ENHANCING THE EFFICIENCY OF DIAGNOSING AND MANAGING MENTAL DISORDERS USING MACHINE LEARNING

Project Id 24-25J-322

Project Proposal Report

Chamaleen D.B.N

B.Sc. (Hons) in Information Technology Specializing in

Data Science

Department of Computer Science

ENHANCING THE EFFICIENCY OF DIAGNOSING AND MANAGING MENTAL DISORDERS USING MACHINE LEARNING

Project Id 24-25J-322

Project Proposal Report

Chamaleen D.B.N-IT21182846

Supervisor: Ms. Wishalya Tissera

Co – Supervisor: Dr. Kapila Dissanayaka

B.Sc. (Hons) in Information Technology Specializing in

Data Science

Department of Computer Science

Declaration

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Chamaleen D.B. N	IT21182846	Nayani

The supervisor/s should certify the proposal report with the following declaration. The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Ms. Wishalya Tissera

....

Signature of the supervisor

22/08/2024

Date

Dissanayake IKG

Signature of the Co-Supervisor

Dr. Kapila Dissanayake.

22/08/2024.

Date

Acknowledgement

I would like to extend my sincere gratitude to all the individuals who supported me to continue my fourth-year research project. First and foremost, I sincerely thank our Research Project supervisor Ms. Wishalya Tissera for her invaluable guidance, encouragement, and support. I am also grateful for the advice and support given by our co-supervisor, Dr.Kapila Dissanayaka. I extend my sincere thanks to the CDAP panel for their guidance throughout our project work. Additionally, I would like to express my appreciation to Dr. Anuradha Baminiwatta, our external supervisor, for her coordination and provision of information, which helped us in the initiation of our research project. I would also like to extend my sincere gratitude for the contributions made by our research project leader, Dilshan G.A.M, and other group members who have supported me throughout the project. Finally, I would like to extend my heartfelt gratitude to my parents and friends for their invaluable support given to make this project a success

Abstract

Autism spectrum disorder (ASD) affects social communication, interaction, and behavior, often leading to repetitive patterns. Early diagnosis is crucial for better outcomes, as it allows timely intervention. This overview focuses on common ASD symptoms like avoiding eye contact, not responding to names, intense fears, and limited pretend play. Recognizing these early signs helps caregivers and healthcare professionals begin suitable therapies, reducing family stress and promoting independence by connecting families with essential support services and community resources.

The proposed system integrates facial image analysis with text-based data for a multimodal approach to early ASD detection. To detect ASD early, the proposed system uses the VGG-16 convolutional neural network (CNN) to analyze facial features in images. Trained on diverse datasets, the model identifies subtle patterns associated with ASD. The system features a user-friendly interface that enables caregivers and general practitioners to upload images easily. After analysis, the system generates a detailed diagnostic report with a probability score for ASD and recommendations for further testing or treatment.

A smartphone application enhances accessibility further. Users can take photos with their mobile devices, and the app handles the analysis, delivering diagnostic results. Along with the analysis, the app provides useful information about ASD and potential interventions. This technology simplifies ASD detection, ensuring quicker and more accurate diagnoses, which improves the quality of life for individuals with autism and their families.

Keywords: Convolutional Neural Network, Autism Spectrum Disorder (ASD), VGG-16 convolutional neural network (CNN), Neurodevelopmental illness

Table of Contents

List Figures

List of Tables

List of abbreviations

Abbreviation	**Description**
CNN	Convolutional Neural Network
ML	Machine Learning
DL	Deep Learning
NLP	Natural Language Processing
ANN	Artificial Neural Networks
CDC	Centers for Disease Control
UI	User Experience

Table 1:List of abbreviations

1.0 INTRODUCTION

A neurodevelopmental disorder known as autism spectrum disorder (ASD) impacts a person's perception of and interactions with others, making social interaction and communication challenging [1]. The Centers for Disease Control and Prevention (CDC) describe ASD as a neurodevelopmental disorder that is caused by variations in the brain [2]. People with ASD sometimes struggle with social interaction, communication, and have repetitive or limited interests and behaviors. Furthermore, there may be differences in the ways that individuals with ASD approach movement, learning, and attention [2]. There is a strong correlation between autism and the genetic condition fragile X, and autism is more common in men and prematurely born children [3]. Since each autistic child requires a unique set of interventions, treating autistic children requires a high number of resources and facilities, mostly because of the necessity for a bigger therapist to client ratio. Enough knowledge on autism is required to justify the number of resources dedicated to the treatment of autistic children. People need to be well-educated because families of autistic children bear heavy financial and psychological costs, and the less knowledgeable they are, the higher the chance of incorrect diagnoses, which could make their child more difficult to treat and more complex [4].

Traditional diagnostic techniques can be difficult and imprecise, yet early and accurate diagnosis is essential for successful intervention. Recent developments in artificial intelligence (AI) have created new opportunities to enhance ASD detection and treatment. The identification of ASD has progressed historically, reflecting our growing knowledge of neurodevelopmental diseases. Clinical observations and behavioral evaluations were major components of traditional diagnosis techniques. These approaches, however, frequently resulted in missed opportunities for early intervention and delayed diagnosis. The use of AI, especially machine learning and deep learning methods, has significantly changed how ASD is diagnosed. By identifying patterns and signals that were previously invisible, these technologies have the potential to produce a more accurate and fast diagnosis ("Deep learning with image-based autism spectrum disorder analysis: A systematic review") [5].

Recent research has shown how useful AI is for diagnosing ASD in its early stages. For example, Rasul et al. (2024) assessed several machines learning techniques, including neural networks, random forests, and support vector machines (SVM), emphasizing their ability to analyze big datasets of physiological and behavioral indicators. To start timely therapies and support, early detection is crucial, and these technologies greatly improve it ("An evaluation of machine learning approaches for early diagnosis of autism spectrum disorder") [6].

Historical records of ASD detection can be compared to old inscriptions in the context of AI applications. The detailed information and patterns captured by these digital recordings help to clarify autism spectrum disorder (ASD) and provide guidance for future research ("autism spectrum disorder detection using face features based on deep neural network") [7]. The absence of suitable machine learning models that successfully integrate facial image analysis with text-based surveys is a prevalent problem in the detection of autism. Numerous current methods fall short in integrating various modalities, which produces less-than-ideal outcomes when detecting ASD. The accuracy and dependability of early-stage autism identification can be greatly increased by using a multimodal method that makes use of both visual and written data, guaranteeing more thorough and efficient examinations.

Developing and improving AI systems that can reliably identify and diagnose ASD using a variety of data sources, including facial traits and text base questionary, is the main goal of current research in this area. Researchers hope to develop models that can translate intricate patterns into useful insights, enabling early and accurate diagnosis, by utilizing cutting edge AI approaches. This goal is in line with the broad mission of improving healthcare procedures and results for people with ASD. There are several advantages to using AI in ASD diagnosis. First, it encourages early and precise detection, making appropriate interventions possible that can greatly enhance the quality of life for those who have ASD. Second, it increases accessibility to diagnostic tools by democratizing their use and decreasing dependency on. We can understand the revolutionary potential of artificial intelligence (AI) in gaining fresh perspectives and enhancing diagnostic procedures by comparing it to the historical relevance of ancient inscriptions. Prolonged investigation and advancement in this field hold potential to improve early identification, intervention, and general quality of life for those with ASD.

