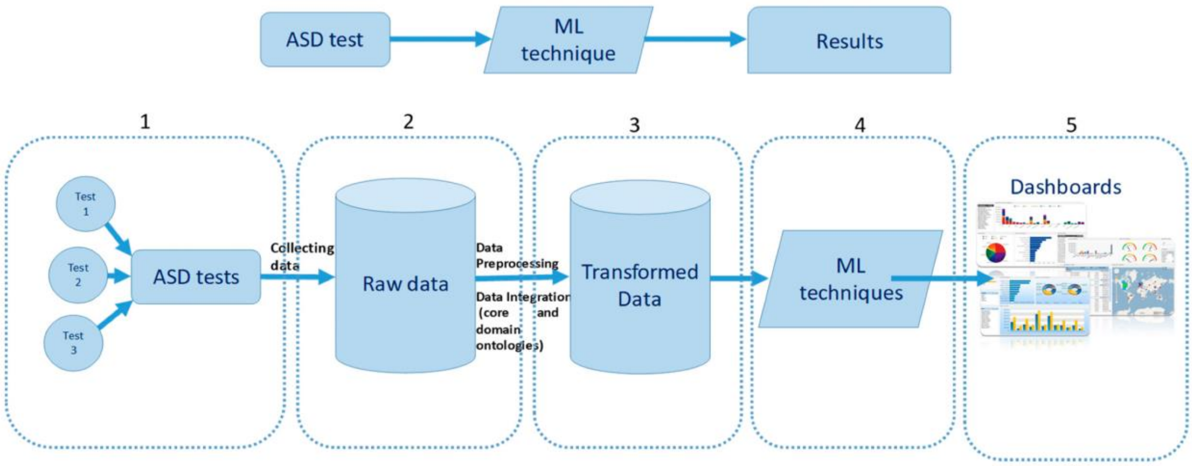

Fig 1.5 Architecture Diagram

The system described in the architecture diagram is a web-based application for classifying users into autism positive and autism negative. Users interact with the system through a web interface, providing inputs regarding their facial data and their habits for the autism test if possible . The inputs are received by a web server, which forwards them to the appropriate components for further processing.

The inputs undergo data preprocessing to clean and transform the data into a suitable format. A classification model is then built using the preprocessed data, trained on existing data and algorithms to predict and classify the user. The model is tested to ensure its accuracy and reliability.

Classification is performed using the tested model to determine the appropriate classification of users into autism positive or negative based on the user's inputs. Classification of the user data is done based on the previously trained model using an existing facial data dataset . The system generates a response containing the result of the classification which is sent back to the web server. The web server then presents the result to the user through the web interface, using visualizations or text-based information.

Overall, this architecture enables users to classify or know their result of the ASD test on their inputs, helping them achieve their results and maintain a healthy lifestyle.

Fig 1.6 Autistic inputs

1.5 Organization of the Report

This report consists of the overview of what all topics discussed in this entire report in a brief and concise manner with the sequence of topics presented.

Introduction

In this section we discussed the definition of autism and signs and symptoms of the disorder to treat effectively .We also discussed the need of effectively treating autism at early stages using data driven and technical approaches which are more economical and time saving . We discussed the basic working of the overall project.

Literature Survey

In this section we discuss the existing approaches to solve this problem and their drawbacks. This section provides the knowledge and momentum to carry out the project.

Proposed Methods

In this section we discussed the logical sequence in which we are solving the problem and the methods that we adopted to solve the problem.

CHAPTER 2

2.1 LITERATURE SURVEY

[1] "A Deep Learning Approach to Predict Autism Spectrum Disorder Using Multisite Resting-State fMRI." Deep learning features created from preprocessed fMRI data are used to detect autism spectrum disorder. To complete the classification task, a deep neural network (DNN) classifier is employed. According to simulation data, the suggested model performs more accurately than cutting-edge techniques. While the state-of-the-art approaches' mean accuracy ranged from 67% to 85%, the proposed model's mean accuracy was 88%.

[2] "A Survey: Approaches for Detecting the Autism Spectrum Disorder" Using an MLP (multilayer perceptron) with an ensemble learning method to merge various deep representations of features. The development of artificial intelligence (AI) and machine learning (ML) algorithms has made it possible to diagnose autism relatively early. Despite the fact that many research have been conducted using various methodologies, these investigations have not led to any conclusive findings about the ability to predict autistic characteristics with respect to various age groups.

[3] "Analysis and Detection of Autism Spectrum Disorder using Machine Learning Techniques" In order to predict and analyse ASD problems in children, adolescents, and adults, this paper attempts to investigate the potential applications of Naïve Bayes, Support Vector Machine, Logistic Regression, KNN, Neural Network, and Convolutional Neural Network. There are 292 occurrences and 21 attributes in the first dataset about ASD screening in children. There are 21 attributes and a total of 704 instances in the second dataset linked to adult subjects undergoing ASD screening. The third dataset includes 21 attributes and 104 instances related to ASD screening in adolescent subjects.

[4] "A Survey On Autism Spectrum Disorder using Machine Learning Techniques." Several machine learning techniques are employed to predict autism at an early stage, thereby reducing the time required for this process. In this field of study, machine learning techniques such as Support Vector Machine (SVM), Decision tree, Naïve Bayes, Random Forest, Logistic Regression, and K-Nearest Neighbour are employed. The development of ASD detection using machine learning and deep learning has been aided by numerous advancements in the fields of artificial intelligence (AI) and machine learning.

