A Project Report on

"SpeakUp - Language Learning Web App"

Submitted to

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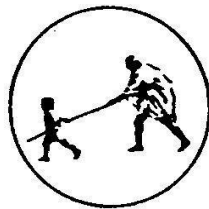
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in
COMPUTER SCIENCE & ENGINEERING

By

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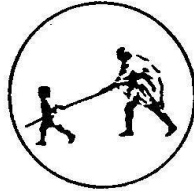of

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This is to certify that the project entitled

SpeakUp – Language Learning Web App

*being submitted by **Ms. Shradha Bandurkar, Ms. Shweta Pattewar, Ms. Roshani Patharkar, Ms. Nakshatra Yerawar** to the Dr. Babasaheb Ambedkar Technological University, Lonere , for the award of the degree of Bachelor of Technology in Computer Science and Engineering, is a record of bonafide work carried out by them under my supervision and guidance. The matter contained in this report has not been submitted to any other university or institute for the award of any degree.*

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ABSTRACT

This project introduces a Full-Stack Web Application designed to help users practice and improve their language skills through Speech Recognition, Interactive Exercises, and Real-Time Pronunciation Correction.

The system offers a user-friendly interface built with React.js, allowing learners to select their target language and engage in various interactive activities such as vocabulary quizzes, sentence completion tasks, and conversation simulations. A key feature is the ability for users to practice speaking directly into the application using a microphone.

On the back-end, developed using Node.js and Express, the platform manages user data, tracks progress, and handles secure authentication. The most advanced aspect is the integration of AI Speech Recognition technologies, such as Google Speech-to-Text API or DeepSpeech, which enables the system to analyze users' spoken input in real-time.

The application uses React.js with HTML, CSS, and JavaScript for the front end, while Node.js and Express.js handle the back-end functionality. MySQL is used for database management, and Google Speech-to-Text API enables AI-based speech recognition for pronunciation and listening practice.

TABLE OF CONTENTS

List of Figures

INTRODUCTION

These days, knowing more than one language isn't just a nice skill to have it's practically a must. Whether you're aiming for better grades, career opportunities, or just want to connect with people, being able to communicate across languages opens doors. But let's be honest: the old methods textbooks, memorizing endless lists, sitting in class don't really help when it comes to speaking up or fixing your accent. Most people walk away still feeling awkward in real conversations because there's never enough real practice or feedback.

That's where this project comes in. We're building a full-stack web app where you can actually speak into the system, get instant feedback on your pronunciation, and work through exercises that actually test your vocabulary, grammar, and listening. It uses AI for speech recognition, so the feedback feels personal and immediate not just generic corrections. By mixing the latest web tech with smart speech processing, we're making language learning less of a chore and more of an experience you'll actually want to stick with.

This platform tackles what current language learning tools miss. It brings together real-time speech analysis, personalized feedback, and progress tracking all in one place. The goal? Help people get better at new languages, boost their confidence, and offer a practical, hands-on way to really learn.

1.1 Project Overview

Language learning tech has come a long way. These days, you've got all sorts of tools apps, games, you name it that help you pick up vocabulary, grammar, pronunciation, listening, and speaking skills. Back in the day, most digital language tools were pretty basic. You'd get computer programs with quizzes, flashcards, grammar drills. Nothing fancy. They didn't really adapt to your needs or give you much feedback, but honestly, they got the ball rolling.

Things really changed when mobile apps got involved. Suddenly, learning a language felt more like playing a game. Apps like Duolingo, Babbel, and Rosetta

Stone added interactive lessons, streaks, rewards the kind of stuff that keeps you coming back every day. Learning started to feel fun. Still, most of those apps focused on reading and listening. Real-time speaking feedback? Not so much. So while they made language learning more accessible, there's still room for better ways to practice speaking.

Speech recognition tech has completely changed how people learn languages. Now, systems can actually listen to what you say and check how accurate your pronunciation is. Thanks to deep learning, AI models pick up on tiny differences in sounds, catch various accents, and even track your intonation. Tools like Google Speech-to-Text, Azure Cognitive Services, and OpenAI's speech models are pretty impressive they turn speech into text quickly and accurately, which makes speaking exercises way more useful.

On top of that, you've got intelligent tutoring systems. These aren't just your basic language apps they watch how you're doing, remember your progress, and adjust the lessons to fit you. If you struggle with certain words or sounds, the system spots it and helps you fix it. That kind of personalization keeps people motivated and helps them move forward consistently. When you put all these elements together speech recognition, smart feedback, gamified features, and lessons that adapt to you get the backbone of today's language learning platforms. The project we're working on taps into all these advancements to build a platform that really focuses on speaking skills and real-time pronunciation.

1.2 Problem Definition

Digital learning platforms have come a long way, but language learners still hit roadblocks—especially when it comes to speaking and pronunciation. Most tools out there just don't give you accurate, instant feedback. So, when people practice on their own, they miss their mistakes. Those bad habits stick, and it's tough to fix them later.

Classrooms aren't much better. Teachers can't always give everyone enough time or personal help with pronunciation. Plus, let's be real, plenty of students feel awkward or nervous about speaking up in front of others. That hesitation means they don't get enough practice, and their fluency takes a hit.

Most language learning apps today push vocabulary drills and grammar exercises pretty hard. Sure, those things matter, but they don't really help you sound natural when you speak. A few apps try to include speech practice, but honestly, they just recycle the same templates over and over. There's not much depth, and they don't really adapt to you as an individual. There's another thing that bugs me: a lot of these tools barely show you how you're actually doing. You don't get real feedback on your fluency, accuracy, speed, or even how your pronunciation stacks up. If you can't see where you're strong or where you need work, it's tough to stay motivated and progress just drags.

1.3 Objectives of the Project

This project aims to build an AI-powered language learning web app that really focuses on speaking and pronunciation. The idea is to make learning feel interactive and personal, no matter your age or background. One big goal: bring in advanced speech recognition that actually listens to how you speak, spots mistakes right away, and gives you quick feedback like showing you where you slipped up, how to fix it, and even rating your performance on the spot. That way, you don't have to wonder what went wrong. You just jump right into practicing and improving.

Another key part is creating exercises that get you talking and listening, not just staring at a screen. Picture pronunciation drills, repeating new words, or tackling speaking tasks that feel like real conversations. You're not just memorizing you're using the language. And honestly, none of this works without a clean, easy-to-use interface. The plan is to design something that looks good and makes sense, so you can move between lessons, see how you're doing, and actually want to keep going. It's about making language learning simple, practical, and kind of fun.

We're building the platform so it actually works on your phone or your computer—no fussing with awkward layouts. The backend needs to be strong enough to handle speech data, user profiles, and real-time feedback without slowing down. We're keeping performance data safe, too, so learners can check their progress and spot where they can do better. At the end of the day, it's all

about blending AI, smart web tech, and proven ways to learn so people can really improve their speaking skills.

1.4 Scope of the System

This project is all about building a full-stack web app that uses AI to help people get better at speaking and pronouncing a new language. It's got a bunch of key features: users can sign up, log in, and manage their profiles. Once they're in, they'll find a set of interactive exercises stuff like listening, speaking, and live pronunciation feedback, all powered by AI.

When someone speaks into the app, the speech recognition module turns their words into text and checks how close their pronunciation is to the target. The backend takes care of all the heavy lifting: storing user info, keeping track of exercises, crunching the numbers on performance, and saving progress and scores. That way, learners can see how much they've improved over time. The infrastructure behind the scenes makes sure everything between the AI engine and the user interface runs quickly and smoothly.

Now, there are a few things this project doesn't cover right now. It won't handle advanced grammar fixes, real-time chats with other learners, or support for more than one language at least not for the initial launch. Those are on the list for possible future updates. And just so it's clear: everything happens online. The backend takes care of all the heavy lifting: storing user info, keeping track of exercises, crunching the numbers on performance, and saving progress and scores. That way, learners can see how much they've improved over time. The infrastructure behind the scenes makes sure everything between the AI engine and the user interface runs quickly and smoothly.

1.5 Background of the Study

Language shapes the way we connect and understand each other. And in today's world, knowing more than one language isn't just a nice-to-have it opens doors, whether you're looking to stand out at work, boost your grades, or just feel more at ease in new places. People have always tried to pick up new languages through classes, textbooks, or just memorizing lists of words. Sure, these methods work to

a point. But they're often too one-size-fits-all, and let's be honest, they don't always match up with what each person actually needs. Plus, real conversation practice the stuff that really helps you learn can be hard to come by.

Now, things look different. Technology has shaken up how we learn. With apps, online courses, and smart devices everywhere, it's way easier for anyone to start learning a new language, no matter where they live. You can practice whenever and wherever you want. Still, even with all these new tools, most of them zero in on reading and writing. Speaking and pronunciation? Those parts still trip people up, and a lot of digital platforms don't do much to help. That's where the real challenge is now.

AI and speech tech are shaking up how we learn. Now, machine learning can listen to your speech, catch pronunciation mistakes, and give you instant feedback. Suddenly, you can practice talking whenever you want, without worrying about messing up in front of someone else or trying to book a lesson. Because of this, there's a real demand for smart language learning systems stuff that combines speech recognition with interactive practice to actually help people get better at speaking.

1.6 Significance

Artificial intelligence has totally shaken up how people learn languages. Now, with tools that act a lot like real tutors, you can practice speaking on your own and get instant, honest feedback—no need to wait around for a teacher. It's a game-changer for anyone, no matter where they live or what time it is. Learning a new language just got a whole lot easier and way more flexible. Speech recognition tech is surprisingly sharp these days. It listens to how people talk, catches pronunciation slip-ups, spots accent issues, and even tracks fluency. Try doing all that in a regular classroom teachers just don't have the time to dig that deep with every single student. But AI? It can. It keeps tabs on each learner, watches how they're doing, and then tweaks lessons to match what they need. Sometimes it'll push harder exercises. Other times, it'll point out exactly where someone needs more work. Honestly, this kind of personal touch keeps people motivated and helps them actually get better.

There's more. AI gives feedback right away, so learners fix mistakes before those bad habits stick. Without that quick correction, it's way too easy for wrong pronunciations to become second nature and a pain to unlearn later. When you get feedback on the spot, you lay down solid basics from day one.

1.7 Project Flow

We start the project by digging into what users actually need. That means figuring out what the system has to do and what limits we're working with. This way, everyone's on the same page from the start, and we know the system will actually help learners the way it should. Next comes the design phase. Here's where we sketch out how everything fits together architectural diagrams, flowcharts, the whole deal. We map out the front-end, back-end, and AI parts so they all play nicely together. On top of that, we put together UI/UX wireframes. These help us picture what the user will see, making sure the whole thing feels easy and natural to use.