1.1 Background & Literature Review

ASD symptoms, indicators, and moral issues

Early indicators can be seen in social engagement and receptiveness, according to the Centers for Disease Control and Prevention (CDC). Avoiding or not making prolonged eye contact, not reacting to their name by the time they are nine months old, and a lack of expressions on their faces such as happiness, sadness, rage, and surprise are some signs of these behaviors. At twelve months of age, there is no longer any involvement in basic interactive games such as pat-a-cake. At the same age, farewell gestures like waving are restricted. By the time the youngster is 15 months old, they are unable to show people their interests by showing excitement for things they find appealing. After eighteen months, nothing is being pointed out as intriguing. By the age of 24 months, the youngster lacks awareness of and empathy for the pain or distress of others. By 36 months, there's no longer any observation or desire to play with other kids. By 48 months, pretend playing characters like superheroes or teachers has stopped. Finally, there won't be any acting, dancing, or singing for 60 months. Particularly interesting examples of restrictive or repetitive behaviors include putting things in a certain order and getting irritated when that arrangement is changed. Echolalia is the term for the repeating of words or phrases. Additional repetitive behaviors include playing with toys in the same way every time, showing acute attention to parts of objects (such as wheels), exhibiting strong reactions to small changes, having compulsive interests, following strict routines, flapping one's hands, rocking one's body, or spinning oneself around, and exhibiting strange reactions to various stimuli. An ASD patient may face a range of problems because of the early indicators, including delayed cognitive development or learning skills, anxiety, hyperactivity or inattentive behaviors, gastrointestinal problems, seizures, and linguistic disorders [8].

Neurodiversity is inherently based on variances in the nervous system, including ASD. The descriptive appendix of ASD has raised concerns about whether it should be viewed as a distinct kind of normal or as a disease. When autism is classified as a disease in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSMV), it can be a complicated and uncomfortable position for a pediatrician [9]. The view that autism spectrum disorder is not a sickness has been promoted by numerous pediatricians, which frequently frustrates the families of those who have ASD. When faced with the difficulties of providing care for their loved ones, who could struggle to communicate their feelings or build normal social relationships, they might feel despondent. As autism is not a sickness and can be extremely taxing on families, neurodiversity for ASD raises a difficult ethical conundrum. Nevertheless, if therapy is medically necessary, the sum does not bar it. When evaluating treatment alternatives, medical practitioners should keep in mind the objectives of their interventions and maintain respect for the personhood of individuals with autism [10].

Benefits of an early diagnosis of ASD

When a kid is diagnosed between the ages of two and five, there is a chance that they could benefit from therapy that could help them develop certain abilities, such movement, social interaction, and communication. Early therapeutic adoption may help the child feel less frustrated and perhaps improve their quality of life. Early intervention may have a greater effect than commencing therapy later in life because a child's brain is still developing throughout this time.

Numerous research, such as a systematic review and meta-analysis by Vivanti et al., which discovered that early interventions significantly improved the cognitive, linguistic, and social emotional functioning of children with ASD [11], have validated the advantages of early diagnosis of ASD. Early ASD diagnosis results in earlier interventions, which have been demonstrated to enhance the developmental outcomes of ASD children. Grzadzinski et al.
reported that parents with an early diagnosis of their child's ASD reported lower levels of anxiety and stress [12]. Consequently, these parents were more likely to get their child the services and support they needed, as well as contribute to a reduction in parental stress and an improvement in family functioning.

Early diagnosis and intervention have been linked to improved social results and increased independence in adulthood [8], as well as long-term cost savings and less stress for the family. Long-term cost savings were so great that they also decreased the demand for special education services and more intense treatments [9]. Early enrolment in specialized educational programs catered to the requirements of kids with ASD has also been demonstrated to result from early diagnosis. For kids with ASD, these activities have raised socialization possibilities and enhanced scholastic or educational results [13].
These studies, taken together, provide evidence for the significance of early identification of ASD in terms of bettering the lives of impacted individuals and their families as well as lowering long-term medical expenses.

Future directions in the early diagnosis of ASD

The prognosis of people with ASD can be considerably improved by early diagnosis and management. The creation of biomarkers that objective can be used in the early detection of ASD is a topic of active research. These biomarkers could include physiological variables linked to ASD that can be measured, neuroimaging, and epigenetic changes [14]. While early detection and diagnosis of ASD are crucial, existing techniques might not catch every case in time. To swiftly and precisely identify infants at risk for ASD, researchers are looking at novel methods and technologies [15]. According to research, the diagnosis of ASD may benefit from the use of machine learning and artificial intelligence tools. An earlier and more precise diagnosis of ASD is made by analyzing patterns in behavioral and physiological data [6].

An increasingly precise diagnosis of ASD could result from improvements in assessment techniques, such as the use of standardized test batteries that include a variety of clinical domains.

Automated or computerized versions that combine neuropsychology, sensory, and cognitive testing are examples of new assessment techniques [7]. These are just a few fascinating areas of study for autism spectrum disease early diagnosis. Better and earlier identification of ASD can result in earlier and more successful therapies, which will ultimately enhance the quality of life for those who have the disorder.

The developmental outcomes of people with ASD can be improved by early detection and intervention. Early intervention, especially before the age of three, has been demonstrated to dramatically improve cognitive, social, and language skills. Over time, interventions customized to the child's unique needs can improve adaptive functioning and lessen the intensity of symptoms. Therefore, to optimize the advantages of early therapeutic approaches, fast and correct identification of ASD is essential.

Conventional approaches to ASD diagnosis mostly focus on clinical observations and behavioral assessments, which are usually carried out by qualified experts utilizing standardized diagnostic instruments like the Autism Diagnostic Interview-Revised (ADI-R) and the Autism Diagnostic Observation Schedule (ADOS). Even though these techniques are regarded as the best, they can take a long time and require substantial expertise actions that could point to ASD. The diagnosis process can be streamlined with automated detection technologies, which can make it quicker, easier to use, and possibly more accurate. This technological strategy can be used in conjunction with conventional techniques to offer a more thorough and effective route to early diagnosis and intervention.

Automated detection techniques have shown promise in several investigations. To identify distinctive traits of ASD, for example, deep learning algorithms have been trained on extensive datasets of face picture data. These models are highly accurate in classifying individuals, making them a useful first screening tool that can notify doctors when a more thorough assessment is necessary. These techniques can be incorporated into regular physical examinations, guaranteeing that kids with ASD are recognized and assisted as soon as feasible. Better results for individuals with ASD and their families can be achieved by utilizing technology and addressing the need for more efficient diagnostic tools.

Within machine learning techniques, which is a subset of artificial intelligence (AI), lies deep learning. The word "deep" refers to the ability of deep learning models to learn and process learn from massive volumes of data using numerous layers of computing. These models often called neural networks are modelled after the composition and operations of the human brain.
One kind of deep learning model that is especially well-suited for image processing applications is the convolutional neural network (CNN). CNNs use a variety of building pieces, including convolution layers, pooling layers, and fully connected layers, to automatically and adaptively learn spatial hierarchies of information using backpropagation. Most importantly, these networks have shown remarkable performance in tasks related to object identification, image categorization, and facial recognition and analysis.

CNNs are used in the detection of autism spectrum disorder (ASD) by making use of their capacity to handle and interpret complicated visual input, including facial images. Large datasets of face image data are used to train CNNs so they can recognize minute variations and patterns that might be signs of ASD.

