TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

SAGARMATHA ENGINEERING COLLEGE

A

PROGRESS REPORT

ON

AI-BASED ASD SCREENING WEBSITE: ENHANCING EARLY DIAGNOSIS AND INTERVENTION

BY

ARUN SINGH NEPALI SEC076BCT012

NISTHA THAPA SEC076BCT027

PRATIMA PANDE SEC076BCT031

SUMESH SHRESTHA SEC076BCT044

A PROGRESS REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR IN COMPUTER/ELECTRONICS ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

SANEPA, LALITPUR, NEPAL

AUGUST, 2023

ABSTRACT

Autism Spectrum Disorder (ASD) is a complex neuro-developmental condition that has a global impact. Early detection and timely intervention are essential for improving outcomes in individuals with ASD. This proposal presents the development of an AI-based Autism Detection Website, utilizing artificial intelligence to aid ASD diagnosis and enhance intervention accessibility.

Our project aims to utilize machine learning algorithms to detect ASD patterns by analyzing data inputs such as video footages and questionnaires/surveys. By training the machine learning models on data-sets including video footages of both ASD and non-ASD children, the algorithms can identify distinguishable traits such as limited eye contact and excessive blinking. The proposed website will provide a user-friendly platform for uploading video footage and completing assessments. Integrating machine learning models will provide aid in initial screening and assist healthcare professionals in making more accurate diagnose.

The successful implementation of this project has the potential to significantly impact the lives of individuals with ASD and their families by promoting early detection and timely interventions. By harnessing the power of AI, the goal is to enhance the screening process, improve outcomes, and contribute to a more inclusive and understanding society.

Keywords: Autism, ASD, AI, Python, TensorFlow, PyTorch

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ADHD	Attention Deficit Hyperactivity Disorder
ASD	Autism Spectrum Disorder
ASQ	Ages and Stages Questionnaire
CNN	Convolutional Neural Network
ML	Machine Learning
OCD	Obsessive-Compulsive Disorder
Q-CHAT	Quantitative Checklist for Autism in Toddlers
SDG	Sustainable Development Goal
UI	User Interface

CHAPTER 1

INTRODUCTION

1.1 Background

ASD is a neurological disorder characterized by challenges in social interaction, communication, and restricted and repetitive behaviors. Despite being a recognized neuro-developmental condition, it is often accompanied by societal stigmas and misconceptions. These misunderstandings can lead to the marginalization and exclusion of individuals with ASD, hindering their opportunities for growth and development. It is crucial to address the stigma associated with them and highlight the diverse abilities and strengths that they possess. People with ASD may exhibit exceptional talents and unique cognitive abilities as some of them may have hyper-sensory development, enabling them to excel in specific areas or demonstrate extraordinary skills. Recognizing and nurturing these talents and also rehabilitating affected individuals in a vulnerable state, can not only enhance their quality of life but also contribute to society in meaningful ways.

However, it is important to acknowledge that ASD can manifest in various degrees of severity, and individuals affected by it may require specialized support and interventions. Early identification and appropriate rehabilitation and treatment play a vital role in optimizing outcomes for these individuals. Realizing this need, we bring forward a solution- by leveraging AI-based tools and machine learning algorithms, this project aims to aid in ASD detection, enabling timely access to tailored interventions. Furthermore, by emphasizing the importance of comprehensive rehabilitation and treatment, the project aims to enhance the understanding and acceptance of ASD in society, challenging the prevailing stigma.

1.2 Problem Definition

ASD encompasses a range of symptoms and varying degrees of severity, making early recognition and diagnosis complex. Without timely identification, individuals with ASD may encounter difficulties in areas such as social interactions, communication and sensory sensitivities. These challenges can have a significant impact on their well-being, education, employment prospects, and overall quality of life. Accurate diagnosis is essential in facilitating early intervention and providing tailored support for these individuals. Early detection of ASD in individuals enable the implementation of targeted interventions and therapies as per their needs.

Relying on just the subjective assessments made by healthcare professionals can lead to the absence of prompt diagnosis and consequent delay in receiving suitable treatment, which prolongs the challenges encountered by individuals with ASD, impeding their development and potential for favorable results. Early detection plays a vital role in effective rehabilitation, and losing its window can prove a major drawback. Moreover, the postponed availability of intervention services places an additional burden on families and caregivers, who may experience heightened stress and difficulties in attending to the distinct requirements of their loved ones with ASD.

To overcome these limitations and improve the accuracy and efficiency of autism detection, this project aims to develop an AI-based system that can automatically identify potential indicators of autism in individuals. By leveraging machine learning, computer vision, and neural network algorithms, we seek to create a reliable and scalable solution that can assist healthcare professionals, parents, and caregivers in the early identification of autism.

1.3 Objectives

To develop an AI-based ASD screening tool to aid early diagnosis using vision transformer.

1.4 Features

The features of our project are as follows:

- AI-Based Autism Screening: The project revolves around the development of an AI-based Autism Screening Website, utilizing artificial intelligence to aid in the diagnosis of Autism Spectrum Disorder (ASD) and enhance accessibility to interventions.
- Machine Learning Algorithms: The project aims to utilize machine learning algorithms to detect patterns indicative of ASD by analyzing training the models on data-sets comprising video footage of both ASD and non-ASD, and questionnaires/surveys.
- Video Analysis: The website includes a key feature of video analysis, enabling the AI system to identify distinguishing traits associated with ASD, such as limited eye contact and excessive eye blinking.
- Aid in Initial Screening: By integrating machine learning models, the website aims to aid in the initial screening process for ASD. It assists healthcare professionals in making more accurate diagnoses by providing them with additional insights and information.

1.5 Feasibility

1.5.1 Technical Feasibility

The proposed AI-based Autism Detection Website demonstrates promising technical feasibility. The project's primary objective is to leverage machine learning algorithms, specifically those specializing in video analysis and data inputs such as questionnaires and surveys, to identify patterns indicative of Autism Spectrum Disorder (ASD). The availability of machine learning libraries and frameworks like TensorFlow and PyTorch further supports the feasibility of algorithm implementation. Additionally, the project necessitates proficiency in Python, a widely-used programming language within the machine learning domain. These factors collectively suggest that the project is technically feasible and can be successfully executed.

1.5.2 Operational Feasibility

The operational feasibility of the proposed Autism Detection Website hinges on several critical factors. Foremost, successful implementation necessitates close collaboration with healthcare professionals and individuals capable of providing video footage and completing assessments. This will require establishing strategic partnerships with medical institutions, clinics, and families of both ASD and non-ASD children to ensure the availability of diverse and relevant data. Moreover, the website's usability is paramount, with a user-friendly interface facilitating seamless video uploading and assessment completion. The operational feasibility of the project depends on the efficient acquisition of requisite data inputs and the assurance of a streamlined user experience at every stage of the process.

