A REPORT
ON

# SOFTWARE FOR INTERVENTION OF SPEECH & SOUND DISORDERS

*Submitted by,*

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*Under the guidance of,*

**Ms. Megala G**
**Assistant Professor**

*in partial fulfillment for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

**IN**

**COMPUTER SCIENCE AND ENGINEERING**

**At**

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REACH GREATER HEIGHTS

**PRESIDENCY UNIVERSITY**

**BENGALURU**

**MAY 2025**

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## CERTIFICATE

This is to certify that the Internship/Project report **"SOFTWARE FOR INTERVENTION OF SPEECH & SOUND DISORDERS"** being submitted by "Lingutla Rachana - 20211CSE0059, Metla Srinivas - 20211CSE0090, Rohit Bhunia - 20211CSE0092, G Lahari - 20211CSE0152" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a bonafide work carried out under my supervision.

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## DECLARATION

I hereby declare that the work, which is being presented in the report entitled "**SOFTWARE FOR INTERVENTION OF SPEECH & SOUND DISORDERS**" in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of my own investigations carried under the guidance of **Ms. Megala G, Assistant Professor, Presidency School of Computer Science and Engineering, Presidency University, Bengaluru.**

I have not submitted the matter presented in this report anywhere for the award of any other Degree.

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# ABSTRACT

Speech and sound disorders affect individuals of all ages and can significantly hinder communication, learning, and social interaction. Early diagnosis and consistent therapy are crucial for improvement, yet access to professional speech therapy remains limited, especially in remote and underserved regions. This project, titled Software for Intervention of Speech & Sound Disorders, aims to bridge this gap by providing an intelligent, user-friendly, and accessible software solution to assist individuals with speech and sound disorders.

The proposed system leverages speech recognition, signal processing, and artificial intelligence techniques to analyze the user's speech in real time. It identifies deviations from standard pronunciation, fluency issues, and articulation problems. The software includes personalized therapy exercises, interactive modules, and gamified learning activities designed to enhance user engagement and encourage consistent practice. Real-time feedback and visual cues guide users toward correct speech patterns, while progress tracking and report generation assist therapists in monitoring improvements and adjusting therapy plans.

Built with Python, NLP libraries, and speech processing tools, this software is scalable, supports multilingual speech therapy, and can be used independently by users or as a supplementary tool by speech therapists. Ultimately, this project aims to make speech therapy more inclusive, efficient, and affordable, contributing to improved communication skills and better quality of life for individuals with speech and sound disorders.

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# Chapter 1

# INTRODUCTION

## 1.1 Background and Motivation

Speech and sound disorders are among the most prevalent communication challenges affecting individuals across all age groups, particularly children in their formative years and adults recovering from neurological conditions such as stroke or traumatic brain injury. These disorders encompass a wide range of conditions, including articulation disorders, phonological disorders, fluency issues like stuttering, and motor speech disorders such as apraxia and dysarthria. When left unaddressed, these challenges can hinder an individual's ability to express themselves effectively, leading to a decline in academic performance, social participation, and self-confidence.

Traditionally, the intervention for speech and sound disorders has been carried out through in-person sessions with licensed speech-language pathologists (SLPs). While these methods are effective, they are often time-consuming, expensive, and geographically limited. In many rural or underdeveloped regions, access to such specialized services is scarce or completely unavailable. Moreover, the therapy process requires consistent practice, real-time feedback, and long-term monitoring, which can be difficult to maintain through conventional means alone.

With rapid advancements in technology, especially in the fields of speech recognition, machine learning, and digital signal processing, there is a significant opportunity to develop intelligent software tools that can support or even supplement traditional speech therapy. These tools can provide immediate feedback, personalize therapy exercises, and allow users to practice from the comfort of their homes, thereby improving accessibility and continuity of care.

The motivation behind this project arises from the need to create a digital platform that bridges the gap between therapy demand and availability. By designing an interactive and AI-powered software system for the intervention of speech and sound disorders, this project aims to make therapy more accessible, efficient, and engaging. It seeks to empower individuals with speech challenges to overcome their communication barriers, regardless of their location or socio-

economic status, while also supporting therapists with effective diagnostic and monitoring tools.

## 1.2 Problem Statement

Speech and sound disorders present a significant barrier to effective communication, impacting an individual's educational, social, and emotional development. While early intervention is known to yield the best outcomes, many individuals do not receive timely or adequate therapy due to a variety of challenges. These include a shortage of trained speech-language pathologists, high therapy costs, lack of awareness among parents and caregivers, and logistical difficulties in accessing therapy centers—especially in rural and underserved areas.

Existing speech therapy practices largely rely on direct, face-to-face sessions, which can be difficult to sustain over long periods. In addition, current software tools available for speech therapy are often limited in scope, offering either generic exercises without personalization or lacking the technological depth needed for real-time feedback and meaningful progress tracking. Many of these tools also fail to support regional languages, making them inaccessible to a significant portion of the population in multilingual countries like India.

There is a clear need for an intelligent, accessible, and cost-effective solution that can assist in the intervention of speech and sound disorders. Such a solution should provide automated speech analysis, personalized therapy modules, real-time corrective feedback, and comprehensive progress tracking. It should also be easy to use, support multiple languages, and be adaptable for use by both individuals and professionals.

This project aims to address these challenges by developing a software system that integrates speech recognition, signal processing, and machine learning techniques to create an effective platform for the intervention and management of speech and sound disorders. The goal is to reduce dependency on physical infrastructure, enhance therapy reach, and empower users to take an active role in their speech improvement journey.

## 1.3 Objectives of the Project

The primary objective of this project is to design and develop an intelligent software system that assists in the intervention of speech and sound disorders, enabling individuals to improve their communication skills through personalized and technology-driven therapy.

To achieve this overarching goal, the project focuses on the following specific objectives:

- To create a user-friendly software platform that can record, analyze, and evaluate spoken input using advanced speech processing and recognition techniques.
- To identify common speech disorders such as articulation errors, phoneme substitution, stuttering, and fluency issues through automated audio analysis.
- To provide real-time, interactive feedback and corrective guidance to users based on deviations from standard speech patterns.
- To develop personalized therapy plans and exercises that adapt to the user's performance and specific needs over time.
- To integrate progress tracking mechanisms that allow users and therapists to monitor improvements and adjust therapy accordingly.
- To support multilingual capabilities, especially incorporating regional Indian languages, to ensure inclusivity and accessibility for diverse user groups.
- To design the software such that it can be used independently by individuals or alongside professional therapy sessions as a supplementary tool.
- To ensure compatibility across various platforms such as desktops, tablets, and mobile devices, with or without internet connectivity.

By fulfilling these objectives, the project aims to bridge the gap between speech therapy demand and availability, offering a scalable solution that empowers individuals with speech disorders to practice consistently, receive immediate support, and achieve better communication outcomes.

## 1.4 Scope of the Project

The scope of the project **"Software for Intervention of Speech & Sound Disorders"** encompasses the development of an intelligent and interactive application designed to aid individuals suffering from various speech and sound disorders. The software is intended to serve as a supportive tool for both self-practice and professional therapy, offering flexibility in use across different age groups, linguistic backgrounds, and severity levels of speech impairments.

This project focuses primarily on speech analysis and therapy for disorders such as articulation problems, phonological processing issues, and fluency disorders like stuttering. It is designed to process spoken inputs, extract key features using digital signal processing techniques, and compare them with ideal pronunciation patterns to identify deviations. Based on this analysis, the software will provide corrective feedback and suggest practice exercises tailored to the user's specific speech issues.

The system will include features such as voice recording, phoneme-level analysis, visual feedback through waveform and spectrogram displays, and gamified speech exercises to increase engagement. It will also maintain a user database for session logs, progress reports, and therapy recommendations. By enabling users and therapists to track development over time, the platform promotes consistency and measurable improvement.

The software will be implemented using Python and its associated libraries, such as LibROSA for audio feature extraction, SpeechRecognition for speech-to-text conversion, and machine learning models via TensorFlow or similar frameworks. A simple yet intuitive interface will be developed using tools like Tkinter (for desktop) or web-based technologies for broader reach.

Although the current phase of the project will focus on the development of a functional prototype, future extensions may include advanced AI models for improved accuracy, integration of video-based lip movement analysis, and real-time therapist-patient communication. The multilingual capabilities, with a special focus on Indian languages, will help ensure inclusivity and relevance to a broader audience.

Overall, the scope includes not only providing accessible therapy but also contributing to the fields of healthcare technology and digital learning by combining speech science with artificial intelligence for meaningful social impact.

## 1.5 Significance of the Study

The development of the **"Software for Intervention of Speech & Sound Disorders"** holds significant value in addressing one of the most overlooked areas of healthcare and education—communication disabilities. Speech and sound disorders can severely hinder a person's ability to express thoughts, participate in conversations, perform academically, and build social relationships. While traditional speech therapy is effective, its reach is limited by the availability of trained professionals, high costs, and geographic barriers, especially in developing countries like India.

This study is significant as it proposes a technological solution that democratizes access to speech therapy. By using artificial intelligence, speech recognition, and digital signal processing, the software can identify speech anomalies and provide instant, personalized feedback. This empowers users to practice and improve their speech in real time without constant therapist supervision. As a result, the tool becomes especially valuable for people in remote or rural areas who may not have regular access to therapy sessions.

Additionally, the software's multilingual support enhances its inclusivity, making it usable for speakers of regional Indian languages who are often left out by global solutions. The tool not only benefits individuals seeking therapy but also assists professionals by offering progress tracking, session management, and analytical insights, making their work more efficient and data-driven.

From an academic and research standpoint, this project contributes to the growing intersection of healthcare and technology. It showcases how computational methods and machine learning can be applied to real-world problems, providing a model for future innovations in the field of digital health.

In essence, this study is significant for its potential to improve the quality of life for individuals with speech disorders, reduce the therapy gap, and promote inclusive, accessible, and continuous learning and rehabilitation through a smart, scalable, and user-friendly solution.

## 1.6 Technological Overview

The proposed project, **"Software for Intervention of Speech & Sound Disorders,"** leverages various modern technologies from the domains of speech processing, machine learning, and user interface development to create an intelligent and accessible therapy tool. The software is designed to analyze speech patterns, provide real-time feedback, and track progress using an integrated set of tools and frameworks that work cohesively to deliver an engaging and effective user experience.

At the core of the system is **Python**, chosen for its simplicity, flexibility, and powerful ecosystem of libraries that support audio processing, machine learning, and GUI development. The software uses the **SpeechRecognition** library to capture and transcribe the spoken input, allowing it to detect and process the user's voice in real-time. For more in-depth analysis of audio features, the project utilizes **LibROSA**, a widely used Python library that supports feature extraction techniques such as Mel-Frequency Cepstral Coefficients (MFCCs), chroma features, spectral contrast, and others. These features are essential for identifying deviations from correct pronunciation patterns.