[5] "Detection of Autism Spectrum Disorder in Children Using Eye Tracking and Machine Learning Techniques." A computer vision algorithm called Viola-Jones was used to support vector machines in a machine learning programme that was developed in Python with the goal of diagnosing autism by eye. 89% accuracy has been attained by the algorithm. The suggested algorithm helps vector machines use eye tracking technology to accurately predict autism spectrum disorders. We evaluated group photos of kids using it, and we also used it to find the eye.

[6] "ML Based Approach to Detect Autism Spectrum Disorder (ASD)." ML models are favoured over alternative techniques because they typically examine the relationships between different brain regions. Additionally, compared to alternative models, machine learning algorithms are known for their higher prediction accuracy. In order to improve the methods for detecting autism, machine learning (ML), a branch of artificial intelligence, can investigate the genetics of the disorder and create efficient treatment plans.

[7] "Smart autism — A mobile, interactive and integrated framework for screening and confirmation of autism." In this case, if autism is suspected, the child watches a video, records their response, and uploads it to the cloud for a remote expert assessment as part of the virtual assessment process. The child is referred to the closest Autism Resource Centre (ARC) for a formal assessment if autism is still suspected. After analysing these data, the integrated framework reduces the number of ARC visits made by users and automatically confirms autism. It is anticipated that the suggested framework will raise awareness and alter the process of diagnosing autism.

[8] "Detecting self-stimulatory behaviours for autism diagnosis" The dominant motion flow in the identified body regions is used to calculate the Histogram of Dominant Motions (HDM), a global motion descriptor. The self-stimulatory behaviours are detected by means of the motion model that was constructed based on this descriptor. Tests carried out on the recently made available unconstrained SSBD video dataset demonstrate a notable increase in detection accuracy when compared to the baseline method.

[9] “Autism Spectrum Disorder classification using EEG and 1D-CNN.” This study uses a convolutional neural network (CNN) and electroencephalography (EEG) signals to detect ASD. Using the EEG signals from both the autistic and normal subjects, we trained a multi-layered CNN. The model was evaluated using a test set that included information from both autistic and normal control subjects. We used the 5-fold validation technique to train the model. To prevent over-fitting, dropout layers and batch normalisation were employed. A 0.922 accuracy was obtained with the suggested CNN.

[10] “An Experiment on Logistic Regression Analysis to Detect Autism Spectrum Disorder.” An experiment on one such analysis of autism uses a machine learning technique, specifically logistic regression, and focuses on a dataset of autism that includes toddlers, children, adolescents, and adults. Chi-square and information gain are feature selection techniques used in the analysis to minimise the dataset's dimensionality. Ninety percent of the results of the experimental analysis are accurate.

[11] “Detecting A Child’s Stimming Behaviours for Autism Spectrum Disorder Diagnosis using Rgbpose-Slowfast Network.” A method using deep learning to automatically forecast a child's stimming behaviours from videos taken in an unrestricted environment. The pose estimator is used to track the child's area in the video and derive the location of its skeletal joints. The two pathways of the RGBPose-SlowFast deep network are used to model stimming behaviours. The inputs are the raw video signals and the heatmap representation of skeletal joints. The Self-Stimulatory Behaviour Dataset (SSBD), a publicly accessible dataset of stimming behaviours, is used to assess the suggested model. The Autism dataset, which contains the motor actions of children, is used to validate the model's generalisation capacity.

[12] “Detection of Autism Spectrum Disorder in Children Using Machine Learning Techniques” We apply various models to our dataset, including Support Vector Machines (SVM), Random Forest Classifier (RFC), Naïve Bayes (NB), Logistic Regression (LR), and KNN, and build predictive models based on the results. In order to expedite the diagnosis process, the primary goal of this paper is to ascertain whether the child is susceptible to ASD in its early stages. For the dataset we chose, logistic regression yields the best accuracy, according to our findings.

[13] “Autism Spectrum Disorder Studies Using fMRI Data and Machine Learning” Classification accuracies of 48.3% to 97% were achieved by utilising various machine learning techniques and fMRI data obtained from various sites. Additionally, informative brain regions and networks were identified. After careful examination, it was discovered that studies using task-based fMRI data, a single dataset for a particular selection principle, efficient feature selection techniques, or sophisticated machine learning techniques typically had high classification accuracy.

[14] “Advanced Neuroimaging Methods for Studying Autism Disorder” The purpose of this research topic is to introduce sophisticated neuroimaging techniques capable of capturing the intricacy of the neural abnormalities manifested in autism. New research employing Magnetoencephalography, structural and functional MRI, and innovative data analysis techniques (such as Noise Reduction Strategies, Source-based Morphometry, Functional Connectivity Density, Restriction Spectrum Imaging, and Analysis of Cluster Variability) are presented.

[15]”Early screening of autism spectrum disorders in primary health care.”The results of this study indicate the availability of several diagnostic tools for early ASD screening in primary care setting concordant culturally and linguistically with a given population. They could be an effective method of accelerating the diagnostic process and starting personalized therapy faster.

