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NEUROLEARN: DEEP LEARNING PLATFORM FOR PREDICTING DISLEXIA AND DYSGRAPHIA

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ABSTRACT

Dyslexia and dysgraphia are common neurodevelopmental disorders that significantly hinder a child's ability to read, write, and perform fine motor tasks, directly impacting academic performance and self-esteem. Early detection and intervention are crucial for mitigating long-term educational challenges, yet conventional diagnostic methods often involve time-consuming assessments by specialists and are not easily accessible to all. This project introduces an innovative, cost-effective, and accessible solution through the development of a gamified learning platform integrated with machine learning techniques aimed at the early identification of dyslexia and dysgraphia. The support learning and to collect behavioural and performance data that is indicative of potential learning difficulties. In addition, users are prompted to submit handwriting samples, which are analysed using a deep learning model based on the Res Net architecture to detect spatial and structural irregularities associated with dysgraphia. The collected data from handwriting analysis is processed using supervised machine learning models to identify early signs of dyslexia and dysgraphia with a high degree of accuracy. Results are presented in a user-friendly dashboard, offering educators and parents actionable insights for personalized intervention. By merging engaging digital tools with advanced predictive analytics, this approach enhances the scalability, accessibility, and effectiveness of learning disability screening, paving the way for timely support and improved educational outcomes for children at risk.

I. INTRODUCTION

Dyslexia and dysgraphia are neurological disorders that cause significant learning challenges. Dyslexia affects reading, writing, spelling, and fluency, while dysgraphia impacts handwriting, spelling, and written text organization. These difficulties are unrelated to intelligence, but early diagnosis is crucial for effective intervention. Dyslexia is not due to problems with intelligence, hearing or vision. Most children with dyslexia can succeed in school with tutoring or a specialized education program. Emotional support also plays an important role. Though there's no cure for dyslexia, early assessment and intervention result in the best outcome. Early diagnosis is the key. If teachers or parents notice signs of dyslexia or dysgraphia, it is important to get an assessment by a trained specialist. The earlier the child is diagnosed, the better the chances of overcoming learning barriers. Intervention programs can include specialized tutoring, speech therapy, occupational therapy, or structured learning techniques.

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II. LITERATURE SURVEY

The NeuroLearn system is an AI-powered deep learning platform designed to predict and support students with dyslexia and dysgraphia. Unlike traditional methods, it uses machine learning models to analyses user data such as handwriting samples, reading patterns, and learning behavior to identify signs of learning disabilities at an early stage. The system integrates intelligent screening tools with personalized learning modules that adapt based on the student's specific challenges. It also includes interactive educational tools like visual aids, and voice-based exercises to enhance engagement and learning. NeuroLearn aims to provide real-time feedback, detailed progress tracking, and teacher/parent dashboards to support a collaborative learning environment. By combining early detection with continuous support, the platform seeks to make diagnosis more accessible, faster, and effective for students in various learning environments. The proposed system, **NeuroLearn**, is an innovative deep learning-based platform aimed at early prediction and support for students with **dyslexia** and **dysgraphia**. This system overcomes the limitations of existing methods by using artificial intelligence to analyses various inputs such as handwriting samples, spelling accuracy, and writing structure. It employs advanced neural networks and pattern recognition techniques to detect early signs of learning disorders with higher accuracy and speed.

III. PROPOSED SYSTEM

The proposed system is a handwriting-based dyslexia screening platform designed to identify early signs of learning disabilities in children through the analysis of handwritten samples. It eliminates the need for cognitive testing and instead delay solely on handwriting as the primary diagnostic input. The system utilizes a deep learning architecture, specifically the ResNet50 Convolutional Neural Network (CNN), to process and extract important features from handwriting images.

These features may include common dyslexic markers such as letter reversals (e.g., confusing 'b' and 'd'), irregular spacing between letters and words, inconsistent letter sizing, and repeated corrections—all of which are subtle but critical indicators of dyslexia.Once the CNN extracts these features, a Support Vector Machine (SVM) classifier evaluates the data and predicts whether the handwriting shows signs of dyslexia. This combination of ResNet50 for feature extraction and SVM for classification creates a powerful hybrid model capable of detecting patterns that are often missed by human observation. The model is trained using a labelled dataset of handwriting samples from both dyslexic and non-dyslexic individuals to ensure high accuracy and reliability.