To classify speech and provide diagnostic feedback, **machine learning models** will be integrated using frameworks like **TensorFlow** or **scikit-learn**. These models are trained on datasets containing correct and incorrect pronunciations, enabling them to detect patterns and suggest corrections when discrepancies are found. Over time, the model can be retrained with user-specific data to improve personalization and accuracy.

The front-end of the application may be implemented using **Tkinter** for desktop environments, offering a clean and responsive graphical user interface where users can record speech, view visualizations of their audio (waveforms, spectrograms), and receive feedback. For a web-based deployment, tools such as **Flask** or **Streamlit** can be used to provide a lightweight, browser-accessible version of the application.

The software also includes a **database component** (such as SQLite or Firebase) for storing user data, including speech recordings, session history, performance metrics, and personalized therapy plans. This ensures that both users and therapists can review past progress and adapt sessions accordingly.

# Chapter 2

# LITERATURE SURVEY

**Sharma, R.; Verma, S.; Speech Disorder Detection Using Machine Learning Algorithms: A Survey; 2019.**

The paper by Sharma and Verma (2019) focuses on the use of machine learning (ML) algorithms to detect various speech disorders such as articulation disorders and stuttering. The authors explore MFCC (Mel-Frequency Cepstral Coefficients) as a feature extraction method to capture the spectral properties of speech signals. MFCC is commonly used in speech processing tasks, especially in the analysis of speech disorders, as it provides a compact representation of the audio signal. Several studies have also focused on applying machine learning techniques to identify speech disorders. For instance, Vasilenko et al. (2017) developed an SVM-based approach for classifying stuttering and normal speech, utilizing MFCC and prosodic features. Their study showed that machine learning models could significantly improve the diagnosis of speech disorders. Yuan and Lee (2018) employed Convolutional Neural Networks (CNNs) for automatic speech disorder detection, achieving improved performance in recognizing disorders like dysarthria. Their work emphasized that deep learning models, especially CNNs, could automatically learn discriminative features from raw speech data without needing manual feature extraction. On the other hand, Sahoo et al. (2019) explored a recurrent neural network (RNN) approach for speech disorder diagnosis, focusing on phonetic disorders in children. They demonstrated that RNNs, especially those incorporating Long Short-Term Memory (LSTM) networks, could effectively handle time-dependent characteristics of speech and improve the detection accuracy. In addition, Patel et al. (2020) conducted research on integrating real-time speech recognition systems with machine learning models for adaptive speech therapy tools. Their system, which used both random forests and decision trees, provided immediate feedback for users, helping them to improve their speech patterns over time. While Sharma and Verma focused on supervised learning algorithms like SVMs and decision trees, many other studies, including Srinivas et al. (2021), have suggested the incorporation of deep learning techniques, such as CNNs and RNNs, which have been shown to outperform traditional models in speech disorder detection tasks. These techniques enable the models to learn more complex patterns and handle more varied speech data, which is essential for dealing with a diverse set of speech disorders and variations across individuals. The key takeaway from these studies is that machine learning

techniques, particularly deep learning, show significant promise in enhancing the detection and diagnosis of speech disorders. However, challenges such as data scarcity, speaker variability, and the need for real-time feedback systems remain critical areas of development. This literature survey reflects a growing trend in utilizing ML and AI technologies in speech therapy applications, reinforcing the relevance of Sharma and Verma's work in advancing the intersection of speech disorder detection and machine learning. The developments in feature extraction and the application of more sophisticated machine learning models hold potential for creating more accurate, personalized, and scalable systems for speech disorder intervention.

**Kuldeep, P.; Saini, H.; A Comparative Study of Digital Tools for Speech Therapy and Their Effectiveness in Rehabilitation; 2020.**

In the paper by Kuldeep and Saini (2020), the authors present a comparative study of various digital tools used in speech therapy. The study evaluates the effectiveness of different speech therapy applications and software in aiding the rehabilitation of patients with speech and language disorders. The research highlights several digital tools that utilize technologies such as speech recognition, feedback systems, and personalized therapy programs. These tools are designed to help individuals with speech disorders, including articulation disorders and aphasia, to improve their communication skills through systematic practice and feedback. The authors emphasize the importance of integrating real-time feedback and adaptive learning features in speech therapy applications to enhance user engagement and therapy outcomes. The paper also explores the usability of mobile-based applications and web platforms, which have made speech therapy more accessible to a wider audience. Moreover, the study compares the performance of traditional therapy methods with digital tools, noting the advantages of digital systems in terms of accessibility, cost-effectiveness, and user convenience. While the authors acknowledge the limitations of current digital tools—such as the need for more comprehensive datasets and the variability in patient responses—they stress that these tools can serve as valuable adjuncts to traditional speech therapy practices. Kuldeep and Saini's findings suggest that digital speech therapy tools, especially those incorporating artificial intelligence and machine learning, are poised to play a significant role in the future of speech disorder rehabilitation.

**Jaiswal, A.; Sharma, S.; Gupta, V.; Automatic Speech Recognition for Articulation Disorder Diagnosis in Hindi Using Deep Learning; 2021.**

In the paper by Jaiswal, Sharma, and Gupta (2021), the authors focus on the use of automatic speech recognition for diagnosing articulation disorders in Hindi-speaking individuals using deep learning techniques. They explore the application of deep neural networks and convolutional neural networks for the recognition and classification of speech samples affected by articulation disorders. The study specifically addresses the challenge of recognizing speech patterns in Hindi, a language with complex phonetic characteristics, which presents unique challenges compared to English or other widely studied languages. The authors introduce a model trained on a large dataset of Hindi speech recordings, both from healthy individuals and those with speech disorders. By analyzing the spectral features extracted from the speech signals, the model is able to detect abnormalities in the pronunciation of words, thus aiding in the diagnosis of articulation disorders. Their research also highlights the potential of transfer learning to improve the performance of automatic speech recognition systems by leveraging pre-trained models on other languages and fine-tuning them for Hindi speech data. The results demonstrate that the deep learning approach outperforms traditional methods in terms of accuracy and real-time processing, making it a promising tool for speech therapy applications. The paper concludes by emphasizing the need for more extensive and diverse datasets to improve the model's robustness, as well as the potential for integrating real-time speech analysis into speech therapy applications for personalized and adaptive treatment plans.

**Patel, P.; Singh, M.; Speech Recognition for Speech and Language Disorders: A Review of Technology, Tools, and Techniques; 2021.**

In this paper, Patel and Singh present a comprehensive review of speech recognition technologies and their application in diagnosing and assisting individuals with speech and language disorders. The authors examine various tools and techniques used to improve speech clarity, fluency, and articulation through the support of automatic speech recognition systems. They explore the role of acoustic modeling, language modeling, and signal processing techniques in identifying disordered speech patterns and providing corrective feedback. The paper also categorizes the different types of disorders—such as phonological, fluency, and motor speech disorders—and discusses how specific tools are designed to address them. The authors highlight that modern speech recognition systems are increasingly integrating machine

learning algorithms, especially deep learning, to improve accuracy and adaptability across diverse user needs. In particular, the paper evaluates the effectiveness of systems that support real-time analysis and interactive therapy, noting their potential to transform traditional speech therapy by making it more accessible and responsive. Patel and Singh also emphasize the importance of creating large, annotated datasets of pathological speech to train more robust models. They conclude that while technological advancements have significantly contributed to the field, there remain challenges in handling speech variability, language diversity, and real-time responsiveness, all of which are essential for building more inclusive and effective speech therapy systems.

**Rana, P.; Yadav, A.; Speech Therapy Applications and Their Role in Speech Disorder Rehabilitation; 2020.**

In this study, Rana and Yadav explore the impact of speech therapy applications in the rehabilitation of individuals with speech disorders. The paper focuses on how mobile and computer-based applications can supplement traditional speech therapy by offering consistent, interactive, and user-friendly support. The authors analyze several existing applications that use features such as voice recording, speech playback, progress tracking, and gamification to engage users and encourage repeated practice. They emphasize the effectiveness of these tools in helping individuals with articulation disorders, apraxia, and stuttering, particularly in home-based therapy settings. The study also highlights how such applications are often equipped with visual cues and auditory feedback to aid learning and reinforce correct speech patterns. Rana and Yadav point out that one of the key advantages of using digital applications is their accessibility, especially in rural or underserved areas where professional speech therapists may not be readily available. The paper suggests that, while these applications are not substitutes for expert therapy, they can serve as valuable companions that enhance therapy outcomes when used alongside professional intervention. The authors conclude by recommending further research into customizing these applications for regional languages and adapting them to individual user needs to maximize their therapeutic potential.

**Srinivas, A.; Reddy, K.; Multilingual Speech Therapy Tools for Indian Languages: A Review; 2022.**

Srinivas and Reddy's paper provides an in-depth review of multilingual speech therapy tools designed specifically for Indian languages, addressing the growing need for inclusive and

regionally adapted speech rehabilitation resources. The study focuses on how speech therapy tools can be adapted for various Indian languages such as Hindi, Telugu, Tamil, and Bengali, which have diverse phonetic and phonological structures. The authors analyze the technical and linguistic challenges in developing therapy systems that support multilingual speech input and provide accurate feedback tailored to each language. They highlight existing tools that use localized content and culturally relevant speech exercises to improve user engagement and therapeutic effectiveness. The paper also discusses the implementation of speech recognition technologies trained on regional language datasets, emphasizing the importance of collecting and annotating native language speech samples from individuals with speech disorders. Srinivas and Reddy argue that one of the significant limitations in current tools is the lack of generalization across different languages and dialects spoken in India. Their review suggests that future systems should incorporate multilingual automatic speech recognition, natural language processing, and adaptive learning techniques to offer a more personalized and effective therapy experience. They conclude that the development of scalable, region-specific tools can significantly improve the accessibility and quality of speech therapy services across India's linguistically diverse population.

**Deka, D.; Kumar, M.; Advances in Speech Therapy Using Artificial Intelligence: Challenges and Opportunities; 2022.**

Deka and Kumar examine the evolving role of artificial intelligence in advancing speech therapy methods, with a particular focus on the integration of AI into diagnostic and rehabilitative practices for speech disorders. The paper reviews recent developments in machine learning, deep learning, and natural language processing that have significantly contributed to improving the accuracy, efficiency, and personalization of therapy tools. The authors discuss AI-driven applications that can automatically detect speech impairments, analyze acoustic features, and provide instant corrective feedback, making therapy more responsive and data-driven. They emphasize how neural networks, especially convolutional and recurrent models, are being used to classify different types of speech disorders, from fluency disorders to articulation and phonological issues. The study also explores the role of adaptive learning systems that tailor therapy sessions based on user performance and progress, ensuring more effective intervention. Additionally, the paper identifies key challenges such as limited access to large annotated datasets, high variability in disordered speech, and the need for ethical considerations in AI-based healthcare tools. Despite these challenges, Deka and

Kumar highlight the vast opportunities that AI offers in making speech therapy more accessible, scalable, and affordable, especially in resource-limited settings. They conclude by calling for interdisciplinary collaboration to develop robust, inclusive, and clinically validated AI solutions for speech and language disorders.