Eye-tracking data was used in a well-known study that has been emphasized in the literature to evaluate visual attention and gaze behavior in people with ASD. According to this study, people with autism frequently exhibit unusual gaze patterns, such as giving the mouth preference over the eyes or concentrating on exterior face characteristics rather than interior ones like the mouth, nose, and eyes [5], [6]. CNNs may be efficiently used to identify these patterns in facial photos by integrating these insights into the training process.

When paired with CNNs such as VGG-16, facial feature analysis greatly improves the accuracy and efficiency of ASD identification. These networks offer a scalable approach for early detection and intervention because of their ability to process massive volumes of data quickly. CNN-based solutions lessen the subjectivity and variability present in traditional diagnostics by providing a standardized and objective detection approach. The system's accuracy can be further validated by adding classification findings from confusion matrices. This ensures that true positives are maximized, and false positives are minimized, hence boosting the reliability of ASD detection and supporting more focused interventions.

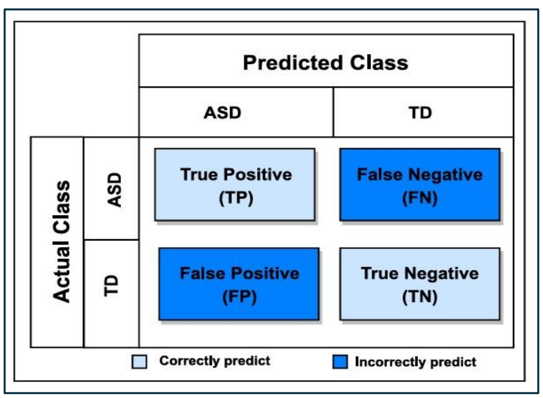

Figure 1. Example of a confusion matrix for the classification of ASD and TD. TP: true

The purpose of the Autism Spectrum Quotient, or AQ-10, tool is to screen people and determine whether they need a full autism diagnostic. Respondents can get zero or one point for each of the ten questions. A higher overall score suggests that autism is more likely to be present and calls for additional research. Ten adaptive behavioral traits, including communication, attention, switching, attention to detail, social interaction, responsiveness, expression, and imagination, are included in the AQ-10 datasets for both adults and children. The participant's age, gender, ethnicity, jaundice at birth, the family history of Pervasive Developmental Disorder (PDD), place of residence, prior use of the screening app, screening test results, the relationship with the test-taker, and class/ASD are among the additional attributes that reveal information about them. The specific characteristics of figure 2 refer to the datasets for children and adults, respectively. To uncover patterns suggestive of ASD, these ten behavioral qualities together with ten other variables must be analyzed to diagnose ASD patients.

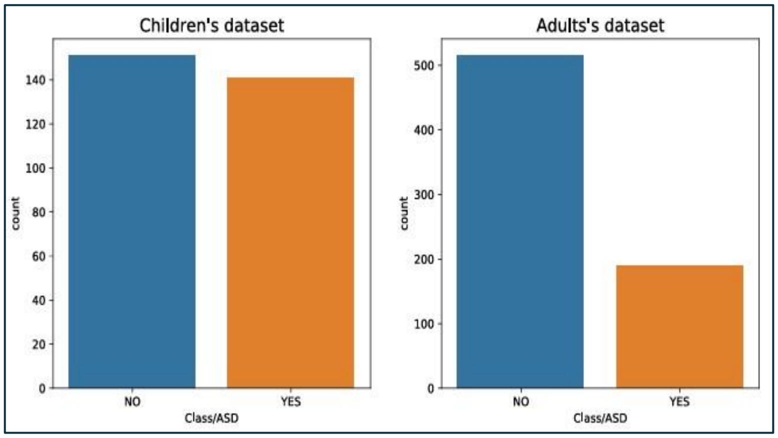

Figure 2. Data distribution for Children and Adult dataset

1.2 Research Gap

Despite significant advancements in facial image recognition for autism detection, many researchers have primarily focused on single-model approaches that often overlook crucial variables necessary for accurate ASD identification. These models, while useful, are limited by inconsistencies in image quality, lighting, and facial expressions, as well as a lack of diversity in datasets. To address these limitations, there is need for growing multimodal approaches that combine both facial images and text-based data. By integrating textual information with facial analysis, researchers can capture a broader range of ASD indicators, leading to more robust and comprehensive models. This approach has the potential to fill existing research gaps, enhance prediction accuracy, and improve the generalizability of autism detection methods across different populations.

Instead of concentrating on specialized consultants, current research efforts are increasingly directed towards the development of tools and systems that general practitioners (GPs) may employ. This change is beneficial for everyone since it enables general practitioners (GPs), who are frequently the initial point of contact in the healthcare system, to detect autism early on, especially in areas with limited access to specialized treatment. Developing accurate, comprehensible, and user-friendly technologies for non-specialists is the primary area of unmet research need. To ensure early identification even in the absence of specialized expertise, these systems must close the knowledge gap that exists between general practitioners and higher-level consultants.

The early detection and diagnosis of mental health issues, which is essential for prompt care, is the primary area of this project's deficit. Treatment for these illnesses is frequently postponed since current techniques are frequently unable to identify them early. The main goal of the project is to create an AI-driven system that mainly uses cutting-edge machine learning methods for early detection and management to address this. The specific gaps are related to my component highlighted by the following key points using:

Study "A" [5] Recent developments in deep learning (DL) have demonstrated potential for using facial image analysis to automatically diagnose autism spectrum disorder (ASD). Still in its early phases, current research is constrained by tiny, homogeneous datasets, which may result in misdiagnosis. Building complete datasets with more than just facial photographs is crucial to enhancing accuracy and reliability. Furthermore, concentrating only on facial analysis ignores other important aspects of ASD identification. Future studies could build on these models by adding more factors and investigating easily available, reasonably priced options, such as smartphone apps, for more comprehensive diagnosis and rehabilitation. These developments would improve the accessibility and efficacy of DL-based ASD screening systems.

Study "B" [6] In our research, we identified key characteristics associated with autism spectrum disorder (ASD), finding that the A9 score, which indicates a version to physical contact, is a significant factor in adults and combined datasets. For children, the A4 score, which reflects difficulty in understanding others' emotions, emerged as the primary trait. However, the analysis was constrained by the relatively small size of the available datasets. Additionally, our research primarily relied on raw data, without incorporating image processing techniques. This highlights a critical gap, as integrating image processing with raw data could potentially lead to more accurate and comprehensive models. To address these issues, we plan to apply advanced classification and clustering models to larger datasets and explore deep neural network-based approaches that can simultaneously learn features, classification, and clustering metrics.

Study "C' [16]" Currently, there is a big gap in the creation of diagnostic tools that are accurate, scalable, and easily accessible: multimodal data, integration is not given enough attention, including text-based questionnaires and facial images, in data-driven mobile applications for early-stage autism detection. Although the goal of these applications is to identify ASD by data-driven methods, they frequently fail to consider the value of adding image-based data, which can improve the diagnosis' precision and dependability. Furthermore, the lack of standardized information makes it more difficult to develop dynamic, responsive systems that can track patients' progress over time. Future studies should concentrate on filling in these gaps by creating all-encompassing digital diagnostic systems that can adjust to the specific requirements of each patient, guaranteeing more efficient and customized care.

