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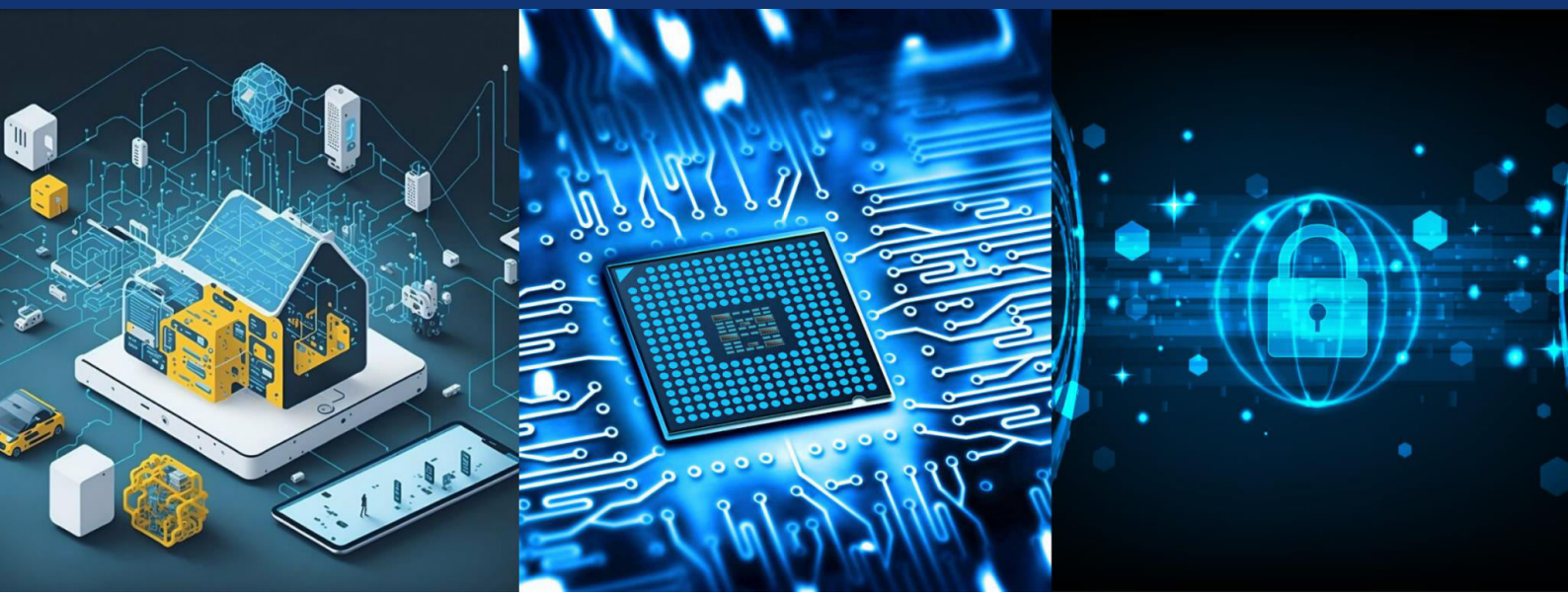