Picking the right technology is a big deal here. The team looks at front-end frameworks, backend setups, databases, and AI speech recognition tools, always keeping performance, scalability, and easy integration in mind. That way, the system runs well now and can grow later if needed. When it's time to build, developers break things down into modules like user authentication, exercise features, and speech recognition. They test each one separately first. Once those pieces work on their own, they fit everything together, making sure all the parts actually talk to each other without any hiccups.

They don't really give you much chance to practice speaking, even though that's a huge part of learning a language. In the last ten years, technology has completely changed how we learn. Online tools and digital platforms have opened up language learning for just about anyone, anywhere. Now, as long as you've got an internet connection and a phone or laptop, you can work on a new language from your couch, a café wherever. But here's the thing: most of these digital tools still put the spotlight on reading and writing. Speaking and pronunciation? Those are still tough for a lot of people because the tools just don't give them enough attention.

LITERATURE REVIEW

Over the last ten years, artificial intelligence has completely changed how people learn new languages. Instead of sticking to old-school methods that depend on constant teacher guidance, AI lets you move at your own speed and get help whenever you need it. Studies show that AI-driven tools make learning more effective by tailoring lessons to fit your needs, switching things up as you go, and giving instant feedback. These systems can pick up on details like your pronunciation, grammar, vocabulary, and how smoothly you speak. You find out right away where you're struggling, so you can actually work on those weak spots. Plus, with natural language processing, AI can even mimic real conversations, making practice feel less like homework and more like talking to someone. All in all, AI makes language learning a lot more flexible and centered around what you need.

Look at today's language learning apps and you'll see just how much technology has changed the game. Duolingo is everywhere you know, the one with the little green owl. It uses rewards, points, and daily streaks to keep people coming back. Still, its pronunciation feedback is pretty basic; it doesn't really get into the nitty-gritty of how you're saying each sound. Babbel takes a different route. It leans into real-world conversations and everyday phrases, but skips over deep speech analysis. Then there's Rosetta Stone, which throws you into immersive lessons with lots of pictures and context. It uses its TruAccent tool to check your pronunciation, but sometimes it just can't handle the way different people speak. Elsa Speak is a bit of a standout it's powered by AI and actually picks up on tiny mistakes in how you articulate words, stress syllables, or use intonation. Even with all these choices, none of them really nails it when it comes to combining real-time speech analysis, personalized feedback, and interactive practice all in one package.

2.1 Introduction to SpeakUp

Language learning apps put a new language right in your pocket. With just your

phone or laptop, you can jump into lessons that cover everything vocabulary, grammar, listening, reading, even speaking. The best part? You don't have to stick to a classroom schedule. You can practice whenever you want, wherever you are. That kind of freedom makes picking up a new language a lot easier for everyone. Language learning apps really shine when it comes to multimedia. They mix in audio, videos, animations, and images, all to help you understand and remember things better. Listening to real voices is a huge deal, too. It lets you hear how things actually sound, so your pronunciation and listening skills get a real boost.

These days, language learning apps lean hard on artificial intelligence to make things more personal. AI keeps an eye on how you're doing, spots the stuff you struggle with, and lines up exercises that actually fit your needs. So, instead of trudging through the same lessons as everyone else, you move at your own speed. But it's not just about the technology watching you. These apps pull you in with interactive quizzes, pronunciation practice, and instant feedback. You're not just reading or memorizing words you're actually using them. And when it comes to speaking, built-in speech recognition lets you work on your pronunciation whenever you want, no teacher required.

Language learning apps keep you on track with reminders, daily goals, and progress tracking, so you don't just forget about your lessons. That regular push really helps you stick with it and honestly, that's what makes the difference when you're trying to get fluent. The gamification side, like earning points, badges, or keeping up a streak, adds a bit of fun and keeps you coming back. These apps aren't just a new trend they've changed how people approach language learning. Instead of old-school memorization, you get interactive tools that actually help you build real communication skills. They blend tech and teaching in a way that just makes sense for how people learn today.

2.2 Review of Existing Platforms

Right now, there are a bunch of language learning apps out there, and each one takes its own approach. Duolingo, Babbel, Rosetta Stone, and Busuu are some of the big names mmillions of people use them, mostly because they're simple to use and the lessons make sense. Usually, these platforms zero in on building your

vocabulary, helping you practice grammar, and giving you the basics of putting sentences together. Duolingo turns language learning into a bit of a game, with quick lessons, quizzes, and those little rewards that keep you coming back. It lets you practice speaking by repeating words or sentences into your phone, and the app listens to check your pronunciation. But honestly, the feedback doesn't go much further than telling you if you got it right or wrong. There's not a lot of help on what you need to fix or how to get better.

Babbel's all about getting you talking. It leans into real conversations and breaks down grammar in a way that actually makes sense when you're out there using the language. Sure, you get some speaking practice, but don't expect super detailed feedback on your pronunciation—it keeps things pretty simple. Rosetta Stone takes a different route. It throws you right into the language, skipping translations and pushing you to think in that new language from the start. There's speech recognition to check your pronunciation, but if you want the really good features, you'll usually have to pay extra, which can be a dealbreaker for some people.

Busuu mixes self-paced lessons with a real community feel native speakers actually check your responses. For pronunciation, you're mostly counting on other users, not on any fancy automated tools. These platforms work well if you're just starting out, but they usually don't offer sharp, real-time help for pronunciation or the finer points of speaking. Honestly, there's still a gap when it comes to tools that really help you nail accuracy and fluency.

Platform	Speech Feedback	Real-time Correction	Pronunciation Depth
Duolingo	Basic	Limited	Word-level
Babbel	Moderate	Limited	Phrase-level
Rosetta Stone	Advanced	Partial	Accent-level
SpeakUp	Advanced	Yes	Phoneme-level

Table. 2.1: Comparison of Existing Platforms

2.3 Features and Limitations

Most language learning platforms pack in a bunch of tools to help you actually pick up a new language. You'll find things like step-by-step lessons, vocab practice, grammar workouts, listening exercises, and a bit of speaking practice. All this stuff comes together to give learners a solid base in their new language.

A lot of platforms let you track your progress and see how you're doing. You can check your scores, get feedback on lessons you've finished, and see where you're strong or where you still need work. That kind of feedback keeps people motivated and makes it easier to keep getting better. Accessibility matters toomost language apps work on both web and mobile, so you can switch between your phone and computer without missing a beat. Thanks to cloud syncing, your progress follows you everywhere, which just makes the whole process smoother and easier.

But there are some real drawbacks, too. The biggest issue? You don't get much help with pronunciation. Sure, speech recognition picks up what you're saying, but it usually misses the little mistakes and doesn't tell you how to fix them. There's also not much support for different accents or dialects. If you have a strong regional accent, chances are the system won't always understand you, which just leads to bad feedback and a lot of frustration. In the end, this makes speech-based learning less useful for a lot of people. A lot of platforms depend on a steady internet connection and stick to rigid lesson plans. If you're aiming for things like accent training or just want to get better at real conversations, that setup can feel pretty limiting. Honestly, it just shows why we need smarter language learning apps—ones that use AI to give real-time pronunciation help and feedback that actually fits each person.

SYSTEM REQUIREMENTS

Building an AI-powered language learning web app starts with clear system requirements. You need to know exactly what the app should do, how it needs to run, and what resources you'll need to pull it off. These requirements lay out what the system can handle, any limits it has, and what you'll need to make everything work smoothly.

The platform needs to be both secure and easy to use. Learners should be able to sign up, log in, and update their profiles without any hassle. Once they're in, they can practice different languages through a mix of activities—think speaking, listening, and quizzes. Real-time speech recognition is a must, so users can record themselves and get quick feedback on how they sound. The system should listen carefully, catch mistakes, and offer helpful tips, along with confidence scores and insights into their performance. Progress tracking and analytics help learners see how they're doing and watch themselves improve over time.

3.1 System Overview

This system is a web app that uses AI to help people get better at speaking and pronouncing a new language. Old-school methods lean heavily on textbooks, classroom lessons, and feedback that usually comes way too late. That's not great if you actually want to speak the language out loud. With this app, you just talk right into it, and it gives you feedback in real time. You get to practice as much as you want, work on your pronunciation, and see your progress right away. It's a setup that makes it easier to keep learning, stick with it, and actually feel more confident when you speak.

Recent studies in language education keep coming back to one thing: personalization matters. This new system doesn't just hand out the same lessons to everyone. It actually watches how you're doing, spots where your pronunciation slips up, and then gives you practice that zeroes in on those trouble areas. You get to pick your language and your skill level, and the system adjusts everything to fit. So, whether you're just starting out or you've been at it for years, you get

material that makes sense for you. It's a whole lot more effective than just tossing everyone the same exercises and hoping for the best.

The system pulls together three main parts: the front end, the back end, and the AI-powered speech recognition. On the front end, learners get an easy-to-use interface where they can dive into lessons, record their voices, and check out feedback. The back end takes care of all the behind-the-scenes stuff—user logins, sessions, lesson tracking, and keeping data safe. Then there's the AI speech engine, which listens to what users say, turns their speech into text, and checks how well they're pronouncing things. All these pieces work together so users get instant feedback and the whole thing runs smoothly.

Speech recognition and pronunciation correction sit at the heart of this system. The moment someone speaks, the system grabs the audio and runs it through AI models built on tons of speech data. Then, it checks what was said against standard pronunciations, catching mistakes down to single sounds and whole words. After that, it hands out accuracy scores and tips on how to fix any slip-ups. Studies keep showing that quick feedback really matters for learning how to pronounce things right—it lets people fix their mistakes before they turn into habits.

User engagement really matters here. The system uses interactive exercises, visual feedback, and progress tracking to keep people coming back. It records your learning and shows how you're doing, so you can actually see your progress. Plus, things like scores and achievement badges give you that extra push to keep going. Research shows that when platforms are interactive and engaging like this, people stick with them longer and feel way more satisfied.

Because the system runs in a web browser, people can jump in and practice their language skills whenever they want, wherever they are no need to mess with special software. It's easy for lots of users to join at once, and adding new languages or features is pretty straightforward. This flexible setup just makes sense for today's schools and learners, who expect technology to be open and accessible to everyone.

3.2 System Architecture

We built the AI-powered language learning app on a client server model, plugging in cloud-based AI for all the heavy lifting. This setup isn't just popular in research you see it a lot in speech-based learning tools because it handles real-time data fast and smoothly. By keeping client and server roles separate, the system tackles tough speech recognition jobs without slowing down the user experience. This architecture really holds everything together, making sure users can count on smart, responsive interactions every time they use the app.

