Pre-thesis Report-I

Detecting Autism Spectrum Disorder in children using Deep Learning

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Abstract

Autism Spectrum Disorder (ASD) is a complex and enduring condition characterized by challenges related to communication and behavior. It is a complex neurological disorder related to an individual's psychological difficulties, which eventually impact their behavior or reactions to the outside world. While it is feasible to detect autism symptoms at any stage of an individual's life, there is a greater likelihood of detection within the first two years after birth, as differences in typical activities, communication gaps, or a lack of understanding typically become more noticeable during this early developmental period. This paper aims to identify children on the autism spectrum using various AI techniques, including machine learning, image processing techniques, deep learning techniques, and more. Identifying autism at a younger age offers several advantages, including the opportunity for the individual to lead a better life, enabling preparation for their future and that of their close family members, and contributing to increased awareness and understanding of various medical conditions. Our objective is to utilize data sets from the ASD Tests program as a primary data source for another research project involving different modern methodologies and algorithms. We have plans to integrate a confusion matrix into our research for enhanced results in the detection of autism. This will help in evaluating and fine-tuning the performance of our detection model. Our plan also involves utilizing a facial feature dataset collected from autistic patients to identify and discern symptoms of autism. Autistic children often display unique patterns of facial features that distinguish them distinctly from neurotypical children, so we want to utilize a deep learning-based web application for the detection of autism. This application will rely on experimentally tested facial features, employing techniques like Convolutional Neural Networks (CNNs) to aid in the detection process which is commonly used by researchers to analyze autism-related data. We plan to acquire facial images from a publicly available dataset, such as the one found on platforms like Kaggle. Our primary goal is to enhance autism detection by harnessing various contemporary AI techniques that are currently available.

Chapter 1

Introduction

Autism Spectrum Disorder (ASD) represents a lifelong condition that is associated with the development of the human brain. It's a rapidly growing category of disabilities characterized by repetitive behavior patterns, specific interests, and challenges in social interactions. Autistic individuals often encounter difficulty in expressing themselves, whether through verbal communication or non-verbal means such as gestures, facial expressions, and physical touch. Individuals with autism may experience difficulties in the learning process, and their skill development may occur unevenly, with some areas progressing at a different pace than others. This variability is a characteristic feature of autism. Now, individuals with autism can also exhibit remarkable abilities in various memory-intensive activities, excelling in areas such as mathematics, art, and more. These exceptional talents can be a unique aspect of their cognitive profile. These specialized areas of strength are sometimes referred to as "splinter skills" or "special talents" and can be a notable aspect of autism. The classification of autism as high-functioning or low-functioning is contingent upon the individual's level of severity. The high-functioning autistic individuals may excel in communication, have higher IQ levels, or demonstrate slightly more proficiency in typical daily activities compared to their low-functioning counterparts.

Autistic individuals typically exhibit symptoms that differ from those seen in neurotypical individuals. The symptoms of autism can include lack of eye contact, a limited range of interests or intense focus on specific topics, repetitive behaviors, heightened sensitivity to sensory stimuli, difficulty in social engagement, aversion to physical touch, and challenges in adapting to changes in routines. Occasionally, individuals with autism can become overwhelmed in certain situations, leading to what is known as a meltdown, they may express their distress by crying, screaming, or engaging in physical behaviors or they might completely withdraw and become unresponsive.

A considerable amount of research has been dedicated to enhancing the accuracy of autism detection through the utilization of various algorithms. Many research studies employ K Nearest Neighbors (KNN) and Linear Discriminant Analysis (LDA) for detecting autism in children aged between 4-11. Additionally, researchers frequently utilize deep learning techniques with datasets like the Autism Brain Imaging Data Exchange (ABIDE) to analyze autism-related data. Again, neuroscientific research has the potential to bridge the gap by providing a clearer understanding of the intricate relationship between the wide spectrum of alterations in autism behavior and the corresponding neural patterns. Many existing research merges machine-learning approaches with brain imaging data which has facilitated the categorization of mental states related to the processing and representation of semantic categories in the context of learning (Bauer and Just, 2015). Research studies utilizing neuroimaging techniques like magnetic resonance imaging (MRI) or positron emission tomography (PET) have yielded numerous insights into the neurodevelopmental features that underlie Autism Spectrum Disorder (ASD). One of the challenges in brain imaging studies of brain disorders is replicating findings across larger and more diverse datasets that accurately represent the varied demographics. We can also apply machine learning algorithms to brain images and these algorithms have the capability to extract consistent and resilient neural patterns from data obtained from individuals with psychiatric disorders (Pereira et al., 2009).

