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Machine Learning Based Early Detection of Autism Spectrum Disorder

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Abstract: ***The Autism Screening System is a web-based application designed to support early detection of Autism Spectrum Disorder (ASD) using machine learning techniques. Early identification is important for timely intervention and improving individuals' quality of life. The system is developed using the Flask framework and provides an interactive interface for healthcare professionals. It analyzes various clinical parameters such as age, gender, family history, communication skills, social interaction, and behavioral patterns. Multiple machine learning algorithms, including Random Forest, Decision Tree, K-Nearest Neighbors, Naive Bayes, and Logistic Regression, are implemented and compared. The model with the highest accuracy is automatically selected for prediction. The system also includes graphical visualization to evaluate model performance. It generates predictions along with confidence levels to assist doctors in decision-making. This tool is intended to support, not replace, clinical diagnosis. Overall, it provides a fast and data-driven approach for preliminary ASD screening, with potential for future improvements using real-world data and healthcare deployment.***

Keywords: Random Forest, Decision Tree, K-Nearest Neighbors, Naive Bayes, Logistic Regression.

I. INTRODUCTION

The Autism Screening System is a web-based application developed to support the early detection of Autism Spectrum Disorder (ASD) using machine learning techniques. Autism is a neurological condition that affects communication, behavior, and social interaction in individuals. Early identification of autism is essential for providing timely treatment and improving the quality of life. Traditional diagnosis methods are time-consuming and depend on expert observation, which may not always be easily accessible. To address this issue, the proposed system automates the screening process using data-driven techniques. The application is built using the Flask framework and provides a simple and user-friendly interface. Users can enter patient details such as age, gender, family history, and behavioral responses. These inputs are processed by a trained machine learning model to predict the likelihood of autism. The system generates results quickly and displays them with a confidence score. It also stores patient history for future reference and analysis. Visualization tools like charts are included to better understand prediction patterns. This helps doctors and users to make informed decisions. The system reduces manual effort and increases accuracy in screening. It can be used in hospitals, clinics, and educational institutions. Overall, the project provides an efficient and reliable solution for early autism detection.

II. LITERATURE SURVEY

The study of Autism Spectrum Disorder (ASD) has attracted significant research interest due to the importance of early diagnosis and intervention [3]. Many researchers have explored the use of machine learning techniques to improve the detection of autism. Traditional diagnostic methods rely on clinical observation and expert analysis, which can be time-consuming and subjective. To overcome these limitations, various automated systems have been proposed using classification algorithms. Techniques such as Decision Trees, Support Vector Machines, and Naive Bayes have been widely used for autism prediction [15]. These models analyze behavioral and demographic data to identify patterns associated with ASD. Some studies have also used Artificial Neural Networks to improve prediction accuracy. Feature selection methods have been applied to identify the most relevant attributes for better performance [7]. In addition, researchers have developed web-based and mobile applications to make autism screening more accessible. These systems allow users to input data and receive instant results. Ensemble learning methods have also been explored to combine multiple models for improved accuracy. However, many existing systems lack user-friendly interfaces and proper data visualization. Some applications do not maintain patient history for future analysis.

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III. CHALLENGES

The development of the Autism Screening System involves several challenges that affect accuracy, usability, and implementation. One major challenge is the availability of high-quality and reliable datasets for training the machine learning model. Incomplete or imbalanced data can lead to incorrect predictions. Another challenge is selecting the most suitable algorithm that provides high accuracy while maintaining efficiency. Handling real-world data variations is also difficult, as user inputs may be inconsistent or incorrect. Ensuring proper preprocessing and feature selection is essential but complex [2]. The system must also maintain a balance between simplicity and functionality to provide a user-friendly interface. Database management is another challenge, especially when storing and retrieving patient history securely. Ensuring data privacy and confidentiality is important since medical information is sensitive. Integration of the machine learning model with the web application can also create technical issues.