The front-end is where users actually interact with the system. It's the side they see and use whether they're registering, logging in, picking a language, or jumping into a speaking exercise. This layer grabs audio straight from the browser, then shows real-time feedback like pronunciation scores and helpful tips. A good front-end isn't just about looks; it keeps people engaged and makes everything feel easier, which matters a lot in educational tools that rely on constant back-and-forth.

The back-end is really the heart of the system. It handles things like user logins, sessions, managing lessons, and keeping data safe. On top of that, it connects the front-end with the AI speech engines. When a client sends in speech data, the back-end checks the request, sorts out the details, and sends the audio to the right AI service. Studies show that having this central layer boosts security, keeps data consistent, and makes it easier to maintain everything.

We use a layered, modular setup to make the system more flexible and easier to scale. The front-end, back-end, and AI processing parts all work on their own, so you can tweak or upgrade one without messing up the rest. Want to add a new language, drop in a fresh learning module, or swap in a better AI model? No problem it's all built for that. Studies back this up too; modular designs work especially well for AI projects because they keep things open for updates and new tech down the road.

Real-time speech processing needs different parts of the system to talk to each other quickly and stay in sync. The setup uses asynchronous communication, so when someone speaks, the system can handle that input right away without

13

freezing up the user interface. That keeps things moving smoothly and cuts down on lag. People who've studied this stuff say that using a layered architecture with asynchronous processing works best for educational apps that run in real time. It spreads out the work and keeps the user experience solid.
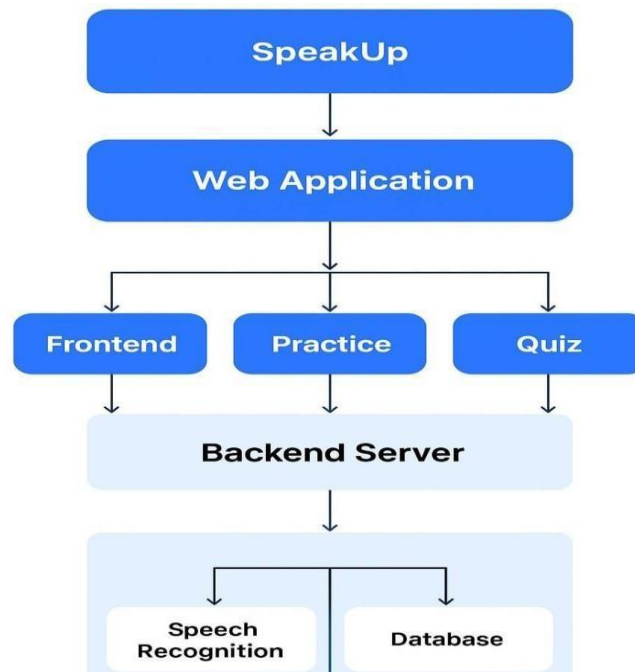

Fig. 3.1: System Architecture

3.3 System Modules

This AI-powered language learning web app breaks everything down into clear, separate modules. That makes it easier to keep things running smoothly, fix problems, and expand the system later on. Developers love this kind of modular setup, especially for AI projects, because it helps them tackle complicated problems by splitting the work into smaller, manageable chunks. Each module handles its own job and connects with the others only where needed. That way, if you need to update or fix something, you don't have to worry about messing up the whole system. It just keeps things flexible and a lot less stressful.

The User Authentication Module keeps access to the app secure. It takes care of registration, login, logout, and all the session stuff. Basically, it makes sure only the right people get to use personalized learning features and see their saved progress. This part also handles user profiles—stuff like language settings and how advanced someone is. People who study this kind of thing always say strong

authentication is key for protecting user data and keeping trust in online education platforms. With the Language Selection Module, users pick the language they want to learn and sometimes, the level that matches their skills. It's a big deal for making the whole experience feel personal. Once users make their choices, the system pulls up the right lessons, pronunciation practice, and vocabulary drills. Studies show that when people get to choose what they study, they're more motivated and learn better. That's why this module sits at the heart of the system.

The Speech Recognition Module sits at the heart of the app. It listens to what users say and turns their speech into text, thanks to AI-powered speech recognition models. These models learn from huge amounts of data, so they pick up on all sorts of accents and ways of speaking. Research backs up using ASR for language learning because it lets people practice speaking whenever they want and get instant feedback no teacher needed.

The Pronunciation Scoring Module listens to how you speak and checks your pronunciation against standard examples. It digs into each sound, spots any that don't quite match, and gives you a score. After that, the system points out what you got wrong maybe it highlights tricky sounds or shows you how to shape your mouth better. Studies show this kind of detailed, sound-by-sound feedback actually helps people improve their pronunciation more than just correcting whole words.

The Interactive Exercises Module packs in all sorts of activities speaking drills, vocabulary work, pronunciation practice, you name it. These aren't just about clicking through; they push you to jump in and really practice. The interactive setup keeps you coming back, and the more you use it, the more your confidence grows, especially when it comes to speaking. Research backs this up too: when you learn by doing and keep things hands-on, you remember more and get way better at using the language for real.

The Progress Tracking Module keeps tabs on how users are doing as they learn. It saves pronunciation scores, tracks which exercises they've finished, and logs their learning history. Then it shows all this in a way that's easy to understand think

charts or progress bars so people can actually see how far they've come. Studies show that tracking progress keeps learners motivated and aware of their growth, so this feature really matters in today's language learning tools. The interactive setup keeps you coming back, and the more you use it, the more your confidence grows, especially when it comes to speaking. Research backs this up too: when you learn by doing and keep things hands-on, you remember more and get way better at using the language for real.

So, here's the thing: the system's modular setup just works. It's reliable, easy to fix, and you can tweak or upgrade it down the road without any headaches. Every module does its own job, but together, they make the whole language learning platform smarter and more efficient. This approach follows solid software engineering principles—you can keep improving each part without messing up everything else.

3.4 Flow Chart

Flowcharts make it easy to see how the AI-powered language learning system works, step by step. They lay out exactly what happens when a user interacts with the system and how the system responds. Developers and evaluators both find flowcharts helpful—they turn complicated workflows into something you can actually follow with your eyes. In this project, flowcharts show how the system takes someone's speech and turns it into useful feedback. It's a clear way to break down what's going on behind the scenes.

It all starts when the user tries to log in. The system checks their credentials using the authentication module. If everything checks out, the user lands on the dashboard. If not, the system asks them to enter their information again. This step keeps things secure and makes sure only the right people get to their own learning data. Researchers point out that showing authentication steps in a flowchart makes it easier to spot how the system handles both validation and errors.

After logging in, you pick your language and set your skill level. From there, the system pulls up lessons and exercises that fit what you chose. You can see in the flowchart how your decisions shape what you get, which makes the whole personalization thing pretty straightforward. Researchers point out that showing

these decision points in a flowchart actually helps people design better adaptive learning systems. Once you pick a language, you start the speaking exercise. At that point, the system turns on the audio recording tool to catch what you say. It grabs your voice, then sends the audio over to the speech recognition engine, which gets to work figuring out what you said. This is where things really shift from you talking, to the AI doing its thing. Flowcharts make it easier to see this handoff, especially when you're dealing with real-time data like speech.

Now comes the part where speech recognition and pronunciation analysis kick in. The AI engine takes the recorded audio, turns it into text, and lines it up against the reference pronunciations. It digs deep, right down to the phoneme level, to spot any pronunciation mistakes. This stage is really the heart of the process the flowchart shows it as the key spot where the system crunches the numbers and figures out accuracy scores. Studies say that showing these AI steps visually actually makes it way easier for stakeholders to wrap their heads around how the whole thing works.

After the system finishes analyzing your pronunciation, it gives you feedback right away. You'll see things like your accuracy score and tips on what to fix, all right there on the screen. This instant feedback really helps you learn a new language faster. While you're getting that feedback, the system also saves your performance data in the background. Studies show that showing these steps how you get feedback and how your progress gets recorded makes it easier to see how you're improving over time.

Flowcharts lay out the whole language learning system in a way that just makes sense. You can see what users do, where the system makes choices, how the AI works behind the scenes, and even where data ends up. Everything's right there, so you don't get lost in the details. They're not just helpful for planning flowcharts actually make it easier to spot problems and talk through how the system works with other people. Honestly, if you want to build or explain this kind of project, you need flowcharts in your toolkit.
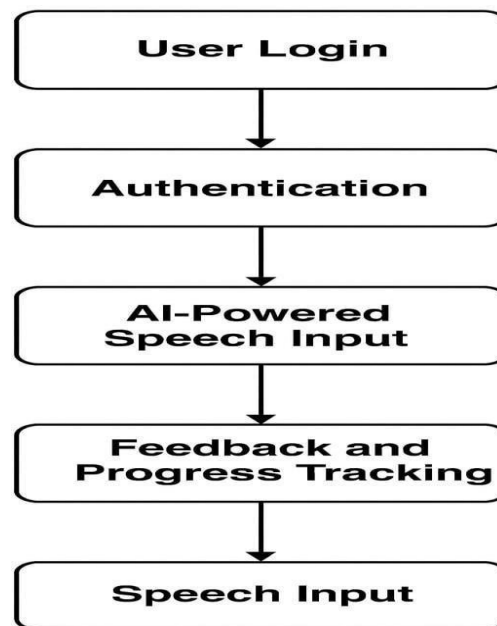
Fig. 3.2: Flow Chart

3.5 Use Cases

Use case analysis helps software engineers figure out exactly how people will use a system. For this AI-powered language learning web app, use cases show how learners move through the platform and what they want to accomplish. Researchers point out that modeling use cases makes it easier to capture what users actually need. You end up designing something that fits real situations, not just what looks good on paper. In the end, this approach makes the system easier to use and covers all the important things users want to do.

User Registration lets new folks set up an account. They type in some basics— name, email, password. The system checks their info and locks it safely in the database. Once they're in, users can start using the personalized learning features. Keeping this process clear doesn't just make things smoother for new users, it also helps keep security problems at bay. That's what research shows, anyway. The Login use case lets registered users get into the app safely. They type in their username and password, and the authentication module checks if everything matches. If it does, they're in they see the dashboard. If not, the system throws an error message their way. Researchers point out that a solid login process keeps access secure and protects sensitive info.