Application Reference	Face Images Detection	Text Base Data Gathering	Get the Feedback through the report base classifications	Mobile Application	Use Multimodal Approach
[A]	Yes	No	No	No	No
[B]	No	Yes	No	No	No
[C]	No	No	No	Yes	No
[D]	No	Yes	No	Yes	No
[E]	Yes	Yes	No	No	Yes
Proposed system	Yes	Yes	Yes	Yes	Yes

Figure 3 Comparison of former research

1.3 Research Problem

1. Currently, manual techniques that rely on behavioral observations by parents and expert medical judgement are used for the detection and diagnosis of autism spectrum disorder (ASD). These techniques are expensive and time-consuming, and they are frequently impracticable for gathering data in everyday activity scenarios. To make a diagnosis, for instance, the Autism Diagnostic Interview-Revised (ADI-R) procedure can take two to three hours to finish. This inefficiency makes it difficult to diagnose ASD patients in a fast and reliable manner, which frequently results in delays in aiding and intervention.

   Researchers have been working on automated technologies to improve the speed and accuracy of ASD diagnosis to overcome these constraints. Conventional machine learning (ML) techniques have been used to develop automated screening systems that outperform manual methods in terms of efficiency and performance. Deep learning (DL) techniques have lately demonstrated great potential in disease diagnosis and detection by automatically extracting features, decreasing mistakes, and surpassing conventional ML approaches. DL-based methods have been useful in several medical domains. Within the field of autism research, DL-based techniques, especially those that examine facial photos have been shown to be effective instruments for identifying, categorizing, diagnosing, and tracking ASD in kids. The main objective is to Develop an automated, effective, and precise system for detecting ASD that can function in real-world situations and drastically cut down on the time and expense involved in using conventional diagnostic techniques.

2. Considerable obstacles still exist despite improvements in automated diagnostic techniques for autism spectrum disorder (ASD). Many current diagnostic approaches need children to be around four and a half years old. The lack of clinical training data, however, hinders the existing diagnosis system because parents frequently put off seeking medical attention until symptoms worsen despite early observations. Furthermore, children may not always benefit from data collection techniques like wearable sensors, MRI scanners, and eye trackers because of their limited communication abilities. Due to the lack of clinical training data with ground truth labels, it is difficult to create reliable machine learning (ML) or deep learning (DL) models for the early diagnosis of ASD.

3. The main research issue is the small number of available datasets for autism spectrum disorder (ASD), which limits the power of clustering and classification analysis. The accuracy and robustness of the current models are impacted by this constraint. We intend to use larger datasets and more sophisticated classification and clustering techniques to address this problem. We further hope to improve our research by integrating deep neural network-based models that can overcome the existing limitations and increase the diagnostic precision for ASD by simultaneously learning features, performing classification, and clustering.

4. The treatment, diagnosis, and intervention for autism using mobile applications for smartphones and tablets is reviewed systematically in this article, with an emphasis on the development and use of these apps rather than their effectiveness in treating the condition. The review tackles five major research questions: determining the target audience for these apps, their main goals, the usability mechanisms they employ, the design principles they adhere to, and the theories and frameworks that support their efficacy. The review identifies multiple user groups, including kids, teens with ASD, and classifies the apps into parental assistance, autistic support, and data gathering categories. It also emphasizes user-centered design methods, autism-specific mechanisms to suit special demands, and engagement techniques like gamification and virtual reality. Lastly, it examines the underlying theories and frameworks that direct app interventions for behavior modification and skill development, such as video modelling and augmentative communication [17].

5. The difficulty of creating appropriate machine learning models that successfully integrate multimodal data, particularly face photos and text-based questionnaires, is a major research issue in the early diagnosis of autism spectrum disorder (ASD). Although

each modality might offer insightful information, it can be difficult to combine them into a coherent model because of variations in data structures, processing demands, and the requirement for a model that precisely represents the subtle patterns connected to ASD. The combination is not optimized by current methods very often, which results in gaps in diagnostic accuracy. Innovative approaches that can integrate these various data sources into a single, dependable machine learning model for accurate ASD detection are needed to solve this issue.

2.0 OBJECTIVES

2.1 Main Objectives

The main target of this project is to create a smartphone application that will make it easier to identify early indicators of autism in youngsters. With only a few simple clicks of the web camera, users can take pictures of children's faces, and the program will employ sophisticated face recognition algorithms to pinpoint the facial expressions and characteristics linked to autism, enabling an early and exact diagnosis.

2.1.1 Specific Objectives

2.1.1.1 Detect the ASD use in face images used in the deep learning model.

To improve facial recognition accuracy, use the VGG-16 deep learning model in the mobile application. To accurately identify facial traits and expressions linked to autism, this includes applying its 16 convolutional layers and efficient image compression techniques. This will ultimately improve early identification and intervention efforts.

2.1.1.2 Identify the prediction level of face images of autistic children use in CNN.

Convolutional Neural Networks (CNNs) use their deep learning capabilities to analyze and classify photos based on learnt patterns to identify autism spectrum disorder (ASD) using facial photographs. The CNN can recognize characteristic facial traits linked to ASD by processing input face images through several layers, including the pooling layer for dimensionality reduction, the convolutional layer for feature extraction, and activation functions like ReLU to induce non-linearity. These features are then integrated by the fully linked layers of the network to produce accurate output predictions. By using a technique that mimics how neurons in the human brain communicate, CNN can discriminate between typical and atypical face patterns, which helps in the early detection of autism spectrum disorders.

2.1.1.3 Utilizing Machine Learning Models for ASD Detection.

To improve the precision and effectiveness of ASD identification using survey data, machine learning algorithms like Random Forest and Naive Bayes can be utilized. To increase classification accuracy and reduce over-fitting , an ensemble learning technique, Random Forest constructs numerous decision trees during combines and training them outputs. In contrast, Naive Bayes is a classifier of probabilistic that relies on the independence of characteristics and is that based on the Bayes theorem. Because of how easy it is to use and how well it handles big datasets with categorical variables, this model is especially helpful. These models can detect minute patterns and correlations suggestive of ASD by being trained on an extensive dataset of questionnaire responses. This allows the models to be used as a solid and trustworthy diagnostic tool that uses statistical and probabilistic insights to improve decision-making.

3.0 Methodology

3.1 Overall Architecture

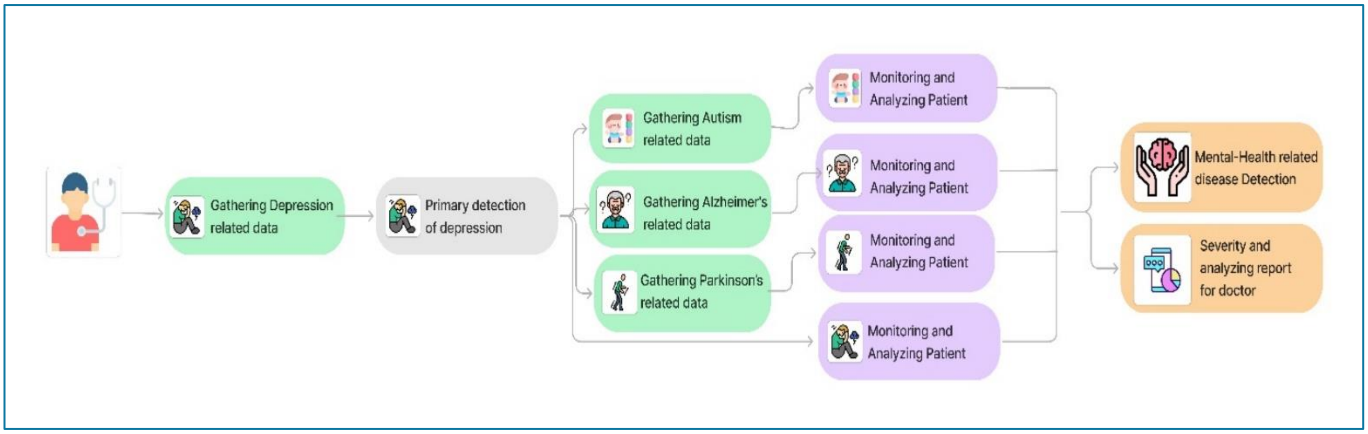

Figure 4.Overall System Diagram

The process of identifying and keeping track of different mental health problems is depicted in detail in the diagram. When a patient first sees a doctor, pertinent information about depression is gathered, and an initial evaluation is conducted to identify whether the patient is exhibiting signs of depression. The system then collects more information to look for indications of Parkinson's, Alzheimer's, or autism when depression is detected. The patient's medical history and progress are recorded over time, and they are registered for ongoing monitoring and analysis as soon as these problems are reported. Following that, the data is assembled into comprehensive reports that give physicians historical context and the intensity of symptoms, assisting them in making more educated decisions for patient care.