Table 2.1 Literature Survey

S.No	Title	Methodology	Drawbacks
1.	A Deep Learning Approach to Predict Autism Spectrum Disorder Using Multisite Resting-State fMRI.	A Deep learning approach to detect autism spectrum disorder from functional connectivity features derived from preprocessed fMRI data.	Cross-Validation Method: The cross-validation method employed could potentially introduce overfitting.
2.	A Survey: Approaches for Detecting the Autism Spectrum Disorder	Employing an MLP (multilayer perceptron) and a method based on ensemble learning to combine multiple deep representations of features.	**Interpretability** : MLPs are often considered "black boxes" because their decision-making process is not easily interpretable
3	Analysis and Detection of Autism Spectrum Disorder.	Various Machine Learning and Deep learning algorithms are used.	**Data Acquisition**: The data used in the research might have been acquired from rest-state brain imaging[1]. This could limit the scope of the study.
4	A Survey On Autism Spectrum Disorder using Machine Learning Techniques.	Support Vector Machine (SVM), Decision tree, Naïve Bayes, Random Forest, Logistic Regression and K-Nearest neighbour are some of the machine learning techniques used.	SVMs can be sensitive to the choice of the kernel parameters, which can make it difficult to choose the best model.
5	Detection of Autism Spectrum Disorder in Children Using Machine Learning Techniques.	A new ML technique called Rules- Machine Learning (RML) that offers users a knowledge base of rules is implemented.	The system generates results as per the rules, so the learning capacity of the system by itself is much less.
6	ML Based Approach to Detect Autism Spectrum	ML models are usually working with the relationship among	The diagnosis of ASD remains a formidable challenge as studies

	Disorder (ASD).	various brain regions and hence are preferred over other methods.	based on ML have shown different results that may reflect the diversity of behavioral symptoms.
7	Smart autism — A mobile, interactive and integrated framework for screening and confirmation of autism.	If autism is suspected, then in virtual assessment process, the child watches a video, its reaction is recorded and uploaded to the cloud for remote expert assessment.	The model relies on remote expert assessment for the virtual.This could be a limitation in areas with limited or lack of experts available for remote assessment.
8	Detecting self-stimulatory behaviours for autism diagnosis.	A global motion descriptor - Histogram of Dominant Motions (HDM) - is computed using the dominant motion flow in the detected body.	The HDM descriptor might not capture the contextual information necessary to interpret certain behaviors.
9	Autism Spectrum Disorder classification using EEG and 1D-CNN.	A multi-layered CNN using the EEG signals from both the autism and normal subjects.	The labeling of EEG signals as ‘autism’ or ‘normal’ can be subjective and may vary between experts.
10	An Experiment on Logistic Regression Analysis to Detect Autism Spectrum Disorder.	An experiment on one such analysis is focussed on a toddler, child, .adolescent and adult autism dataset using a machine learning technique, specifically logistic regression.	The method relies on expert annotation for training the model, which can be time-consuming and subject to inter-rater variability.
11	Detecting A Child’s Stimming Behaviours for Autism Spectrum Disorder Diagnosis using Rgbpose-Slowfast Network.	The heatmap representation of skeletal joints and the raw video signals are used as inputs to the two pathways of the RGBPose-SlowFast deep network to model stimming behaviours.	The heatmap representation of skeletal joints and the raw video signals are used as inputs to the two pathways of the RGBPose-SlowFast deep network to model stimming behaviours.
12	Detecting autism	Diagnosing autism	Given the conflict

	spectrum disorder in children using eye tracking and machine learning.	mechanism was built by eye in the Python language and using machine-learning technology to support vector machines with the use of a computer vision algorithm known as Viola-Jones.	between a small sample size and huge model parameters, overfitting or other erratic model behavior can occur.
13	Tools for early screening of autism spectrum disorders in primary health care.	Extracted specific features of the questionnaires relevant to primary health care workers, psychometric and diagnostic values of a given adaptation of screening tools,the linguistic and cultural changes made.	The study did not consider the cultural and linguistic adaptations of the screening tools, which could affect their applicability in different regions.
14	Autism Spectrum Disorder Studies Using fMRI Data and Machine Learning: A Review	Applied machine learning methods to analyze the functional magnetic resonance imaging (fMRI) data of autistic individuals and the typical controls.	The conclusions are based on the analysis of previous studies, and the accuracy of the findings depends on the quality of these studies.
15	Classical Statistics and Statistical Learning in Imaging Neuroscience.	This concept paper discusses the implications of inferential justifications and algorithmic methodologies in common data analysis scenarios in neuroimaging.	The research findings are based on the analysis of the theoretical foundations of classical statistics and statistical learning.

2.2 Drawbacks of existing approaches

Limited accuracy: Existing models may not be accurate enough to effectively classify individuals as autism positive or negative, leading to incorrect diagnoses and treatment recommendations.

Limited flexibility: Many existing models rely on a specific set of features or criteria to classify individuals, which may not capture the full complexity of autism or be appropriate for all populations.

Lack of generalizability: Some existing models may be developed and tested on a specific population or dataset, which may not be representative of other populations or datasets. This can limit the generalizability of the model and its applicability in other settings.

Limited usability: Some existing models may be difficult to use or implement in clinical practice, requiring specialized training or software that may not be widely available or affordable.