Now, the Start Speaking Exercise use case is really where the action happens. The user picks a lesson, hits start, and jumps into a speaking activity. The system switches on the audio recorder and tells the user when to talk. Here, you can see how the system goes from what you say straight to AI processing. Studies say that having a clear speaking practice flow matters it keeps the experience smooth and helps the system collect speech data accurately. That's what research shows, anyway. The Login use case lets registered users get into the app safely. They type in their username and password, and the authentication module checks if everything matches. If it does, they're in they see the dashboard. If not, the system throws an error message their way. Researchers point out that a solid login process keeps access secure and protects sensitive info.

Here's how the Receive Pronunciation Feedback feature works. When someone speaks into the system, it listens, checks how you pronounced things, and jumps right into giving feedback. Right away, you see your accuracy score. The system points out which words tripped you up and suggests how to say them better. Instant feedback like this really makes a difference in learning a language it's not just a nice-to-have, it's essential.
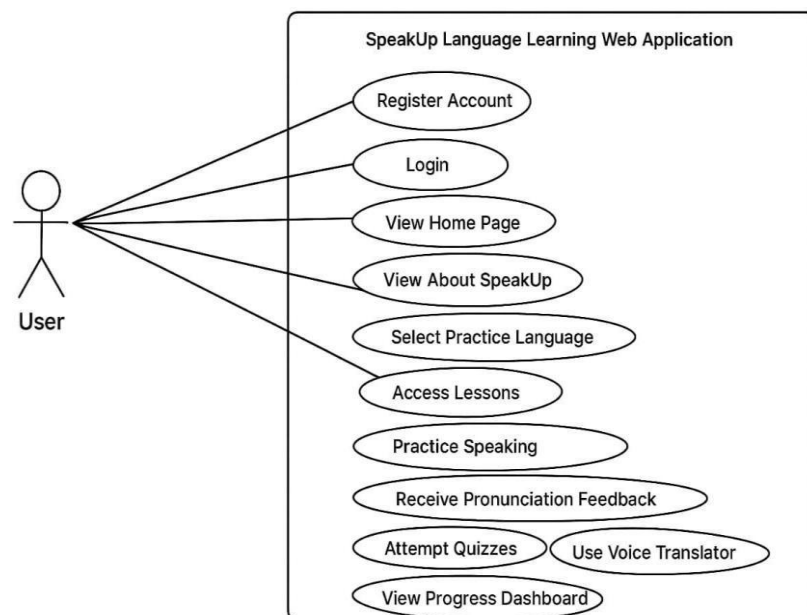

Fig. 3.3: Use Case Diagram

3.6 Sequence Diagram

Sequence diagrams show how different parts of a system interact as time passes. In this AI-powered language learning web app, these diagrams map out how everything talks to each other especially during speaking exercises. Researchers point out that sequence diagrams work really well for real-time and AI systems. They make it easy to see the back-and-forth of messages, method calls, and responses as they happen. First, it checks if the request looks good validates everything, double-checks the user's session, and then gets the data ready for speech processing. Researchers really stress how important this part is. The back-end basically sits in the middle, connecting the front-end with the AI engine, making sure everything stays secure and the data doesn't get messed up along the way.

After validation, the back-end sends the speech data straight to the speech recognition engine. The engine gets to work turning the audio into text and analyzing pronunciation along the way. If you look at the sequence diagram, you can see how everything plays out step by step, highlighting each piece of the AI's process in real time. Researchers say showing these interactions in sequence diagrams actually helps developers spot processing delays and tweak the system for better performance.
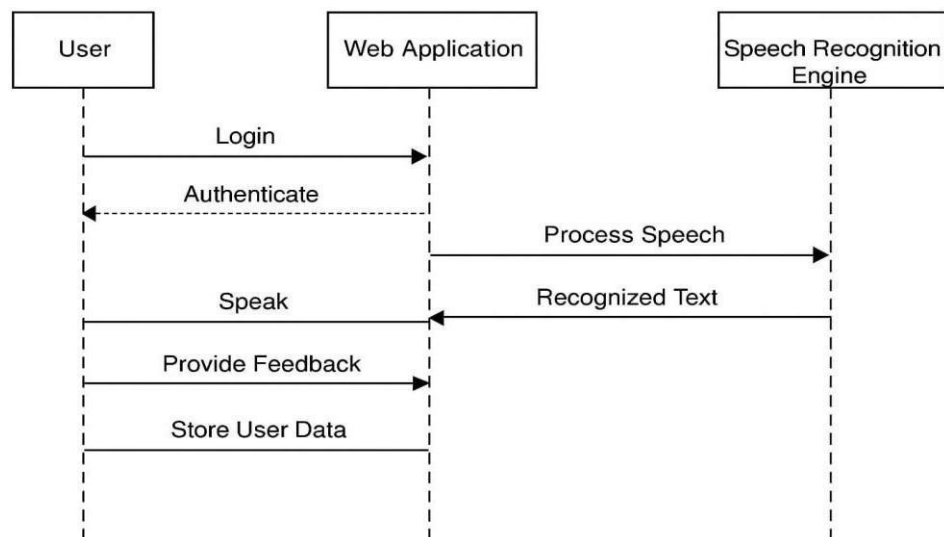

Fig. 3.4: Sequence Diagram

3.7 Database Design

Good database design really matters if you want this AI language learning app to work well. Research shows that personalized learning systems need databases that are organized, secure, and efficient. The database basically keeps everything running it holds user info, tracks learning progress, stores speech recordings, and keeps up with performance results. When you design the database right, the whole system runs faster, pulls up records quickly, and stays reliable. The User Table sits at the heart of the database. It holds all the basics user ID, name, email, encrypted password, and even learning preferences. Thanks to this table, users get secure logins and personalized content. Researchers keep pointing out how crucial it is to protect this kind of data, especially on web-based learning platforms. Encryption and smart access controls really matter when you're dealing with sensitive info.

The Language Courses Table keeps track of all the languages, lessons, difficulty levels, and pronunciation guides the system offers. By organizing things this way, the platform can pull up the right learning materials as soon as someone makes a choice. Separating the course content from user data just makes sense it keeps the database cleaner and updating the courses way easier. If you want to add a new language or tweak a course, you can do it without messing with anyone's personal info. It's a setup that gives you flexibility without the usual headaches.

The Speech Records Table keeps track of details about recorded speech, like where the audio files live, when they were recorded, and which user they belong to. By keeping this speech data separate from user profiles, the system avoids storing the same information twice and saves space. Researchers point out that if you want your AI system to handle lots of audio smoothly especially when it's dealing with nonstop speech you need to organize these big collections of audio really well. Otherwise, the whole thing can slow down fast.

PROGRAMMING SURVEY

The programming survey for this AI-powered language learning app digs into what it actually takes to build a system that's fast, reliable, and easy to use. We're talking about a full-stack setup that needs to handle real-time speech recognition and smart pronunciation feedback, so picking the right programming languages and development platforms really matters.

On the database side, things get interesting. The app needs to track user profiles, learning milestones, exercise scores, and all the speech analysis data. If the data's neatly organized like user info or scores—something like MySQL or PostgreSQL does the job. But for messier stuff, or when you want more flexibility, MongoDB or another NoSQL option makes sense. The final call comes down to what the project needs most: speed, the ability to grow, and how tightly the data needs to stay in sync.

4.1 Full Stack Development

Building the AI-powered language learning web app means pulling together three main parts: the front-end, the back-end, and the AI engine. Each one handles its own job but still talks to the others using secure REST APIs. This setup keeps things simple if you need to fix something or add new features, and it makes it easy to drop in AI tools like speech recognition or pronunciation scoring down the line. The whole thing runs on an MVC (Model–View–Controller) structure, so data, logic, and the user interface each stay in their own lane. That way, everything stays organized and the app runs smoothly.

It all starts when someone logs in through their browser. The front-end shoots the login details over to the back-end, which checks everything and sets up a secure session. Once you're in, you get access to the learning modules stuff like vocabulary practice, speaking tests, and pronunciation correction. If you try a speaking task, the front-end grabs your audio and sends it off to the back-end, nice and secure.

From there, the back-end hands your audio to whichever AI engine is set up Google STT, Whisper AI, or maybe the Web Speech API. The AI listens, turns your speech into text, checks how you did, scores your pronunciation, and spits back a full analysis. The back-end takes that feedback, organizes it, and updates your progress in the database. Then, it shoots everything right back to the front-end, so you get feedback instantly. That real-time response is a big deal for language learning. The faster you get corrections, the more engaged you stay, and honestly, it just helps you remember things better.

4.2 Back-End Development

The back-end runs the show behind the scenes. It handles server logic, processes API requests, manages authentication, connects with AI models, and talks to the database. The way you build this depends on your tech stack. With Node.js, you get an event-driven, non-blocking setup that's great for real-time stuff. Go with Flask or Django, and you'll find it easier to work with Python-based AI tools. Either way, the server puts out REST APIs so the front-end can connect and do its thing.

We use JWT tokens or session-based methods to keep authentication and authorization tight. When the front-end sends over an audio file or some user input, the back-end jumps in—validates it, cleans it up, and gets to work. Our APIs focus on the big stuff: speech processing, vocabulary practice, pronunciation scoring, and progress updates. Each API sticks to a clean architecture, so it's easy to keep things running smoothly.

The back-end also talks directly to the AI engine. It grabs the user's audio, hands it off to the speech recognition module, and waits for the transcript and accuracy details. With those in hand, it calculates scores, crafts feedback, and sends everything back as a tidy JSON response. To keep things fast, we use tricks like compressing audio and handling requests asynchronously. The back-end runs the show behind the scenes. It handles server logic, processes API requests, manages authentication, connects with AI models, and talks to the database. The way you build this depends on your tech stack. With Node.js, you get an event-driven, non-blocking setup that's great for real-time stuff. Go with Flask or Django, and you'll find it easier to work with Python-based AI tools. Either way, the server

puts out REST APIs so the front-end can connect and do its thing. We use ORMs like Sequelize for Node.js and SQLAlchemy for Python to manage database operations. Before we add or update any user progress, validation kicks in to keep the data clean and accurate. On the admin side, the back-end lets you manage courses, keep an eye on user progress, and update vocabulary lists when needed. For errors, middleware functions or decorators step in so the app can deal with server issues smoothly. Tools like Winston, Morgan, or Python's logging module track performance and help us figure out problems fast. All of this keeps the back-end running fast and reliably, so users get quick responses and accurate results while they learn.

4.3 Database Implementation

The database holds user info, learning progress, pronunciation scores, vocabulary, and AI feedback. When you need organized, relational data, MySQL works best. It handles user profiles and progress really well since those follow a clear structure. On the other hand, if you're dealing with more flexible stuff—like audio metadata or unpredictable AI outputs—MongoDB is a better fit. In this setup, MySQL takes care of the structured data, and MongoDB can store the rest when flexibility matters.