1.5.3 Legal Feasibility

The development and implementation of the AI-based Autism Detection Website entail several legal considerations that must be addressed. Compliance with privacy and data protection regulations is imperative when collecting, storing, and processing personal information, particularly when involving children. Strict adherence to obtaining consent from individuals and their legal guardians is mandatory before utilizing their data for research purposes. It is essential to ensure full compliance with relevant healthcare regulations and standards to guarantee the legal validity of the website and its diagnostic functionalities. By diligently addressing these legal concerns, the proposed project will operate within the bounds of the law, safeguarding the privacy and rights of the individuals involved.

1.5.4 Time Feasibility

The time feasibility of the project is contingent upon several factors, encompassing resource availability, expertise, and data collection efforts. The development and training of machine learning models can be a time-intensive endeavor, particularly when dealing with extensive data-sets. Furthermore, the project encompasses various tasks, including data pre-processing, programming, user interface development, and meticulous quality assurance testing. The timeline for accomplishing these tasks will rely on factors such as the scale and intricacy of the project, the accessibility of proficient professionals, and the efficiency of the development process. By considering these aspects, a realistic timeframe can be established to ensure the project's timely execution.

1.5.5 Economic Feasibility

The economic feasibility of the project encompasses several crucial considerations, including development costs, maintenance expenses, and potential scalability. Successful implementation will necessitate financial investments in expertise related to programming languages and machine learning, as well as the required infrastructure. Costs may also arise from data collection efforts and establishing partnerships with medical institutions or organizations. Furthermore, it is important to account for ongoing maintenance and updates to the website and its algorithms. The economic feasibility of the project will depend on the availability of funding or resources to support its development and long-term sustainability. By securing the necessary financial support, the project can be executed effectively, ensuring its economic viability.

1.6 System Requirements

The system requirements of our project are:

1.6.1 Software Requirements

The software requirements for our project are as follows:

(a) Development Tools: Visual Studio Code

(b) Web Browser: Google Chrome

(c) Version Control System: Git

(d) Programming Languages: Python

(e) Computer Vision Libraries: OpenCV, TensorFlow, PyTorch

(f) User Interface and Graphics Design Tool: Figma, Adobe XD, Adobe Photoshop

(g) Debugging and Testing: Espresso

1.6.2 Hardware Requirements

The hardware requirements for our project are as follows:

(a) PC with compatible processing power

(b) High quality camera that can capture detailed video footage of user's face and eye

(c) Reliable network connectivity, either through Wi-Fi or ethernet

(d) To train the model:

  (a) GPU requirements: A powerful GPU is essential for training and running deep learning models, at least 8GB Virtual RAM

  (b) RAM: At least 16GB of RAM, but 32GB or more is ideal.

  (c) CPU: A powerful CPU will also help to speed up the training and inference of the model. A good option would be an Intel Core i7 or i9 processor.

  (d) Storage: The project will need a large amount of storage space for your dataset and model files. A minimum of 1TB of storage

1.6.3 Functional Requirements

FR 1) Eye Blink Detection: The model should accurately detect and analyze eye blinks in real-time or from recorded video input.

FR 2) Eye Contact Analysis: The model should be able to assess eye contact, such as the duration and frequency of eye contact during specific tasks or interactions.

FR 3) Autism Screening Algorithm: The model should incorporate an algorithm that utilizes the eye blink and eye contact data to assess the likelihood of autism.

FR 4) User Interface: Develop a user-friendly interface that allows users to interact with the model, input video data, and view the results of the autism screening.

FR 5) Performance and Accuracy: The model should provide accurate and reliable results, achieving a high level of precision and recall in autism screening.

FR 6) Scalability: The model should be designed to handle a large volume of video data efficiently to support screening for a significant number of individuals.

FR 7) Autism Spectrum Quotient: The model should initially display ASQ questionnaires and the user must be able to answer the questions via the interface and thus the model should also predict autism accordingly.

1.6.4 Non-functional Requirements

NFR 1) Real-Time Processing: The model should process eye blink and eye contact data in real-time, allowing for immediate feedback and screening results.

NFR 2) Privacy and Data Security: Ensure that the collected video data is handled securely and in compliance with privacy regulations to protect the confidentiality of individuals being screened.

NFR 3) Robustness: The model should be able to handle variations in lighting conditions, different camera qualities, and potential occlusions or distractions in the video input.

NFR 4) Compatibility: Ensure that the model can work with a range of hardware and operating systems to maximize accessibility and usability.

NFR 5) Training and Updates: Allow for the model to be regularly updated and improved using additional training data or fine-tuning techniques to enhance its performance over time.

NFR 6) Ethical Considerations: Ensure that the development and deployment of the model consider ethical considerations, such as fairness, bias, and the impact on individuals being screened.

NFR 7) User Friendly Interface: The model should be user friendly, easy to use and understand bring abstractions to the complex working mechanism of ML model.

CHAPTER 2

LITERATURE REVIEW

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by challenges in social interaction, communication, and restricted and repetitive behaviors. Early detection and intervention are crucial for improving outcomes for individuals with ASD. Computer vision techniques offer a promising avenue for automating the screening process, particularly through the analysis of eye blinks and eye contact, which are known to be potential indicators of autism. This literature review examines the current state of research on computer vision-based screening of autism, highlighting studies conducted in various countries, including Nepal.

Several projects have explored the use of computer vision for autism screening by analyzing eye blink patterns. For example, Goldberg et al. (1987) found that children with ASD had higher blink rates than children without ASD and by this inspiration Eye Blink Analysis for Autism Spectrum Disorder (EBAAS) model[3] was developed by researchers at the University of California, San Diego. The EBAAS model uses machine learning to analyze eye blinking patterns and identify potential signs of ASD. In the context of eye contact analysis, studies have utilized computer vision techniques to quantify and analyze gaze behavior. Ahmed et al. (2022)[4] developed an eye-tracking system that recorded and analyzed eye contact during social interactions. Their findings showed significant differences in eye contact patterns between individuals with autism and neurotypical individuals.

While computer vision-based approaches show promise in autism screening, several challenges and limitations persist. Variability in eye blink and eye contact patterns within the autism spectrum poses a challenge for accurate detection. Furthermore, the collection of large and diverse datasets, along with the need for robust machine learning algorithms, presents additional hurdles.

In the context of Nepal, limited research has been conducted on computer vision-based screening for autism. Given the unique cultural context and resource constraints, developing an autism screening model specific to Nepal is crucial. Our preliminary findings from our visit to Autism Center, Harisiddhi[5] showed that the autism detection is still manual and might span from 2 hours to even a month. The symptoms varies from person to person and there is still no such dedicated diagnosis technique, the scope of generalization is vague and we can just account by the most common symptoms which is the behavioral patterns. The closest research resembling to our objective is the eye blink pattern which is also done manually till date in context of Nepal. Future research could focus on collecting a representative dataset of eye blink and eye contact data from Nepalese individuals with autism. Additionally, efforts to adapt existing computer vision techniques to the Nepalese population would enhance the accuracy and reliability of the screening model.