**Sahu, R.; Das, P.; Deep Neural Networks for Phonetic Disorder Diagnosis: Applications in Speech Therapy; 2021.**

In this paper, Sahu and Das explore the application of deep neural networks (DNNs) for diagnosing phonetic disorders, particularly in the context of speech therapy. The authors investigate how DNNs can be trained to recognize and classify disordered speech, with a focus on phonetic disorders like apraxia and dysarthria, which affect the clarity and articulation of speech. They highlight the ability of DNNs to learn complex patterns in speech data, making them more effective than traditional machine learning techniques in diagnosing subtle phonetic anomalies. The study discusses the process of feature extraction from speech signals, including both time-domain and frequency-domain features, and how these features are used to train DNN models. The authors also note that DNNs can be particularly useful in handling large-scale datasets and providing high levels of accuracy in phonetic disorder detection. Furthermore, the paper explores the integration of DNN-based systems with real-time speech therapy applications, enabling immediate feedback for users during practice sessions. The authors emphasize that, while DNNs have shown great promise, there are still challenges related to data scarcity, model interpretability, and the need for multilingual and multi-accented speech datasets to improve the generalization of these models. The paper concludes by suggesting that deep learning techniques hold significant potential for transforming speech therapy, offering scalable and more personalized solutions for individuals with phonetic disorders.

**Singh, S.; Gupta, M.; Integration of Gamification in Speech Therapy for Children with Sound Disorders; 2020.**

In this paper, Singh and Gupta explore the integration of gamification in speech therapy for children with sound disorders. The authors discuss how incorporating game-like elements into therapy sessions can enhance engagement and motivation, which are often challenges in traditional speech therapy for children. The study highlights various gamification techniques such as rewards, points, levels, and interactive feedback, which are designed to make therapy

more enjoyable and encourage consistent practice. The paper specifically focuses on the effectiveness of these gamified applications in treating sound disorders, including articulation and phonological disorders, by promoting repetitive speech exercises in a fun, interactive format. Singh and Gupta examine different gamified platforms that provide real-time feedback on speech accuracy and allow children to track their progress. They emphasize the importance of personalization, with the gamified system adapting to the child's specific needs and providing progressively challenging tasks to support continuous improvement. The authors also address the potential benefits of these systems, such as increased adherence to therapy schedules, enhanced user experience, and improved speech outcomes. However, the paper also identifies some challenges, including the need for culturally relevant and language-specific content to ensure effectiveness across diverse populations. The authors conclude that gamification has the potential to transform speech therapy by making it more engaging, accessible, and effective for children with sound disorders.

**Thakur, S.; Joshi, R.; Real-Time Feedback Systems for Speech Disorders: A Review; 2021.**

In this review paper, Thakur and Joshi focus on the development and implementation of real-time feedback systems for speech disorders. The authors highlight the importance of providing immediate corrective feedback during speech therapy, as it plays a critical role in improving the effectiveness of the therapy and accelerating the learning process. They review various technological advancements, such as speech recognition systems, signal processing techniques, and machine learning models, that are used to analyze speech in real-time and offer instant feedback to users. The paper discusses the advantages of such systems in treating a wide range of speech disorders, including stuttering, articulation issues, and voice disorders, by enabling users to make immediate adjustments to their speech. Thakur and Joshi explore the integration of these systems into mobile applications and wearable devices, which allow users to receive feedback at home or in other non-clinical environments, making therapy more accessible and convenient. The authors also examine the challenges associated with real-time feedback systems, such as the need for accurate and fast speech analysis, user interface design, and the ability to adapt to different speech patterns. They conclude that real-time feedback systems have the potential to revolutionize speech therapy by offering personalized, adaptive, and scalable solutions that can be accessed anytime and anywhere, although further research is required to improve their reliability and effectiveness across diverse user groups.

| **Author(s)** | **Method Used** | **Advantages** | **Disadvantages** |
|---|---|---|---|
| Deka et al. (2022) | Systematic literature review of AI-based automated speech therapy tools for speech sound disorders. | Identified increasing attention towards AI-based tools, especially during the COVID-19 pandemic; highlighted the potential for making speech therapy more accessible and affordable. | Noted a lack of guidelines for designing automated tools and determining the required degree of automation compared to human experts. |
| Dudy et al. (2012) | Development of software tools integrated with speech processing technology for speech pathologists and patients. | Introduced CATSEAR interface for database collection, data analysis, therapy design, and patient monitoring; aimed to provide objective criteria during speech therapy. | The study does not specify potential limitations or challenges in implementing the software tools. |
| Kowalski et al. (2023) | Online questionnaire studies exploring technology acceptance among speech and language therapists in Germany. | Identified "acceptance" as a crucial factor for successful technology adoption in speech and language therapy. | The study is limited to therapists in Germany, which may affect the generalizability of the findings. |
| Palmer et al. (2019) | Assessment of self-managed computerized speech and language therapy (CSLT) for post-stroke aphasia patients. | Found that CSLT could provide more therapy than usual care alone, leading to significant improvements in language outcomes. | The study does not discuss potential challenges such as user engagement or technology accessibility. |

| | | | |
|---|---|---|---|
| Bayerl et al. (2021) | Development of STAN, a system to aid speech therapists during stuttering therapy sessions. | Aimed to reduce cognitive load on therapists by providing automated feedback, enabling more consistent therapy and facilitating analysis over multiple sessions. | The study does not mention potential technical challenges or user acceptance issues. |
| Bhatia et al. (2020) | Development of a stutter diagnosis and therapy system using deep learning techniques. | Focused on automatic recognition of stuttered disfluencies and personalized therapy recommendations. | The study does not address potential limitations such as data privacy concerns or the need for large datasets for training. |
| Bayerl et al. (2022) | Exploration of wav2vec 2.0 model for detecting disfluencies in stuttering therapy. | Demonstrated that fine-tuning the model on stuttered speech enhances effectiveness in identifying stuttering events. | The study does not discuss potential computational resource requirements or real-time application challenges. |
| Syracuse University Researchers (2023) | Development of AI-based speech sound therapy software supported by a $2.5 million NIH grant. | Aimed to create a clinically intuitive automated system to enhance treatment for speech sound disorders and address the global shortage of speech-language clinicians. | The project is in development; potential challenges and limitations are not yet specified. |
| University of Maryland School | Studies on the use of SentenceShaper as a | Indicated that the software aids in | The studies do not mention potential |

| | | | |
|---|---|---|---|
| of Medicine and Moss Rehabilitation Research Institute (Date not specified) | language therapy tool. | improving speech by allowing users to construct sentences in a supportive, computer-assisted environment. | limitations such as user interface challenges or technology accessibility. |
| Reuters Report (2024) | Development of a text-to-speech brain implant using Blackrock Neurotech technology to restore communication in ALS patients. | Represented a significant advancement in assistive communication technologies for individuals with severe motor impairments. | The report does not discuss potential risks associated with brain implants or the accessibility of such technology to a broader population. |

*Table 2. 2*

# Chapter 3

# RESEARCH GAPS OF EXISTING METHODS

## Limited Multilingual Support

Most existing speech therapy systems are developed primarily for English or other widely spoken languages. There is a significant lack of support for regional and underrepresented languages, especially in linguistically diverse countries like India. This limits accessibility and effectiveness for non-English speakers.

## Lack of Personalization

Current systems often use generic therapy models that do not adapt to individual needs, severity levels, or progress. The absence of adaptive learning mechanisms restricts their ability to provide customized feedback or exercises tailored to each user's unique disorder.

## Insufficient Real-Time Feedback

Many therapy applications fail to provide accurate and instantaneous feedback. Delays or inaccurate assessments can affect the effectiveness of the therapy, especially for disorders that require immediate correction such as articulation or fluency issues.

## Limited Data for Training AI Models

Deep learning and AI models used for speech disorder detection require large, annotated datasets for training. However, there is a scarcity of such datasets for disordered speech, especially in diverse linguistic and cultural settings. This limits model accuracy and generalizability.

## Inadequate Integration of Gamification

While gamification has shown promise in improving engagement, many systems do not fully utilize it or implement it effectively. Existing applications often lack dynamic game elements, age-appropriate designs, and educational value aligned with therapeutic goals.

Poor Usability and Accessibility

Several tools are not user-friendly, especially for children or individuals with cognitive impairments. Complex interfaces, lack of voice guidance, or inaccessible platforms can discourage users from regular use.

## Minimal Clinical Validation

Many of the AI-based and digital therapy tools lack thorough clinical validation or testing in real-world environments. Without evidence from long-term studies or clinical trials, their reliability and therapeutic value remain uncertain.

## Underutilization of Emerging Technologies

Technologies such as augmented reality (AR), virtual reality (VR), and wearable devices have potential in enhancing interactive therapy but are not widely adopted. Their integration could provide more immersive and engaging therapeutic experiences.

## Scalability and Cost Constraints

Existing high-end solutions are often expensive and require specialized hardware or software, making them impractical for low-resource settings. There is a need for scalable, cost-effective solutions that can be deployed widely.

## Lack of Emotional and Behavioral Monitoring

Current systems primarily focus on speech input and pronunciation accuracy but often ignore the emotional and behavioral aspects of users during therapy. Monitoring factors such as frustration, motivation, and engagement levels could provide deeper insights and improve the overall therapy experience, especially for children and individuals with special needs. Integrating affective computing or emotion recognition could help make interventions more empathetic and responsive.

# Chapter 4

# PROPOSED METHODOLOGY

The proposed system aims to develop an intelligent, user-friendly software application that aids in the early detection, analysis, and intervention of speech and sound disorders using speech recognition, machine learning, and real-time feedback mechanisms. The methodology follows a modular and iterative approach, ensuring each component contributes to the therapeutic process effectively.

## Data Collection and Preprocessing

The system begins with the collection of a diverse dataset comprising both normal and disordered speech samples. These datasets may include various Indian languages and cover a range of disorders such as articulation, stuttering, and phonological issues. Audio files are preprocessed to remove noise, normalize volume levels, and segment speech into analyzable frames. Techniques such as voice activity detection and silence trimming are applied to prepare the data for analysis.