The database has tables or collections like Users, Lessons, Vocabulary, Scores, Pronunciation History, and Leaderboard. Users can have a bunch of scores (one-to-many), and they can join several lessons while each lesson has many users (that's many-to-many). In MySQL, foreign keys handle these links; in MongoDB, you get embedded documents instead. To speed up searches, the system adds indexes on fields you look up all the time, like user_id. Data normalization keeps things tidy and avoids repeating info, and constraints make sure everything stays accurate. So, for instance, users can't sign up with the same email twice, and the system won't let random progress records float around without a user attached. To keep the data safe, there are regular backups and replication in place, just in case something goes wrong.

During database implementation, the finalized schema is created in the DBMS by defining tables, attributes, data types, and relationships. Constraints such as primary keys, foreign keys, unique constraints, and not-null rules are applied to

maintain data integrity and consistency. At this stage, normalization rules are enforced to reduce redundancy and avoid data anomalies. Once the structure is ready, data is loaded into the database either manually or through bulk data import tools. Existing data from legacy systems may be migrated after proper cleaning and validation. Indexes are also created to improve query performance and ensure faster data retrieval, especially for large datasets. Security and access control are important aspects of database implementation. User accounts, roles, and permissions are defined to ensure that only authorized users can access or modify data. Backup and recovery mechanisms are also configured to protect data against system failures or data loss.

4.4 Speech Recognition

➢ **Google Speech-to-Text Integration**

Google Speech-to-Text works by sending your recorded audio straight to Google Cloud through secure API calls. Google takes it from there processing the audio and sending back the transcript, confidence scores, and even timestamps for every phoneme. On the back end, the system compares how you pronounced things to what it expected. Google's model doesn't get tripped up by background noise, and it understands a bunch of different accents. That makes it a solid choice for real-world situations.

➢ **Whisper AI Integration**

Whisper AI is an open-source speech recognition model from OpenAI that runs right on your server or GPU. It transcribes audio with impressive accuracy even if the sound quality isn't great. One of the best things about Whisper is that it doesn't rely on any external APIs, so your data stays private. The backend just sends audio clips to Whisper, gets the text back, and checks how accurate it is. Everything happens offline, which keeps things secure and helps cut costs, especially if you're dealing with a lot of data.

➢ **Web Speech API Integration**

The Web Speech API lets browsers handle speech recognition right on your device, so you don't need to send anything to a server. That means faster results—

no waiting around for your words to come back from the cloud. As you talk, the front end listens, transcribes your speech instantly, and throws the text up on the screen right away. It works well for quick tasks, but honestly, it's not as accurate as Google STT or Whisper. Still, having all these engines gives you options, depending on how you want to learn and what your system can handle.

4.5 Pronunciation Correction Logic

Pronunciation correction starts by listening to what the user says and checking it against the right way to say it. First, the system turns the audio into text. Then it digs deeper, breaking words down into phonemes and using tools like CMUdict or phoneme mapping models to compare each sound. It spots mistakes like wrong vowels, dropped sounds, or messed-up stress by lining up the user's pronunciation with the correct one using phonetic alignment algorithms.

The AI module checks how clear your speech is, how fast you're talking, how you pronounce words, and where you put stress in each word. It pulls out features from your voice—using things like MFCC or spectrograms—to see how your pronunciation stacks up against the standard sounds of the language you're learning. Based on this, the system gives you direct feedback, like "Your sound isn't clear," "You stressed the wrong syllable," or "Try holding the vowel a bit longer." You'll also see visual cues, like color-coded words, so you know exactly where you went off. All this makes learning faster and turns pronunciation practice into something you can really interact with.

Feature extraction plays a big role in working with voice datasets. Rather than saving the whole audio signal, the system pulls out things you can actually measure MFCCs, spectrograms, formant frequencies like F1, F2, and F3, pitch contours, even how energy spreads through the sound. These features go straight into pronunciation scoring, neural networks, and models that classify phonemes. They're what let the system pick up on those little details in how someone says a word, so it can tell the difference between native-like pronunciation and learner speech. It spots mistakes like wrong vowels, dropped sounds, or messed-up stress by lining up the user's pronunciation with the correct one using phonetic alignment algorithms.

4.6 Performance Optimization

Performance optimization keeps pronunciation feedback instant. The team squeezes every millisecond out of the process compressing audio, running tasks in the background, caching results, and cutting down on API calls. Sometimes Whisper AI even runs right on a GPU to speed things up. When traffic surges, load balancers step in and spread out the work. To keep things snappy, they trim down network requests, use lightweight audio files, and tap into local speech engines whenever they can. Scaling up isn't a problem either. With Docker containers and Kubernetes handling orchestration, the system can grow to handle way more users without breaking a sweat.

The system leans on audio compression and lightweight data transmission to keep things running smoothly. Raw audio files are huge and really slow everything down. So, before anything gets sent to the server, it shrinks the speech into smaller formats like WebM, OGG, or AAC. These keep the sound clear enough for speech recognition but don't take forever to upload. It also cuts out any silence from the recordings, so there's nothing extra dragging things out. This way, the speech recognition engine only deals with what matters, which speeds up the whole process and makes responses faster.

The app speeds things up by handling tasks like speech recognition, scoring, and phoneme alignment in the background. So, while those heavy tasks run on separate threads or async workers, the main interface stays quick and responsive. You don't have to sit around waiting results just pop up when they're ready. Tools like Node.js async handlers, Python's asyncio, or queue systems like RabbitMQ and Celery help run these jobs in parallel, so everything moves faster and you waste less time waiting.

EXPERIMENTAL RESULTS

We tested the AI language learning app to see how well it handled speech recognition, pronunciation correction, system performance, and whether people actually liked using it. For the experiments, several users tried out different languages. They worked through speaking drills, took interactive quizzes, and practiced pronunciation over a set period.

The speech recognition tool did a solid job. When users spoke clearly, it nailed the transcription almost every time. The ASR engine had no trouble turning spoken words and sentences into text. Sure, there were a few hiccups strong accents, background noise, or mumbling sometimes threw it off. Even then, the system usually picked up the main sounds and still managed to give useful feedback.

Learners really improved their pronunciation after practicing several times. The system picked up on common mistakes down to the phoneme and gave instant feedback. People who stuck with regular practice saw their scores go up and started speaking more smoothly, which shows the AI feedback works. When you look at their scores from the beginning and the end, you see steady progress clear proof they got better.

5.1 Home Page

When you land on the SpeakUp Home Page, everything feels simple and inviting. Right away, you see what this app is all about helping you get better at speaking and language skills with the help of AI. There's a bold headline that grabs your attention, and a short description lays out exactly how it works: practice your pronunciation, get feedback instantly, and watch yourself improve.

You'll find the navigation bar right at the top, giving you quick links to About, Contact, Sign In, and Sign Up. There's also a big "Start Your Practice Session" button on the home page, basically inviting you to jump right in. Everything's laid out clearly, so it's obvious what the app's for and getting started feels simple, not overwhelming as shown in fig. 5.1 given below.
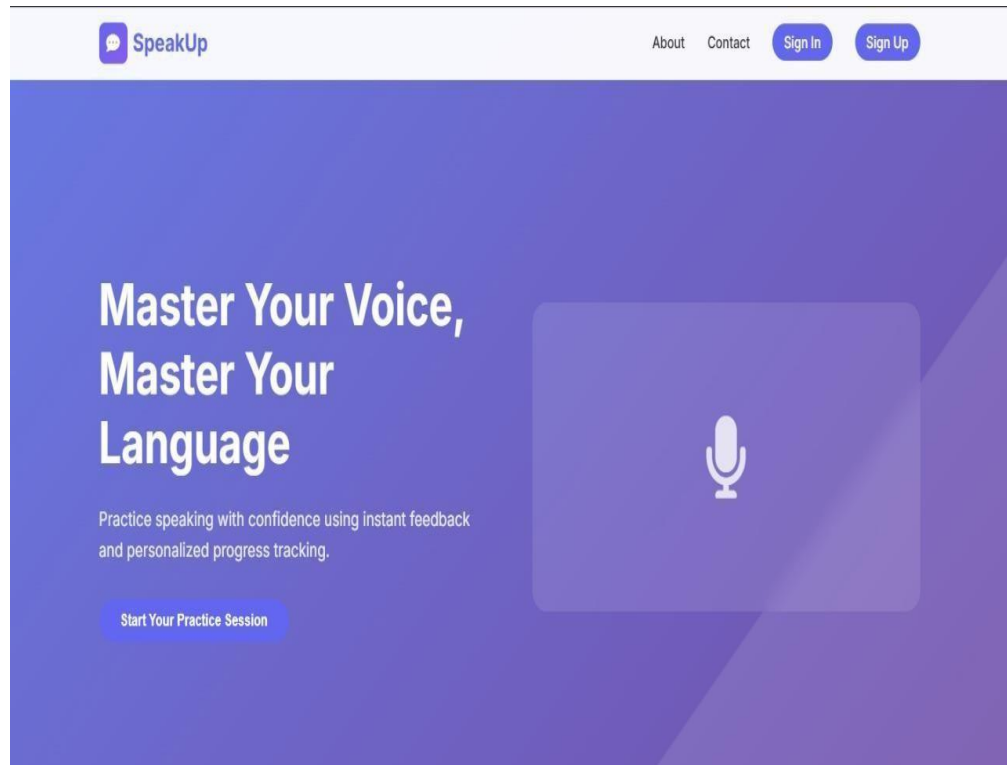
Fig. 5.1: Home page

5.2 Learning Features

SpeakUp makes language learning a lot smoother and actually kind of fun. The app's Speech Practice feature lets you talk right into your mic, and then the AI steps in it checks how you say things and points out where you're nailing pronunciation or missing the mark. You can see your progress, too. There's a dashboard that tracks your day-to-day performance and shows you how you're improving over time, so it's easy to stay motivated and keep your streak going.