CHAPTER 3

PROPOSED METHOD

3.1 Problem Statement and Objective

3.1.1 Problem Statement

There are several existing approaches for detecting Autism Spectrum Disorder (ASD). These methods often involve a combination of clinical assessments, behavioral observations, and standardized tests.However , these processes can be time - consuming , costly and subjected to individuals . Additionally, these methods may not be sensitive enough to detect subtle early signs of ASD, particularly in individuals with milder presentations or in those from diverse cultural and linguistic backgrounds.

So a much more advanced data driven technology based machine learning or deep learning model using various algorithms is much more reliable and it also is less time consuming and much cheaper compared to traditional techniques .

3.1.2 Objective of project

The aim of the project is to Develop methods that can reliably detect signs of ASD in early childhood,ideally before the age of two years , to enable timely intervention and support and to Integrate advanced technologies and data-driven approaches to provide more objective and quantifiable assessments of ASD, reducing reliance on subjective observations. Also to Create models and algorithms that are robust, reliable across different age groups, severity levels, and demographic backgrounds, enhancing the reliability of ASD detection.

3.2 Architecture Diagram

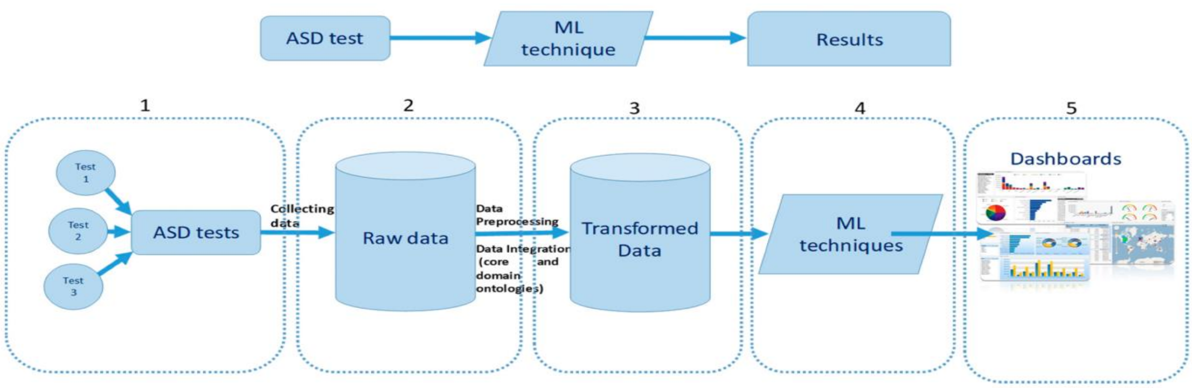

Fig 3.1 Architecture Diagram

The web-based programme that the architecture diagram depicts is used to categorise users as either autistic positive or negative. Through a web interface, users engage with the system, entering information about their facial features and, if applicable, their autism test habits. A web server receives the inputs and routes them to the relevant parts for additional processing.

Data preprocessing is applied to the inputs to clean up and format the data appropriately. The preprocessed data is then used to build a classification model, which is then trained on preexisting data and algorithms to predict and classify the user. To make sure the model is accurate and dependable, it is tested.

In order to classify users as either autistic positive or negative based on their inputs, the tested model is used for classification. Using an already-existing facial data dataset, the user data is classified using the previously trained model. The web server receives a response from the system that includes the classification's outcome. The user is then shown the outcome by the web server via the web interface, which may include textual or visual content.

All things considered, this architecture helps users meet their goals and keep up a healthy lifestyle by allowing them to categorise or determine the outcome of the ASD test on their inputs.

3.3 Software and Hardware requirements

Software Requirements

1. Python language for data processing, analysis, and modelling.
2. Jupyter Notebook and VS Code as an integrated development environment (IDE) for developing code and documenting the analysis process.
3. Machine learning libraries such as Scikit-Learn , TensorFlow for building the model.
4. Pandas and NumPy for data manipulation and analysis.
5. Matplotlib or Seaborn for data visualization.
6. Operating System(os) : Windows or Macos

Hardware Requirements

1. A computer with a minimum of 8GB RAM, and an Intel i5 or better processor for processing data and running machine learning models.
2. Sufficient storage space for storing the dataset and any intermediate results.

3. A fast and stable internet connection for downloading and installing the required software and libraries.

3.4 Modules and its Description

1. **Module 1** *Data Preprocessing.* This module will handle tasks such as loading and preparing the dataset for training. It may include tasks like data augmentation, normalization, and splitting into training and testing sets.

2. **Module 2** *Training and Evaluation.* This module will contain functions or classes for training the deep learning model on the prepared dataset. It will include functions for evaluating the model's performance using metrics like accuracy, precision, recall, etc.

3. **Module 3** *Autism Detection.* This module will utilize OpenCV to perform actual autism detection. It will handle tasks like image preprocessing, feeding images to the trained model, and interpreting the results.
4. **Module 4** *User Interface.* This module will use Streamlit to create a user-friendly interface for interacting with the application. It will allow users to upload images, initiate the autism detection process, and view the results.
5. **Module 5** *Visualization.* This module will include functions to generate visualizations like plots or images that help in understanding the model's performance or the process of autism detection.
6. **Module 6** *Deployment*. This module is responsible for deploying the final model into a production environment, such as a web application or mobile app. It involves selecting appropriate deployment tools, testing and debugging the application, and ensuring that the solution is scalable and reliable.
7. **Module 7** *Maintenance*. This module is responsible for maintaining and updating the deployed solution over time. It involves monitoring the performance of the application, identifying and fixing bugs, and updating the solution to incorporate new data or features.

