The Journal of Computational Science and Engineering (TJCSE)
ISSN 2583-9055 (Media Online)
Vol 4, No 5, May 2026
PP 19–24

# Analyzing Dysarthria Assessment Using Speech Features and AI Models

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## Abstract

Dysarthria is a neurological disorder affecting the process of speech and significantly impairing communication through speech. The conventional method of assessing the presence of dysarthria uses perceptual analysis performed by a speech-language therapist and is subjective, time-consuming, and depends on the availability of trained specialists. In this paper, a new machine learning technique for automatic dysarthria assessment based on the use of speech features and artificial intelligence is described. The suggested technique consists in the extraction of acoustic features like MFCCs, pitch, and energy from the speech signal followed by its classification with the help of the Random Forest algorithm. The performance of the classifier is compared to SVM and CNN classifiers' performances. Experimental findings confirm that the Random Forest classifier can provide an accurate classification result by requiring relatively low computational effort and performing well even in the case of limited training data sets. The online application designed in this study ensures efficient speech processing and enables early diagnosis and evaluation of patients with dysarthria. The presented system is a viable solution to the problem of computer-assisted diagnosis of speech disorders and can be used by medical experts to improve their decision-making process.

**Keywords:** Dysarthria, Speech Disorder Detection, Speech Feature Extraction, Machine Learning, Random Forest, Support Vector Machine (SVM), Convolutional Neural Network (CNN), Mel-Frequency Cepstral Coefficients (MFCC), Artificial Intelligence, Speech Signal Processing, Healthcare Analytics, Remote Diagnosis.

## 1. Introduction

Dysarthria is a motor speech disorder characterized by difficulty in speaking in an articulate manner. This is caused by neurological problems that cause difficulty with coordination of the muscles involved in speech. Dysarthria may be caused by other conditions including Parkinson's disease, strokes, cerebral palsy, and traumatic brain injuries. Assessment of dysarthria is very crucial to ensure proper management and treatment of this condition.

Conventional dysarthria assessment involves the use of speech-language pathologists who

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conduct perceptual assessments of speech. This is a reliable procedure; however, it is a subjective and time-consuming process. As a result, there is a rising need for more automated and objective assessment procedures.Recently, many developments have been made in Artificial Intelligence (AI) and Machine Learning (ML), which have enabled intelligent speech processing using acoustic features like MFCCs, pitch, and energy, which provide useful data in distinguishing normal speech from dysarthric speech. In this paper, we introduce a novel classification model using random forests to identify dysarthria based on the extracted speech features. The performance of our proposed method is compared to other existing approaches such as SVMs and CNNs. We develop a web-based application that provides an efficient and accurate dysarthria identification system.

## 2. Literature Survey

Dysarthria is considered to be a motor speech disorder that occurs due to neurological problems leading to difficulties in speaking and communication. The current methods of evaluating dysarthria use speech-language pathologists as the main tool of analysis, making the whole process highly subjective and time-consuming. In order to overcome these shortcomings, scientists have employed Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL) in detecting dysarthria and classifying its levels.

Several studies have used Support Vector Machine (SVM) for dysarthria classification using speech features such as MFCC, pitch, and energy. Although SVM may yield good classification results, it requires manual extraction of features and depends very much on the quality of the features extracted.

Modern studies have focused mainly on CNNs and other deep neural networks that automatically detect speech patterns in spectrograms but yield better accuracy. However, these networks need huge amounts of data, require extensive computational power, and take long hours for training purposes, making them unsuitable for real-time application.

In order to meet these challenges, this research paper introduces a RF-based dysarthria severity classifier that will employ speech acoustic features such as Mel-frequency cepstral coefficients, pitch, and energy to classify speech samples. The RF technique provides improved interpretability, quick training time, lesser risk of overfitting, and better performance in small sample size conditions, thus making it appropriate for use in clinical and telemedicine settings.