Interactive Lessons break things up with exercises and activities, so you're not just staring at a screen. If you get stuck on a word or phrase, the Language Translator jumps in and translates text or speech between different languages super handy when you're learning something new. And if you want to check how much you've picked up, there are Knowledge Quizzes that test your understanding and help lock in what you've learned. Additionally, Instant Feedback provides real-time corrections and suggestions, helping users identify mistakes and improve their pronunciation immediately as shown in fig. 5.2 given below.
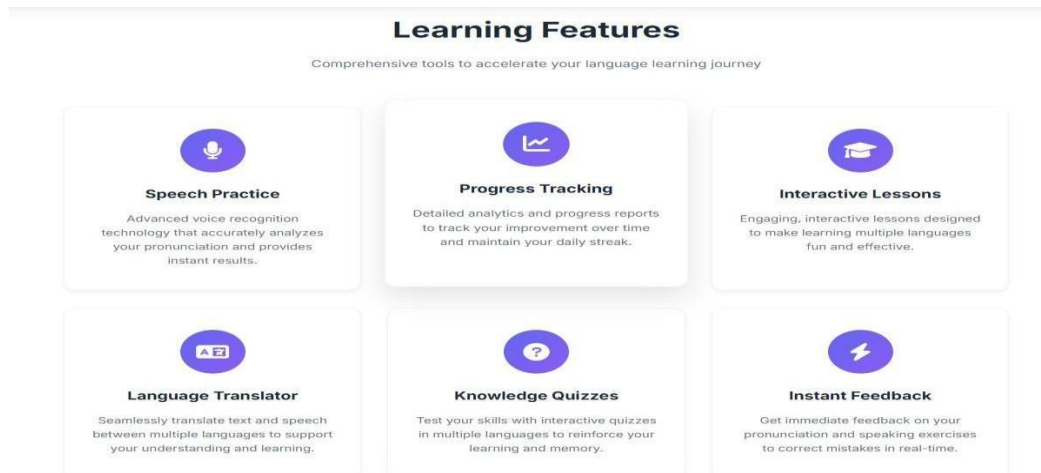
Fig. 5.2: Learning Features

5.3 About SpeakUp

The About SpeakUp page gets right to the point—it tells you what SpeakUp is all about and why it exists. SpeakUp helps you nail your pronunciation, feel more confident when you speak, and really get the hang of a new language. How? It leans on the latest tech. You get AI-powered speech recognition and instant feedback, so you actually know how you're doing as you go. SpeakUp makes language learning a lot smoother and actually kind of fun. The app's Speech Practice feature lets you talk right into your mic, and then the AI steps in it checks how you say things and points out where you're nailing pronunciation or missing the mark. You can see your progress, too. There's a dashboard that tracks your day-to-day performance and shows you how you're improving over time, so it's easy to stay motivated and keep your streak going.

The page also lays out SpeakUp's mission: to give you practice sessions that fit you, not just some generic lesson. SpeakUp helps you nail your pronunciation, feel more confident when you speak, and really get the hang of a new language. Everything you see on the page is clear and straightforward, so it's easy to figure out how SpeakUp makes language learning more effective, interactive, and honestly, just a lot more enjoyable as shown in fig. 5.3 given below.
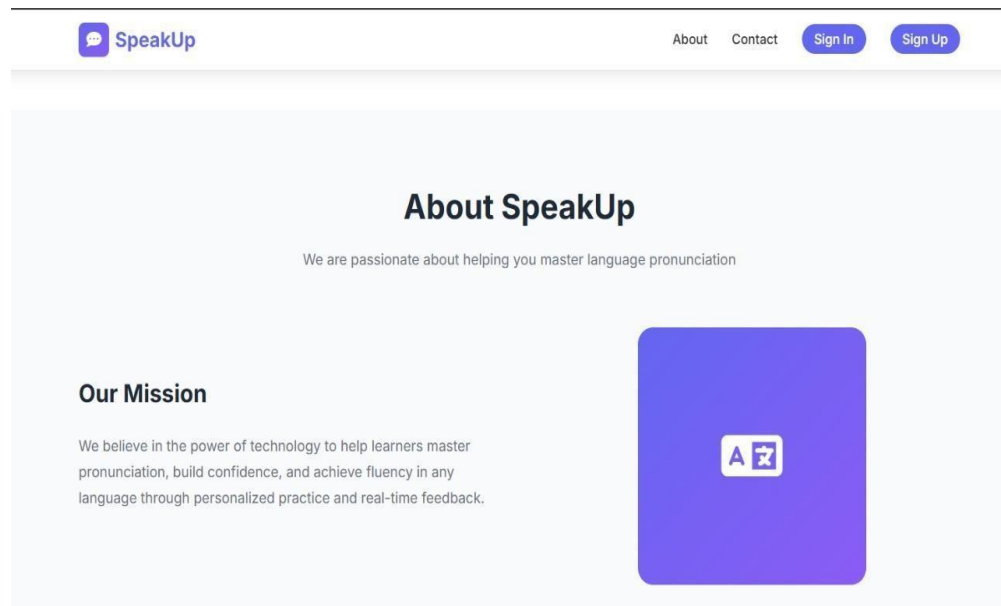
Fig. 5.3: About SpeakUp

5.4 User Dashboard Module

The User Dashboard is the first thing you see when you log in to SpeakUp. Right away, it greets you by name and shows your key details your email, native language, the language you're learning, when you joined, and the last time you logged in. Everything's right there, so you can check or update your info without hunting around. The dashboard also presents key learning statistics including daily streak count, total minutes practiced for the day, overall performance score, and the number of lessons completed.

You'll also see your chosen learning language, your current skill level, and how far you've come overall. The dashboard puts everything you need in one spot: speaking practice, pronunciation, vocab drills, quizzes, listening activities. You don't have to dig through menus or get lost in options. Just pick what you want to work on and dive in. The dashboard also presents key learning statistics including daily streak count, total minutes practiced for the day, overall performance score, and the number of lessons completed. These indicators help users understand their learning consistency and overall progress at a glance as shown in fig. 5.4 given below.
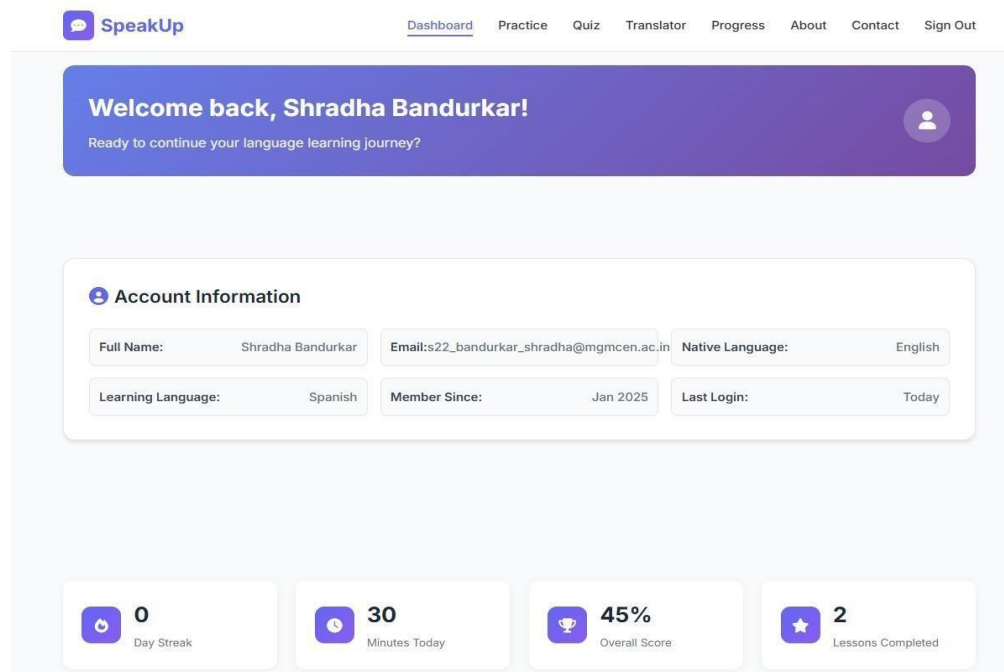
Fig. 5.4: User Dashboard Module

5.5 Progress Tracking

The dashboard has a Today's Goal section that lays out your daily practice target, shows how far you've come with a progress percentage, and gives you a "Continue Practice" button to keep you going. It's there to nudge you to hit your learning goals every day. You'll also find a Practice Modules section, where you can jump into different activities like daily conversations, pronunciation drills, or brushing up on grammar and vocabulary. Each module has its own progress bar, so you can see at a glance how much you've finished.

The Recent Activity section shows what you've been working on lately, with your scores right there so you can quickly see how your last practice sessions went. The Weekly Progress graph gives you a snapshot of your activity across the week. It's easy to spot trends like if you're slipping or really nailing your goals which keeps you motivated to keep at it.

Learning Activity and Progress Tracking aren't just extra features they make a real difference in how you learn. The system tracks everything: what you do, how long you practice, your quiz results, and even how well you pronounce words. It takes all that info and turns it into something you can actually use progress bars,

percentages, charts—so you know exactly where you're crushing it and where you

need to step up. You get regular feedback and a clear view of your progress, which makes it easier to stick with your routine. It's all about keeping you motivated and helping you learn in a way that fits you. That's what makes SpeakUp stand out as shown in fig. 5.5 given below.
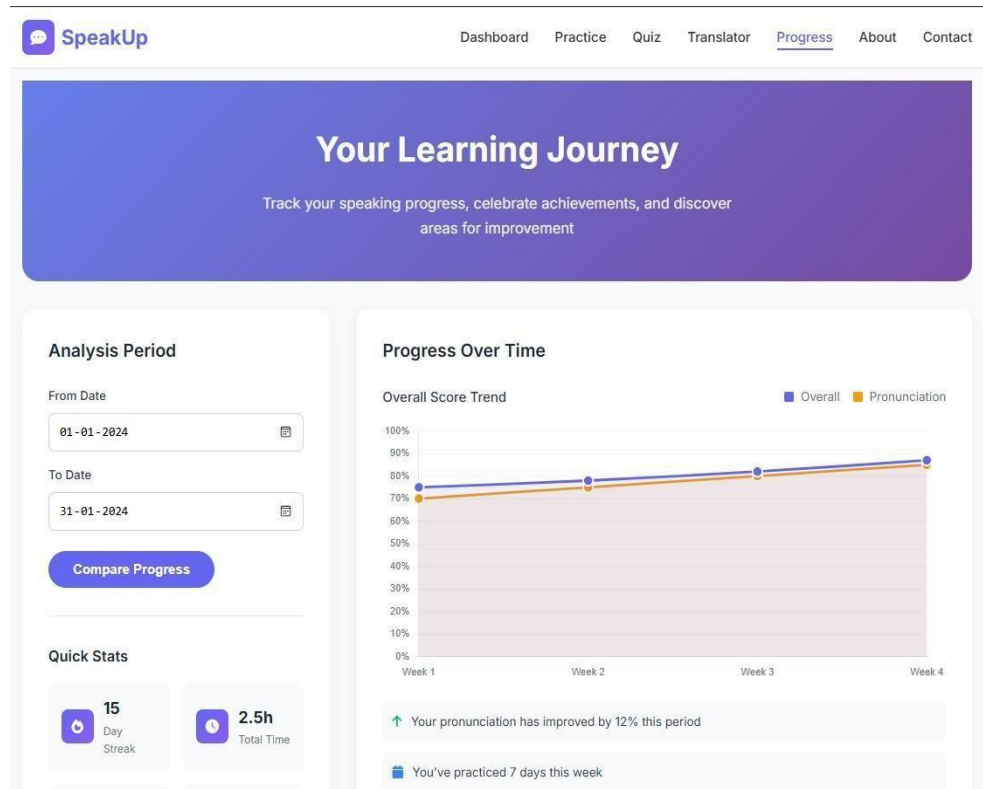

Fig. 5.5: Progress Tracking

5.6 Practice Module – Language Selection Page

The Practice Module Language Selection Page kicks off your learning journey in the SpeakUp web app. Here, you pick the language you want to practice—English, Spanish, Japanese, or Hindi—depending on what you're after. With all these choices, SpeakUp opens the door to multilingual learning and welcomes all kinds of learners.