3.5 Requirements Engineering

Functional Requirements

Data Input Users should be able to enter their facial picture information into the system.

Autism Classification The system should classify the user's autism based on the given input by the user.

Autism Detection The system should provide percentage or chance of child effecting by the autism spectrum disorder.

Reporting and Analysis The system should generate reports and perform analysis to provide insights into the user's progress and recommend adjustments to their behaviour. **Non-Functional Requirements**

Usability The system should have an intuitive and user-friendly interface to ensure easy interaction for users of all technical backgrounds.

Performance The system should respond quickly to user inputs, ensuring minimal delays in providing obesity classification, diet and exercise suggestions, and progress tracking.

Scalability The system should be able to manage an increasing number of users and data without significant performance reduction.

Compatibility The system should be interoperable with different platforms (e.g., web, mobile) and devices (e.g., smartphones, tablets) to enable access for a wide range of users.

These requirements provide a framework for constructing and developing a diet and exercise advice system based on obesity classification. It's vital to further clarify and prioritise these requirements based on unique project goals, stakeholder needs, and technical constraints.

3.6 Analysis and Design through UML

Software system modelling and design are aided by visual diagrams known as UML (Unified Modelling Language) diagrams. There are different UML diagram kinds, each serving a particular purpose. These UML diagrams are some of the most common ones used in software development.

1. **Class Diagram** Represents the static structure of the system, showcasing classes, attributes, methods, and their relationships.
2. **Sequence Diagram** Visualizes the interactions and messages exchanged between objects or actors over time, showing the flow of events in a particular scenario or use case.
3. **Use Case Diagram** Illustrates the interaction between actors (users or external systems) and the system, focusing on the system's functionalities from a user's perspective.

3.5.1 Class Diagram

Class UML diagrams are a sort of static structural diagram in the Unified Modelling Language (UML) that depict the classes, attributes, methods, and relationships inside a system. They give a visual representation of the structure and behaviour of the classes in an object-oriented system.

Here are some major concepts and aspects of class UML diagrams

Class Represents a template or blueprint for constructing objects. A class is illustrated as a rectangle with three compartments.

Attributes represent the attributes or data associated with a class. Attributes describe the state or features of objects produced by the class.
Methods They represent the actions or activities that objects in the class can do. Methods define the functionality or operations that objects can exhibit.

Fig 3.2 Class Diagram

3.5.2 Sequence Diagram

A series of An UML diagram is a particular sort of behavioural diagram in the Unified Modelling Language (UML) that depicts the communications and interactions that take place over time between actors or objects. By displaying the series of events or activities that take place in a certain scenario or use case, it illustrates the dynamic behaviour of a system.

Key elements and concepts in sequence UML diagrams include

Lifelines Represent the participating objects or actors in the sequence diagram. Lifelines are depicted as vertical lines, usually labeled with the name of the object or actor they represent.

Messages Represent the communication or interaction between lifelines. Messages are shown as arrows or dashed lines with labels indicating the nature of the communication. They can be synchronous (denoted by a solid line), asynchronous (denoted by a dashed line), or self-referential (loopback arrow).

Activation Bars Represent the period of time during which an object or actor is actively processing a message. Activation bars are horizontal lines that extend across the lifeline's lifespan to indicate the duration of the method execution.

Return Messages Indicate the response or return value from a method call. Return messages are depicted as dashed arrows, often labeled with the return value or the message "return".