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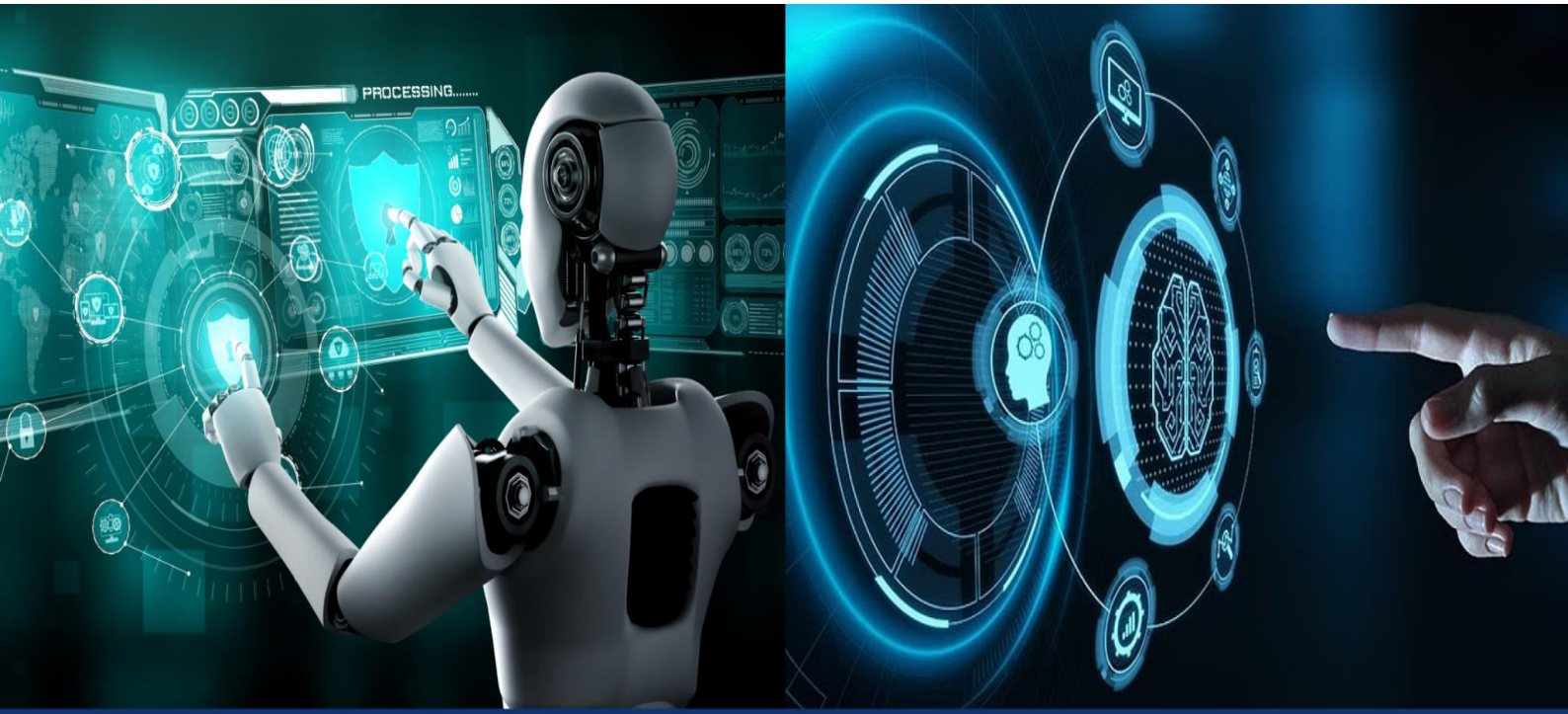

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Predictive Analysis of Autism Spectrum Disorder Using Machine Learning an Intelligent Machine Learning-Based Web Framework for Early ASD Prediction

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ABSTRACT: The project called "Predictive Analysis of Autism Spectrum Disorder Using Machine Learning" attempts to create a simple but efficient system that will be used to determine the likelihood of someone having the Autism Spectrum Disorder (ASD). The system involves filling out the basic information about the user, such as the age and gender and AQ-10 screening answers.

The data provided by the user is analyzed through the use of a trained machine learning model, which predicts whether there is a likelihood of ASD among users. Various algorithms such as Logistic Regression, Decision Tree, Random Forest and Support Vector Machine were tried and the most accurate model was picked for the purpose. The algorithm is integrated into a Flask back end to provide better performance and results.

Once the information is uploaded into the system, the user gets a result immediately together with the probability percentage and the AQ score. In doing so, the output becomes easy to interpret and useful for users.

It should not be considered as an alternative to professional diagnostics; however, it can become a helpful preliminary tool for this purpose. As for the future perspectives for improvement of the proposed solution, one may suggest its development considering several aspects: patient's medical history, enhanced modeling techniques, effective databases, and mobile applications.

KEYWORDS: Machine Learning, Predictive Analysis, AQ-10 Test, Online System, Real-time Prediction, Classification Algorithms, Data Preparation

I. INTRODUCTION

Autism spectrum disorder refers to a mental illness where one exhibits some disorders in behavior and social interactions. Early prediction of the ASD is essential since it leads to appropriate measures being taken to improve quality of life. Nevertheless, the conventional methods of predicting ASD involve several limitations such as delay, expertise, and limited availability, thus creating the need for more efficient methods. In response to this issue, this study uses machine learning technology to provide a fast and convenient prediction of autism.