3.2 Component Diagram

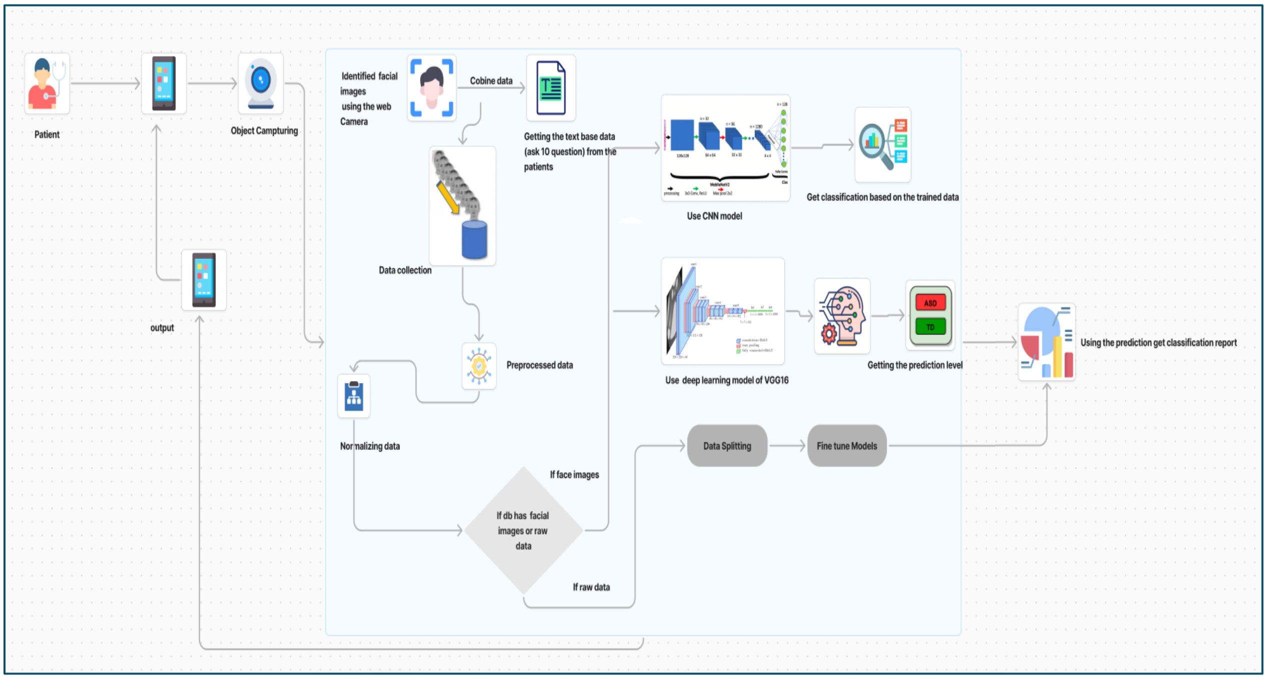

Figure 5.System diagram for detecting autism

Data for this project was gathered from several trustworthy sources, including Keggle, a well-known platform for machine learning and data science datasets. The gathered data consists of both textual and picture-based information. The dataset comprises 5,884 photos in total, which were crucial for examining visual patterns and aspects associated with the research. To supplement the image data, 2,500 text-based data entries were also gathered, offering a thorough understanding of the topic. Through the integration of both forms of data, the research guarantees a strong methodology for pattern identification and analysis, utilizing machine learning techniques to obtain more profound understanding. The models will be trained and validated using this data to improve prediction and diagnostic accuracy.

The first thing a patient needs to do before seeing a doctor is register via the system. To gather real-time visual data, this procedure involves taking pictures of the patient with a webcam. At this point, capturing high-quality images is critical since it supplies vital inputs for later data processing. Taking this first picture aids in building a trustworthy dataset that captures the unique characteristics and facial expressions of the patient. This fundamental stage guarantees that the data utilized in subsequent stages is complete and reliable, which is essential for correct analysis and early detection of autism.

Asking the patient a series of ten questions yields text-based data in addition to face image capture. [6] This dual strategy of merging textual and visual data enhances the dataset and offers a more thorough understanding of the patient's state. The purpose of the questions is to elicit answers that strengthen the dataset by providing an important context for the visual data. Through the integration of many information sources, this combination improves overall analysis and increases the precision and thoroughness of the detection process.

The data must go through an important preparation step after it is gathered. In this stage, any missing values are handled, the data is cleaned to remove noise and extraneous information, and the format of the data is ensured to be consistent and useful. Preprocessing for textual data could comprise tokenization and text cleaning, while for visual data it might involve picture enhancement and normalization. Preparing the data for precise and effective analysis by the machine learning models is the aim of preprocessing. This stage is crucial for dataset optimization, guaranteeing that the analysis that follows will produce insightful findings.
The data is normalized after preprocessing to make sure it adheres to a standard scale. By adjusting the data, normalization ensures that every element contributes equally to the analysis and keeps any one factor from having an outsized impact on the outcomes. This stage guarantees that the models can learn from the data in an efficient manner, which is crucial for increasing the performance and accuracy of the machine learning models. Normalization improves the predictability of the results by balancing the dataset and standardizing the data.

Taking care of the data according to its type is the following stage. The VGG16 deep learning model is applied to facial picture analysis. Convolutional neural networks (CNNs) like VGG16 are well known for their efficiency in image recognition applications. After processing the face photos, this algorithm extracts important characteristics that are necessary for predicting autism. To prepare it for model input, the data that is in a raw (non-image) format goes through some changes. This stage makes sure that every kind of data is handled correctly while utilizing the advantages of the models that are employed [5].Finally, the models produce predictions about the probability of autism after processing the data. A classification report is created from these predictions, offering comprehensive explanations of the model's conclusions. The report assists medical practitioners in formulating sensible intervention plans and making well-informed judgements. This methodology attempts to enhance the early detection of autism, enabling prompt and efficient interventions that can greatly benefit patients. It does this by utilizing sophisticated machine learning models and comprehensive data processing methodologies.

