INSTRUMETA

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ABSTRACT

The AI-Based Instrument Recognition and Music Metadata System identifies musical instruments in audio tracks and links them with relevant metadata using Machine learning and integrated APIs. In addition to audio analysis, the system now offers virtual learning modules for piano, guitar, and drums, along with curated learning notes. Users can engage in interactive music quizzes to test their knowledge and improve musical literacy. A chatbot feature facilitates real-time communication between users and admins, enhancing support and user experience. The platform combines AI-powered backend processing with an intuitive frontend and efficient database management. It caters to music learners, enthusiasts, researchers, and industry professionals, promoting rich content exploration and interactive learning.

1-INTRODUCTION

The scope of this project encompasses the design, development, and deployment of an integrated system that performs musical instrument recognition from audio tracks and metadata extraction from music. The project aims to improve content management, retrieval, and user experience across digital platforms. The system also offers virtual learning for piano, guitar, and drums with learning notes, music quizzes, and a chatbot for user-admin interaction. This system would serve as a tool for filmmakers, singers, researchers, musicians, and streaming services to enhance user experiences, streamline content management, and provide valuable insights into the media.

Existing System

The Current systems for instrumental recognition and metadata retrieval are fragmented and operate independently. Most tools either focus solely on instrument detection in audio or provide metadata about movies and songs, lacking integration. They do not support interactive features such as virtual instrument learning, music quizzes, or user-admin communication. As a result, users must rely on multiple platforms, making it difficult to gain a complete and engaging experience of how musical instruments are used in media content.

Proposed System

Instrumeta is an all-in-one platform that identifies musical instruments from audio files and retrieves related movie metadata, including movie name, actors, and singers. It supports real- time audio analysis with an integrated movie and song database.Alongside recognition, the platform offers virtual learning for piano, guitar, and drums, structured notes for self-practice, interactive music quizzes, and a chatbot for user-admin interaction—making it both a smart recognition tool and an interactive learning hub.

2-REQUIREMENT ANALYSIS

Functional Requirements

• Admin Module

• User Module

Admin Module

The admin module is designed for backend management and monitoring. The admin can directly log in through a separate secure interface. Once authenticated, the admin has the ability to manage user

access, including reviewing registered users and granting authentication. The admin can view detailed user activity, including the number of registered users, the songs they've uploaded, quizzes attempted, and scores achieved. Additionally, the admin has full control over user management, with capabilities to add, delete, or update user accounts, as well as upload songs into the system. The admin also shares access to the learning platform and can update quiz questions, track how many users have attempted the quizzes, and view their scores. A logout option is provided for secure session termination. These functionalities ensure that both user engagement and content management are streamlined and well-monitored within the Instrumeta application.

User Module

The user module begins with a secure login and registration system, allowing new users to create accounts by providing essential details such as email, first name, and last name. Once logged in, users can upload a song, and the system will automatically extract and display relevant movie metadata and instrument information using integrated audio recognition techniques. Following this, users can access a learning platform where instructional PDFs are provided for various instruments, including piano, guitar, xylophone, and drums. Alongside the documents, users can engage with virtual versions of these instruments, enabling them to practice interactively—simulating the experience of playing actual instruments by generating sound upon key presses, much like in musical games. To enhance learning, a quiz module is available with multiple-choice questions focused on instruments and music theory, allowing users to test their knowledge. Each quiz includes navigation through questions, and at the end, users receive a summary showing their results and any incorrectly answered questions. A logout option is provided, and all functionalities are accessible via a menu on the homepage, which also serves as a visually appealing starting point. The menu includes options such as uploading a song, accessing user account information, exploring learning content, attempting quizzes, and optionally viewing learning progress.

Non-Functional Requirement

Scalability: The system should efficiently handle a growing database of instruments movies, and songs. It should support an increasing number of users without performance degradation.**Performance**: The instrument recognition process should deliver results within a few seconds. The database queries for movie and song metadata retrieval should be optimized for quick responses.