According to the literature, the application of artificial intelligence technology in the analysis of speech can significantly increase the precision and efficiency of dysarthria diagnosis. This work aims to provide a robust, economical, and easy-to-use model for early identification and grading of dysarthria patients.

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## 3. Methodology

This is a system that uses Random Forest machine learning for dysarthria recognition using speech signals. To start with, speech signals are recorded and undergo noise removal and normalization. After this, important features in the speech signal are extracted. This includes extraction of MFCC, pitch, and energy of the speech signal. The extracted features are used for training the Random Forest model. Finally, the model will be deployed in the Django-based web application for prediction of dysarthria presence.

## 4. Experimental Setup and Implementation

The dysarthria assessment system designed for this study has been created using Python and machine learning libraries such as Pandas, NumPy, Librosa, Scikit-learn, and Django. The dataset has been processed in order to obtain relevant acoustic features, namely Mel-Frequency Cepstral Coefficients (MFCCs), pitch, and energy for training a Random Forest classifier for detection and severity prediction of dysarthria.

### 4.1 Implementation

Implementation of the suggested system will involve the following steps performed sequentially:

1. **Data Collection:** Collecting the samples of speech either from the TORGO database or through the web interface.

2. **Data Preprocessing**: Applying techniques that reduce noise, silence trimmer, and normalizing audio signals to improve audio quality.

3. **Feature Extraction:** Extracting acoustic features such as Mel-frequency cepstral coefficients, pitch, and energy from each speech sample.

4. **Model Training:** The dataset was divided into training and testing sets (80:20). CNN and SVM were implemented as existing models, while Random Forest was used as the proposed model.

5. **Prediction:** Classifying whether the speech sample collected/uploaded is dysarthric or not with the severity level predicted.

6. **Model Evaluation:** Evaluation of the model based on accuracy, precision, recall, and F1-score.

### 4.2 Performance Evaluation

The trained Random Forest model was evaluated using standard classification metrics:

- **Accuracy** – Overall percentage of correctly classified samples.
- **Precision** – Ability of the model to correctly identify dysarthria cases.
- **Recall (Sensitivity)** – Ability to detect all actual dysarthria cases.
- **F1-Score –** Harmonic mean of precision and recall.

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## 5. Result Analysis

The performance of the existing CNN and SVM models was compared with the proposed Random Forest model using Accuracy, Precision, Recall, and F1-Score. Experimental results showed that the proposed Random Forest model achieved the highest performance with an accuracy of 94.83%, outperforming CNN (58.00%) and SVM (86.55%). The Random Forest model also obtained superior Precision (97.00%), Recall (95.00%), and F1-Score (96.00%), demonstrating its effectiveness in accurately classifying dysarthric and non-dysarthric speech. These results confirm that the proposed approach provides more reliable and consistent performance than the existing models.

**Table 1. Performance Comparison**

| Performance Metrics (%) | CNN | SVM | Proposed Random Forest |
|---|---|---|---|
| **Accuracy** | 58.00 | 86.55 | 94.83 |
| **Precision** | 33.64 | 90.00 | 97.00 |
| **Recall** | 58.00 | 90.00 | 95.00 |
| **F1-Score** | 42.58 | 90.00 | 96.00 |