A multimodal fusion strategy is necessary to efficiently merge text-based and image-based data for early autism screening. To improve the machine learning model’s prediction capacity, the fusion model combines data from the two modalities to provide a single, cohesive representation. It is possible to apply methods such as concatenation-based fusion, in which text and picture information are integrated into a single vector and then subjected to neural network processing. Advanced methods, such attention mechanisms, can dynamically modify the weight of each modality's properties, enabling the model to concentrate on the most pertinent information. Current models like as ViLBERT (Vision-and-Language BERT) and CLIP (Contrastive Language-Image

Pre-training) provide strong frameworks for managing multimodal data, making them appropriate for jobs requiring comprehending intricate links between visual and textual information. [18]
The combined data is fed into a model during the training process, and the model learns to predict outcomes, such as an autism diagnosis, based on the combined data. The model's ability to capture complex patterns across modalities is further improved using attention mechanisms and cross-modal transformers. Assuring that the model appropriately balances the contributions of text and image data is another critical function of weight assignment. Need to create a strong system that enhances the precision and breadth of early autism identification by utilizing these methods and models, which will ultimately improve patient outcomes and help clinicians make more educated decisions.

3.3 Project Requirement

3.3.1 Functional Requirements

1. Detecting the facial images
2. Identifying the text base data
3. Getting the prediction level whether having ASD
4. Application loading time and response time need to be minimum

3.3.2 Non-Functional Requirements

1. The application should be reliable.

The system must reliably and consistently produce accurate results. General practitioners can rely on the system's outcomes when it is reliable, especially in urgent circumstances. It should function consistently over time by handling several kinds of data inputs (text-based data and facial photos) without making any mistakes.

2. User-friendly interfaces should be used.

Even users with less technical knowledge should be able to easily navigate and understand the system's interface. To ensure that general practitioners can effectively utilize the system without requiring substantial training or support, accessible features, clear instructions, and simple navigation are crucial.

3. higher outcomes' accuracy.

To reduce negatives false positives , the system needs to analyze and predict data with high accuracy. Because the system's assessments allow practitioners to make well-informed decisions, this precision is essential for the early detection of autism.

4. Interfaces should be User-friendly.

The system must be tuned for rapid processing and reaction times, especially when working with sizable datasets or intricate multimodal analysis. By guaranteeing that general practitioners may receive results quickly, performance efficiency enhances the diagnostic workflow.

3.4 Software Solution

Code accuracy and coherence are ensured via the Software Development Life Cycle (SDLC), an approach that is in organized manner to software development [14]. Software engineers that use the traditional method are unable to go back and modify earlier phases of the process if the project's needs change. Consequently, they must finish all the tasks in the correct order. However, this is not something that the developers are expected to do if the SDLC employs the agile technique. The ability to adapt to shifting conditions is essential for agility. When compared to the other agile frameworks on the list and to other agile frameworks, Scrum is the most effective agile framework. Scrum is an agile project management methodology and is a simple method that could be utilized to handle and finish challenging adaptive jobs [14].

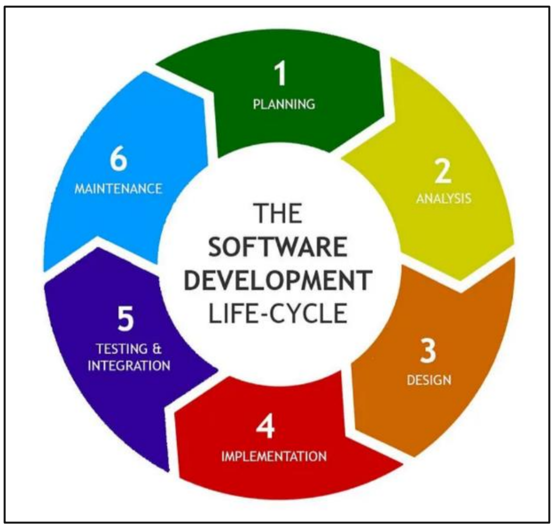

Figure 6.SDLC

3.4.1 Requirement gathering

Conducting survey

Surveys, which take the form of distributing questionnaires to people, are useful for gathering feedback on a range of subjects, inscriptions, and other data.

1. **Data gathering**

Find trustworthy sources of information, including books, websites, and scholarly journals. Visit the archaeological sites to learn more about the inscription directly from the source. Visit these sites to learn more about the inscriptions and to see pictures of the letters there.

2. **Collecting Information**

Our goal in this project is to gather and examine face image data related to autism spectrum disorder (ASD) using publicly accessible datasets from websites such as Keggle. To ensure the accuracy and applicability of the findings, these photos will be confirmed using face data unique to ASD that was gathered at Ragama Hospital. We want to improve the early diagnosis of autism by merging multiple data sources and doing a thorough examination of facial traits linked to ASD. To build a more durable and trustworthy detection system, this method incorporates real-world medical data in addition to making use of already-existing resources.

3.4.1 Feasibility study (Planning)

1. **Economic viability**: The evaluation of economic viability considers both the advantages, and the costs related to the project's development. A thorough plan for a technique's economic viability must be included, or else the operation is likely to fail. This means that the method that was suggested must be more economical as well as efficient.

2. **Scheduled feasibility**: If a scheduled feasibility study is not finished by the deadline, the project will not succeed in reaching its objective, therefore its impact will be felt right away. A timeline feasibility study is used to establish project timelines. This means that the suggested system ought to be able to finish each work in the allotted time.

3. **Technical feasibility**: To evaluate the knowledge and abilities needed to develop mobile and web applications, as well as the capacity to comprehend software designs and the communication skills required to successfully gather stakeholder feedback, planning for technical feasibility is necessary. To assess the ability to comprehend software ideas, it is also critical to consider technical feasibility.

3.4.2 Design (system and software design documents)

After the planning stage, system and software design documents are created, which complement the overall system diagram.

3.4.3 Dataset

Visit a website related to mental disorders in the field of autistic disorder and acquire pictures of the inscription and the meanings behind the characters.

3.4.4 Implementation

The functions must be created in accordance with the methodology to satisfy user needs and produce an end solution characterized by high accuracy and dependability.

- An identification system that is mobile-based and cross-platform is implemented using Expo and React Native.

- Putting into practice a model based on facial image detection.
- An application of variable/facts linked to ASD disorder identification.
- Application to obtain potential using these models.

3.4.5 Testing

Assessing the models' accuracy

• 70% of the data from the dataset was used to train the model.

• 15% of the data is got from the dataset and used to validate the model.

• 15% of data getting from the dataset's was used to test the model.

Testing the application in accordance with the testing phases, including user, acceptability testing, integration testing ,system testing, and unit testing

3.4.6 Software Specifications

Facilities:

1. A high-performance computing system with GPU capabilities is essential for training and testing a machine learning model to detect and classify facial images in real-time.

2. An efficient ML platform is required for processing ,managing and analyzing collected facial datasets.

Personal Support:

1. Supervisors with expertise in both ML and NLP to give guidance and feedback on the research, evaluation and implementation.
2. General practitioners with experience in detection asd in early stage and provide expert opinions on the effectiveness of the proposed ML-based detection and analyzation approach.

Purpose	Tools & Technologies
Model Building	Python 3.x (TensorFlow,PyTorch)
Mobile App Development	Flutter,React Native
Data Storing	MySQL
IDEs	IntelliJ IDEA, Jupyter Lab ,google Colab
Version Controlling	GitHub
Image Processing	VGG16,OpenCV
Data Processing	Pandas,NumPy

Table 2.Tools & Technologies

4.0 BUDGET AND BUDGET JUSTIFICATION

The following table represents the budget for the proposed system.