The primary objective of this project is to come up with an online machine learning predictor for Autism spectrum disorder. The main intention of designing this predictor would be to make the process of prediction easier for all. It serves as a diagnostic tool for the purpose of helping users find out whether there is the possibility of them having autism or not.

The working of the system depends on user inputs that include age, gender, and answers to the AQ-10 test provided in the form of an interface online. As soon as the user fills out the form, all information goes to the backend where it gets analyzed and converted into the appropriate format using the preprocessing methods. A machine learning model trained

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to do the job analyses the data and determines whether the probability of ASD is high or low. The output is immediately shown on the computer screen along with other relevant information such as percentage of confidence and AQ score.

II. LITERATURE REVIEW

Autism spectrum disorder is a term used to describe a neurodevelopmental condition marked by poor language skills, social interaction impairment, learning difficulties, and behavioral issues. Various scientific studies and practices conducted by researchers and health care providers have attempted to create different approaches to detect and diagnose autism. The importance of early diagnosis has been highlighted because it allows children to receive help and training from an early age. It has always been difficult to accurately diagnose autism due to differences in the symptomatology of autism patients.

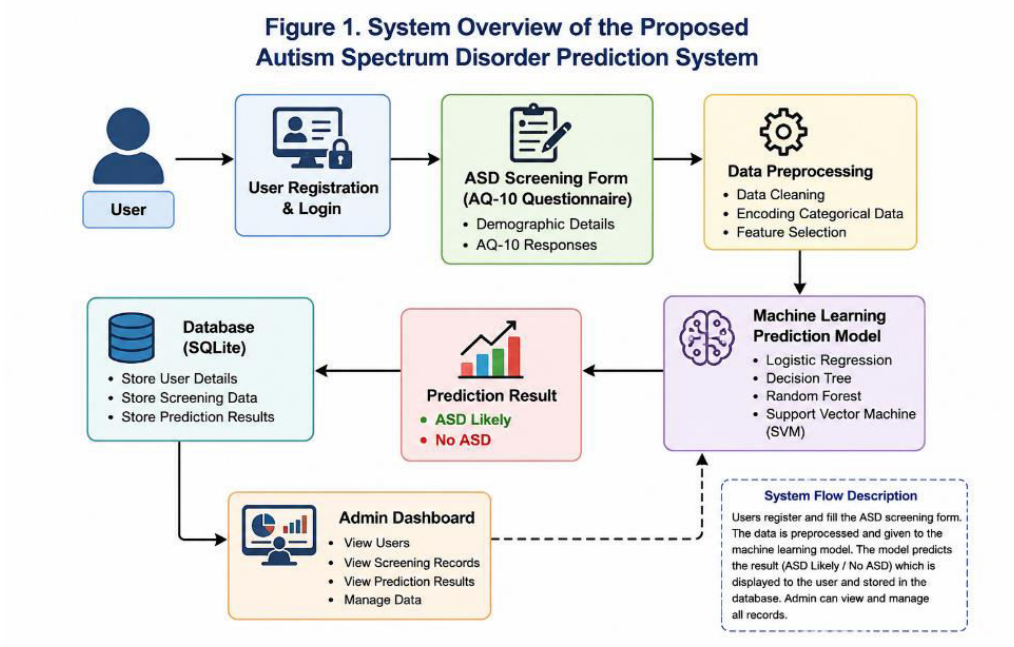
Attempts to diagnose and treat autism began with observation. The first study that focused on autism was conducted in 1943 by Leo Kanner, who identified autism as a developmental disability. In the early years, techniques for detecting autism were based on the observation of behavior and language skills in children with this condition. Such an approach provided valuable information about autism, but it had no objective basis since it was based on clinicians' observations.

To develop a standardized method of diagnosing disorders, the American Psychiatric Association created a guide known as DSM (Diagnostic and Statistical Manual of Mental Disorders). Using DSM was an effective way for identifying autism disorders, as the criteria described how the disorder manifests itself through specific social interactions, repetitive behavior, communication problems, and reactions to various circumstances. Although using DSM facilitated the diagnosing process, only specialists could provide a proper diagnosis, and such a procedure required a lot of resources and time.