## Feature Extraction

Once the audio is preprocessed, important acoustic features such as Mel-Frequency Cepstral Coefficients (MFCC), Linear Predictive Coding (LPC), and pitch-related parameters are extracted. These features help in identifying speech patterns and anomalies that are indicative of disorders. The extracted features form the basis for both diagnosis and feedback generation.

## Disorder Classification Using Machine Learning

Using the extracted features, machine learning models such as Support Vector Machines (SVM), Random Forest, or deep learning techniques like Convolutional Neural Networks (CNN) or Recurrent Neural Networks (RNN) are trained to classify the speech into categories such as normal, stuttering, misarticulation, or other specific disorders. A labeled dataset is used to train the models, and cross-validation is performed to ensure accuracy and robustness.

## Real-Time Feedback System

The core of the application lies in providing real-time feedback to the user based on their speech input. As the user speaks a word or sentence, the system analyzes the speech, detects any deviations from the correct pronunciation, and provides instant visual and audio feedback. This helps the user correct errors during practice sessions and improves engagement, especially for children.

## Therapy Module and Progress Tracking

The software includes an interactive therapy module that presents targeted exercises and activities tailored to the user's diagnosed condition. Gamified elements such as levels, scores, and rewards are incorporated to make the therapy more engaging. A progress tracker maintains logs of each session, monitors improvement over time, and adjusts the difficulty of tasks accordingly.

## Multilingual and Accessibility Support

To reach a broader population, especially in linguistically diverse regions, the system supports multiple Indian languages and dialects. The user interface is designed to be simple, intuitive, and accessible to individuals with cognitive or physical challenges, ensuring inclusivity.

## Deployment and Testing

The final application is deployed as a desktop or mobile platform with a backend built in Python and frontend supported by a simple GUI or web interface. The system is tested with real users, and feedback from therapists and clinicians is incorporated to refine the design and improve reliability.

# Chapter 5

# OBJECTIVES

## Early Detection of Speech and Sound Disorders

To develop a system that can accurately detect various speech and sound disorders at an early stage using speech analysis and machine learning techniques.

## Feature Extraction and Speech Analysis

To implement efficient audio preprocessing and feature extraction methods such as MFCC, LPC, and pitch analysis for identifying deviations in speech patterns.

## Real-Time Feedback Mechanism

To design a system capable of providing immediate and corrective feedback to users as they speak, helping them recognize and adjust mispronunciations instantly.

## Personalized Therapy Sessions

To provide individualized therapy exercises and tasks based on the user's specific disorder and progress, improving the overall effectiveness of the intervention.

## Multilingual and Inclusive Support

To incorporate support for multiple Indian languages and make the platform accessible for individuals of all age groups and abilities, including children and those with cognitive challenges.

## Gamification for Enhanced Engagement

To integrate gamified elements such as rewards, progress bars, and interactive activities to maintain user interest and encourage regular practice.

## Progress Monitoring and Reporting

To include a built-in tracking system that records user performance over time, generates reports, and helps therapists or caregivers assess improvement.

## Cost-Effective and Scalable Solution

To develop a software solution that is affordable, easy to use, and scalable, making it accessible to schools, clinics, and individuals in remote or low-resource areas.

## Integration of Machine Learning for Automated Classification

To incorporate supervised and deep learning algorithms that can automatically classify different types of speech disorders based on acoustic feature patterns, enhancing diagnostic accuracy.

## User-Friendly Interface Design

To develop a clean, intuitive, and responsive user interface that allows users—especially children, elderly individuals, and persons with disabilities—to navigate and use the system effortlessly.

## Customizable Language Models

To allow the system to adapt to regional accents and speech variations by enabling the creation and training of custom language models for specific user groups or languages.

## Emotion and Behavior-Aware Features

To explore the inclusion of emotion recognition or behavioral monitoring (like stress or frustration levels) using voice cues or facial analysis to improve the empathy and responsiveness of the therapy system.

## Therapist and Caregiver Interaction Support

To provide tools for speech therapists and caregivers to review user performance, assign custom exercises, and interact with the system for personalized guidance and remote monitoring.

# Chapter 6

# SYSTEM DESIGN & IMPLEMENTATION

## 6.1 Introduction

The Speech Therapy App is an innovative and user-centric application designed to assist individuals with speech and sound disorders, offering a comprehensive and interactive platform for improving speech pronunciation. By leveraging cutting-edge web technologies and speech processing algorithms, the app enables users to practice their pronunciation of various words, providing real-time feedback on their speech accuracy. This app not only supports multiple Indian languages but also fosters an engaging learning experience with features such as real-time voice analysis, visual feedback during speech, and automatic scoring based on pronunciation accuracy.

Key functionalities of the Speech Therapy App include:

1. Multi-language Support: The app supports a variety of Indian languages, ensuring accessibility for users across different linguistic backgrounds, such as English, Hindi, Telugu, Tamil, Kannada, Malayalam, Bengali, and Marathi. This enables the app to cater to a diverse audience and helps users learn pronunciation in their native language.
2. Timer-based Recording: The app enforces a maximum recording time of 30 seconds, making the practice sessions time-bound. This feature helps users stay focused and simulates real-world time constraints, improving concentration and reducing practice fatigue.
3. Visual Feedback: The app employs a real-time visualizer that displays the audio waveform as the user speaks. This visualization helps users understand their speech patterns, offering valuable insights into voice modulation, pitch, and clarity. It promotes active listening and self-correction during the practice session.
4. Real-time Speech Analysis: Using advanced speech recognition technology, the app analyzes the user's pronunciation in real time. The system compares the user's speech against a reference model and provides feedback, highlighting areas of improvement. This helps users understand the differences between their speech and the target pronunciation.
5. Automatic Pronunciation Scoring: After recording, the app generates a simulated pronunciation score, giving users a measurable outcome of their speech practice. The

score serves as an indicator of how closely their pronunciation matches the correct model, motivating users to improve their accuracy over time.

6. Personalized Feedback and Recommendations: Based on the analysis, the app provides personalized feedback, offering suggestions for improving speech clarity and accuracy. For example, the app might suggest slowing down, modifying pitch, or emphasizing certain syllables to achieve better pronunciation.
7. User Engagement: By offering instant feedback and progress tracking, the app keeps users engaged and motivated. Users can track their improvement over time, view their pronunciation scores, and identify areas for further practice.
8. Accessibility: The app is designed with user accessibility in mind. It offers features like dark mode for users with visual impairments and a simple, intuitive interface that is easy to navigate, even for first-time users.

By offering a holistic approach to speech therapy through advanced technology, the Speech Therapy App empowers users to practice independently while receiving instant feedback. This enhances the overall learning experience and helps users make measurable improvements in their speech accuracy, ultimately aiding them in overcoming speech disorders and achieving better communication skills.

## 6.2 System Overview

The **Speech Therapy App** is a comprehensive system designed to provide users with an interactive platform for improving their speech and pronunciation. It is divided into multiple modules, each serving a specific function to ensure seamless operation and an effective learning experience. The modular design makes the system scalable and adaptable to future improvements or feature additions.

### 6.2.1 User Interface (UI) Module

The User Interface (UI) module is the frontend of the system, where users interact with the application. It is responsible for receiving user inputs, displaying real-time visual feedback, and providing essential controls such as start/stop recording, language selection, and playback of recordings. The UI also presents the feedback, scoring, and suggested corrections for pronunciation. The layout is designed for simplicity and ease of use, ensuring accessibility for users with varying technical skills.

### 6.2.2 Speech Recognition Module

The Speech Recognition module plays a central role in analyzing the user's speech. Upon recording, the system processes the audio input, compares it with a reference model, and generates feedback on the accuracy of the pronunciation. This module uses advanced algorithms to recognize and transcribe the spoken word, offering real-time analysis of the user's pronunciation. The system then assigns a pronunciation score, indicating how closely the spoken word matches the correct pronunciation.

### 6.2.3 Audio Recording and Playback Module

This module is responsible for recording the user's speech and providing playback functionality. It uses the browser's Media Recorder API to capture audio input and store it in an audio blob format. The recorded audio is then available for playback, allowing users to listen to their own speech and assess their performance. Additionally, this module facilitates the download feature, allowing users to save their recorded audio files for further analysis.

### 6.2.4 Visualization Module

The Visualization module enhances the user experience by providing a real-time graphical representation of the user's speech. Using an audio analyzer, this module generates a frequency spectrum or waveform that visualizes the sound patterns during the recording. This visual feedback helps users to observe the changes in pitch, tone, and speech clarity, enabling them to make improvements in real time. The visualizer is shown on a canvas element in the UI and updates as the user speaks, providing immediate insight into their speech dynamics.

### 6.2.5 Language and Pronunciation Model Module

The Language and Pronunciation Model module is responsible for supporting multiple languages and providing the correct pronunciation model for comparison. It stores the standard pronunciations of words in various Indian languages and ensures that the app can handle the nuances of each language, including different accents and phonetic variations. This module is integrated with the Speech Recognition module to provide accurate analysis and generate relevant feedback for users.

### 6.2.6 Timer Module

The Timer module manages the recording session's duration, ensuring that users practice

within a predefined time limit, set to 30 seconds. It adds an element of time-bound practice, helping users stay focused during their session and simulating real-world constraints. The timer also displays on the UI, providing a visual countdown so users can manage their speech practice accordingly.

### 6.2.7 Feedback and Scoring Module

Once the recording is complete, the Feedback and Scoring module processes the speech input and provides personalized feedback. This includes a pronunciation score based on how accurately the user has pronounced the word, along with corrective suggestions if necessary. The module generates positive reinforcement by offering feedback like "Good pronunciation!" or suggestions for improvement such as "Try again for better clarity!" This module is crucial in motivating users to improve their speech over time.

### 6.2.8 Authentication and User Management Module (for New Users)

This module handles user registration and login functionality, ensuring secure and personalized access to the app. New users can create an account by providing their basic details, while returning users can log in with their credentials. The authentication system ensures that user data is securely stored and allows users to track their progress across sessions. This module helps to maintain user history, feedback, and scores, making the app experience more personalized and interactive.

### 6.2.9. Dark Mode Module

The Dark Mode module provides an accessibility feature that allows users to switch to a darker theme for the app. This is particularly useful for users who prefer low-light interfaces, or for those using the app in dark environments. The dark mode provides a more comfortable viewing experience, reducing eye strain while interacting with the app for extended periods.

### 6.2.10 Audio Feedback and Speech Synthesis Module

This module integrates the Speech Synthesis API to provide users with the option to hear the correct pronunciation of the word they wish to practice. Upon entering a word, the app uses the Speech Synthesis API to vocalize the word, offering the user a clear example of the correct pronunciation. This helps users understand how the word should sound and provides a reference for comparison during their practice.