Component	Est.Amount in USD	Est.Amount in LKR
Charges for Tools for Research(Cloud Services, Grammarly, etc.)	31.37	10,000.00
Data Collection through open sources	6.77	2000.00
Cloud Platforms(AWS,GCP,OpenAI key)	40.00	13,000.00
Total	78.14	25,000.00

Table 3.Expenses for the proposed system

5.0 Contribution to the Domain / Commercialization

Mental health disorders affect a significant portion of the global population, making this a large and critical market to address. Traditional methods of diagnosing and managing mental disorders involve in-person consultations, which can be time-consuming and costly for patients. Our solution aims to bridge this gap by providing a convenient and cost-effective tool for diagnosing and managing depression through a mobile application. This approach not only reduces the challenges associated with traditional healthcare methods but also offers continuous monitoring and personalized insights.

We plan to introduce multiple subscription plans for different user segments:

- Monthly Subscription: Rs. 500
- Annual Subscription: Rs. 4,500

Our Target Market is General Practitioners of the MOH centers, Institutes who learn about mental disorders, General population who wish to take self-mental care. We will offer the initial depression diagnosis feature free of charge, allowing users to assess their mental health at no cost. However, to access more detailed reports, continuous monitoring, and personalized treatment plans, users will need to subscribe to one of the available plans. This model ensures accessibility while also generating revenue to sustain and enhance the platform. By offering flexible pricing and targeting a wide range of users, including partnerships with community clinics, we aim to create a scalable and impactful solution in the mental health space, addressing a critical global need.

References

[1] "Autism spectrum disorder," [Online]. Available: https://www.mayoclinic.org/diseases-conditions/autism-spectrum-disorder/symptoms-causes/syc-20352928.

[2] "Autism Spectrum Disorder (ASD)," [Online]. Available: https://www.cdc.gov/autism/signs-symptoms/?CDC_AAref_Val=https://www.cdc.gov/ncbddd/autism/signs.html.

[3] R. Muhle, S. V. T. and . I. R. , "The genetics of autism," *Pediatrics,* vol. 113, no. 5, pp. e472-e486, 2004.

[4] M. S. Anwar, M. T. K. N. and M. R. K. , "Knowledge, awareness, and perceptions regarding autism among parents in Karachi, Pakistan," *Cureus,* vol. 10, p. 9, 2018.

[5] M. A. S. M. N. M. F. A. M. I. P. a. M. A. R. A. M. Z. Uddin, "Deep learning with image-based autism spectrum disorder analysis: A systematic review," *Engineering Applications of Artificial Intelligence,* vol. 127, p. 107185, 2024.

[6] P. S. D. B. S. R. U. K. M. I. A. a. B. S. R. A. Rasul, "An evaluation of machine learning approaches for early diagnosis of autism spectrum disorder," *Healthcare Analytics,* vol. 5, p. 100293, 2024.

[7] A. R. a. S. Shaker, "Autism spectrum disorder detection using face features based on deep neural network," *Wasit Journal of Computer and Mathematics Sciences,* vol. 2, no. 1, pp. 74-83, 2023.

[8] J. L. Taylor, N. A. Henninger and M. R. Mailick, "Longitudinal patterns of employment and postsecondary education for adults with autism and average-range IQ," *Autism,* vol. 19, no. 7, pp. 785-793, 2015.

[9] K. Järbrink and M. Knapp, "The economic impact of autism in Britain," *Autism,* vol. 5, no. 1, pp. 7-22, 2001.

[10] S. W. W. a. B. A. W. (. T. H. Ollendick, "The Oxford handbook of clinical child and adolescent psychology," *Oxford Library of Psychology,* 2018.

[11] T. Vargason, G. Grivas, K. L. Hollowood-Jones and J. Hahn, "Towards a multivariate biomarker-based diagnosis of autism spectrum disorder: Review and discussion of recent advancements," *Seminars in Pediatric Neurology,* vol. 34, p. 100803, 2020.

[12] D. A. R. L. L. W. M. G. L. Z. e. a. R. Grzadzinski, "Pre-symptomatic intervention for autism spectrum disorder (ASD): defining a research agenda," *Journal of Neurodevelopmental Disorders,* vol. 13, pp. 1-23, 2021.

[13] O. L. U. R. C. M. S. S. S. M. a. R. A. R. M. M. Rahman, "A review of machine learning methods of feature selection and classification for autism spectrum disorder," *Brain sciences,* vol. 10, no. 12, p. 949, 2020.

[14] K. B. C. a. R. K. Heaton, "Neuropsychological assessment: Past and future," *Journal of the International Neuropsychological Society,* vol. 23, no. 10, pp. 778-790, 2017.

[15] R. Mahajan and S. H. Mostofsky, "Neuroimaging endophenotypes in autism spectrum disorder," *CNS Spectrums,* vol. 20, no. 4, pp. 412-426, 2015.

[16] N. P. P. S. C. V. A. K. M. V. a. D. P. W. P. Washington, "Data-driven diagnostics and the potential of mobile artificial intelligence for digital therapeutic phenotyping in computational psychiatry," *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging,* vol. 5, no. 8, pp. 759-769, 2020.

[17] W. Z. Q. Q. a. X. L. X. Liu, "A Survey on Autism Care, Diagnosis, and Intervention Based on Mobile Apps: Focusing on Usability and Software Design," *Sensors,* vol. 23, no. 14, p. 6260, 2023.

[18] K. Barik, W. K. B. J. and S. G. , "A fusion-based machine learning approach for autism detection in young children using magnetoencephalography signals," *Journal of Autism and Developmental Disorders,* vol. 53, no. 12, pp. 4830-4848, 2023.

[19] K. K. Miller, "The autism paradox," *AMA Journal of Ethics,* vol. 17, no. 4, pp. 297-298, 2015.

[20] G. Vivanti, M. Prior, K. Williams and C. Dissanayake, "Predictors of outcomes in autism early intervention: why don't we know more?," *Frontiers in Pediatrics,* vol. 2, p. 58, 2014.

[22] S. M. K. a. J. M. B. T. C. McFayden, "Echolalia from a transdiagnostic perspective," *Autism & Developmental Language Impairments,* vol. 7, p. 23969415221140464, 2022.