IV. PROPOSED METHODOLOGY

The proposed system follows a structured machine learning approach for ASD prediction. Initially, the dataset is collected and preprocessed by handling missing values and encoding categorical data. Relevant features such as age, gender, and behavioral scores are selected. Multiple machine learning algorithms including Random Forest, Decision Tree, KNN, Naive Bayes, and Logistic Regression are trained on the dataset [13]. The models are evaluated based on accuracy, and the best-performing model is selected. A Flask-based web application is developed to provide an interactive interface. Users input clinical data, and the system predicts ASD likelihood along with confidence levels.

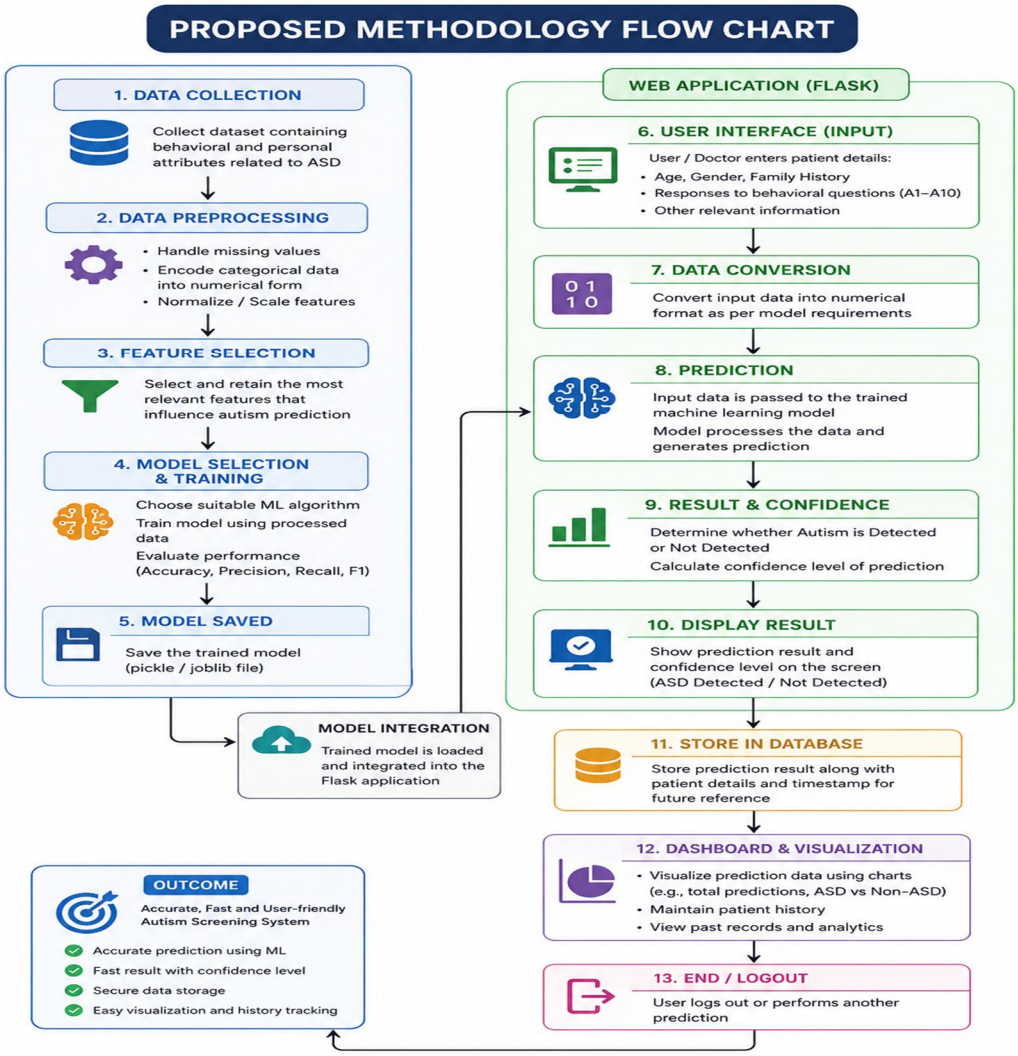


Figure 1: Flow chart of the proposed methodology

V. ALGORITHMS AND TECHNIQUES

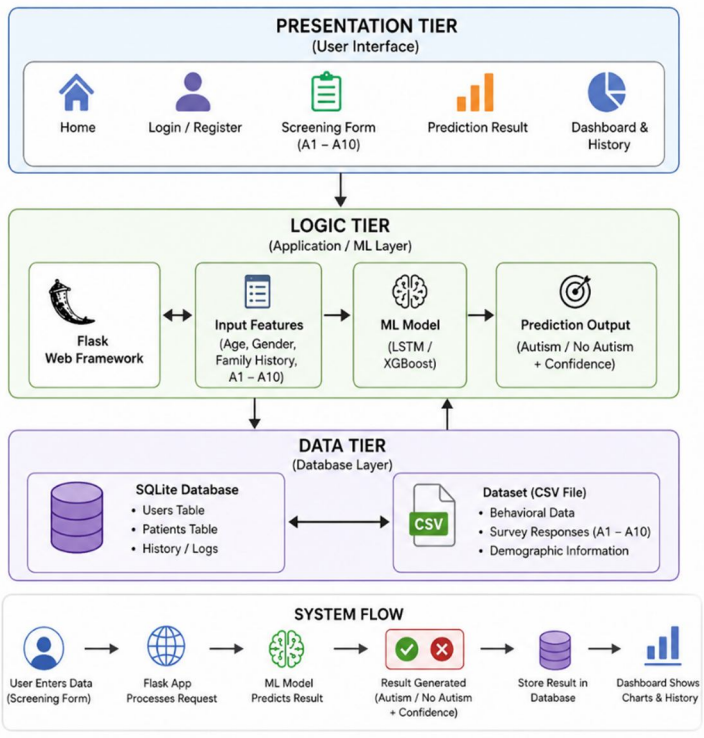
The project utilizes a combination of advanced machine learning models and web technologies to deliver predictive insights for Autism screening:

1) Machine Learning Algorithms: Machine learning algorithms are used in this project to analyze input data and predict whether a person has autism or not. These algorithms learn patterns from previously trained data and apply them to new inputs. Common algorithms like Decision Tree, Logistic Regression, or SVM help in accurate classification [15]. They also provide a confidence score, improving the reliability of the prediction.
2) Flask Web Framework: The core backend technology used to route requests, manage user sessions, and interface with the machine learning models and SQLite databases.
3) Data Preprocessing Techniques:
   - Handling Missing Values: Missing values in the dataset are identified and either removed or replaced with suitable values like mean or median.
     This ensures the model receives complete data and avoids errors during training.
   - Data Encoding (Categorical to Numerical): Categorical data such as gender (Male/Female) is converted into numerical form like 1 and 0.
     This is necessary because machine learning algorithms can only process numerical inputs.
4) SQLite Connectivity: Utilized for secure data storage, handling user registration, login authentication, and maintaining records for the reporting modules.

VI. ARCHITECTURE

The proposed Autism Screening System follows a three-tier architecture consisting of Presentation, Logic, and Data layers. The Presentation Tier handles the user interface using HTML5, CSS3/Bootstrap, and JavaScript to provide an interactive and user-friendly web experience. Users, such as doctors or patients, input screening data through web forms. This data is sent to the backend through the Flask web framework, which acts as the controller in the Logic Tier [12]. The Logic Tier processes the input data and performs prediction using a trained Machine Learning model (such as Decision Tree, Random Forest, or XGBoost). Flask manages request handling, model execution, and response generation. The machine learning engine analyzes behavioral inputs and predicts whether autism is detected or not along with a confidence score.

The Data Tier is responsible for storing and managing data using an SQLite database.