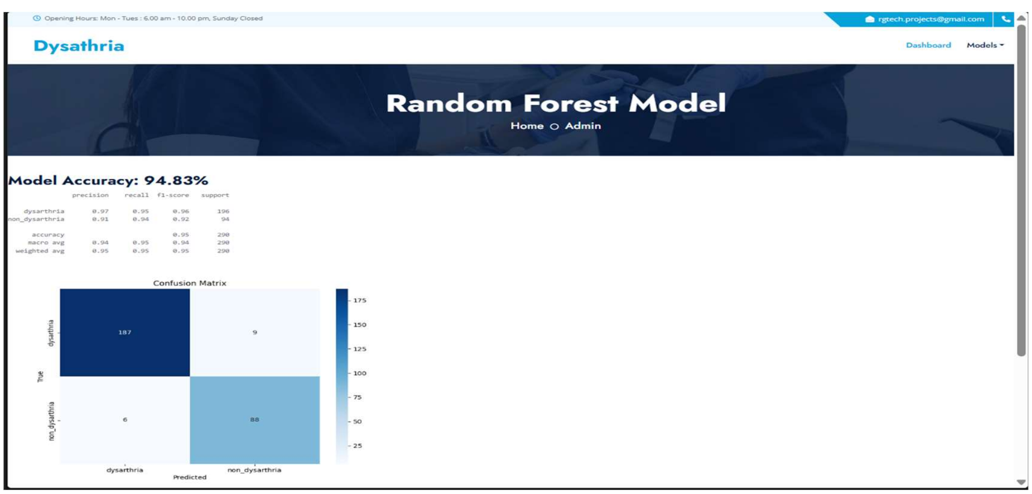


**Figure 1. Confusion Matrix of RF Model**

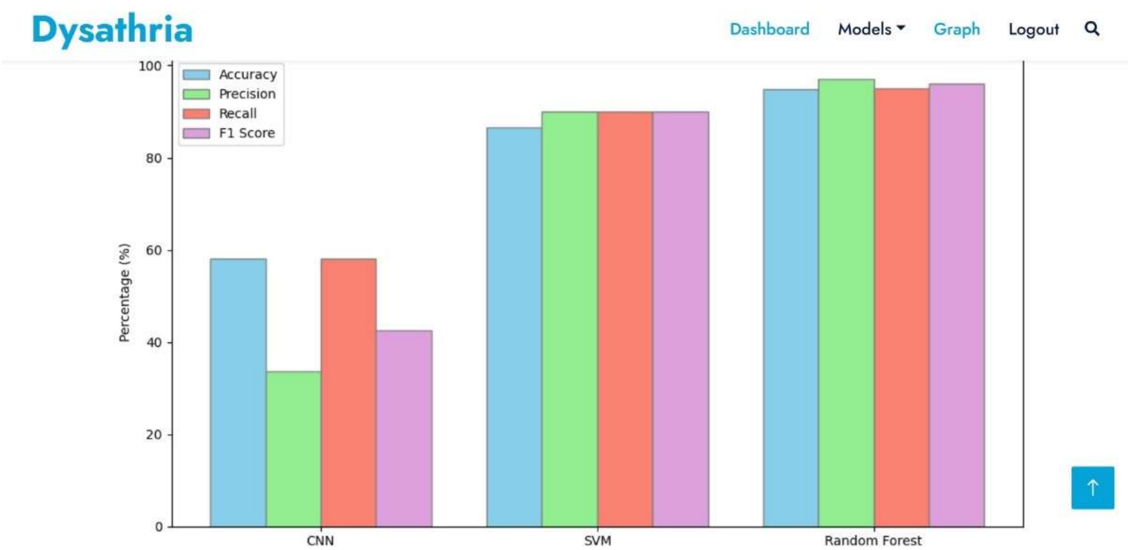


**Figure 2: Performance Comparison of Machine Learning Models**

## 6. Conclusion

The presented research introduces a machine learning-based methodology for evaluating dysarthria using features extracted from audio recordings of speech. The suggested methodology uses acoustic features such as Mel-Frequency Cepstral Coefficients (MFCC), pitch, and energy together with a Random Forest classifier to estimate dysarthric speech accurately. The implemented model has been effectively incorporated into a web application based on Django, allowing users to upload their speech data and get automatic predictions through an easy-to-use interface. It provides an efficient and low-cost way to conduct speech disorder assessment to help clinicians make decisions. For the future, it is possible to improve the algorithm by including bigger and more diverse datasets, using deep learning approaches, analyzing speech in several languages, and developing mobile applications.

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