Availability & Reliability: The system should be available *24/7* with minimal downtime. It should handle errors gracefully and provide meaningful error messages to users. The instrument recognition model should maintain high accuracy even with noisy audio input

Security: User data, including login credentials and activity history, should be securely stored. Secure authentication methods should be implemented for admins and users. API integrations should be protected to prevent unauthorized access to metadata.

Maintainability: The system should be easy to update with new features and improvements. The database and recognition model should allow periodic updates without system downtime. Logs should be maintained for debugging and system monitoring.

Software Requirements

The software requirements document is the specification of the system. It should include both the definition and a specification of the requirements. It

is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification. It is useful in estimating cost, planning team activities, performing tasks and tracking the team's progress throughout the development activity.

- Operating System : Windows 11 and above
- IDE : Visual Studio Code
- Database : MongoDB
- Code Behind **:** Python, JavaScript, React , Node.js,Express.js

Hardware Requirements

Hardware Requirements are the most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware.

- Processor : Intel i5 (min).
- RAM : 8GB (min).
- Hard Disk : 512GB (min).

3-DESIGN

Design of the project represents the number of components we are using as a part of the project and the flow of request processing i.e., what components in processing the request and in which order. An architecture description is a formal description and representation of a system organized in a way that supports reasoning about the structure of the system. Architecture is of two types. They are
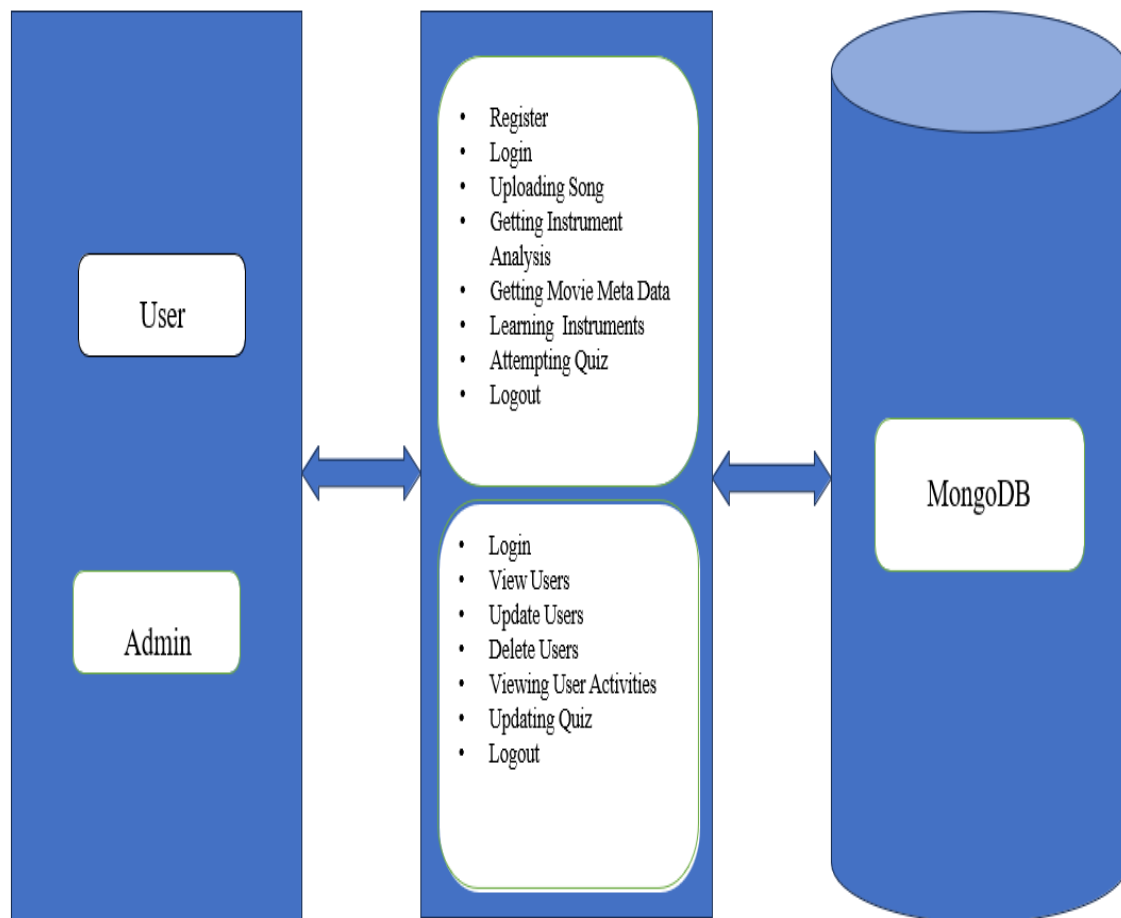
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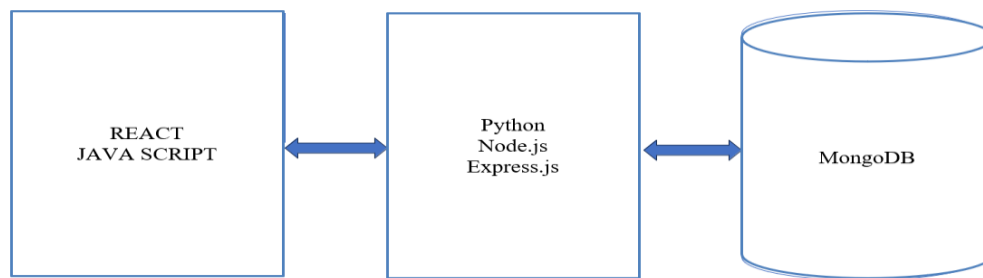