In conclusion, computer vision-based screening of autism holds great potential for early detection and intervention. Studies conducted in various countries have demonstrated the efficacy of analyzing eye blink and eye contact patterns in autism classification. However, further research is required to address the challenges of variability within the autism spectrum and cultural considerations. In the context of Nepal, there is a need for tailored research efforts to develop an accurate and culturally appropriate screening model.

CHAPTER 3

RELATED THEORY

3.1 Autism Spectrum Disorder (ASD)

Autism spectrum disorder (ASD) is a neuro-developmental disability caused by differences in the brain. People with ASD often have problems with social communication and interaction, and restricted or repetitive behaviors or interests. People with ASD may also have different ways of learning, moving, or paying attention.

ASD is called a spectrum because it encompasses a wide range of symptoms, characteristics, and levels of impairment that can vary greatly from person to person. The term "spectrum" emphasizes the idea that autism is not a single condition with a fixed set of traits, but rather a diverse set of conditions that share certain core features.

While autism affects different people differently and the degree and nature of effect can vary significantly, here are some common areas in which autism can have a significant impact on:

1. Social Interaction: Challenges in understanding and interpreting social cues, maintaining eye contact, initiating and sustaining conversations, and developing peer relationships.

2. Sensory Sensitivities: Extreme sensitivity (hyper-sensitive or hypo-sensitive) to certain sensory stimuli such as light, tastes, smells, textures, etc.

3. Communication: Experiencing difficulties in verbal and nonverbal communication due to delayed speech or language development, limited vocabulary, difficulties in understanding and using gestures or facial expressions.

4. Restricted and Repetitive Behaviors: Engagement in repetitive behaviors or having highly focused interests. Manifestation of repetitive movements (e.g., hand-flapping), adherence to strict routines or rituals, intense preoccupation

with specific topics, or an insistence on sameness.

5. Mental Health and Co-occurring Conditions: Higher likelihood of experiencing mental health challenges such as anxiety, depression, ADHD, or OCD. Co-occurring conditions are common and can further impact an individual's overall well-being.

3.2 Q-CHAT

The Quantitative Checklist for Autism in Toddlers (Q-CHAT) is one of the most commonly used screening tool for autism spectrum disorder (ASD). It consists of parent-report questionnaires that ask questions about a child's development and behaviours in different areas, such as communication, social skills, and daily activities Q-CHAT measures risk of autism in toddlers (18 months- 3 years) but does not actually diagnose a child with autism. It is scored out of 100 points. The closer you get to 100, the higher the risk of autism. For reference, the average score for boys is 28, and for girls is 26. The average score for children with a diagnosis of autism is 52.

Q-CHAT is relatively quick and easy to administer, and can be completed by parents, guardians or caregivers at home, and the results can also be scored online. If a child score falls under the "red zone" on this screening tool, it is recommended that they be referred for further evaluation by a healthcare professional.

3.3 Artificial Intelligence

Artificial intelligence (AI) is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment. AI research has been highly successful in developing effective techniques for solving a wide range of problems, from game playing to medical diagnosis. Some sub-fields of AI are:

1. Natural Language Processing (NLP): This is the ability of a computer to understand and process human language. NLP is used in a variety

of applications, such as speech recognition, machine translation, and text analysis.

2. Machine learning (ML): This is the ability of a computer to learn from data. ML is used in a variety of applications, such as spam filtering, fraud detection, and product recommendations.

3. Computer vision (CV): This is the ability of a computer to see and understand the world around it. CV is used in a variety of applications, such as self-driving cars, facial recognition, and medical image analysis.

3.4 Computer Vision

Computer vision is a field of artificial intelligence that deals with the extraction of meaningful information from digital images or videos. It is a complex field, and there are many different techniques that can be used to identify and extract required and relevant information from these media, some of them are:

1. Image processing: This involves transforming images in order to enhance their features or make them easier to analyze.

2. Machine learning: This involves training computers to learn how to identify objects or patterns in images.

3. Deep learning: This is a type of machine learning that uses artificial neural networks to learn from data.

Computer vision has a wide range of applications including facial recognition, self driving cars, medical analysis and diagnosis, 3D reconstruction, etc.

3.5 Machine Learning

Machine learning is a field of artificial intelligence (AI) that allows computers to learn without being explicitly programmed. Machine learning algorithms use data to learn how to perform tasks such as classification, prediction, and clustering. ML algorithms are mathematical models that uses different data-sets in the form of text, audio, images and videos, in order to help the machine to learn, improving its performance in each iteration.

ML algorithms can be used to perform a variety of tasks like:

1. Classification: This is the task of assigning a label to an input. For example, a machine learning algorithm could be used to classify images as either cats or dogs.

2. Prediction: This is the task of predicting a future value based on past data. For example, a machine learning algorithm could be used to predict the weather or the stock market.

3. Clustering: This is the task of grouping similar data together. For example, a machine learning algorithm could be used to group customers together based on their buying behavior.

Some of the exciting applications of ML technology are fraud detection, spam filtering, medical diagnosis, self-driving cars, recommendation systems, etc.

3.6 Ordinal Regression

Ordinal regression is a statistical technique used for analyzing relationships between a set of independent variables and an ordinal dependent variable. An ordinal variable is one that has categories with a meaningful order but lacks a consistent unit of measurement, such as Likert scale ratings (e.g., strongly disagree, disagree, neutral, agree, strongly agree) or educational levels (e.g., high school, bachelor's degree, master's degree, PhD).

The primary aim of ordinal regression is to estimate the parameters of the model, understand the relationships between the independent variables and the odds of the ordinal categories, and make predictions about the likelihood of an observation falling into a particular category. This technique is commonly used in various fields, including social sciences, psychology, economics, and epidemiology, where researchers often deal with ordinal outcome variables that can't be treated as continuous.

In the context of our project, we intend to use ordinal regression for analyzing the survey answers, which are in the form of "always / usually / sometimes / rarely / never", varied relatively to the question's context. This analysis can help interpret the risk of autism, based on the filled answers.

3.7 Vision Transformer

Vision Transformer (ViT) is a type of artificial neural network that is used for image recognition. ViT is based on the transformer architecture, which was originally developed for natural language processing tasks. However, ViT can be used to process images by treating them as sequences of tokens.

Working Mechanism of ViT:

1. Image to Tokens: The first step is to convert the image into a sequence of tokens. This is done by dividing the image into a grid of patches, and then assigning each patch a unique token.

2. Transformer Encoder: The next step is to feed the sequence of tokens to a Transformer encoder. The Transformer encoder is a stack of self-attention layers, which allow the model to learn relationships between different parts of the image.