Our paper aims to integrate machine-learning techniques with facial features data and utilize artificial intelligence (AI) models which have been proven valuable in the early diagnosis of (ASD) to make more improvements in the autism detection sphere. We plan to collect facial feature images from both autistic patients and neurotypical individuals from available online sources like Kaggle, conduct preprocessing and testing of the data, and then apply deep learning algorithms to analyze and extract valuable insights from the dataset. We will obtain our predictions from the deep learning model, which will enable us to identify and ascertain symptoms of autism based on the analysis of facial feature data. Researchers also have employed the Convolutional Neural Network (CNN) algorithm to train datasets, facilitating the extraction of components associated with human facial expressions. We also intend to incorporate a confusion matrix into our approach to enhance the accuracy of our results. Recently, there has been a focus on analyzing data related to physical biomarkers and assessing clinical data through the application of machine-learning approaches. Early detection of Autism Spectrum Disorder (ASD) can benefit not only the individual with ASD but also their close family and support network, as it allows for better preparation and planning for the future.

1.1 Problem Statement

Early onset of the autism spectrum disease causes issues with social, academic, and occupational functioning later in life.People with ASD frequently show the following symptoms, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), a manual established by the American Psychiatric Association that healthcare professionals use to identify mental disorders: 1.Having trouble communicating and interacting with others 2.Limited interests and recurring patterns of behavior 3.symptoms that interfere with their ability to perform in job, school, and other aspects of their lives.The diagnosis of autism is crucial since living without one can be challenging, upsetting, and perplexing in a variety of ways. This may lead to challenging behaviors, social isolation, and young people performing poorly in school. Once a condition is identified, the young person can better understand themselves and realize they are not alone in how they feel.The behavior and development of a patient are assessed by medical professionals to make an ASD diagnosis. Typically, ASD can be accurately identified by age 2. The earliest possible evaluation should be sought for. The sooner ASD is diagnosed, the sooner assistance and treatments can start .The lengthy and laborious process of diagnosing a typical ASD is the problem here. By the time they receive the required counseling and treatment, the patient may have less opportunities to lessen the severity of any symptoms they may be experiencing. The main goal of this research is to speed up the diagnosis of autism by introducing a machine learning system that makes use of different machine learning algorithms to provide the most accurate predictive model.The suggested remedy comprises creating a predictive algorithm that can correctly identify whether or not a child has autism based on their images.However, utilizing machine learning to detect autism can present some significant challenges.The following sub-problems are possible divisions of the research problem:

Data gathering and integration

We need a significant amount of data to train our model, thus acquiring this data will be challenging for us. As a result, the first sub-problem of this study is around the effective acquisition and integration of images of autistic or non-autistic patients from numerous sources. Again, finding datasets for the medical sector is challenging because they are not permitted to disclose.This sub-problem focuses on the difficulties and factors to be taken into account while assuring data quality, reliability, completeness, and consistency for efficient analysis.

Selected and Represented Features

For the purpose of diagnosing autism, we must identify the relevant attributes and features from the dataset.This sub-problem tries to address the difficulty of feature selection and representation, ensuring that the chosen features accurately capture the crucial components of autism detection.

Evaluation and Prediction

This study's third sub-problem focuses on the evaluation and prediction of autism.The suggested approach comprises creating a predictive model based on the image of children to identify whether a child has autism or not.The ultimate goal is to take the standard approach to diagnosing autism and turn it into a machine learning model that can efficiently use the enormous quantity of data gathered for making predictions and observations.This subproblem addresses the difficulties in reliably diagnosing and forecasting autism, as well as the need to build acceptable evaluation metrics and procedures for judging the precision, dependability, robustness, and generalized potentiality forecasts.

1.2 Research Object

The goal of detecting autism from images is to identify if someone has autism by looking at their pictures. This research of autism detection will help in:

1) Early Identification: We can find out if a child has autism when they are young, which helps them get special help early on.

2) Understanding Behaviors: We can learn more about how people with autism behave and express themselves through their facial expressions and actions.

3) Objective Diagnosis: It helps doctors make a clear and certain diagnosis based on pictures, which is more accurate than just talking to someone.

4) Different Types: We can discover if there are different types or ways that autism shows up in pictures, which could lead to more personalized treatment.

5) Equality: Using pictures can make sure that everyone, no matter where they come from or who they are, gets a fair chance at being diagnosed with autism.

6) Helpful Tools: We can create tools and technology that make it easier and less scary for children to go through the diagnosis process.

7) Tracking Progress: We can see how a person's expressions and behaviors change over time, helping us understand how well interventions are working.

8) Privacy and Safety: We can learn how to protect people's privacy and keep their images safe while still using them to help with autism diagnosis.

9) Training AI: By using images, we can teach computers and artificial intelligence to recognize autism, which can be very helpful in the future.