The further progress in methods used to identify autism led to the creation of structured tests, including ADI-R (Autism Diagnostic Interview-Revised) and ADOS (Autism Diagnostic Observation Schedule). They made it possible to diagnose autism more accurately by interviewing patients and observing their behavior. Such techniques were widely applied in practice owing to their high level of reliability compared to general observations. However, one should mention that conducting structured tests takes too much time and effort.

III. SYSTEM OVERVIEW

Figure 1. System Overview of the Proposed Autism Spectrum Disorder Prediction System



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Proposed ASD Prediction System is a web application based on the Machine Learning technology, which will be used to conduct the preliminary autism screening. The application will analyze the demographic data and answers submitted during the AQ-10 test and predict the probability of Autism Spectrum Disorder.

The web application was created using the following technologies: Python, Flask, HTML, CSS, JavaScript, SQLite. User registration, logging-in, ASD screening, prediction, database management and administration modules were implemented. Several machine learning models (such as Logistic Regression, Decision Tree, Random Forest and Support Vector Machine (SVM)) were trained and tested, and the best model was chosen for the web application implementation.

The web application is very simple to use and provides the comfortable and secured way to conduct the autism screening and receive the prediction result instantly.

IV. METHODOLOGY

Autism Spectrum Disorder (ASD) Prediction System applies a systematic approach of Machine Learning in order to provide effective and accurate autism screening. This approach consists of the following stages.

4.1 Data Collection

Autism dataset is collected from reliable resources and includes demographic information as well as responses to AQ-10 questionnaire. This dataset is used for training and testing Machine Learning models.

4.2 Data Preprocessing

Dataset is preprocessed by managing missing values, removing duplicates and feature encoding. Features required for further use are selected in order to get the dataset ready for training.

4.3 Model Training

Training and testing datasets are derived from the prepared dataset. Performance of Machine Learning algorithms, such as Logistic Regression, Decision Tree, Random Forest, and Support Vector Machine (SVM), is evaluated in order to define the most suitable model.

4.4 Prediction Process

Users fill out their demographic information and responses to AQ-10 questionnaire on the web application. Machine Learning model analyzes the entered information and predicts whether individual has Autism Spectrum Disorder.

4.5 Result Generation

Prediction result is presented as ASD Likely or No ASD on the web application. Information about screening process and prediction results is also stored in the database.

4.6 Performance Evaluation

The system has been tested by functional tests and performance evaluation of Machine Learning based on parameters such as Accuracy, Precision, Recall and F1-Score.

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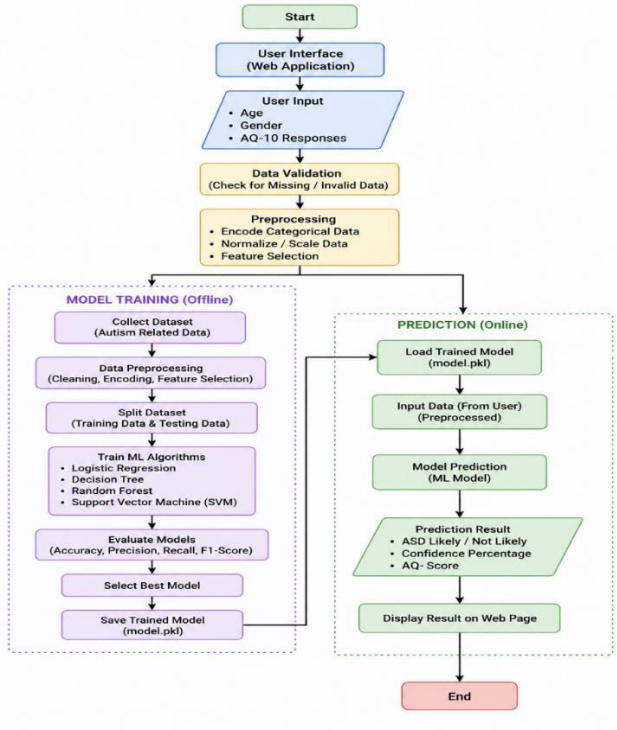
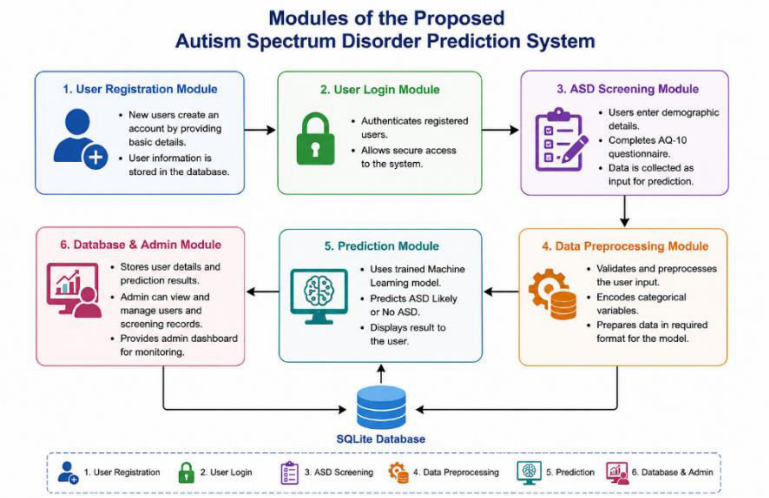
V. SYSTEM ARCHITECTURE