3. Classification: The final step is to classify the image by feeding the output of the Transformer encoder to a linear layer. The linear layer outputs a probability distribution over the different classes, and the class with the highest probability is the predicted class.

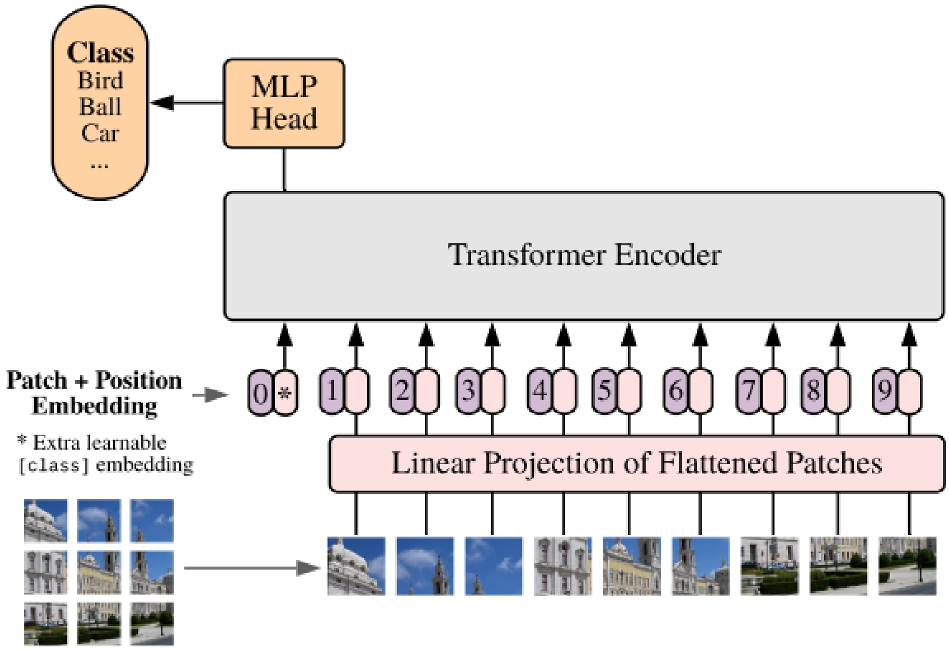

Figure 3.1: Working Mechanism of Vision Transformer [1]

ViT has been shown to be very effective for image recognition tasks. In fact, ViT has surpassed the performance of traditional convolutional neural networks (CNNs) on some tasks. ViT is still a relatively new architecture, but it has the potential to revolutionize the field of computer vision.

CHAPTER 4

METHODOLOGY

4.1 Software Development Methodology

Iterative software development methodology is a software development life cycle (SDLC) approach in which initial development work is carried out based on well-stated basic requirements, and successive enhancements are added to this base piece of software through iterations until the final system is built.

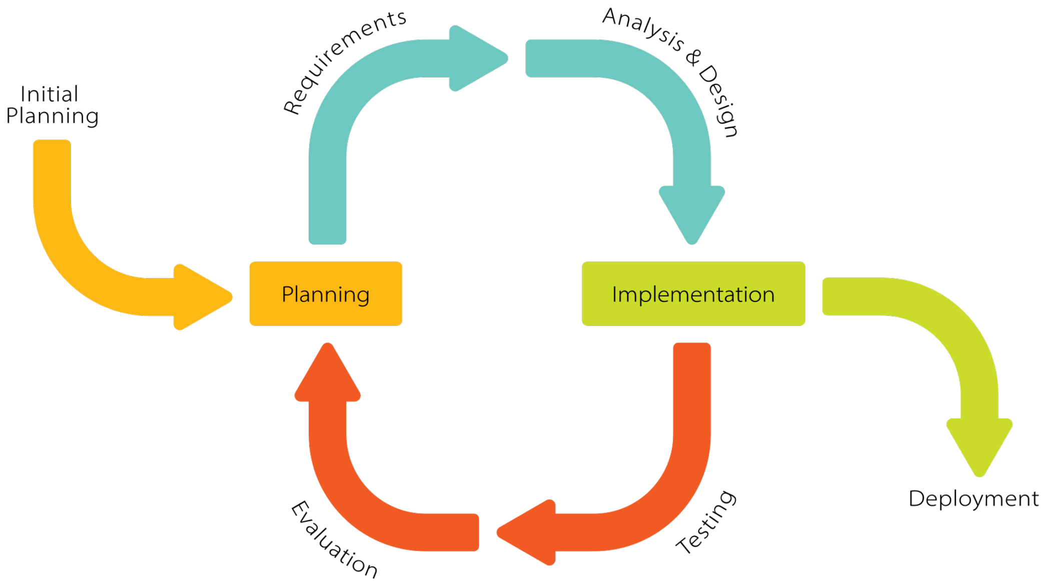

Figure 4.1: Iterative Software Development Methodology [2]

Our project, being AI-based, requires continuous training, testing and adjustments, with new data sources to improve performance. ML project like ours requires high flexibility, responsiveness and adaptability to changes, thus iterative methodology provides just that. This methodology is way better for AI-based software as it allows for continuous improvement and refinement of the model, and also through incorporation of feedback from users and experts into the model, we can improve it's accuracy in an iterative fashion.

4.2 SYSTEM BLOCK DIAGRAM

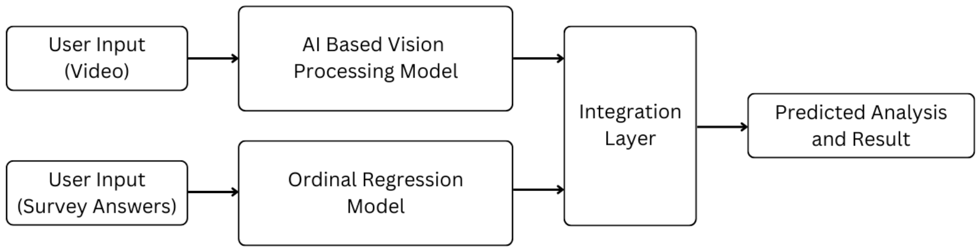

Figure 4.2: System Block Diagram of AI-Based ASD Screening Website

1. User Inputs: The user uploads relevant videos of suspected individual's eye behaviour as well as fills out the questionnaires/surveys as input to the model.

2. AI-based Vision Processing Model: An AI based model is then used to pre-process the video, analyze and identify any distinguishable traits.

3. Ordinal Regression Model: The ordinal regression model is a statistical tool that helps us understand and predict how different factors (independent variables) influence the likelihood of an event falling into a specific ordered category or level (ordinal outcome variable).

4. Integration Layer: This layer uses ensemble modeling technique to essentially combine the results of these two models, evaluate and refine them in order to produce the best result.