Fig 3.1 Software Architecture

Technical Architecture

Fig 3.2 Technical Architecture

4-IMPLEMENTATION

MERN

The **MERN stack** is a popular full-stack web development framework that combines four powerful technologies: **MongoDB**, **Express.js**, **React.js**, and **Node.js**. Its architecture supports efficient end-to-end JavaScript development, allowing developers to build scalable and responsive web applications using a single language across both the client and server sides. MongoDB serves as a NoSQL database designed for flexibility and performance; Express.js is a lightweight web application framework that simplifies backend logic; React.js is a front-end library developed by Facebook for building dynamic and component-based user interfaces; and Node.js enables high-performance, event-driven server-side scripting using JavaScript. The MERN stack promotes modular development, real-time data handling, and seamless integration of APIs. It gained popularity in the mid-2010s with the rise of JavaScript as a universal programming language and continues to be widely adopted for building modern web applications. The open-source nature and strong community support around each component make MERN a go-to stack for startups, developers, and enterprises alike.

Pseudo Code

Pseudocode is a detailed yet readable description of what a computer program or algorithm must do, expressed in a formally-styled natural language rather than in a programming language. It allows designers to express the design in great detail and provides programmers a detailed template for the next step of writing code in a specific programming language. Because pseudocode is detailed yet readable, it can be inspected by the team of designers and programmers as a way to ensure that actual programming is likely to match design specifications. Catching errors at the pseudocode stage is less costly than catching them later in the development process. Once the pseudocode is accepted, it is rewritten using the vocabulary and syntax of a programming language
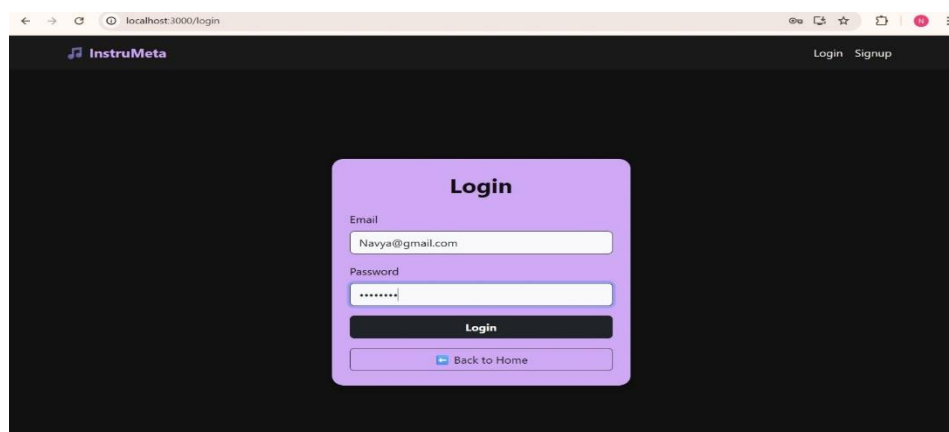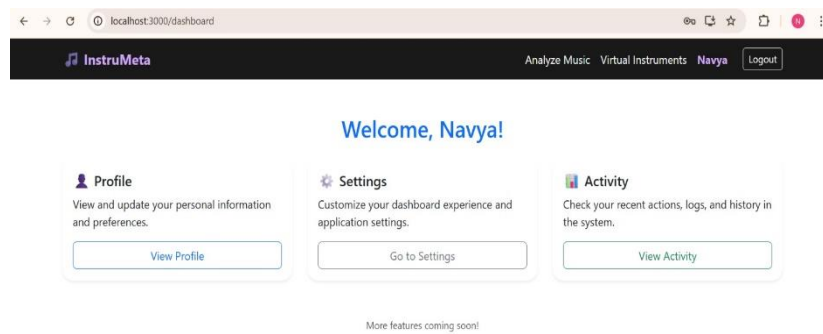
6-SCREENSHOTS
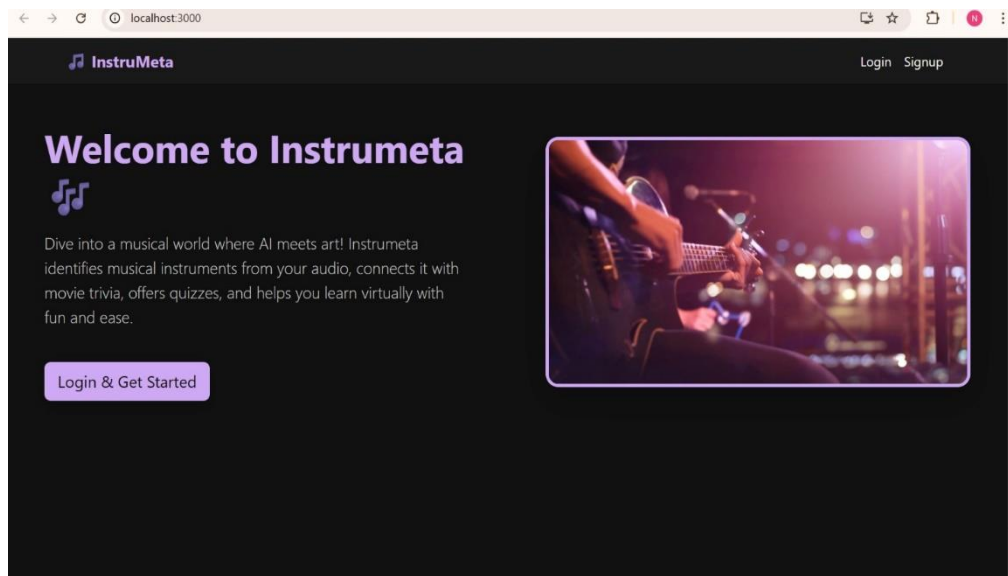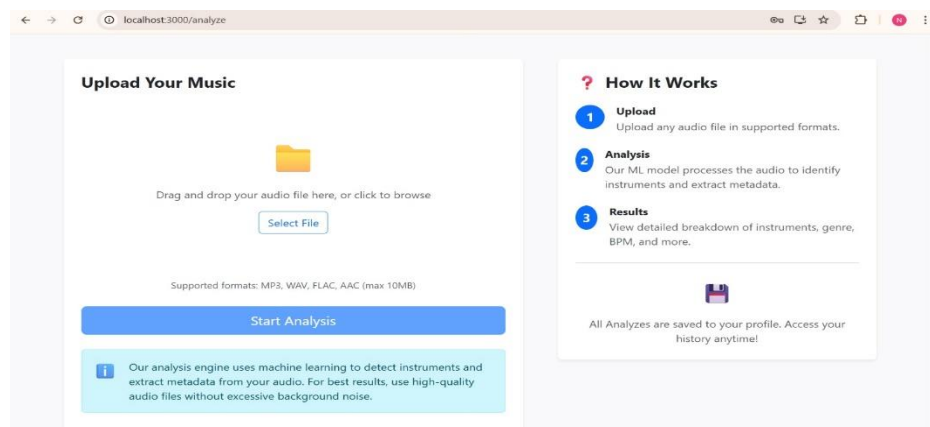