VII. OUTPUTS

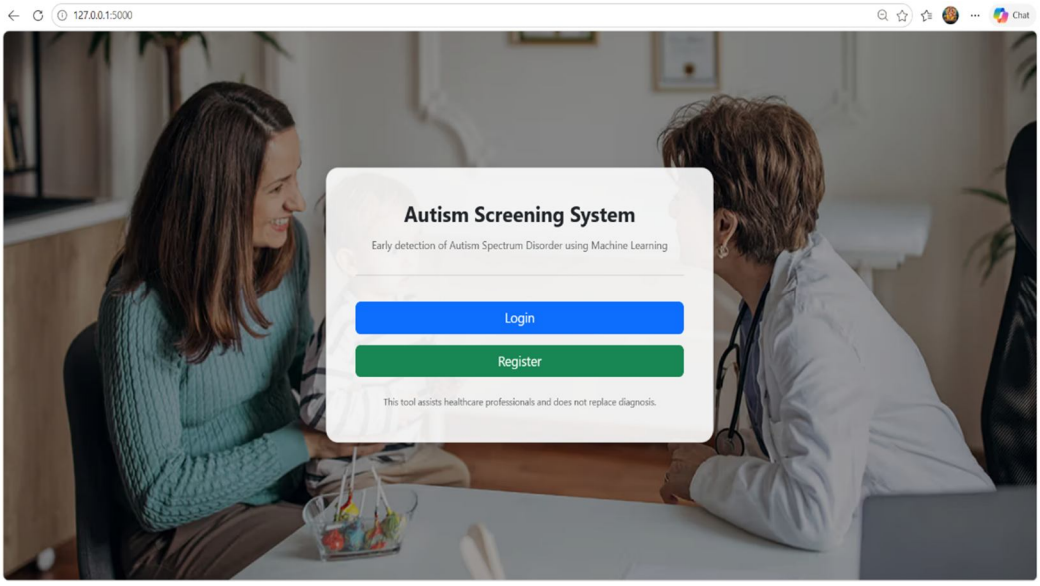


FIG1: HOME PAGE

The home page of the Autism Screening System provides a simple and user-friendly interface.
It contains two main options: Login and Register for users to access the system.
The background image represents a healthcare environment, making the interface visually relevant [2]. A clean card layout is used to highlight the application title and navigation options. This page acts as the entry point for both doctors and user. It ensures easy navigation and accessibility for first-time users.