You'll see a clear heading at the top, plus a short description that gets you ready to jump in and start working on your pronunciation, fluency, and speaking

confidence. Each language sits in its own card, complete with familiar icons and language codes, so picking one feels easy and natural. The layout stays clean and simple, so you can find and choose your language fast—no guesswork needed.

This feature really shapes the learning experience. It lets users pick the language they want to focus on, and once they do, everything shifts to match that choice. The system brings up lessons and practice tailored to their selected language. The Language Selection Page makes the app easier to use, draws people in, and sets the stage for a more effective, personalized way to learn with SpeakUp as shown in fig. 5.6 given below.
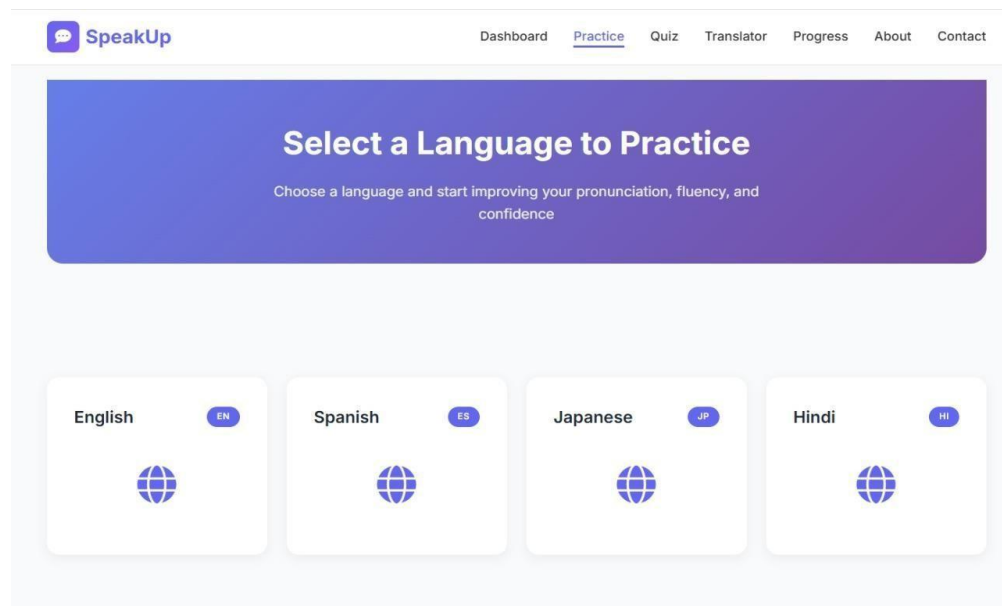

Fig. 5.6: Practice Module – Language Selection Page

5.7 Lesson Selection Page

Here's what the Lesson Selection page looks like after you pick a language—let's say English. You'll see a clear list of lessons, each one zeroing in on something different: basics, pronunciation, vocabulary, grammar, conversation, and even advanced stuff. On the lesson selecting page, each lesson is typically shown with a title, brief description, and sometimes additional details such as duration, difficulty level, or completion status. Visual elements like buttons, icons, or progress indicators are used to make navigation simple and user-friendly. This design ensures that learners can easily browse through lessons without confusion.

The page also supports personalized learning by highlighting completed lessons and suggesting the next lesson to continue. Some systems allow filtering or sorting lessons based on categories or performance. Overall, the lesson selecting page improves user experience by providing clear navigation, encouraging engagement, and making the learning process more organized and efficient. The lessons are split up by level, so you can start as a beginner and work your way up. This setup makes learning smoother and keeps things from getting overwhelming as shown in fig. 5.7 given below.

Fig. 5.7: Lesson Selection Page

5.8 Practice Exercise Page

Here's the Practice Exercise page from the SpeakUp web app. It's all about getting you comfortable with speaking English, starting right from the basics Level 0. This page helps beginners pick up simple greetings and everyday phrases. You can tap an audio button to hear how things should sound, then try saying it yourself and record your voice with the mic. On the left, there's a handy list of exercises greetings, basic phrases, introductions and you can see which ones you've finished. It makes tracking your progress simple as you move through the lesson.

Here, you'll find the basics of English simple greetings, everyday phrases, that

sort of thing. If you're just getting started, this is the place. You can listen to how each phrase sounds, then try saying it yourself by recording your voice. Over on the left, there's a list of exercises greetings, basic phrases, introductions and you can see which ones you've finished. In the main area, you get step-by-step instructions, a progress bar for your recordings, and a button to jump to the next exercise. It all feels pretty straightforward and interactive, so learning actually becomes enjoyable as shown in fig. 5.8 given below.
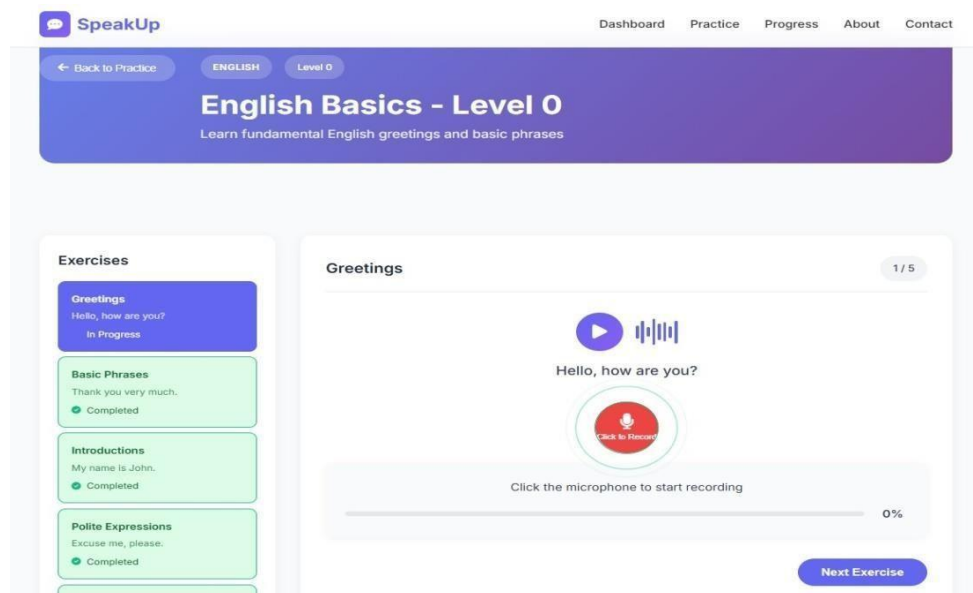

Fig. 5.8: Practice Exercise Page

5.9 Quiz Interface

Here's a look at the Quiz page from the "SpeakUp" language learning app. It's built to help you practice your language skills and see how you're doing, all in a pretty interactive setup. Up at the top, there's a navigation bar with options like Dashboard, Practice, Quiz, Translator, Progress, About, and Contact—so moving around the app feels easy and straightforward. On the Quiz page itself, you can tweak your quiz by picking the lesson (like Basic Greetings), setting how many questions you want, and choosing your target language—Hindi, in this case.

You'll see a question in the main area, with several answer choices and a Listen button. Tap that to hear the question out loud—it's great for practicing how things sound and how to say them. If you want to move through the quiz, just use the

Prev and Next buttons. Over on the right, there's a panel that tracks your progress. It shows how far you've come, your current score, and gives you options like Submit Quiz or Reset if you need a fresh start. At the bottom, there's a little tip reminding you to use the audio feature—it really helps with learning. Altogether, the page feels easy to use. It supports multiple languages, helps with pronunciation, tracks your progress, and keeps things interactive. It's a solid tool for practicing conversations and getting better at a new language every day as shown in fig. 5.9 given below.
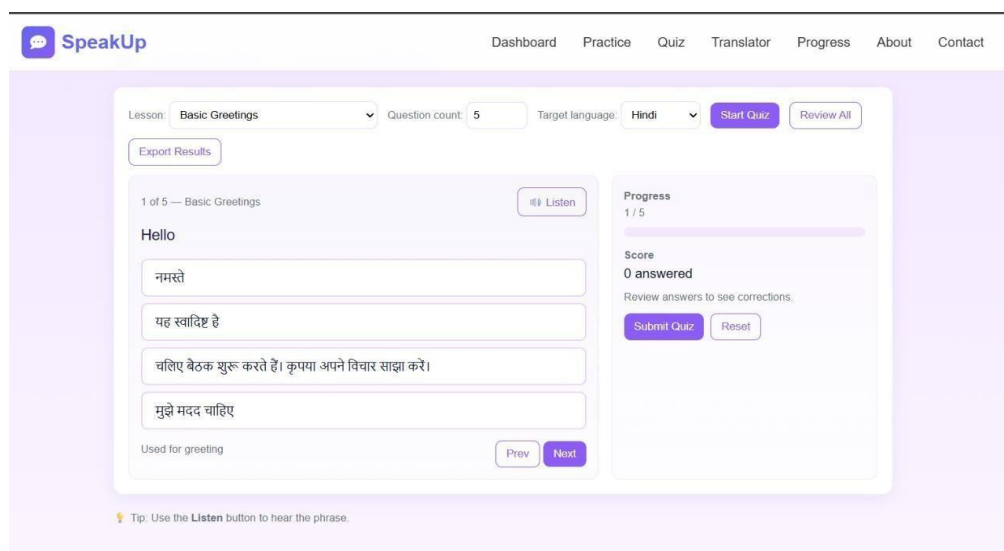

Fig. 5.9: Quiz Interface

5.10 Voice Translator Interface

Here, you see the SpeakUp Voice Translator in action. It's part of a language learning app that lets you translate using either your voice or by typing. You can also upload documents if that's easier. The app figures out what language you're using on its own—no need to set it yourself. For this example, it's translating everything into German. Once you hit translate, your results pop up clearly on the right, so you can check your translation fast and without any fuss.