5. Predicted Result and Analysis: Using the output provided by the models, the user can predict the risk of probability of autism in the suspected individual, and the model will suggest for further diagnosis.

4.3 USE CASE DIAGRAM

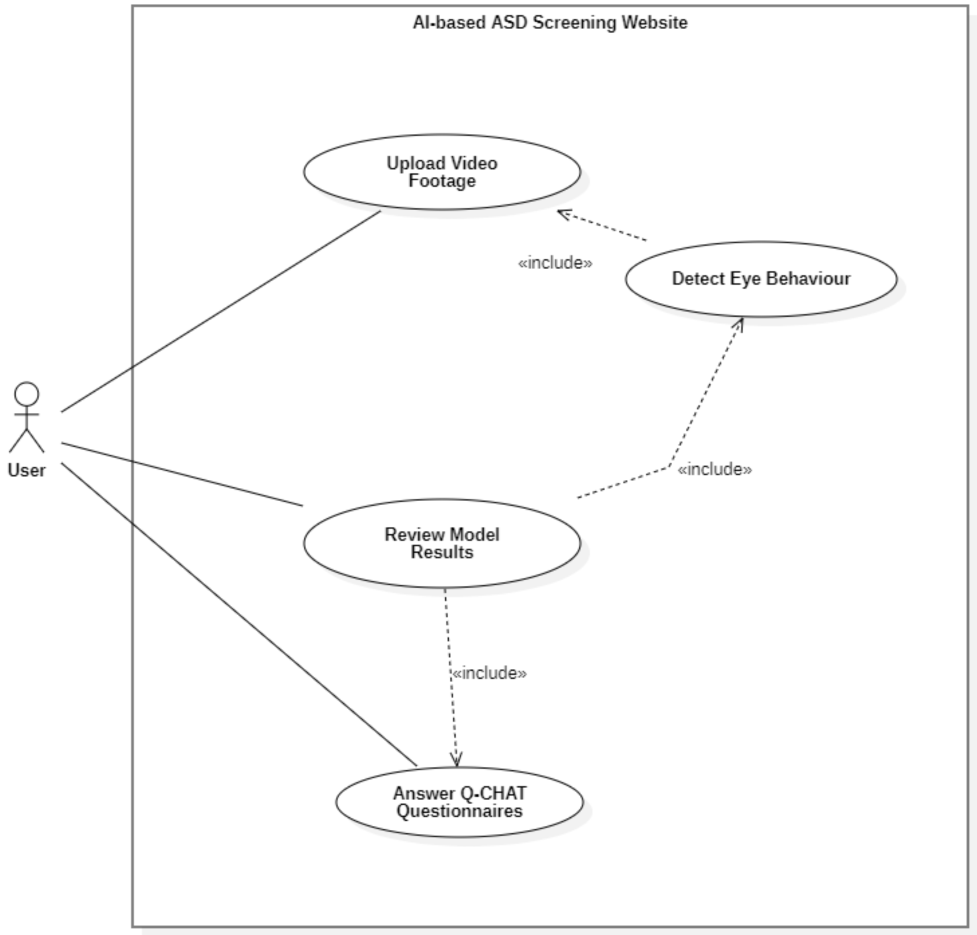

Figure 4.3: Use Case Diagram of AI-Based ASD Screening Website

The user uploads a footage of the individual suspected to have ASD. The footage is processed by the AI-model and specifically the individual's eye behaviour is targeted and the blinking rate and eye contact manner are analyzed to produce a predicted outcome. Also, the user takes the Q-CHAT survey, which is analyzed by the AI model and both the outcomes are collectively presented to the user. The user views the result and goes for expert's aid if necessary.