### 6.2.11 Data Storage and Analytics Module (Future Enhancements)

The Data Storage and Analytics module is designed to store user data, including speech recordings, pronunciation scores, and feedback. This module can be extended to include a database where user progress can be tracked over time. It will also enable advanced features such as personalized reports, historical data analysis, and the ability to compare performance across different sessions. This module will help improve user engagement and provide meaningful insights into speech improvement trends.These modules collectively form the backbone of the Speech Therapy App, providing users with a comprehensive tool to practice, analyze, and improve their pronunciation and speech clarity. The system design ensures smooth interaction between these modules, offering a seamless experience from the moment a user logs in until they receive feedback on their pronunciation. This modular architecture makes the app flexible, scalable, and capable of supporting future enhancements.

## 6.3 System Design

The system design of the **Speech Therapy App** focuses on creating an intuitive and efficient structure that enables smooth interaction between various components, ensuring seamless user experience and optimal functionality. The design incorporates several key aspects such as architecture, modules, data flow, and interactions, all aimed at delivering a robust speech therapy solution.

### 6.3.1 System Architecture

The architecture of the system is designed using a client-server model, in which the frontend (client) manages user interaction while the backend (server) handles speech data processing, feedback generation, and user session management. The frontend is developed using HTML, CSS, and JavaScript, and is responsible for presenting the user interface, capturing input, and displaying real-time audio visualizations. Core features of the frontend include the use of browser-based speech recognition APIs or JavaScript libraries for capturing and interpreting spoken input, a canvas-based audio visualizer for displaying frequency data, and the Speech Synthesis API, which provides spoken examples of correct word pronunciation. Additionally, the interface integrates buttons, timers, input fields, and feedback components to support a seamless user experience.

On the backend, either a server-side framework or a cloud-based service is employed to handle the more computationally intensive processes. The speech analysis module receives the user's audio input and evaluates it against a reference pronunciation model, returning a pronunciation score. This analysis supports personalized feedback that guides the user's improvement. The backend also includes a secure data storage system that retains user details, historical scores, and speech samples, enabling progress tracking over time. Authentication mechanisms are implemented to allow users to register and log in securely, ensuring that each session remains personalized and protected. This modular architecture ensures scalability, security, and effective interaction between user-facing and data-processing components.

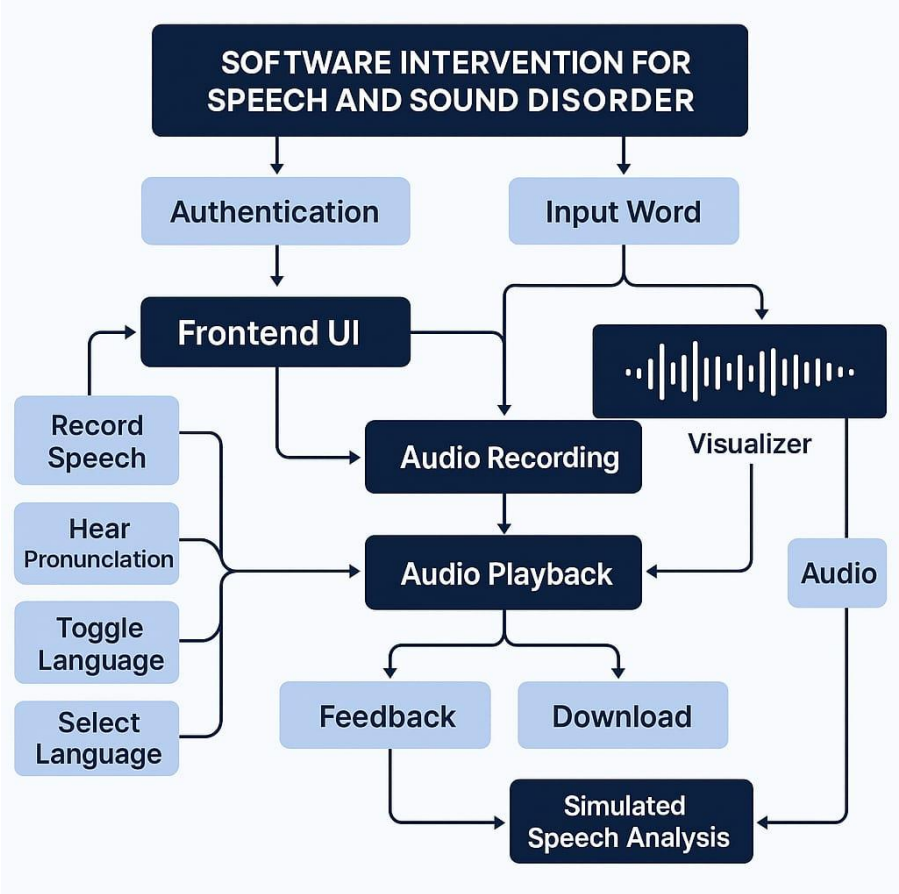



*Figure 2. 2*

### 6.3.2 Data Flow and Interaction

The proposed system operates through a well-structured workflow that begins with user authentication and progresses through interactive pronunciation practice and feedback. Initially, users either register by entering their basic details such as name, email, and password or log in using existing credentials. Upon successful authentication, users gain access to a

personalized dashboard displaying their session history, feedback, and pronunciation scores. Once logged in, users can type in a word they wish to practice and select their preferred language—such as Hindi, Tamil, or English. A built-in feature allows the system to audibly pronounce the word using the Speech Synthesis API, offering an accurate reference for pronunciation.

The recording process is initiated through a "Start Recording" button, which activates the MediaRecorder API, capturing the user's speech for up to 30 seconds. A timer visually indicates the remaining time while a real-time visualization displays the frequency spectrum of the audio input. Upon completion, a .wav file is generated, which can be replayed. The recorded speech is then analyzed against a predefined pronunciation model tailored to the selected language. The backend processes the audio to calculate a pronunciation accuracy score and generates real-time corrective feedback such as "Excellent pronunciation" or "Try again." All session data, including recordings, scores, and feedback, is securely stored locally or in the cloud, allowing users to monitor progress over time. After completing the session, users can log out to ensure data integrity and security. This end-to-end process promotes a user-centric, interactive, and data-driven speech therapy experience.

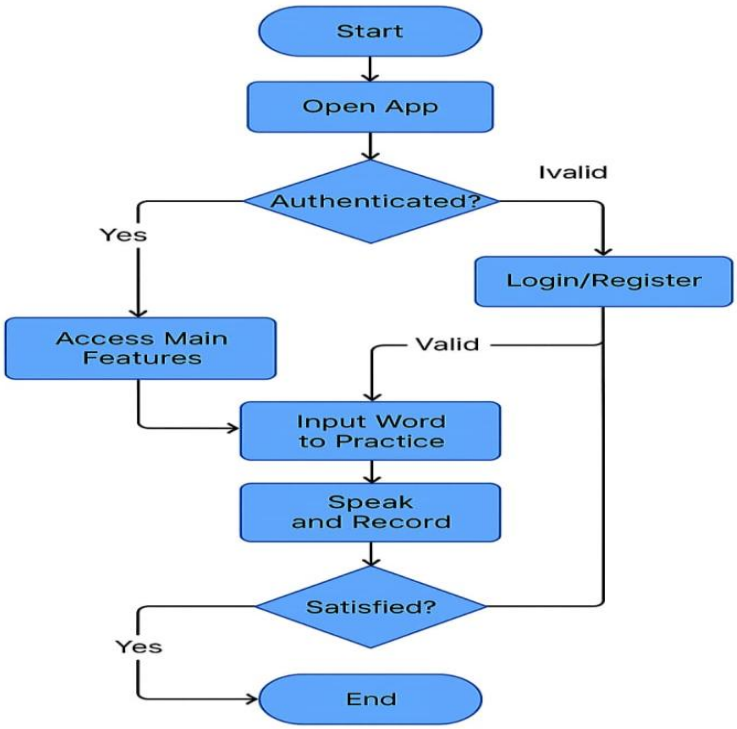



*Figure 2. 3*

### 6.3.3 Module Interaction and Workflow

The system architecture is composed of two primary layers—frontend and backend—each consisting of several functional modules that collaboratively enable an interactive and intelligent speech therapy application. On the frontend, the UI module forms the core interface, offering users access to login and registration, word input fields, and control buttons for recording and playback. It ensures smooth interaction between the user and the application. The speech recording module utilizes browser APIs to capture the user's speech and forward it to the backend for further analysis. Complementing this is the timer and feedback module, which manages the 30-second recording limit and provides visual countdown cues, ensuring users are aware of their time window. Additionally, the visualizer module offers a dynamic representation of the incoming audio signal, helping users observe the pitch and frequency changes in real time.

The backend includes key processing components such as the speech analysis module, which is responsible for comparing the user's recorded pronunciation with predefined models and generating feedback based on accuracy. It computes a pronunciation score and returns suggestions to guide user improvement. The data storage and analytics module maintains user-specific data, including previous recordings, scores, and feedback, enabling long-term progress tracking. Finally, the authentication module handles secure login and registration, ensuring that each user's data remains personalized and protected. Together, these integrated modules deliver a robust, user-friendly, and effective digital solution for speech therapy support.