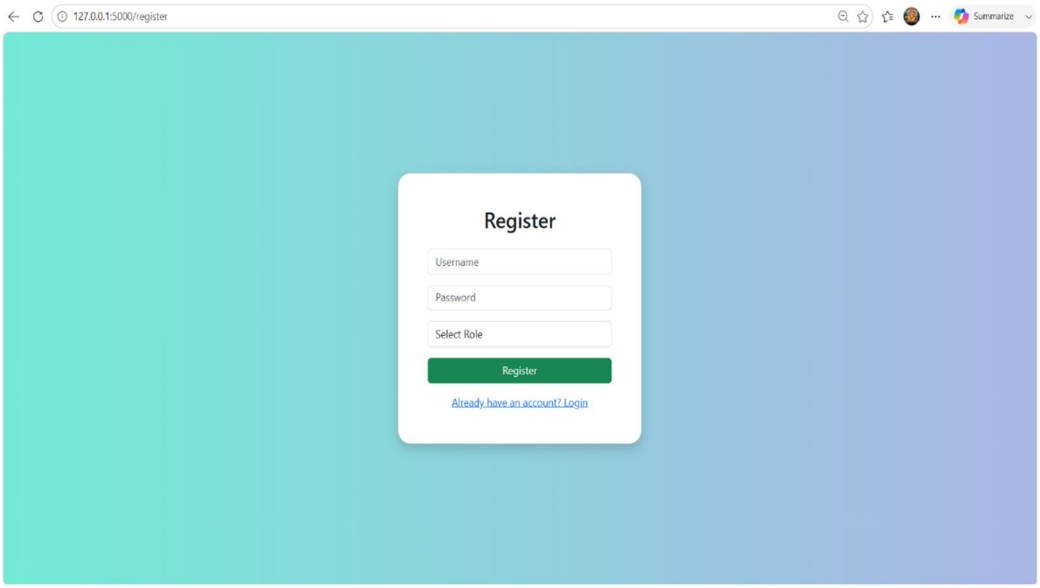


FIG2: REGISTRATION PAGE

The registration page allows new users to create an account in the system. It collects basic details such as username, password, and user role [12]. The interface is simple and cantered for better usability. Bootstrap styling is used to make the form responsive and visually appealing. Users can easily switch to the login page if they already have an account. This page ensures secure access to the system through user authentication.

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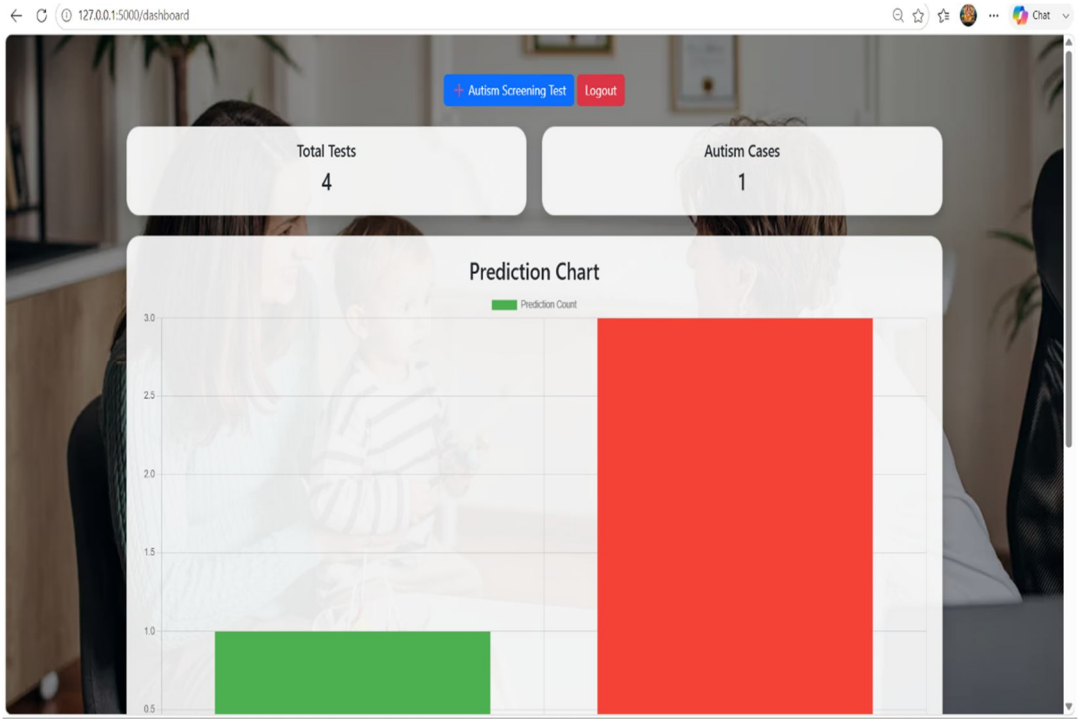

FIG3: DASHBOARD

The dashboard provides an overview of all screening activities. It displays key statistics such as total tests conducted and autism cases detected. A bar chart is used to visualize prediction results using Chart.js [5]. Users can quickly understand trends and outcomes through graphical representation. Navigation buttons allow access to screening tests and logout functionality. This page acts as the central control panel of the application.