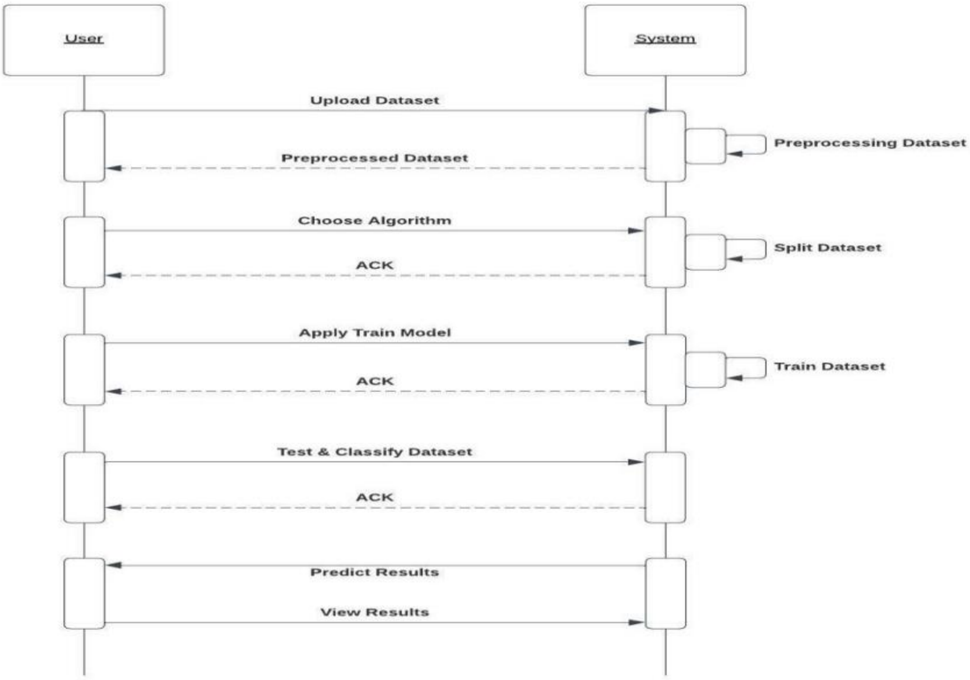

Fig 3.3 Sequence Diagram

3.5.3 Use Case Diagram

A UML diagram is a behavioural diagram in the Unified Modelling Language (UML) that illustrates the interactions between actors (people or external systems) and a system. It focuses on capturing the system's functionality from a user's perspective, showcasing the many use cases and how actors interact with the system to achieve specific goals.

Key elements and concepts in use case UML diagrams include

Actors Represent the roles or entities outside the system that interact with it. Actors might be people, other systems, or even hardware components. They are depicted as stick figures or marked blocks.

Use Cases Represent the specific functionalities or tasks that the system provides to its users. Use cases describe the interactions between actors and the system to accomplish a specific goal. They are depicted as ovals or ellipses and labelled with descriptive names.

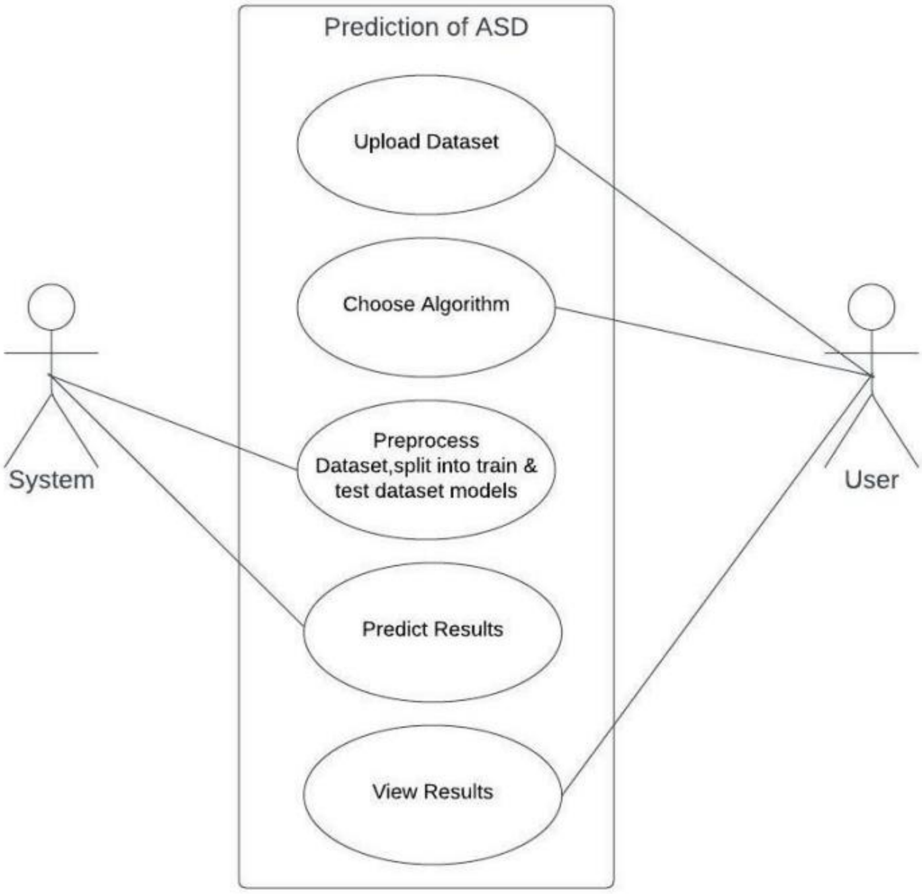

Fig 3.4 Use Case Diagram

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Description about Dataset

The Autism_dataset is a large-scale dataset used to work on projects and studies related to Autism Spectrum Disorder(ASD). This dataset is related to facial data of children, and it contains both raw and synthetic data. It likely includes information about various images which have a wide variety in data . Dataset consists of more than 6000 images of children of wide variety in their age , color , angles ,eyes etc. Dataset is evenly divided into autistic and non autistic facial data to avoid both underfitting and overfitting.

Fig 4.1 Sample Data

The dataset consists of High-resolution images of children's faces in various expressions, poses, and lighting conditions. These images would capture different emotions, ranging from happiness and sadness to neutrality and surprise. These images could be captured through different cameras and devices to ensure diversity in quality and perspective. This helps to pinpoint specific features on the face, such as eyes, nose, mouth, and eyebrows. These landmarks help in analyzing the geometry and structure of the face, enabling detailed measurements and comparisons. Researchers and developers can use this dataset to train AI models for various purposes, including emotion recognition, diagnostic support systems, and understanding the nuances in facial expressions associated with ASD. Furthermore, the dataset could contribute to advancing research in the field, fostering better understanding and support for individuals with autism.