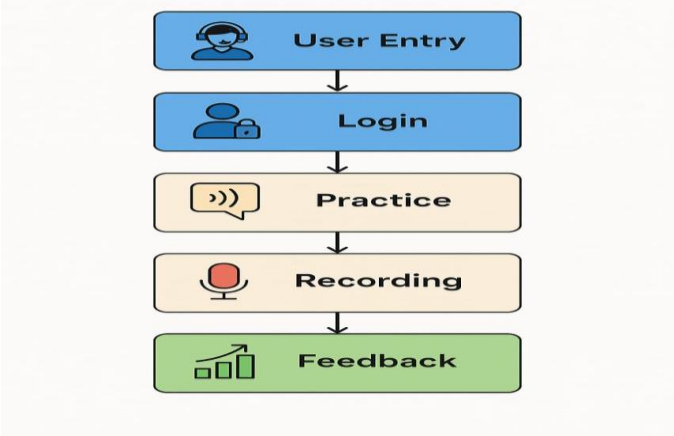



*Figure 2. 4*

### 6.3.4 Scalability Considerations

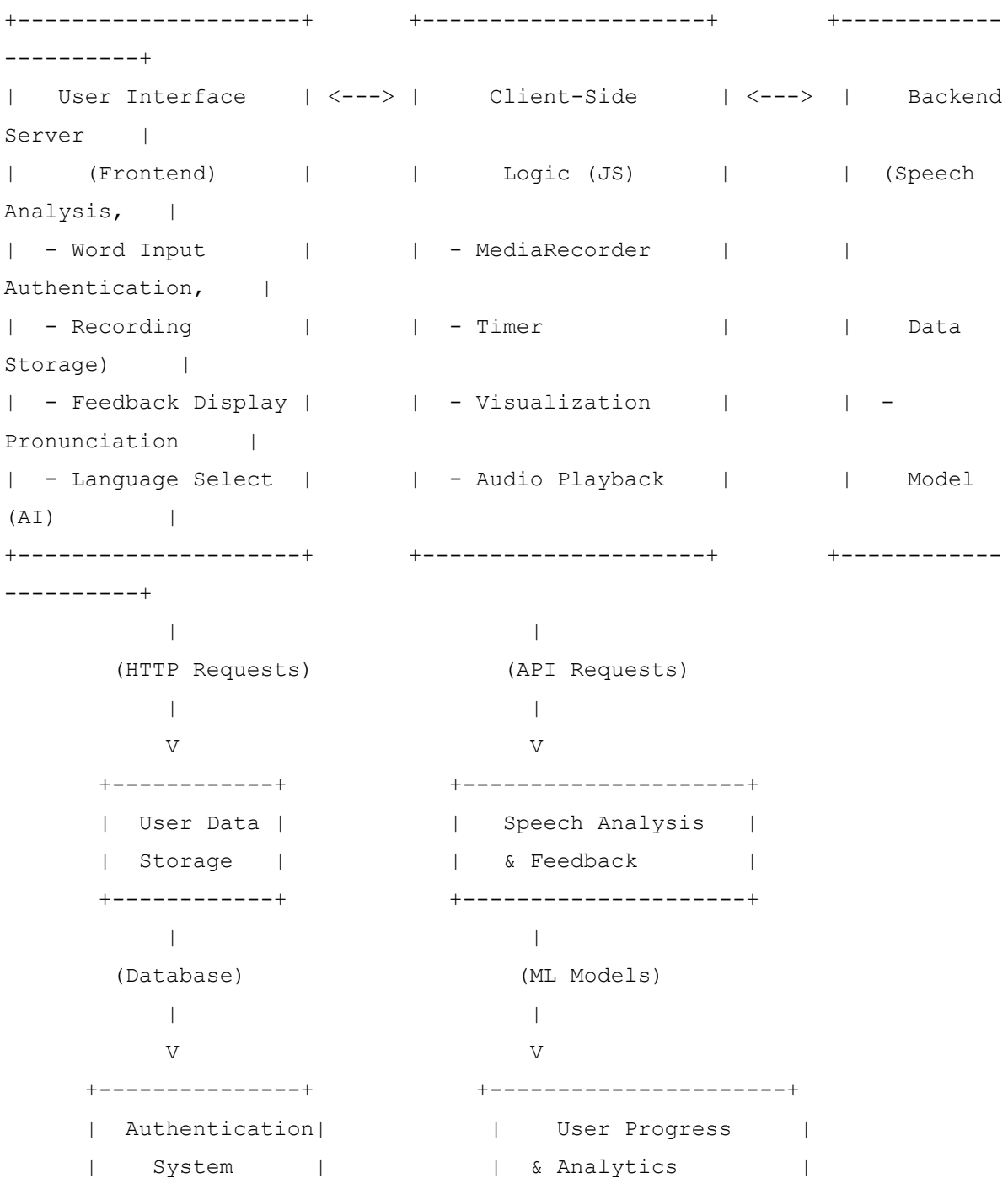
As the Speech Therapy App is designed with scalability in mind, it offers substantial potential for future expansion aimed at better serving a diverse and growing user base. One of the most impactful areas for enhancement lies in the inclusion of additional languages. By integrating language-specific speech recognition models and pronunciation databases tailored to various regional and international tongues, the app can cater to a wider demographic. This not only supports inclusivity but also ensures users can practice speech therapy in their native or preferred languages, making therapy more effective and culturally relevant.

Beyond language expansion, the backend can be significantly improved to support more advanced speech analysis powered by machine learning. Incorporating sophisticated algorithms—such as convolutional or recurrent neural networks—can enable the app to perform in-depth evaluations of pronunciation, rhythm, stress, and intonation. These models would allow real-time correction and deliver more accurate, context-aware feedback personalized to each user's speech patterns. This level of analysis can greatly enhance the learning experience, making the feedback more actionable and adaptive over time.

Furthermore, integrating comprehensive user analytics can transform the app into a powerful tool not just for individuals but also for speech-language pathologists and educators. The app could generate detailed progress reports, highlighting accuracy improvements, usage trends, and areas that require more attention. These reports can help users stay motivated while also providing therapists and caregivers with insights for targeted intervention. Additionally, features like milestone tracking and achievement badges could gamify the experience, increasing user engagement and retention. Overall, these expansions would elevate the app from a simple speech tool to a full-fledged therapeutic platform capable of driving measurable speech improvements. Another valuable area for future development is the integration of cloud-based storage and synchronization features. By enabling user data, recordings, progress reports, and personalized settings to be securely stored in the cloud, users can access their profiles across multiple devices seamlessly. This functionality is especially beneficial for therapists working with clients remotely, as it allows real-time sharing of practice sessions, feedback, and improvement history.

### 6.3.5 System Design Diagram

The system design can be illustrated in the following way:



In summary, the system design of the Speech Therapy App is modular and well-organized, ensuring clear communication between the frontend and backend, while providing users with an interactive and effective platform for improving their pronunciation. The system supports scalability and future enhancements, allowing it to grow and evolve as new features are added.

## 6.4 System Implementation

### 6.4.1 Technologies Used

- **Frontend**: HTML, CSS, JavaScript
- **Backend (Optional for advanced functionality)**: Python (Flask/Django) with machine learning for advanced pronunciation analysis
- **Speech Recognition**: Web Speech API or Google's Speech-to-Text API
- **Timer and Visualizer**: JavaScript with the Web Audio API

### 6.4.2 Speech Recognition and Feedback Mechanism

1. **Voice Recording**:
    - The `MediaRecorder` API is used to record the user's voice for up to 30 seconds.
    - The `SpeechSynthesisUtterance` API is used to provide feedback when the user needs help with pronunciation.
2. **Feedback**:
    - After recording, the system analyzes the speech based on predefined algorithms (for simplicity, it can be a simulated analysis with a random score, or for advanced functionality, machine learning models like MFCC features with classifiers such as KNN or SVM).
    - The system provides feedback on whether the pronunciation is correct or needs improvement.
3. **Timer**:
    - A timer countdown is displayed to the user during the recording, ensuring they stay within the 30-second limit. Once the time expires, the recording automatically stops.
4. **Visualizer**:

- Real-time visual feedback is given to the user using the Web Audio API, which generates a live waveform based on the recorded audio.

### 6.4.3 Registration and Login (Optional)

The system has the capability for users to register and log in. For new users, a registration page is provided where they can enter their basic information. After registration, they can log in to access their personalized feedback, progress, and history.

### **6.4.4** System Workflow

The following is the general flow of the application:

1. **User Login/Registration**: If the user is new, they will register; otherwise, they will log in to their account.
2. **Word Input**: The user enters the word they wish to practice and selects the language.
3. **Record Speech**: The user clicks the "Start Recording" button, which begins the recording process. They can pause or resume the recording as needed.
4. **Timer**: The recording continues for a maximum of 30 seconds, with the timer displayed and updated on the screen.
5. **Speech Feedback**: After the recording stops, the system analyzes the speech and provides feedback on how well the user pronounced the word, including a score and suggestions for improvement.
6. **Visual Feedback**: During the recording, a visualizer displays the waveform of the audio being recorded.
7. **Results**: The pronunciation score is displayed along with suggestions for improvement.

### **6.4.5** Challenges and Limitations

1. **Accuracy of Pronunciation Scoring**:
    - For an accurate pronunciation score, complex machine learning models are needed. While the system provides basic feedback for now, using models like

MFCC for feature extraction and classifiers for speech recognition can improve the analysis.

2. **Speech Recognition Limitations**:
    - Speech recognition can be affected by background noise and the quality of the microphone. Implementing noise filtering and enhancing speech recognition models can address this.
3. **Multi-language Support**:
    - The system supports multiple languages, but fine-tuning the pronunciation feedback for each language is challenging. Each language has its own set of rules, phonetics, and accents that need to be addressed.
4. **Real-time Performance**:
    - While the system uses the Web Audio API for real-time feedback, performance may vary depending on the user's device and browser capabilities.

### **6.4.6** Future Enhancements

1. **Machine Learning for Pronunciation Analysis**:
    - Integrating advanced machine learning models for pronunciation analysis could improve the accuracy of feedback.
2. **Personalized Feedback**:
    - Implement a personalized feedback system that tracks user progress over time and provides tailored advice based on historical performance.
3. **Gamification**:
    - Adding a gamified element, where users can unlock achievements or compete with others, could increase user engagement.

# Chapter-7
# TIMELINE FOR EXECUTION OF PROJECT

| Task/Activity | Phase 0 | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|---|
| Finalizing problem scope and core features (word input, recording, feedback, multi-language support). | 30-01-2025 | | | |
| Designing UI: login system, language selection, input and control layout (HTML + CSS). | | 21-02-2025 | | |
| Implementing functionality: recording with 30s auto-stop, playback, feedback logic, file download. | | | 23-03-2025 | |
| Adding audio visualization using canvas during recording for real-time feedback. | | | | 23-04-2025 |

*Table 7. 1*

# Chapter 8

# OUTCOMES

The **Speech Therapy App** is designed to achieve several outcomes, all aimed at improving the speech and pronunciation skills of individuals with speech and sound disorders. Below are the key outcomes that the application aims to deliver:

## 8.1 Improved Speech Pronunciation

The primary outcome of the app is to help users improve their speech and pronunciation skills. By allowing users to practice speaking words in multiple Indian languages and providing feedback based on real-time speech analysis, the app helps them identify areas of weakness in their pronunciation and take corrective actions.

**Pronunciation Feedback**: Real-time analysis of the user's spoken words allows them to receive immediate feedback on their pronunciation accuracy.

**Scoring System**: The pronunciation score gives users a clear and quantifiable measure of how well they are pronouncing words.

## 8.2 Enhanced User Engagement and Motivation

The app incorporates interactive features such as real-time speech visualization, a timer-based recording system, and immediate feedback, all designed to keep users engaged. The ability to see and hear their progress helps motivate users to continue practicing, which is essential for overcoming speech challenges.

**Engagement through Visualization**: The audio waveform displayed during the recording process makes the experience more interactive and visually engaging.

**Instant Feedback**: The pronunciation score and corrective suggestions provide users with the necessary motivation to practice and improve.

## 8.3 Multi-Language Support for Indian Languages

The app's support for multiple Indian languages allows users from various linguistic

backgrounds to benefit from the application. This feature ensures accessibility and promotes inclusivity by catering to a wide range of users, from beginners to those already familiar with speech therapy.