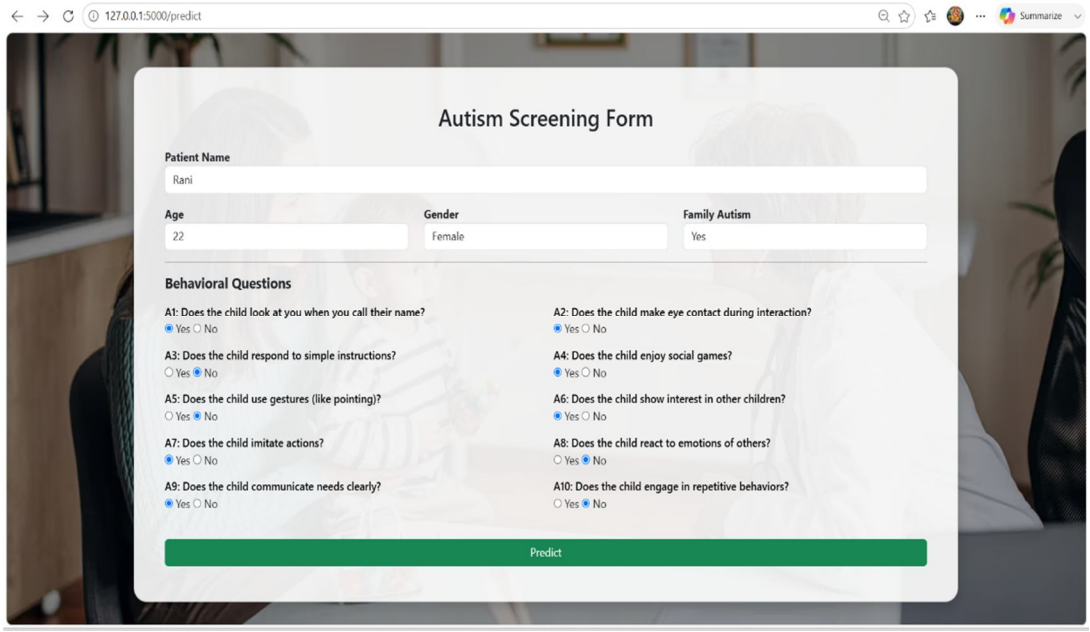

FIG4: PREDICTION PAGE

The Autism Screening Form page is used to collect patient details and behavioral responses. It includes fields such as patient name, age, gender, and family autism history. The form contains 10 behavioral questions (A1–A10) designed to assess autism-related traits [3]. Each question provides Yes/No options for easy and quick input. A clean and responsive design ensures a smooth user experience. After submitting, the data is sent to the machine learning model for prediction.