4.2 Detailed explanation about the Experimental Results (using Graphs, Screen Shots).

Keras module is a high-level, deep learning API developed by Google for implementing neural networks. It is written in Python and is used to make the implementation of neural networks easy. It also supports multiple backend neural network computation.

```
In [4]:  train_df['category'].value_counts().plot.bar()

Out[4]:  <matplotlib.axes._subplots.AxesSubplot at 0x7fc7ece62490>
```

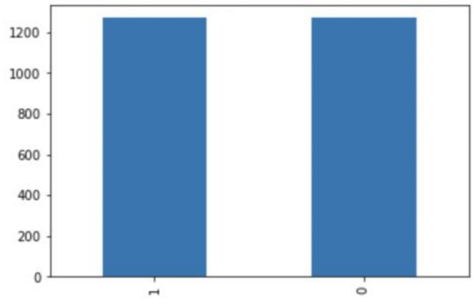

Fig 4.2 Distribution of classes

The above figure shows the distribution of children with autism and non autism.

```
In [12]:
#Fit Model
history = model.fit_generator(
    train_generator,
    epochs=epochs,
    validation_data=validation_generator,
    validation_steps=total_validate//batch_size,
    steps_per_epoch=total_train//batch_size)
```

```
Epoch 1/4
114/114 [==============================] - 59s 516ms/step - loss: 0.7039 - accuracy: 0.5499 - val_loss: 0.5479 - va
l_accuracy: 0.7458
Epoch 2/4
114/114 [==============================] - 52s 456ms/step - loss: 0.5711 - accuracy: 0.7070 - val_loss: 0.4813 - va
l_accuracy: 0.7393
Epoch 3/4
114/114 [==============================] - 52s 453ms/step - loss: 0.5282 - accuracy: 0.7246 - val_loss: 0.4093 - va
l_accuracy: 0.7821
Epoch 4/4
114/114 [==============================] - 51s 451ms/step - loss: 0.4853 - accuracy: 0.7568 - val_loss: 0.2807 - va
l_accuracy: 0.8034
```

Fig 4.3 Model Training

The above figure depicts the working of different epochs in building the model.

```
In [13]:
loss, accuracy = model.evaluate_generator(validation_generator, total_validate//batch_size, workers=12)
print("Test: accuracy = %f  ;  loss = %f " % (accuracy, loss))
```

```
Test: accuracy = 0.825000  ;  loss = 0.376272
```

```
In [14]:
#Prepare Testing
test_filenames = os.listdir("../input/autism-image-data/AutismDataset/test/")
test_df = pd.DataFrame({
    'filename': test_filenames
})
nb_samples = test_df.shape[0]
```

Fig 4.4 Model Metrics

The above figure depicts the accuracy and loss in testing the above model.

The above model gives an accuracy of 82% by using VGG16 model in keras module in cnn.

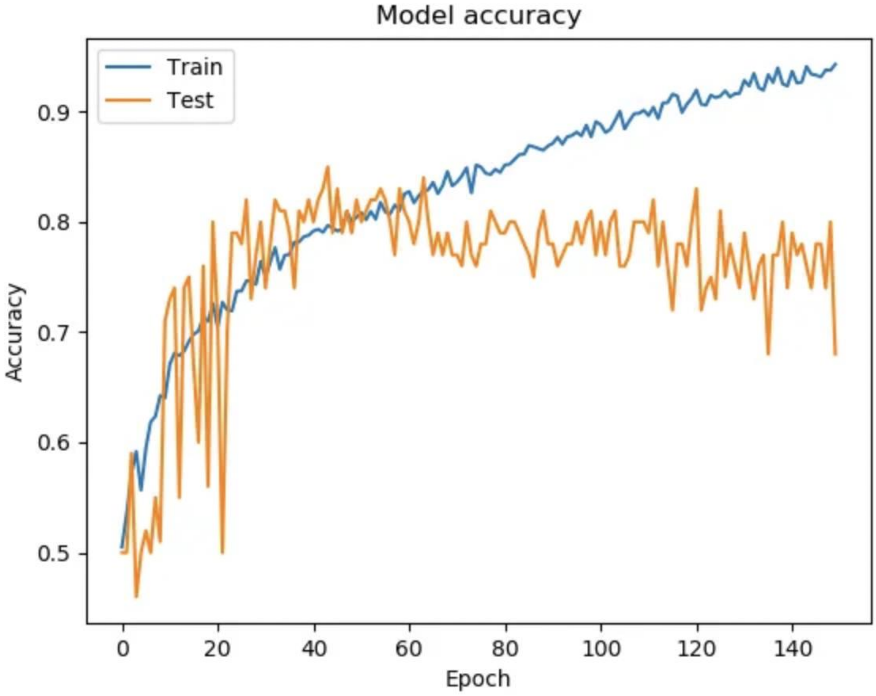

Fig 4.5 Accuracy vs Epochs

The model achieves 85% accuracy on the validation set after 44 epochs. The model starts to overfit around epoch 60.