Screenshot 1: Home Page
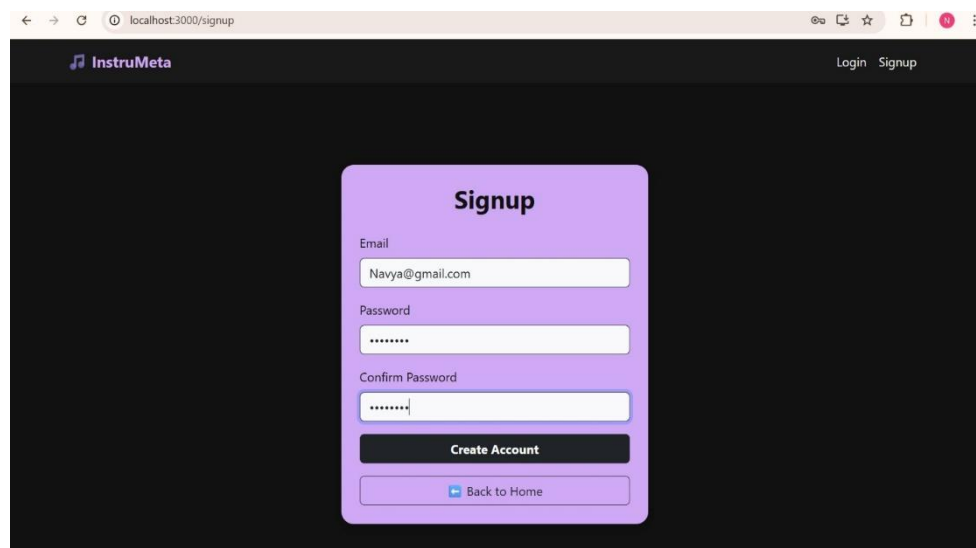
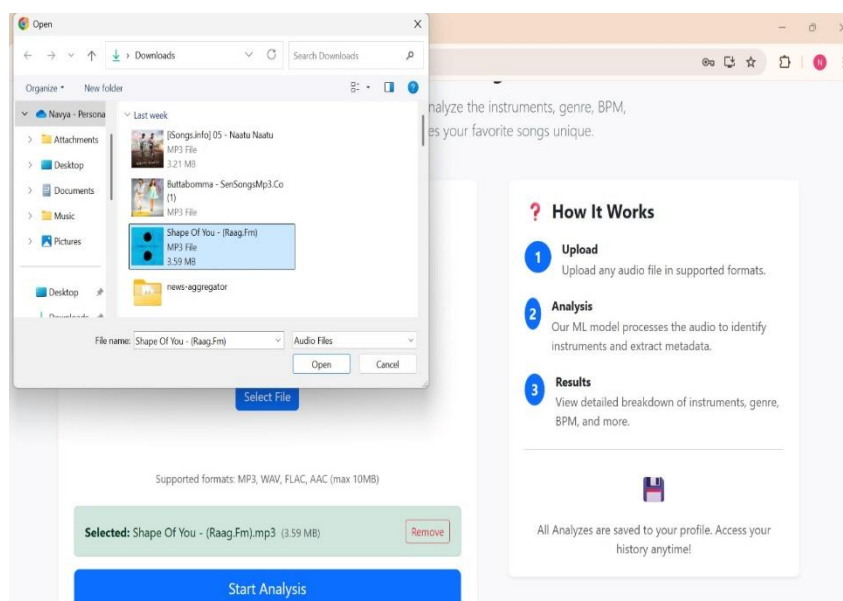
Screenshot 2: User Registration Page
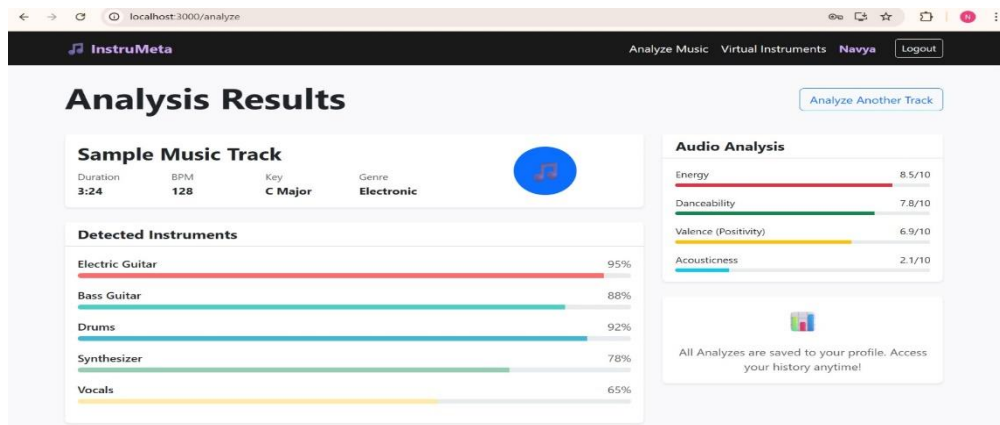