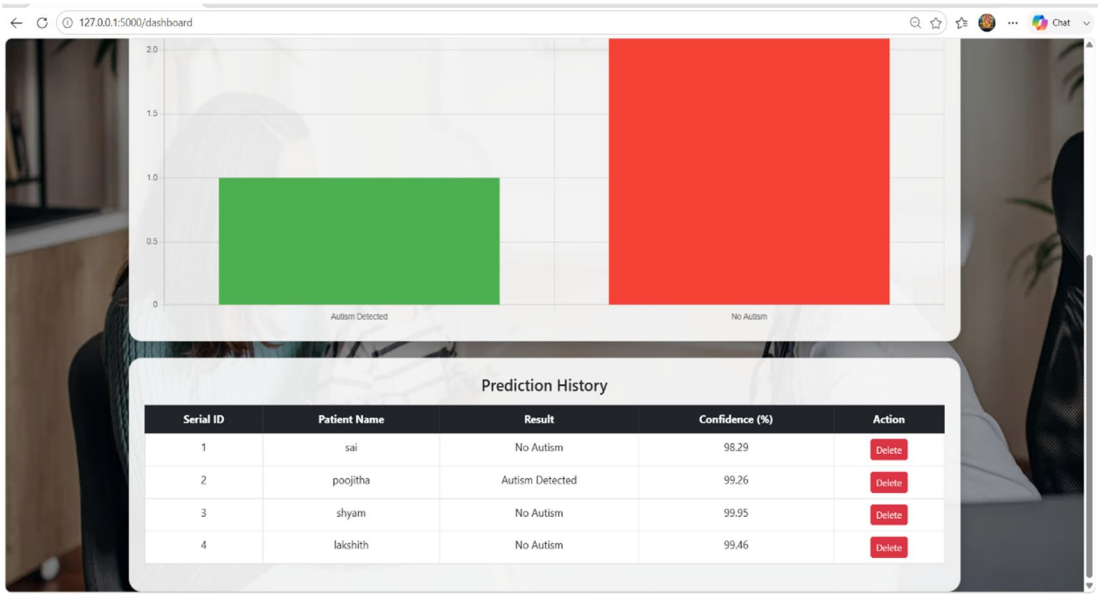

FIG6: PATIENT'S HISTORY

The prediction history section displays all previous screening results. It includes patient name, result, confidence score, and action options. Each record can be deleted using the delete button for better data management [16]. A structured table layout is used for clear data presentation. This feature helps doctors track and review past patient records. It improves usability by maintaining organized patient history.

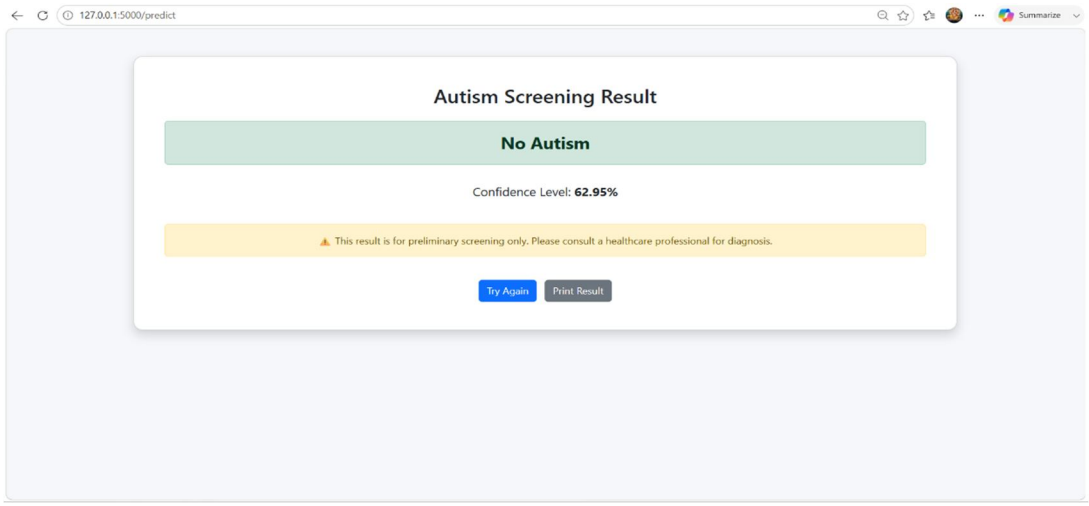

FIG7: PREDICTION OUTPUT

The result page displays the final prediction generated by the model. It clearly indicates whether autism is detected or not. A confidence percentage is shown to represent prediction accuracy. A warning message reminds users that the system is not a substitute for medical diagnosis [5]. Options like "Try Again" allow users to perform another screening. This page ensures clear communication of results to the user.

VIII. CONCLUSION

The Autism Screening System is an effective web-based application that uses machine learning to assist in the early detection of Autism Spectrum Disorder. It provides a simple interface for entering patient details and behavioral responses. The system processes the input data and generates predictions along with confidence levels. Features like dashboard, charts, and patient history improve usability and data management. It helps healthcare professionals make quicker preliminary assessments. However, it is not a substitute for expert medical diagnosis. The project demonstrates the power of integrating AI with healthcare systems. Overall, it contributes to faster screening and better awareness of autism.

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BIBLOGRAPHY

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P. Manikantha is currently pursuing her final semester of Master of Computer Applications (MCA) at Sanketika Vidya Parishad Engineering College, which is accredited with an 'A' grade by NAAC, affiliated to Andhra University, and approved by AICTE. With a keen interest in Machine Learning and Artificial Intelligence, he has undertaken her postgraduate project titled "Machine Learning Based Early Detection of Autism Spectrum Disorder." The project has been successfully carried out under the guidance of P. Bindhu Priya, Assistant Professor, SVPEC.