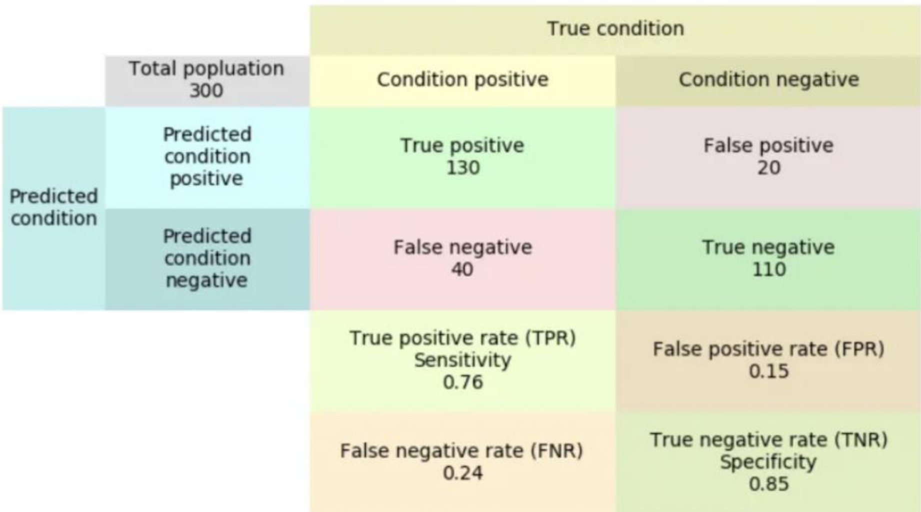

Fig 4.6 Confusion Matrix

The above figure depicts the confusion matrix of the sample data.

CHAPTER 5

CONCLUSION AND FUTURE ENHANCEMENTS

5.1 Conclusion

The use of deep learning algorithms in Autism Spectrum Disorder detecting systems is a successful strategy for detecting autism in children in age 0-2.The facial data were most accurately represented by various deep learning algorithms(CNN), which can be used by medical professionals to effectively counsel and prescribe for children with chance of autism. The method has the ability to lower the risk of diseases linked to autism and enhance people's general health and behaviour. Overall, using deep learning algorithms to detect autism can be a viable strategy for combating the rising ASD concerns in children.

5.2 Future Enhancements

The future enhancements we can do to our project are given below

Integration with Better Advancements: We can integrate the system with various algorithms in future and chose the best one that suits the needs of current social life.

Social and Community Features: Implement social features that allow users to connect with others who have ASD , share their progress, and provide support. Additionally, incorporate a community forum where users can ask questions, share tips, and engage in discussions related to ASD.

Mobile Application: Develop a dedicated mobile application for easy access to the system's features on smartphones and tablets. This will enhance user convenience and enable them to detect ASD on-the-go.

Gamification Elements: Incorporate gamification elements, such as achievements, challenges, and rewards, to increase user engagement and motivation. This can help users stay motivated and committed to their social interactive skills.

These enhancements can contribute to a more robust and user-centric ASD detecting system empowering individuals to make healthier choices, achieve their social interactive goals, and maintain a balanced and normal life.

CHAPTER 6

APPENDICES

6.1 Source Code

```
import numpy as np

import pandas as pd

import seaborn as sns

from keras.preprocessing.image import ImageDataGenerator, load_img

from keras.utils import to_categorical

from sklearn.model_selection import train_test_split

import matplotlib.pyplot as plt

import random

import os

print(os.listdir("../inimport keras,os

from keras.models import Sequential

from keras.layers import Conv2D, MaxPooling2D, Dropout, Flatten, Dense, Activation,GlobalMaxPooling2D

import numpy as np

from keras.applications import VGG16

from keras.models import Model

from keras import optimizers , layers, applications

filenames = os.listdir("../input/autism-image-data/AutismDataset/train")

categories = []

for filename in filenames:

    category = filename.split('.')[0]
```

```
    if category == 'Autistic':
        categories.append(str(1))
    else:
        categories.append(str(0))


train_df = pd.DataFrame({
    'filename': filenames,
    'category': categories
})
train_df['category'].value_counts().plot.bar()
test_filenames = os.listdir("../input/autism-image-data/AutismDataset/test")
categories = []
for filename in filenames:
    category = filename.split('.')[0]
    if category == 'Autistic':
        categories.append(str(1))
    else:
        categories.append(str(0))
test_df = pd.DataFrame({
    'filename': filenames,
    'category': categories
})
test_df.head()
sample = random.choice(filenames)
```

```
image = load_img("../input/autism-image-data/AutismDataset/train/"+sample)

plt.imshow(image)

image_size = 224

input_shape = (image_size, image_size, 3)

#Hyperparameters

epochs = 6

batch_size = 20

pre_trained_model =VGG16(input_shape=input_shape, include_top=False, weights="imagenet")

last_layer = pre_trained_model.get_layer('block5_pool')

last_output = last_layer.output


# Flatten the output layer to 1 dimension

x = GlobalMaxPooling2D()(last_output)

# Add a fully connected layer with 512 hidden units and ReLU activation

x = Dense(512, activation='relu')(x)

# Add a dropout rate of 0.5

x = Dropout(0.5)(x)

# Add a final sigmoid layer for classification

x = layers.Dense(1, activation='sigmoid')(x)

model = Model(pre_trained_model.input, x)

model.compile(loss='binary_crossentropy',

              optimizer=optimizers.SGD(lr=1e-3, momentum=0.9),

              metrics=['accuracy'])

model.summary()
```

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[2]A Survey: Approaches for Detecting the Autism Spectrum Disorder

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