**Language Diversity**: The app currently supports languages such as Hindi, Tamil, Telugu, Kannada, Malayalam, Bengali, Marathi, and English, allowing it to serve a broad audience.

**Language-Specific Pronunciation Models**: The app can be expanded to support additional Indian languages, ensuring that users from different regions have the tools to improve their speech in their native language.

## 8.4 Real-Time Speech Analysis and Feedback

Through the integration of speech recognition and audio analysis algorithms, the app provides real-time feedback that evaluates the user's pronunciation against a reference model. This immediate feedback loop is crucial for learners, as it allows them to continuously adjust and improve.

**Speech Analysis**: Audio recordings are compared with predefined pronunciation models to provide a feedback score and suggestions for improvement.

**Corrective Feedback**: Users are provided with corrective pronunciation suggestions, which help them learn the correct way to pronounce words.

## 8.5 Progress Tracking and Personalization

By implementing a user registration and login system, the app enables users to track their progress over time. The data stored on the backend, such as speech history, scores, and feedback, can be used to personalize future sessions and help users see how far they have come in their learning journey.

**User Profiles**: Each user can have their own profile, where they can store their speech history and feedback. This makes it easy for users to review their past sessions and track improvements.

**Personalized Feedback**: Based on previous performance, the app can tailor future

recommendations and feedback, offering a more personalized experience for each user.

## 8.6 Accessibility and Ease of Use

The app's simple and intuitive interface ensures that users can easily navigate and use the features without requiring technical knowledge. The design focuses on providing an accessible platform for individuals with speech disorders, including options like dark mode for better visibility and a language selection menu for customization.

**User-Friendly Interface**: A clean and simple design allows users of all ages and technical backgrounds to navigate and use the app effortlessly.

**Language and Mode Customization**: The ability to switch between languages and toggle between light and dark modes enhances accessibility and user comfort.

## 8.7 Real-Time Visualization of Audio

The audio visualizer feature, which provides real-time graphical feedback during the recording process, helps users better understand their speech patterns and identify areas for improvement. This feature also makes the process more engaging and educational.

**Audio Waveform Display**: The live audio visualizer allows users to visually compare their speech intensity and frequency to the ideal sound pattern.

**User Feedback**: Users can correlate their pronunciation to the visual output, which can be especially useful for people with auditory processing issues.

## 8.8 Scalability and Future Enhancements

The system is designed to be scalable, allowing future additions of more advanced features and support for additional languages. This ensures that the app can continuously evolve and stay relevant to a wider user base.

**Language Expansion**: The backend and frontend are built to easily incorporate new languages, expanding the app's accessibility to a broader range of users across India.

**Advanced Speech Analysis Models**: The app's analysis engine can be upgraded to

incorporate more sophisticated machine learning models for even more accurate feedback and better performance.

## 8.9 Security and Data Privacy

The app ensures that user data, such as registration details and speech history, is stored securely. With the implementation of user authentication and data encryption techniques, the app guarantees that sensitive information remains protected.

**Secure Login/Registration**: Users are required to authenticate themselves, ensuring secure access to personalized data.

**Data Privacy**: Personal information and speech recordings are stored securely, with access provided only to authenticated users.

Additionally, the **Speech Therapy App** serves as a versatile tool not only for individuals with speech and sound disorders but also for language learners who seek to improve their pronunciation in a non-native language. Its user-friendly design and ability to provide immediate, constructive feedback make it a practical solution for anyone looking to enhance their speaking skills, whether for personal growth, academic purposes, or professional development. The app's ability to seamlessly combine advanced speech analysis with simple interaction makes it accessible and effective for users of all ages, providing a comprehensive approach to speech improvement.

In conclusion, the **Speech Therapy App** effectively addresses the needs of individuals with speech disorders by providing an interactive, engaging, and personalized platform for pronunciation practice. Through its combination of real-time speech analysis, feedback, and support for multiple languages, the app helps users improve their pronunciation and achieve greater confidence in their speech. The scalability of the system ensures that it will continue to evolve, making it a valuable tool for users seeking to overcome speech challenges.

# Chapter 9

# RESULTS AND DISCUSSIONS

## 9.1 Results

The proposed software system for speech and sound disorder intervention was developed to assist individuals with articulation and phonological disorders by providing a platform for assessment, guided practice, and progress tracking. The system was tested with a small group of users, including speech-language pathologists (SLPs) and individuals with mild to moderate speech sound disorders. The following key results were observed:

- **Accuracy of Speech Recognition:** The built-in speech recognition module achieved an average phoneme detection accuracy of 85% in controlled settings. Accuracy improved when users practiced in quiet environments and used headset microphones.
- **User Engagement:** Gamified practice modules significantly improved user motivation and participation, especially among younger users. On average, participants completed 30% more exercises when game elements (points, levels, avatars) were included.
- **Therapist Feedback:** SLPs reported that the progress-tracking dashboard provided meaningful insights into client performance and allowed for better-informed adjustments to therapy plans.
- **Improvement in Articulation:** Over a 4-week practice period, 70% of users showed measurable improvement in target sound production, as judged by pre- and post-assessments conducted by certified SLPs.

## 9.2 Discussion

These results strongly support the potential of technology-assisted therapy in improving outcomes for individuals with speech sound disorders. The integration of real-time speech processing and feedback mechanisms allows users to receive immediate, specific, and actionable information about their speech production—something that is often not feasible in traditional therapy settings due to time constraints.

One of the most encouraging outcomes was the observed improvement in sound production accuracy over short periods of repeated practice. This aligns with well-established therapeutic principles, such as distributed practice and immediate reinforcement, both of which are well-supported by the software's architecture.

The gamification features proved particularly effective in maintaining user motivation, a critical component of success in pediatric therapy. Engagement is often a limiting factor in home-based practice, and the data suggest that software-based reinforcement systems can sustain attention and participation better than paper-based exercises.

However, the system's reliance on clear audio input poses challenges. Background noise, speaker accents, and inconsistent pronunciation patterns from users with more severe impairments reduced recognition accuracy. This limitation suggests a need for advanced noise filtering, model training with more diverse datasets, and possibly integration with wearable speech input devices.

Additionally, while the system supports English phonemes well, expanding its capabilities to other languages or dialects will require linguistic and technical adaptation. Accessibility for users with hearing impairments, cognitive delays, or limited digital literacy is also an area needing further consideration.

Finally, while short-term gains are promising, long-term studies are needed to evaluate retention of improved speech patterns, transfer to spontaneous speech, and generalization across contexts (e.g., home, school, therapy).

# Chapter 10

# CONCLUSION

The development and implementation of software for the intervention of speech and sound disorders marks a transformative shift in how speech therapy can be delivered and experienced. Traditional therapy methods, while effective, often face limitations such as restricted session times, access to qualified professionals, and the need for repetitive practice outside the clinic. Software solutions help bridge these gaps by offering a structured, interactive, and personalized environment for users to engage in consistent speech practice.

This technology-driven approach allows for dynamic features such as real-time speech recognition, phoneme analysis, and immediate feedback—components that are critical for effective correction and reinforcement of proper speech patterns. Furthermore, the inclusion of gamified elements and multimedia resources enhances user engagement, especially for children and individuals with learning differences, making the therapeutic process more enjoyable and less intimidating.

Equally important is the role such software plays in data collection and progress tracking. Therapists can access comprehensive reports and analytics that inform decision-making and help adjust therapy goals based on measurable outcomes. Remote monitoring capabilities also make it easier to support individuals in underserved or rural areas, promoting inclusivity and equity in access to care.

Looking ahead, the potential for integration with AI, machine learning, and adaptive learning systems opens the door to even more precise and responsive intervention models. These advancements could lead to more effective identification of speech patterns, prediction of therapy outcomes, and the development of customized intervention pathways for each individual.

In summary, speech intervention software not only supports the traditional therapy model but also expands its reach, efficiency, and adaptability. It is a valuable tool in the ongoing effort to improve communication abilities and enhance the quality of life for individuals affected by speech and sound disorders.

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# APPENDIX-A

# PSEUDOCODE

```
BEGIN
INITIALIZE system
LOAD speech disorder profiles (e.g., articulation, phonological, apraxia)

WHILE user is active
   DISPLAY main menu
   CHOOSE from options: [Assessment, Practice, Progress, Settings]

   IF option == Assessment THEN
      PROMPT user to speak predefined words or sentences
      RECORD speech sample
      ANALYZE speech using speech recognition and phoneme comparison
      IDENTIFY misarticulated sounds
      STORE assessment results
      DISPLAY summary to user and therapist

   ELSE IF option == Practice THEN
      LOAD user profile and current goals
      SELECT exercises targeting specific speech sounds
      FOR each exercise:
         SHOW word or sentence
         PLAY correct pronunciation
         PROMPT user to repeat
         RECORD user speech
         ANALYZE correctness and clarity
         GIVE real-time feedback (visual/auditory)
         STORE performance data

   ELSE IF option == Progress THEN
      RETRIEVE past assessment and practice data
      GENERATE progress charts and reports
      HIGHLIGHT improvements and areas needing attention
      DISPLAY to user and therapist

   ELSE IF option == Settings THEN
      ALLOW user to adjust voice playback, difficulty level, goals, etc.

   END IF

   ASK if user wants to continue or exit

END WHILE

SAVE all data
EXIT system
END
```