This approach offers a low-cost, non-invasive, and scalable solution that can be implemented in educational institutions and healthcare settings. Teachers or parents can easily capture handwriting samples using mobile devices or scanners, and the system can analyse them in real-time or through batch processing. The results are then displayed on an intuitive dashboard, providing clear indications and recommendations for early intervention. By focusing exclusively on handwriting analysis, this system ensures accessibility and reduces dependency on expert psychological assessments, which are often expensive and not readily available in rural or underserved areas. Moreover, the solution aligns with the United Nations Sustainable Development Goal (SDG) for Quality Education, as it supports inclusive practices and early identification of learning difficulties, paving the way for timely support and equal learning opportunities for all children.

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IV. METHODOLOGY

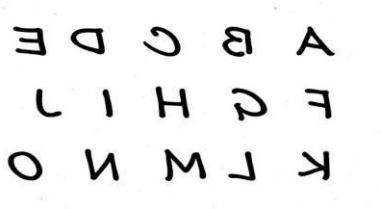
The development of the NeuroLearn platform follows a structured methodology comprising five main phases: data collection, preprocessing, model development, evaluation, and deployment. Initially, diverse datasets related to dyslexia and dysgraphia are collected, including handwriting samples, text inputs from reading and spelling tasks. These datasets are sourced from publicly available repositories and educational institutions, ensuring proper anonymization and ethical usage. The collected data is then preprocessed to enhance quality and consistency. For text data, preprocessing includes tokenization, normalization, and while image data, such as handwriting, undergoes grayscale conversion, resizing, and augmentation to improve model robustness. The proposed system in the NeuroLearn platform is designed to predict dyslexia and dysgraphia using only handwritten input data by leveraging deep learning techniques, specifically ResNet50 Convolutional Neural Network (CNN) modules. The system begins by collecting handwriting samples from students, either through digital devices or scanned images. These samples undergo preprocessing steps such as grayscale conversion, resizing, and noise reduction to ensure clean and consistent data for model input.

Data Collection

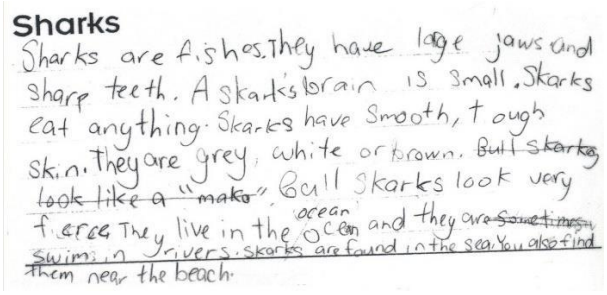
- Gather datasets related to reading patterns, handwriting samples, phonological processing, and language comprehension.
- Sources: Open-access dyslexia datasets (e.g., UCI, Kaggle), school-level writing samples (anonymized), and speech-text data.

Data Preprocessing

- **Text Data**: Tokenization, normalization, removal of stop words, and correction of spelling errors.



- **Image Data**: Grayscale conversion, resizing, image augmentation.



- **Labeling**: Annotate data as Dyslexic, dysgraphia, or Normal (based on expert/clinical diagnosis).