APPENDICES

Figure 7.Application Logo

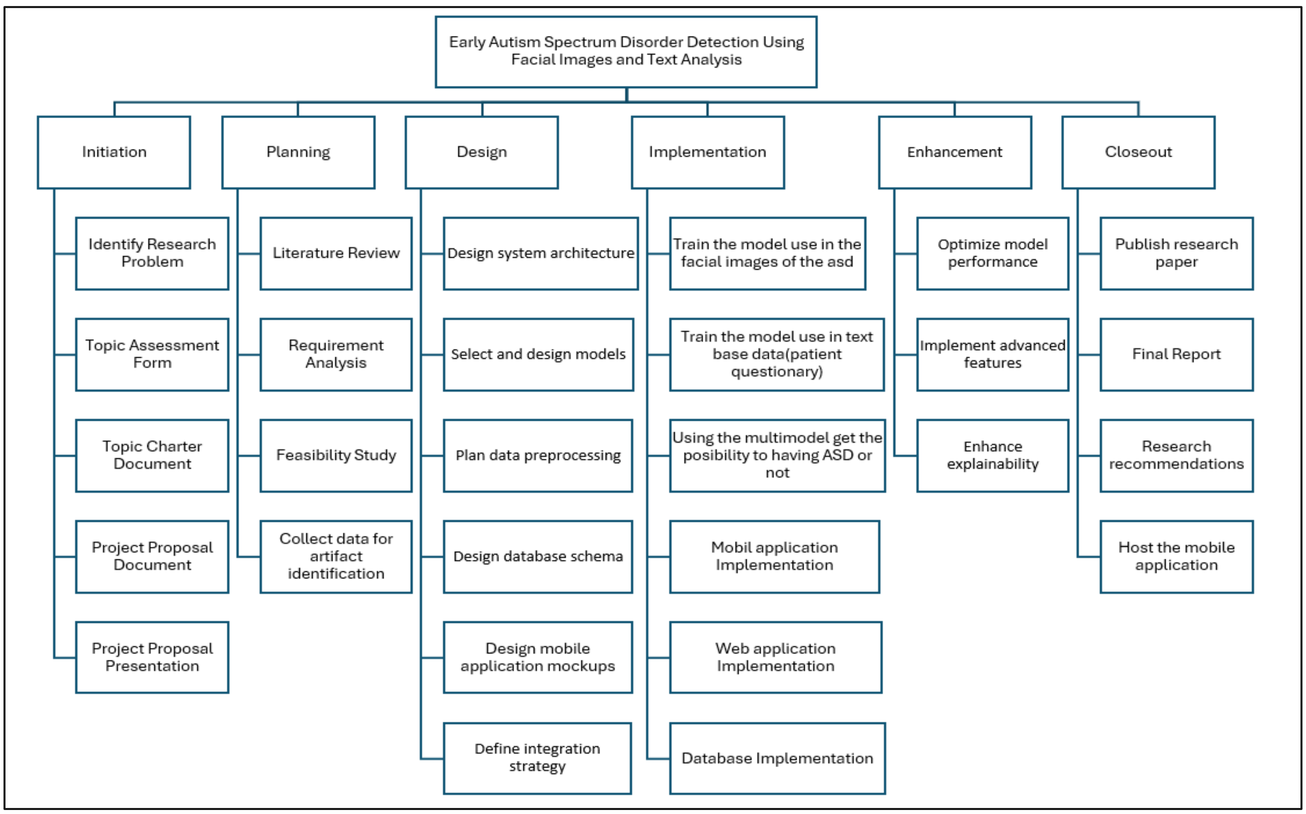

Figure 8.Work Breakdown Chart

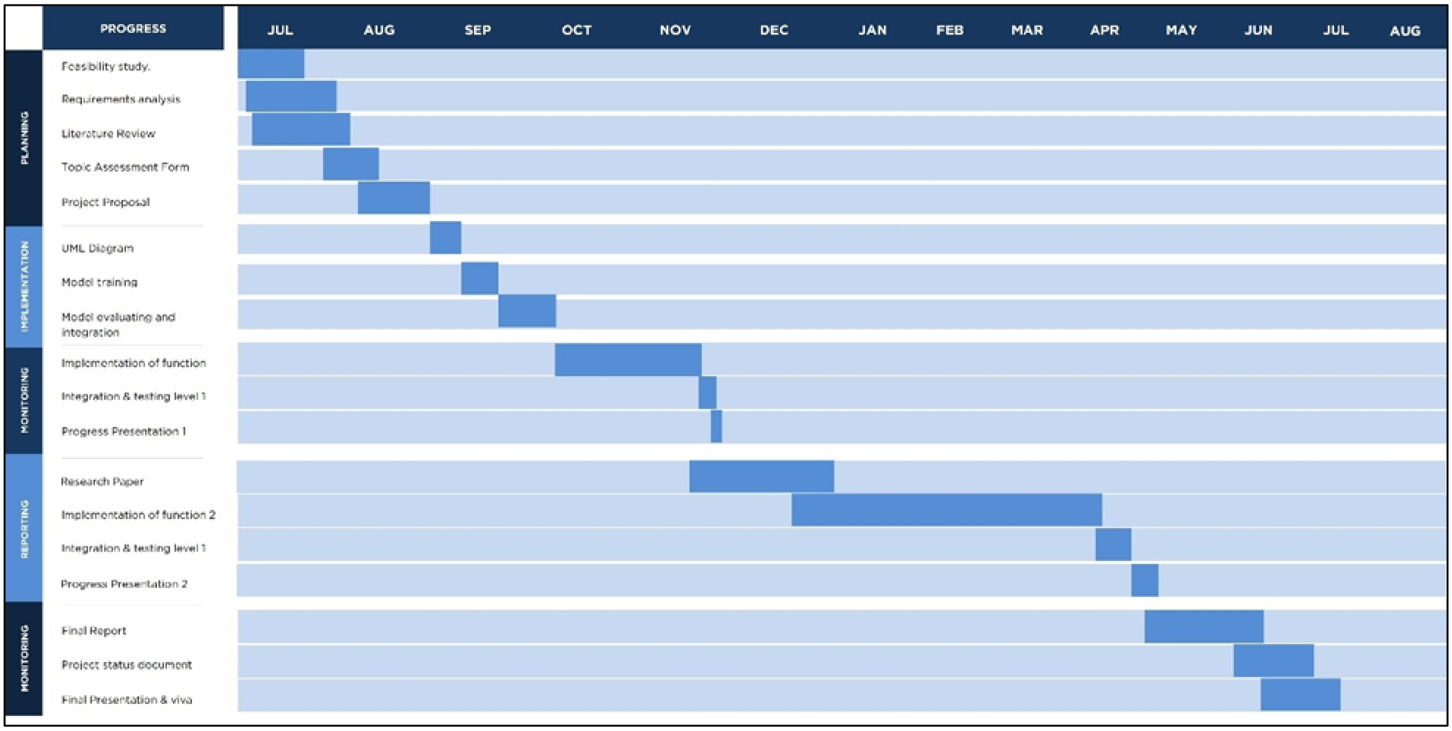

Figure 9.Grant Chart

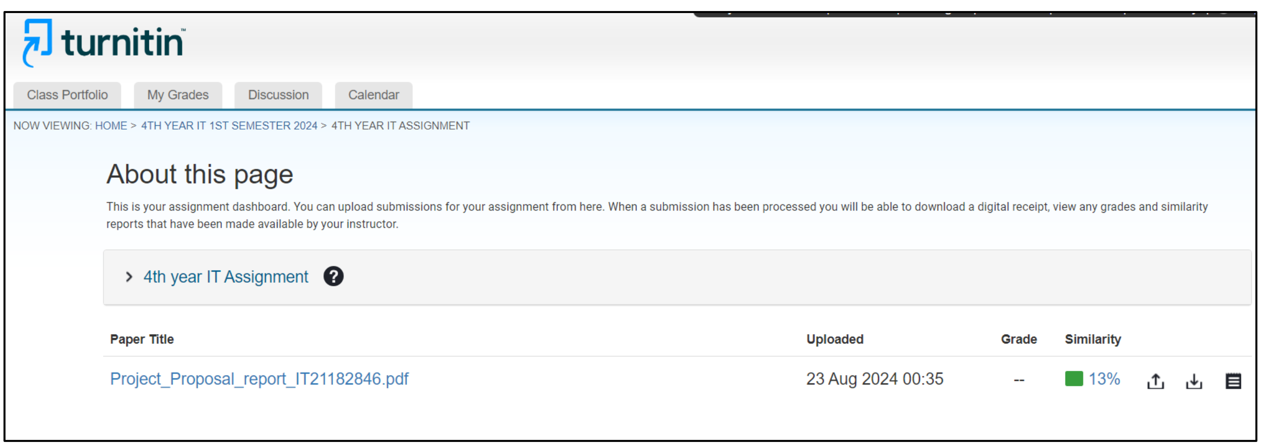

Figure 10.Similarity report check use in turnitin