The proposed ASD Prediction System has been designed in two phases; Offline Model Training and Online Prediction. The offline phase includes collection of the autism dataset, preprocessing of the data, and training the machine learning algorithms like Logistic Regression, Decision Tree, Random Forest, and SVM using the processed dataset. The performance of the model is analyzed and the best performing algorithm is saved.

The online phase involves input of demographic information and AQ-10 question set responses by the users via the web application. This input information is then preprocessed and sent to the machine learning algorithm for making the predictions. If the prediction is “ASD Likely” or “No ASD”, the output is shown on the web application, and the screening results are stored in the database.

VI. MODULES



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1. User Registration Module
This module enables registration for the new users to get their login details stored in the database in a secure manner.

2. User Login Module
This module verifies the user's login credentials before giving access to the ASD screening application.

3. ASD Screening Module
User enters his/her demographics and completes the AQ-10 questionnaire form. This information is used as the input to the Machine Learning algorithm.

4. Data Preprocessing Module
Input data from user is preprocessed and verified. Encoding of the categorical data takes place in order to make it fit for the prediction process.

5. Prediction Module
Data is processed using the machine learning algorithm and a prediction is made about the person being ASD Likely or No ASD.

6. Database and Admin Module
Result of the prediction along with the user information is saved in the SQLite database.

VII. IMPLEMENTATION DETAILS

7.1 Technology Stack
Technology stack needed for the Autism Spectrum Disorder (ASD) Prediction System include Python and Flask as backend technologies. The frontend technologies being used include HTML, CSS and Javascript whereas the design of the database has been done using SQLite. The development of Machine Learning algorithms has been done using Scikit-learn library.

7.2 Frontend Implementation
The interface designed by the application is easy to understand and use and has several modules such as User Registration module, Login module, ASD Screening Form module, Prediction Result module, User Data module and Admin Dashboard module. The interface enables users to screen themselves for ASD and get the predictions.

7.3 Backend Implementation
The backend implementation has been done using Flask framework and has user authentication, processing of user input and output data, Machine Learning algorithm integration and database communication.

7.4 Database Design
Database design has been done using SQLite and consists of user registration and login information, screening data, prediction result data and admin data.

7.5 Implementing the Machine Learning Model
Several Machine Learning models, such as Logistic Regression, Decision Tree, Random Forest, and SVM, are trained using data collected through the autism screen test. The most effective model is chosen, stored in model.pkl file, and incorporated into the Flask application in order to make predictions.

7.6 Ensuring Application Security
The following security measures have been implemented in order to increase the level of protection of user data: user authentication, input validation, and database security..

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VIII. EXPERIMENTAL DETAILS AND RESULTS

8.1 Experimental Setup

The above ASD prediction model has been built and tested via Python 3.x, Flask, HTML, CSS, JavaScript, and SQLite. The Machine Learning model has been created using the Scikit-learn library with the dataset comprising patient demographic details and their scores on the AQ-10 questionnaire. The experiments have been conducted using the computer having Intel Core i5 processor and 8 GB RAM with Windows 11. The testing has been done using Google Chrome, Mozilla Firefox, and Microsoft Edge browsers.