10) Raising Awareness: Detecting autism through images can help people understand autism better and be kinder to those who have it, reducing stigma and making the world a more inclusive place.

The main goal of this research is to detect autism with the help of images and to alert them and their families for early treatment and make sure that they get special care from the society. They should get all the opportunities to learn and grow like a normal child.

Chapter 2

Literature Review

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder that impacts people's learning, behavior, communication, and social skills. This can lead to further problems like social isolation, mental health problems, and not being able to find or maintain employment. The lifetime cost of supporting an ASD-affected person, including his or her medical care, special education, and lost productivity, can amount to 2.4 million USD, while those without intellectual disabilities require only about 1.4 million USD [4]. This kind of expense can put a lot of strain on families and society. In recent decades, ASD has become more prevalent. According to a report generated by the CDC, in 2020, 1 in 54 children in the US were diagnosed with ASD, while the previous record of 2000 shows only 1 in 150 children were affected [6]. This clearly highlights how this issue is becoming more concerning each year. The reason why this alarming health condition is not being treated as successfully as it should be is also due to the fact that most people with ASD do not receive early intervention. Research shows that most people diagnosed with ASD in the US are over the age of 4. The importance of early diagnosis is paramount since studies [5] have shown that early intervention can reduce the severity of ASD by improving communication and adaptive behavior skills, reducing repetitive behaviors, and so on. So, we can understand the crucial need for efficient and precise ASD detection methods. Our research will be based upon implementing image processing, which, due to being an objective and non-invasive method, has the potential to help in the early detection of ASDs. This literature review draws on major findings from previous studies in order to establish the framework for our project. Our effort seeks to help ASD patients and their families live better lives by bettering the accuracy and accessibility of ASD identification through image processing. Our research aims to develop an efficient and precise detection tool for the diagnosis of ASD by building upon the foundation established

by earlier researches and improving them. We hope to accomplish this by utilizing comprehensive algorithms, standardizing data collection, including a bigger dataset, and enhancing model interpretability. While we are still in the early phases, we are dedicated to improving the precision and efficacy of ASD diagnosis methods and are taking inspiration from the encouraging results of earlier research. We hope that the work we do will help in the early identification and care of those with ASD.

2.1 Related Work

Many researchers have already done work on detection of autism spectrum using image processing. All of them used different methods to detect autism by using pictures. Image processing played a crucial role in identifying autism in children early. According to Rad and Furnanello, their research was based on the communication and social problems of the young teens having ASD. Besides, while doing their research the characteristic movement of the young patients stood out noticeably. Children with autism have SMMs as an important part of their life. So, it was very important for the researchers to develop a technique that will be effective for locating the changes of the young patients with abnormal behavior[2]. In another case, researchers utilized AI for developing the sequence of repetitive examples of strolling. This research was established by applying the motor and kinematic characteristics of strolling. For detecting the problem, they used linear analysis of learning classification. The negative and positive part of linear analysis helped in regulating the research. DSM-IV was used as an ASD screening tool and it was consistent in its result. With the help of tomography of the cerebrum, they observed significant control of autism [1]. Data sets from the ASD Tests program were used as a source for another Artificial Neural Network in other research. So, 10 questions were used for collecting information. With those questions including the age and gender of the member, research was conducted. In [3] , a prediction system was created by using the previous records of long time patients for distinguishing the signs of ASD. Both traditional and rare types of ASD were detected using this prediction system. For creating a matrix, machine learning and colloquy theory were applied together to establish the system. It utilized all sets of associations to create rules for better results. It must be noted that their ASD system consumed more limited memory for conducting the research. Also, because of single time database access, the system was faster [9]. For another work, K Nearest Neighbors (KNN) and Linear Discriminant analysis (LDA) were utilized for the detection of autism in kids aged between 4-11. So, they used 70 percent