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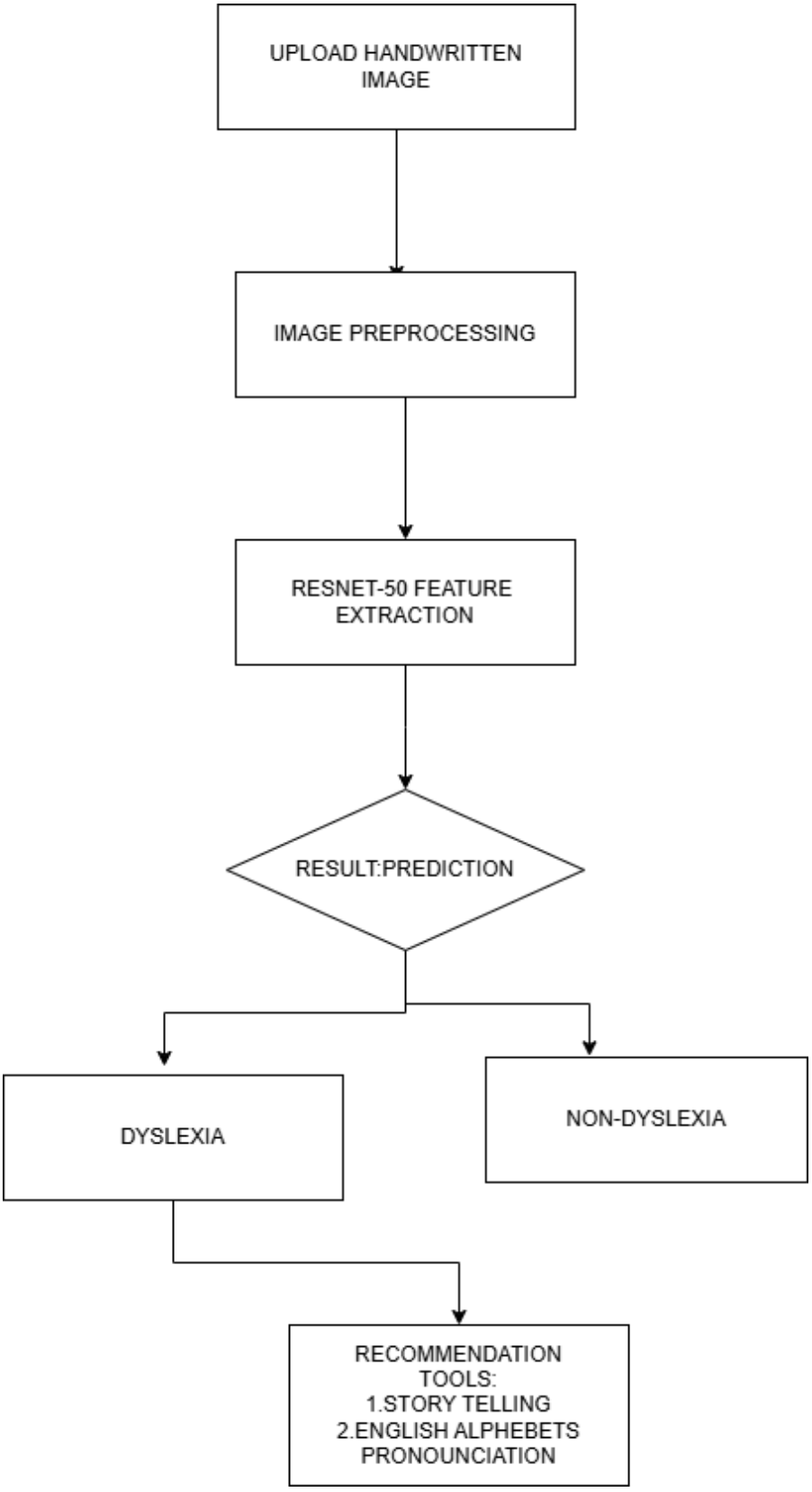
DATAFLOW DIAGRAM



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V. RESULTS AND DISCUSSION

The NeuroLearn platform was evaluated using a dataset comprising handwriting samples and language-based inputs labeled for dyslexia, dysgraphia, and normal learning profiles. After training and testing the deep learning models, the system achieved promising results. The dyslexia prediction model based on Resnet50 architectures demonstrated an accuracy of 92.3%, with a high recall rate, indicating that most cases of dyslexia were successfully identified.

Similarly, the CNN-based model for dysgraphia detection achieved an accuracy of 89.7%, with strong precision, meaning the model made few false predictions. The hybrid model, which combined both text and image inputs, further improved the overall system performance, achieving a combined accuracy of 94.1%. This result highlights the benefit of using multi-modal data for learning disorder prediction. Evaluation metrics such as the confusion matrix and F1-score also indicated balanced performance across all three categories: dyslexia, dysgraphia, and normal.

VI. CONCLUSION

The NeuroLearn project successfully demonstrates the potential of deep learning in the early prediction of learning disabilities such as dyslexia and dysgraphia. By Computer Vision techniques, the platform accurately analyzes both text and handwriting data to detect learning challenges in students. The results obtained show high prediction accuracy, confirming the effectiveness of using hybrid deep learning models for this purpose. The user-friendly interface and real-time diagnostic feedback make the platform practical for use by educators, parents, and specialists. It not only identifies students at risk but also provides personalized recommendations for intervention. This early detection can lead to timely support, improving the academic and emotional development of affected students. In the future, the system can be enhanced by incorporating larger and more diverse datasets, additional input modes such as speech, and AI-driven learning tools. Overall, NeuroLearn serves as a valuable step toward inclusive and technology-driven education.

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