8.2 Test Results

Test Case	Description	Result	Status
User Registration	New user registration completed successfully	Passed	✓
User Login	Valid user authentication	Passed	✓
ASD Screening Form	AQ-10 questionnaire submitted successfully	Passed	✓
Input Validation	Missing and invalid inputs detected correctly	Passed	✓
Data Preprocessing	User data processed successfully	Passed	✓
Model Prediction	ASD prediction generated correctly	Passed	✓
Prediction Result	ASD Likely / No ASD displayed	Passed	✓
Database Storage	User and prediction details stored successfully	Passed	✓
Admin Dashboard	User records displayed correctly	Passed	✓
Record Management	Prediction records retrieved successfully	Passed	✓
Cross-Browser Testing	Chrome, Firefox, and Edge supported	Passed	✓
User Interface	Responsive interface and smooth navigation	Passed	✓

Table 1: Test Case Results for the Proposed ASD Prediction System

8.3 System Evaluation

Performance evaluation of the developed system was done through both functional testing and performance evaluation of Machine Learning techniques. Various algorithms like Logistic Regression, Decision Trees, Random Forests and Support Vector Machines were used and compared, and the selected model demonstrated effective accuracy of prediction along with very minimal response time. The web application was able to take user inputs, predict results and store screening history effectively. The system worked perfectly fine in all web browsers.

8.4 Observations

The proposed system for predicting autism spectrum disorder was able to do preliminary screening of autism based on user demographics and AQ-10 questionnaires. The predictions by the machine learning technique took very little time and were highly accurate, and the web application made it easy for users to use the system.

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IX. APPLICATIONS

Autism Screening at the Preliminary Stage: Helps users screen for possible traits of Autism Spectrum Disorder via an online test.
Facilitation of Early Detection: Promotes early detection of autism symptoms and helps access healthcare in time.
Healthcare Professional Tool: Offers healthcare specialists another tool for preliminary autism screening.
Education on Autistic Behavior Traits: Helps people who have any interest in autism learn more about its symptoms.
Web-Based Access: Enables users to conduct autism screening anywhere using a web application.
Record Keeping of Predictions: Saves user screening data and results of predictions for later use.
Machine Learning Application in Healthcare: Illustrates practical use of machine learning in intelligent healthcare systems.
Future Research Base: Can be used as a base for further research in autism prediction and intelligent healthcare systems.

X. LIMITATIONS

- This is an initial screening tool for Autism and should not be used as an alternative to professional medical diagnosis.
- Accuracy of predictions can depend on the quality of the input training dataset. If it lacks some diversity, the results might not be as accurate as one expects.
- The application requires user-provided demographic data and questionnaire responses.
- At the moment, the algorithm only takes into account data from the questionnaires, and does not involve clinical records, genetic data, previous medical history or behavioral analysis.
- It was developed as a web application, and hence requires the internet connection.
- This specific training dataset was used to train the prediction model. Thus, the effectiveness of it may change depending on which demographic group or population was chosen.
- No personalized medical advice or further consultation can be provided after receiving the result of prediction.
- More advanced Deep Learning methods, as well as other multimodal input (such as voice, expressions, or eye-tracking) were not involved in this project.

XI. FUTURE ENHANCEMENTS

The proposed ASD Prediction System can be improved by using more sophisticated Machine Learning and Deep Learning algorithms, which would help in enhancing its prediction ability. The future models can make use of larger and more diversified data sets to improve the efficiency and performance of the model.

A mobile app can be built for increased portability, while making the system multilingual can help in accommodating users from different parts of the world. Cloud computing can be used to ensure data safety and scalability of the system.

Furthermore, integration of the system with electronic health records, along with speech recognition or facial expressions can also be introduced to facilitate better autism diagnosis. All these improvements will make the system intelligent, more accurate, and more useful for everyone involved.

XII. CONCLUSION

In conclusion, the proposed Autism Spectrum Disorder (ASD) Prediction System effectively shows how Machine Learning can be used in preliminary autism screening by analyzing the user's demographic information and his/her answers on the AQ-10 questionnaire and offering him/her quick and accurate predictions in order to help to detect possible autistic traits.

The combination of such programming languages as Python, Flask, HTML, CSS, JavaScript, and the database SQLite together with Machine Learning methods provided an effective web-based application that allows the users to register themselves, pass the test on possible autism, get predictions and manage their personal data. The system was tested according to its functionality and model performance.

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Despite the fact that the system cannot be regarded as an alternative for professional medical diagnostics, it is a good decision-support tool that contributes to increased autism awareness and medical consultation.

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