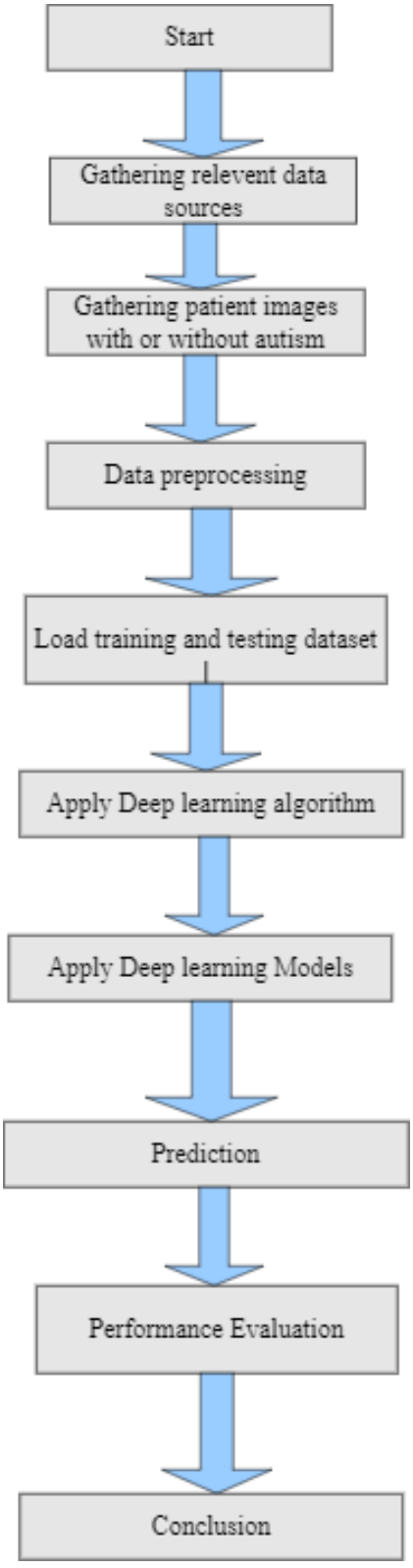
of the data for the training and the rest 30 percent were used for testing. As a result, those algorithms helped in getting more accurate results for prediction and reduced predictions that were biased [10]. Deep learning techniques were utilized by researchers in the Autism Brain Imaging Data Exchange (ABIDE) dataset because of analyzing ASD in [7]. They discovered that the result of accuracy of classification was 70 percent better compared to other state art techniques . Another research [8] suggests a deep learning model for early ASD identification using eye-tracking scan path data. The model was trained and assessed based on eye-tracking data from kids with and without ASD. However, the authors acknowledged that more study is required to verify the model on a bigger, more varied dataset since they had a relatively small sample size. Since this is such an important tool for early ASD diagnosis, we can substantially improve the detection accuracy through longitudinal analysis, using more advanced machine learning models and a more diverse and larger dataset.

From the above research works, it can be concluded that those research papers concentrated more on stereotypical behavior of autism. We will explore more in detail on the characteristics of autism by conducting thorough research. Early detection of autism will help young children to get them necessary treatment and help them adjust early.We expect to attain a more accurate prediction of autism by using algorithms that will give us the required result.

Chapter 3

Work plan

The proposed methodology for detecting autism makes use of the facial characteristics of children who are autistic and those who are not.The concept calls for creating a procedure that receives picture data as input, processes that data in a methodical manner and output predictions that are either "True" or "False".


Start
Gathering relevent data sources
Gathering patient images with or without autism
Data preprocessing
Load training and testing dataset
Apply Deep learning algorithm
Apply Deep learning Models
Prediction
Performance Evaluation
Conclusion

Data gathering and preparation phrase

1.1 determine the relevant data sources.
1.2 collect pictures of patients with and without autism so that the model can be trained and tested.
1.3 The dataset folder images are of varying sizes and contain some noise so we have to apply certain preprocessing techniques to the photos to reduce noise and smooth the dataset.
1.4 The dataset was divided into 2,540 images for training, 100 for validation, and 300 for testing.

Apply Deep Learning Algorithm and models

2.1 To determine the image's class, deep learning algorithms use the input image and prioritize learnable weights and biases. Following the first detection of simpler patterns (such as lines and curves), many more complex patterns (such as faces and objects) are found. (example:CNN).
2.2 Strong deep learning models can be produced using a variety of techniques. These models will be used in our research.

forecast the outcome

3.1 The outcome will depend on the image and could be either True or False.

Model Analysis and Validation Stage

The study will use a variety of performance evaluation criteria, including a confusion matrix, accuracy, sensitivity, and specificity, for the models we will be using in our research.

Chapter 4

Conclusion

The aim of this research project is to identify autism in young children more accurately by using facial image processing. Application of different deep learning algorithms will help us detecting the characteristics of autism beneficially. The research will focus on knowing in detail about the characteristics of autism by studying the facial thoroughly. Moreover, we will be able to create a data driven framework that will help in classifying the characteristics of the spectrum of autism in children effortlessly. As there are different types of autism, this research will help us to diagnose types of autism properly. There will be less chances of misdiagnosis by proper training of deep learning algorithms. Confusion matrix will assess the performance of models we are going to be using in this research. It will help in evaluating the negative and positive classes. With the help of ASD features gathered from individual modalities of data will help us in boosting the rate of accuracy. Parents will be able to help their children get proper treatment if children are properly diagnosed. As a result, children will adjust to life early and can learn skills which will help them with the help of right guidance. By conducting this research, the goal is to achieve more accuracy in the prediction of autism. So, the project focuses on being reliable and accurate to detect autism in children easily by applying advanced algorithms of deep learning.

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