The module comes with a Start Speaking button, so you can jump right into speaking practice and work on your pronunciation in real time. If you want to keep a copy of your translation, just download it or save it to your history—makes it easy to review and keep learning later.

You don't have to pick your starting language either. The system figures it out automatically, while you choose German as your target. Once it's done, your translation shows up clearly on the right, so you can see exactly how it turned out without any hassle. Overall, this feature highlights the application's multilingual support, speech recognition capability, and practical design, making it effective for everyday communication and language learning as shown in fig. 5.10 given below.
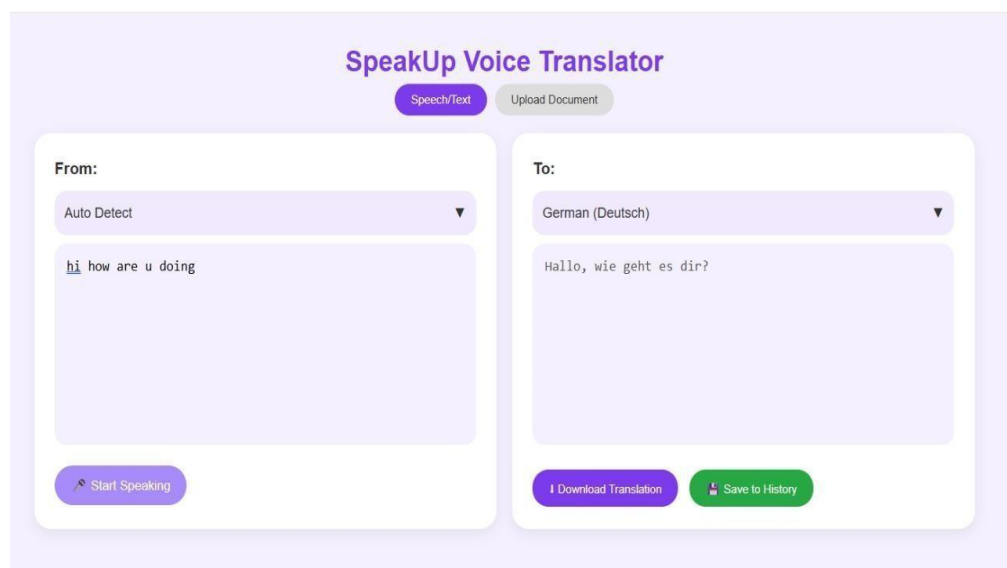

Fig. 5.10: Voice Translator Interface

TESTING & RESULTS

We ran tests to make sure the AI-powered language learning app actually works, runs smoothly, and does what users want. Throughout development, we tried different testing methods to check each part and the whole thing together. We focused on the core stuff first: user registration and login, recording speech, analyzing pronunciation, interactive exercises, quizzes, and tracking progress. Every module did what it was supposed to, and the system managed user inputs and responses without any big issues. Integration testing showed that the front-end, back-end, database, and AI speech recognition all talked to each other without a hitch.

We tested how fast the system responds and whether it gives real-time feedback. During speech recognition and pronunciation practice, the app barely lagged, even when people spoke for a long time. When we had a bunch of users on at once, the system still ran smoothly no big slowdowns so it's definitely built to handle growth.

For usability, we brought in some users and watched how they navigated the app, how clear the feedback felt, and what the whole experience was like. Most people found the interface straightforward and easy to get around. They especially liked getting instant corrections on their pronunciation and being able to see their progress. We did spot a few small areas in the UI that needed tweaking, so we fixed those based on what users told us.

6.1 Integration Testing

We test the language-learning app with a layered quality check. Basically, we look at reliability, how well everything works, and how fast it runs. The team goes through unit tests, integration tests, system tests, and acceptance tests. Each step digs into something different. Unit tests zoom in on single pieces like making sure speech recording or user login actually do their jobs. Integration tests step back and check if parts like the speech recognition engine, the back-end API, and the

database all play nicely together. We rely on automated tools to keep things steady Jest for the front end, and PyTest or JUnit for the back end. That way, nothing slips through the cracks.

Testing focuses a lot on the AI features things like checking if the speech recognition is accurate, making sure pronunciation scores actually mean something, and keeping an eye on how much lag users experience. Since the app lives and dies by its real-time responses, it's important to see how it holds up when the network isn't perfect. Security testing matters, too, especially when it comes to keeping user data safe and encrypted. Usability tests round things out by checking if learners actually find the app easy and helpful. All of this makes sure the app works the way it should, both on the surface and under the hood.

Integration testing comes next. This is where you see if all the moving parts play nicely together. Say a user records their voice now the audio module needs to send that clip to the server, run it through Whisper AI for transcription, and get everything back to the user without a hitch. Integration tests catch hiccups like broken links, weird data formats, or API responses that don't match. With an app that depends on a bunch of services talking to each other in real time, these tests are absolutely essential.

6.2 Test Cases

We keep a detailed test case table where we jot down every input, what we expect to happen, the steps to follow, how important each test is, and the actual results. The tests cover everything—logging in, making a profile, loading lessons, recording speech, checking pronunciation scores, updating the leaderboard, and catching errors. Each test has its own ID, a short description, any pre-conditions, step-by-step instructions, what we expect to see, what actually happens, and whether it passed or failed. This way, we can track how the system behaves as we build it and make sure results are consistent. Whenever we add new features, we update the table to keep everything current.

We put together a detailed test case table to keep track of every situation we need to check for the language-learning app. Every main feature gets its own entry things like user registration, logging in, loading the dashboard, grabbing the

vocabulary list, starting speech recording, sending audio to the AI, getting a pronunciation score, and updating the progress dashboard. Each test case spells out the basics: a unique Test ID, a quick description of what we're testing, and any pre-conditions, like making sure the user's logged in or the microphone's allowed. Then, we break down the exact steps to follow, what's supposed to happen, what actually happens, and whether the test passed or failed. We also note the priority (high, medium, or low), the environment (like which browser or device we're using), and any extra comments or ideas for improvements. This way, we cover everything and don't miss a beat.

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6.3 User Speech Accuracy Result

User speech evaluation is all about checking if the system gets what people actually say. Testers record all kinds of speech different accents, background noise, slow talkers, fast talkers, you name it. Then they line up what the system hears with the real script to see how close it gets. They don't just stick to quiet rooms. Sometimes there's a bit of noise, sometimes it's downright chaotic, just to see how tough the system really is. These accuracy checks lead straight to fixing the model and tuning up the noise filters.

But it doesn't stop there. They pull in voices from all over different ages, dialects, genders, and especially people with strong regional accents or who aren't native English speakers. The system tends to trip up on those, so it's important. Testers make sure to include people who mumble or speak super fast, just to push the model's limits. There's a special focus on non-native speakers, since their accents can throw in sounds the system isn't used to. By throwing all these challenges at the system, the team spots where things break down and figures out how to make

it better. Accent-specific challenges need attention, so teams tweak the recognition pipeline sometimes that means updating phoneme mapping rules, sometimes it means retraining the model with more inclusive datasets. Environmental conditions really shape how well speech recognition works. So, to see what the system can handle, testers try it out in all sorts of places: a quiet room, a regular office with some background chatter, even outside where there's traffic or a lot of noise. They'll throw in all kinds of distractions fan hums, passing cars, people talking, echoes just to see what happens. These tests show how well things like noise-suppression, audio filters, and voice activity detection actually hold up in the real world. If the system starts to slip up in noisy spots, the team jumps in with fixes like stronger denoising models, tighter thresholds, or smarter, adaptive filters.

6.4 Performance Analysis

We put the new app side by side with big names like Duolingo, Elsa Speak, and Google Pronunciation Tool. We looked at things like how well it checks your speech, how clear the pronunciation scores are, the quality of feedback, dashboard features, and how quickly it responds. Honestly, the app stands out when it comes to giving detailed feedback at the phoneme level and scoring in real time, thanks to its built-in AI. This comparison really shows where the app pulls ahead, but it also points out spots where we still need to fine-tune things.

What really sets this system apart is how it digs into your pronunciation at the phoneme level. Duolingo mostly checks if you got the whole word or phrase right, and Google's Pronunciation Tool just flashes a simple right or wrong. Here, you actually see which sounds you're mispronouncing, plus the system sorts your mistakes into minor, moderate, or major categories.

It's the kind of targeted feedback that lets you zero in on stubborn articulation problems and actually see your progress as you go. On top of that, the built-in AI like Whisper AI for speech-to-text and some pretty sharp pronunciation scoring handles different accents better, and you get your results way faster than on most other platforms. When it comes to real-time scoring and low latency, this app really holds its own. Elsa Speak, for example, has a bit of a lag because it relies on cloud processing, so you're always waiting a moment for your feedback. This

system skips that wait. It uses GPU acceleration, compresses audio, and handles tasks at the same time, so feedback pops up almost instantly. Even when lots of people use it at once or the network isn't great, response times stay steady usually under a second. That's important. If you're practicing speaking, you want fast feedback to stay motivated. Plus, the app has these visual dashboards that show your progress, trends, and achievements, so you can actually see how you're growing. It's a more personal and motivating experience than you'll find on most other platforms.

CONCLUSION

The Language Learning Full Stack Web Application successfully achieves its goal of providing an interactive, user-friendly, and effective platform for learning multiple languages. By integrating speech recognition, the system allows learners to practice speaking in real time, improving their confidence and fluency. Features such as pronunciation correction give immediate feedback, helping users identify and correct mistakes at an early stage. The application also includes interactive exercises and quizzes, which make learning engaging while continuously evaluating user progress. The translation module supports better understanding of words and sentences, making it easier for beginners to grasp new languages. Together, these features create a balanced learning environment that focuses on listening, speaking, reading, and comprehension.

As a full stack solution, the system demonstrates efficient integration of frontend and backend technologies, ensuring smooth data handling, responsiveness, and scalability. Overall, this web application proves to be a practical and innovative tool for modern language learning, offering an engaging alternative to traditional methods and , advanced analytics, and additional language support. In addition, the application lays a strong foundation for future enhancements by supporting modular development and continuous improvement. With the potential integration of advanced analytics, the platform can offer personalized learning paths based on user performance and learning patterns. Expanding language support and incorporating adaptive difficulty levels would further enhance accessibility and effectiveness for learners at different proficiency.

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