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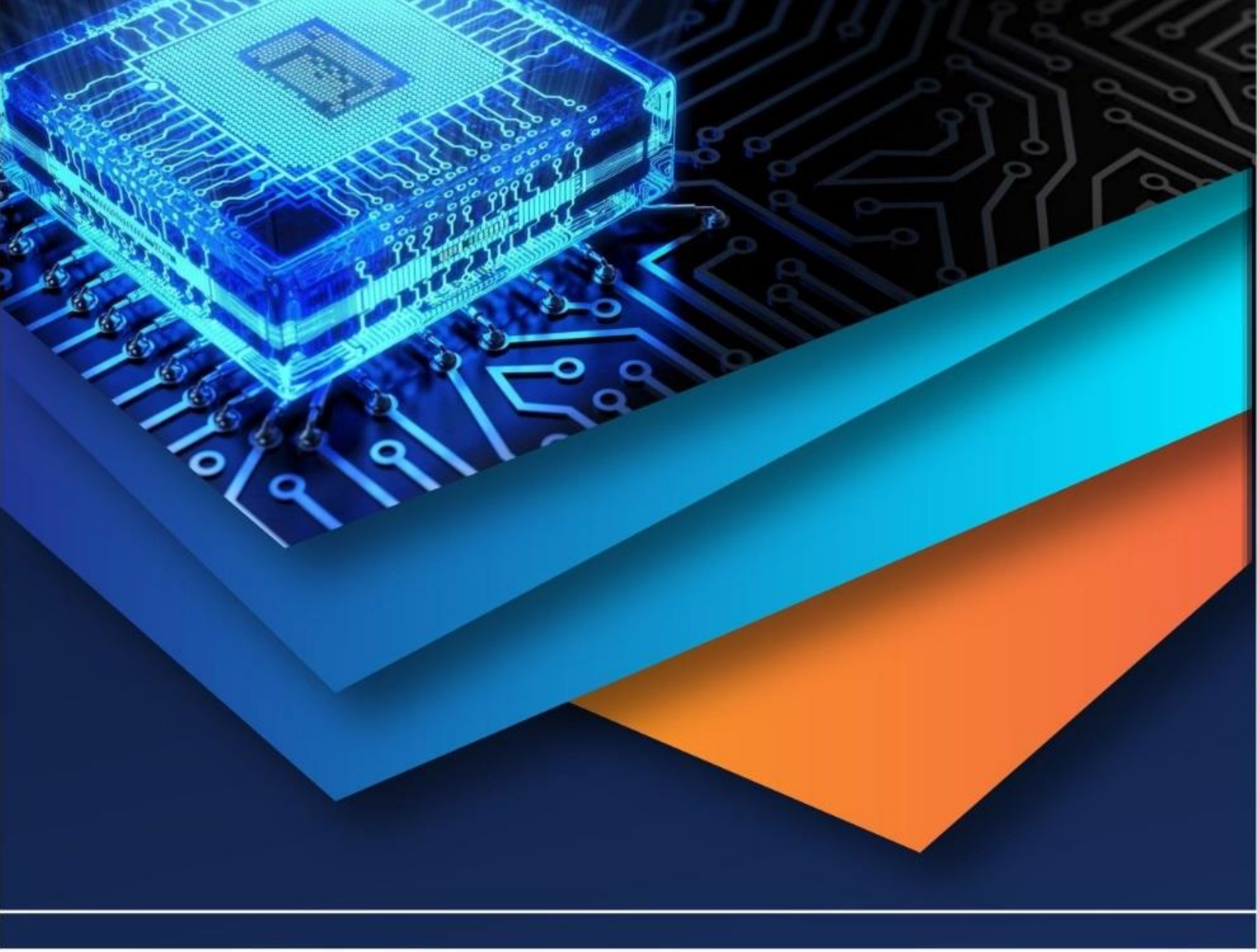

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