4.4 SYSTEM FLOWCHART

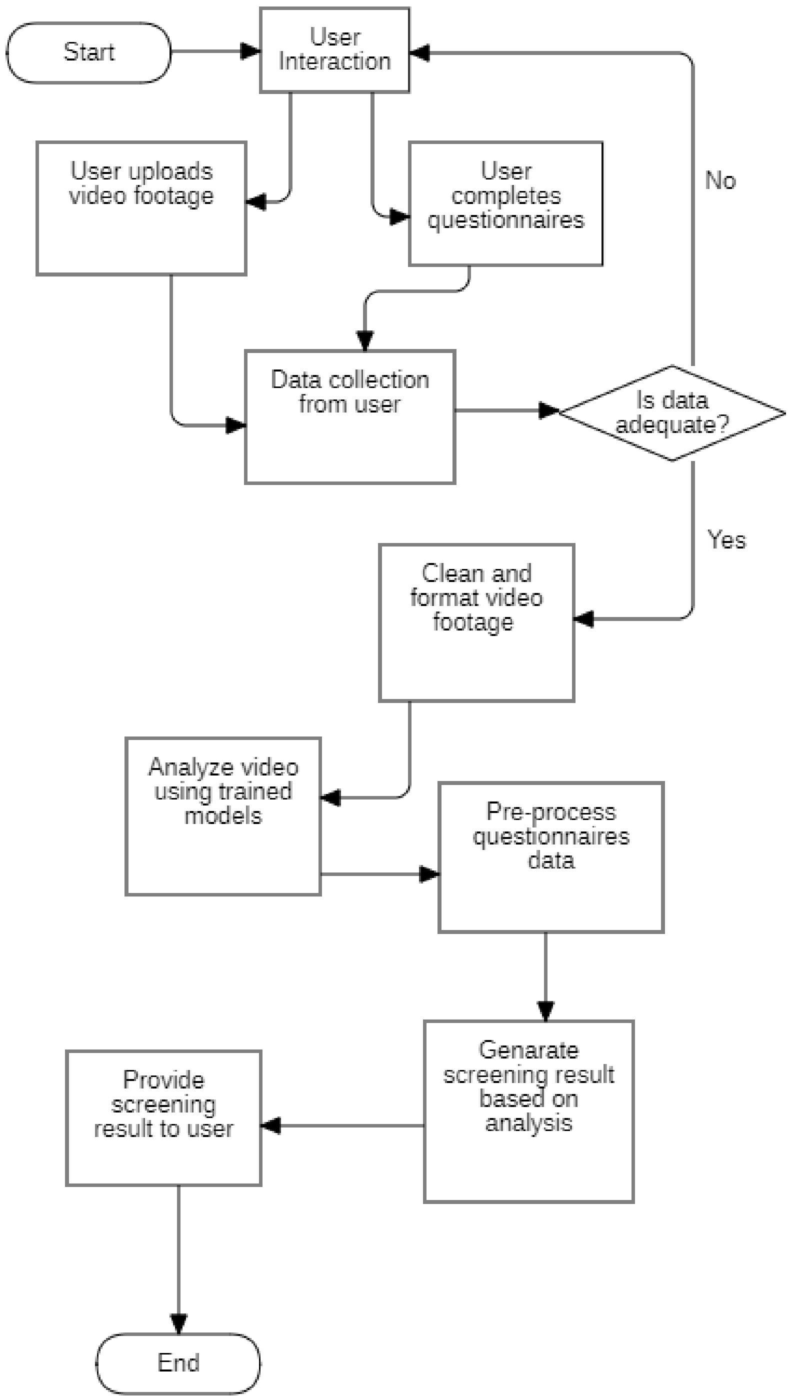

Figure 4.4: System Flow Diagram of AI-Based ASD Screening Website

4.5 DFD Level 0

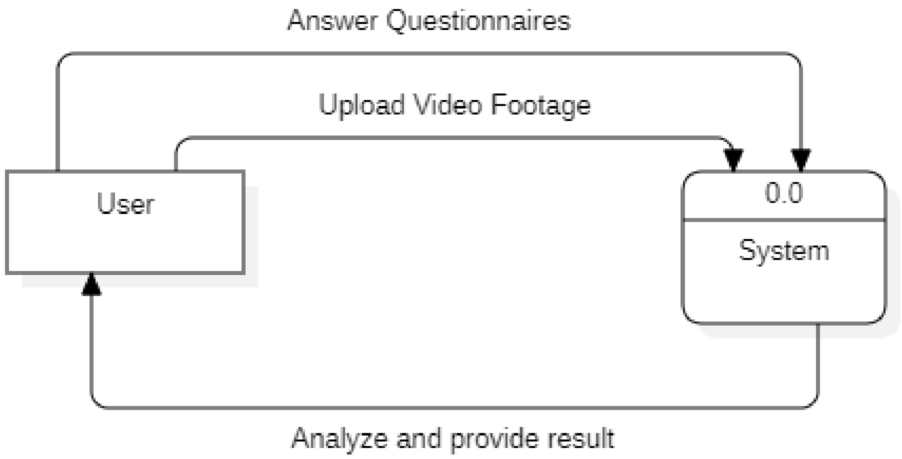

Figure 4.5: DFD Level 0 of AI-Based ASD Screening Website

The users are the external entities who can provide the inputs through questionnaires and by uploading the video footage to the system. The system analyzes the inputs given by the users through the trained model and provides a certain result to the user.

4.6 Basic Model Workflow Diagram

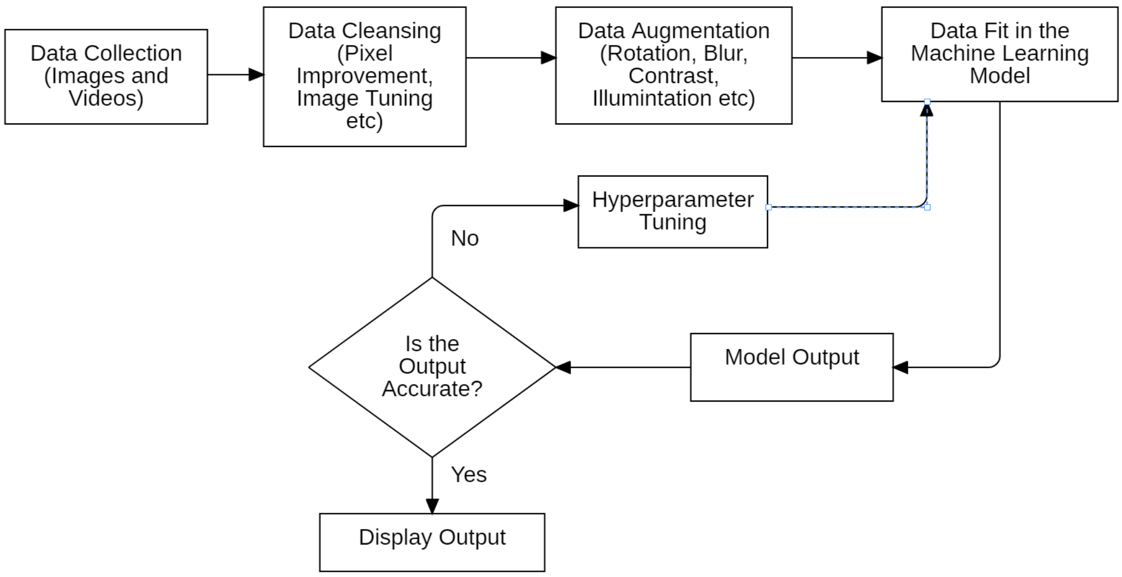

Figure 4.6: Basic Model Workflow Diagram of AI-Based ASD Screening Website

- Data Collection: Quality data is the foundation of accurate predictions. Various data-sets such as video footage, Q-CHAT survey answers, etc. as well as other essential information for the model are gathered, ensuring it has the right building blocks.
- Data Cleansing: Data cleansing corrects errors, removes inconsistencies, and enhances the reliability of the data-sets, improving model performance.
- Data Augmentation: Data augmentation diversifies the data-sets by creating new variations, making the model more adaptable and better at handling different scenarios.
- Hyperparameter Tuning: Hyperparameters impact factors such as model complexity, learning rate, and regularization strength. Hyperparameter tuning fine-tunes the model's settings to achieve optimal performance, maximizing its predictive capabilities, also producing more accurate predictions on new, unseen data.

4.7 Work Breakdown

1. Front End Development: Front-end development focuses on the visual aspects of a website, i.e. the part that users see and interact with. This consists User interface (UI) development along with User Experience (UX) development, and such incorporates various sub-tasks such as :

- UI design
- Web page layout coding using HTML and CSS
- JavaScript Implementation

2. Back End Development: Back-end development means working on serverside software, which focuses on everything you can't see on a website. This task focuses on databases, back-end logic, API, architecture, and servers.

3. Data Collection and Preparation: Gathering and preparing images and videos for an autism screening website involves collecting diverse visual content that showcases relevant behaviors, expressions, and interactions. Various processes involved in data collection and preparation are:

- Data Collection: Gather a diverse collection of images and videos depicting various social interactions, behaviors, and expressions.
- Behavioral Annotations: Expert annotators label the data with autism-related behaviors, gestures, and expressions, providing precise cues for model training.
- Data Diversity: Include images and videos from different age groups, genders, and potentially various cultural backgrounds to ensure a comprehensive representation.
- Data Preprocessing: Enhance image quality, normalize lighting conditions, and extract relevant features like facial landmarks and motion patterns to improve model interpretability.

- Secure Storage: Implement secure data storage protocols to prevent unauthorized access or breaches.

4. AI model Development and Training: The autism screening system incorporates two distinct AI models to comprehensively assess potential indicators. The first model employs AI-based vision processing to analyze input images, scrutinizing facial expressions, gestures, and interactions. The second model is an ordinal regression framework tailored to process user inputs derived from the QChat survey. These inputs encapsulate vital behavioral cues.