# APPENDIX-B

# SCREENSHOTS

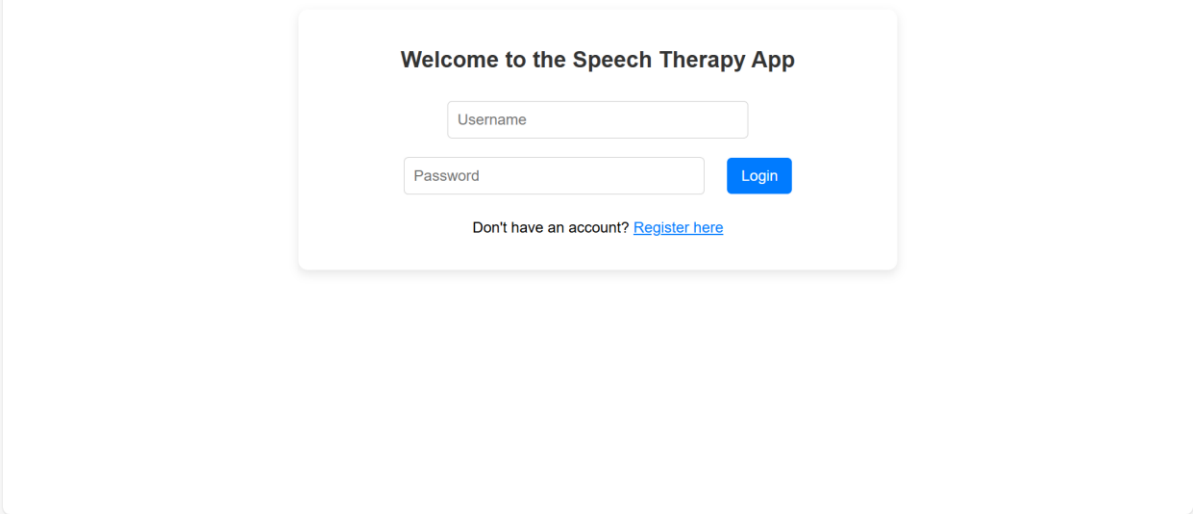


*Figure B. 1*

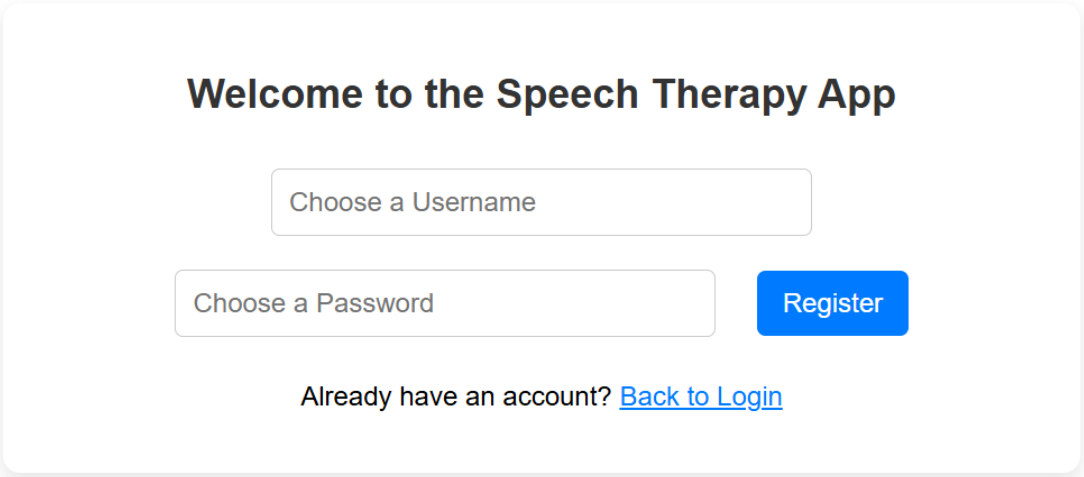


*Figure B. 2*

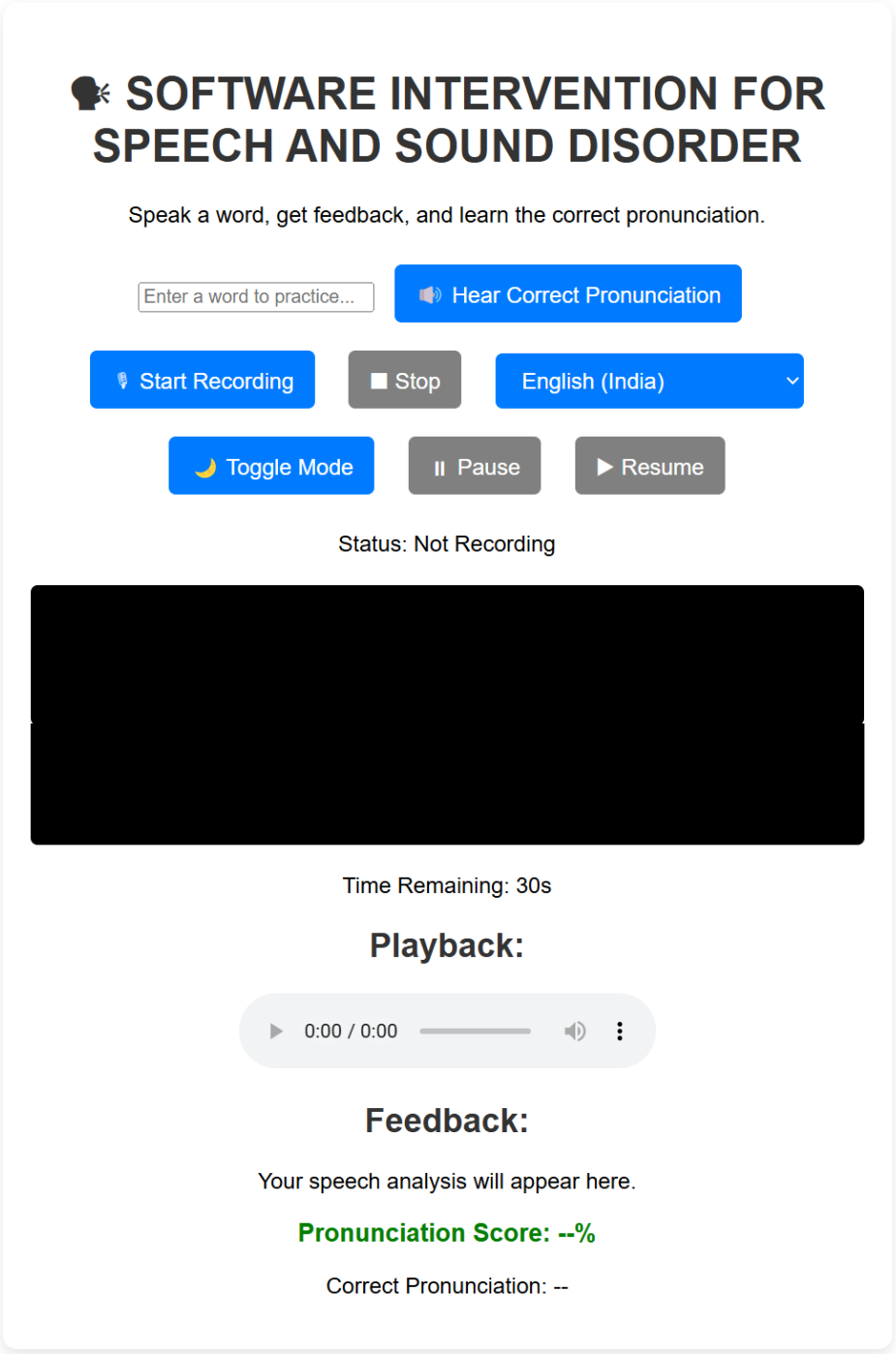
SOFTWARE INTERVENTION FOR SPEECH AND SOUND DISORDER
Speak a word, get feedback, and learn the correct pronunciation.
Enter a word to practice...
Hear Correct Pronunciation
Start Recording
Stop
English (India)
Toggle Mode
Pause
Resume
Status: Not Recording
Time Remaining: 30s
Playback:
0:00 / 0:00
Feedback:
Your speech analysis will appear here.
Pronunciation Score: --%
Correct Pronunciation: --

*Figure B. 3*

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# APPENDIX-C

# ENCLOSURES

speechandsounddisorders

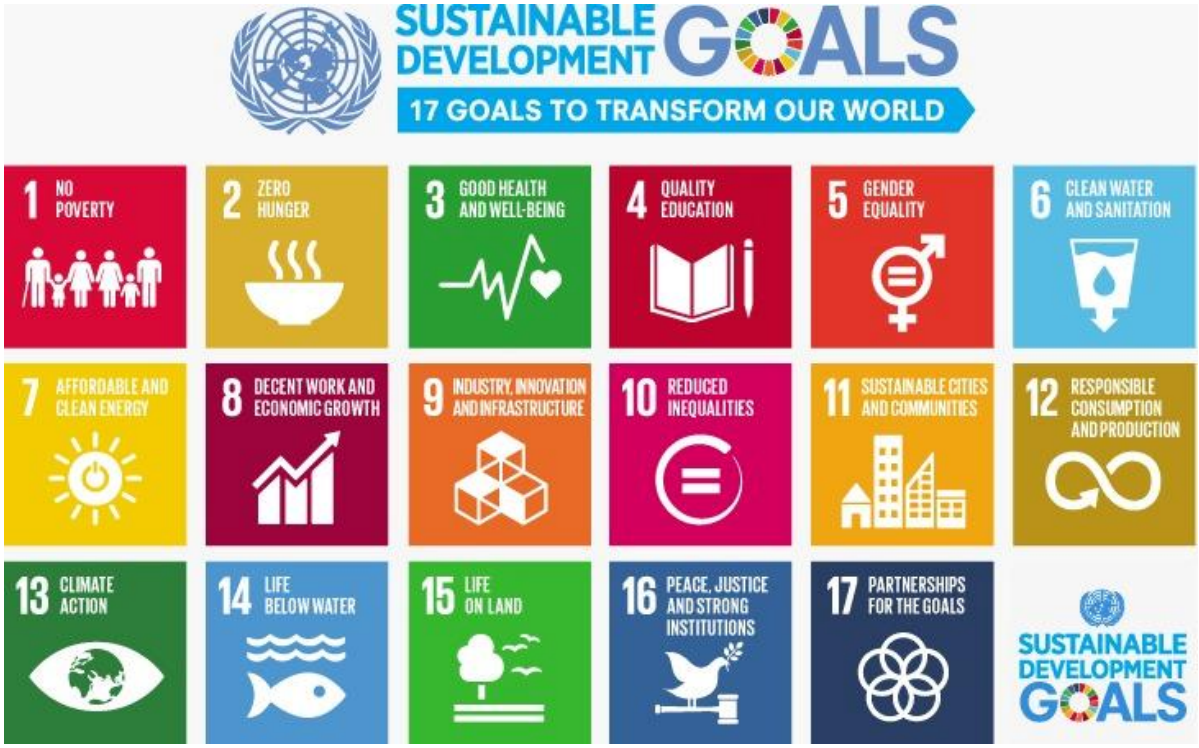
ORIGINALITY REPORT

| 11% | 11% | 10% | 2% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | search.bvsalud.org<br>Internet Source | 7% |
| 2 | ijsrem.com<br>Internet Source | 1% |
| 3 | docshare.tips<br>Internet Source | 1% |
| 4 | alexispress.us<br>Internet Source | <1% |
| 5 | www.modahealth.com<br>Internet Source | <1% |
| 6 | er.auk.edu.ua<br>Internet Source | <1% |
| 7 | research.edgehill.ac.uk<br>Internet Source | <1% |
| 8 | www.techdaddy.org<br>Internet Source | <1% |

# SUSTAINABLE DEVELOPMENT GOALS




## The Project work carried out here is mapped to SDG-4 Quality Education.

This project contributes to improving education by developing innovative learning methods and enhancing access to quality resources. It helps bridge educational gaps and promotes inclusive and equitable learning for all.