5. Model Integration: Model integration involves seamlessly combining the outputs of two distinct AI models within the autism screening system: the AI-based vision processing model and the ordinal regression model. The integration process is a critical juncture where the strengths of both models converge. The results generated by each model are harmonized, leveraging the unique insights derived from visual analysis and survey-based inputs. By integrating these diverse sources of information, the autism screening system gains a more comprehensive and accurate understanding of the individual's profile. This integrated analysis serves as a predictive tool, offering valuable insights that contribute to early detection and intervention strategies. Through this cohesive approach, the screening system optimizes its capability to assess potential autism indicators effectively.

6. Testing and Refinement: The testing of the two distinct models initially follows separate paths. Each model undergoes dedicated testing procedures tailored to its specific functionality and data processing methods. This approach allows us to ensure the individual accuracy and reliability of both the AI-based vision processing model and the ordinal regression model.

Subsequently, once both models demonstrate their proficiency individually, a pivotal phase of integration testing ensues. At this stage, the integrated system is meticulously tested as a whole, incorporating both models harmoniously. We employ a range of comprehensive testing tools and methodologies to evaluate the system's end-to-end functionality, data flow, and the seamless interplay between the two models.

Given the sensitive nature of our system, especially within the medical field, the testing protocols are conducted under the vigilant supervision of qualified medical experts. Their domain expertise ensures that the system aligns with stringent medical standards and guidelines. Additionally, the involvement of medical experts enhances the accuracy and relevance of the testing scenarios, further validating the system's suitability for use in the healthcare context.

Through this rigorous and multidimensional testing approach, we ensure that our autism screening system not only meets technical benchmarks but also adheres to the highest medical standards. The integration of separate model testing and comprehensive system testing, coupled with expert oversight, guarantees a dependable and robust tool that can contribute effectively to autism detection within the medical field.

CHAPTER 5

WORK PROGRESS

5.1 Work Completed

We have decided to first focus on the Q-CHAT survey front-end development as well as the regression model development for the survey. Having completed the questionnaire web-page development as well as the ML coding part for the model, as illustrated below, we intend to move on with the data-set preparation and training phase for this model.

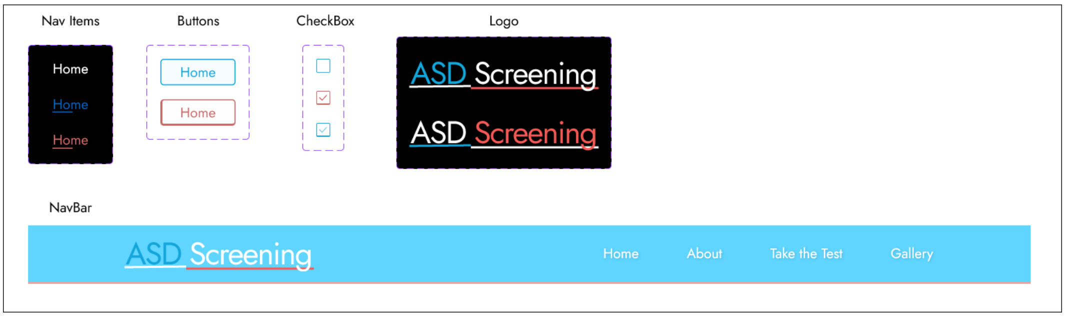

Figure 5.1: Preparing UI components in Figma

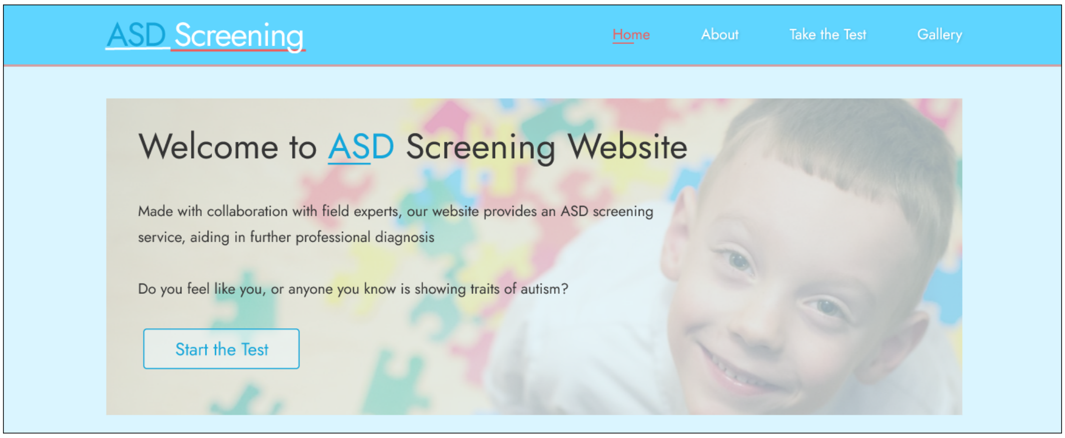

Figure 5.2: Landing Page for ASD Screening Website

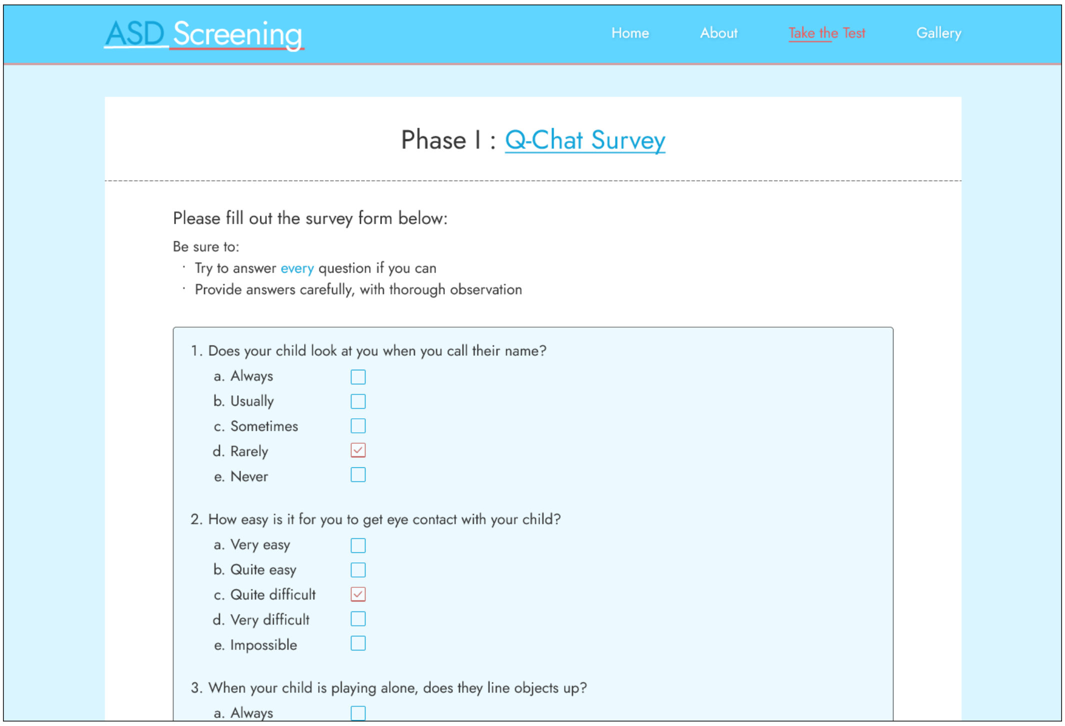

Figure 5.3: Survey Page for ASD Screening Website

```
from flask import Flask, render_template, request, jsonify
import pandas as pd
from mord import OrdinalRidge
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score

app = Flask(__name__)

# Load your Q-chat questionnaire dataset
# Replace 'your_dataset.csv' with the actual dataset file
data = pd.read_csv('your_dataset.csv')

# Separate features (questionnaire responses) and labels
X = data.drop('Label', axis=1)
y = data['Label']

# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create and train the Ordinal Regression model
ordinal_model = OrdinalRidge()
ordinal_model.fit(X_train, y_train)

@app.route('/', methods=['GET', 'POST'])
def index():
    if request.method == 'POST':
        # Retrieve questionnaire responses from the form
        response_values = []
        for i in range(1, 11):  # Assuming there are 10 questions
            response = int(request.form[f'question_{i}'])
```

Figure 5.4: Regression model code snapshot

5.2 Work Remaining

- Integration of Computer Vision Data:
  - Collect and pre-process Computer Vision data from the screening process.
  - Implement necessary data pre-processing steps to ensure consistency and quality.
  - Develop a pipeline to incorporate Computer Vision features or outputs into the overall screening process.
- Feature Engineering and Selection:
  - Analyze the Computer Vision data to identify relevant features or patterns.
  - Collaborate with experts to determine which Computer Vision features are most indicative of autism-related behaviors.
  - Use techniques like dimensionality reduction or feature selection to extract meaningful information and reduce noise.
- Data Fusion and Integration:
  - Investigate methods for effectively combining Q-chat questionnaire responses with Computer Vision features.
  - Decide on an integration strategy that preserves the unique contributions of each data source.
  - Implement the chosen fusion approach to create a unified dataset for analysis.
- Machine Learning Model Development:
  - Select appropriate machine learning algorithms that can handle the fused dataset.
  - Design and develop a predictive model that leverages both Q-chat questionnaire responses and Computer Vision features.

- Integration with Decision Support System:
  - Ensure a user-friendly interface for users to input Q-chat questionnaire responses and upload Computer Vision data.
- Ethical Considerations and Privacy:
  - Address ethical considerations related to data privacy, consent, and potential bias.
  - Ensure compliance with data protection regulations and guidelines.
- Validation and Clinical Collaboration:
  - Collaborate with clinical experts to validate the model's outcomes against established diagnostic criteria.
  - Seek feedback from domain specialists to refine the model's utility and accuracy.

5.3 Challenges

- Data Integration Complexity:
  - Integrating Q-chat questionnaire responses and Computer Vision data while preserving the integrity of both sources can be complex.
- Feature Selection and Relevance:
  - Identifying relevant Computer Vision features that align with autism-related behaviors might require domain expertise and extensive analysis.
- Ethical Considerations:
  - Navigating ethical considerations such as data privacy, consent, and potential biases in the collected data is crucial.
- Interpretable Results:

  - Generating interpretable results that provide insights into how the model makes decisions can be challenging, especially with complex Computer Vision data.

- Model Over-fitting:

  - Preventing the model from over-fitting, particularly when dealing with limited data, requires careful regularization and validation strategies.

- Cross-Domain Variability:

  - Accounting for variability between the Q-chat questionnaire responses and Computer Vision data can affect the model's performance.

- Clinical Validation:

  - Collaborating with clinical experts to validate the model's outcomes against established diagnostic criteria may pose logistical and interpretation challenges.

- User Acceptance:

  - Ensuring that end-users, such as clinicians or caregivers, understand and trust the model's outcomes is essential for successful deployment.

- Resource Constraints:

  - Limited resources, such as computing power or budget, might impact the ability to pre-process, analyze, and train models effectively.

- Unforeseen Biases:

  - Identifying and addressing potential biases that may emerge from the combination of Q-chat and Computer Vision data.

- Regulatory Compliance:

  - Ensuring compliance with data protection regulations and guidelines while dealing with sensitive health-related information.

CHAPTER 6

PROJECT INTEGRATION WITH SDG

Sustainable Development Goals (SDGs), are a set of global objectives established by the United Nations in 2015 to address a wide range of social, economic, and environmental challenges. The SDGs provide a framework for international co-operation and action to achieve a more sustainable and equitable world by the year 2030. There are 17 SDGs, each with specific targets and indicators to track progress. Among these various SDGs, our project aims to contribute to the 3^{rd} SDG - "Good Health and Well-Being".

Figure 6.1: SDG 3 - Good Health and Well-being

By leveraging technology to aid in autism screening, our project can assist in promoting early detection and intervention, which is crucial for the well-being and development of individuals with ASD. With early screening through our AI model, children and individuals with autism can receive timely support and specialized care, leading to improved health outcomes and enhanced quality of life. By reducing the time between identification and intervention, our project can potentially help in addressing developmental challenges associated with autism and pave the way for better long-term prospects for affected individuals.

Moreover, our approach of using computer vision also has the potential to increase accessibility to autism screening in underserved communities in context of Nepal, where resources and expert diagnosis are limited. This inclusivity aligns with the broader principle of leaving no one behind, which is a central tenet of the Sustainable Development Goals.

In summary, our AI model for autism screening aligns with SDG 3 by promoting early detection, intervention, and improved health outcomes for individuals with autism spectrum disorder. By leveraging technology for a socially impactful purpose, we are contributing to the global efforts to ensure good health and well-being for all, fostering a more inclusive and equitable society.

REFERENCES

[1] Vision transformer. https://paperswithcode.com/method/vision-transformer.

[2] Iterative and incremental development. https://en.wikipedia.org/wiki/ Iterative_and_incremental_development.

[3] Eye blink analysis for autism spectrum disorder (ebaas) model. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4980680/.

[4] Eye tracking-based diagnosis and early detection of autism spectrum disorder using machine learning and deep learning techniques. https://www.mdpi.com/2079-9292/11/4/530.

[5] Autismcare nepal society: A national center for autism. https://autismnepal.org/.

[6] Classification and detection of autism spectrum disorder based on deep learning algorithms. https://www.hindawi.com/journals/cin/2022/8709145/.

[7] The use of artificial intelligence in screening and diagnosis of autism spectrum disorder. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7298904/.