Screenshot 3: User Login Page
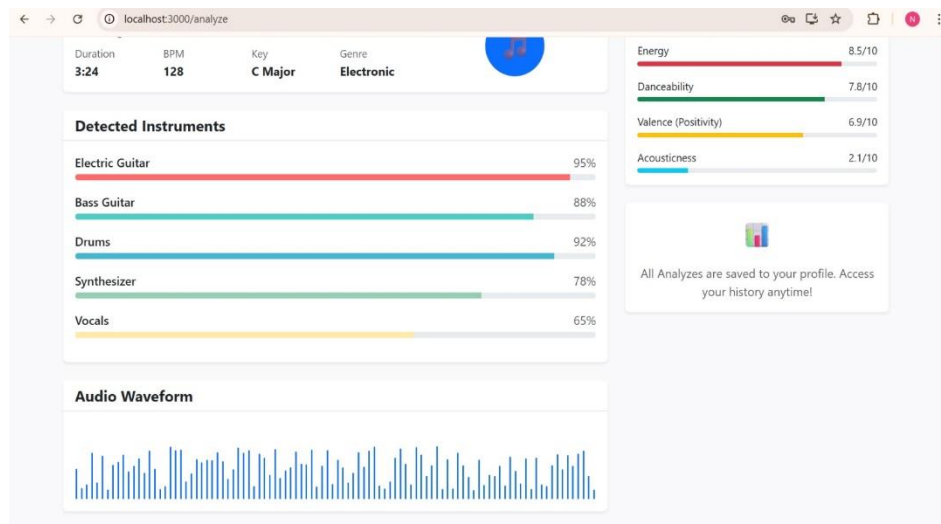
Screenshot 4: Dashboard

Screenshot 5: Uploading the audio file for instrument recognition

Screenshot 6: Selecting the audio
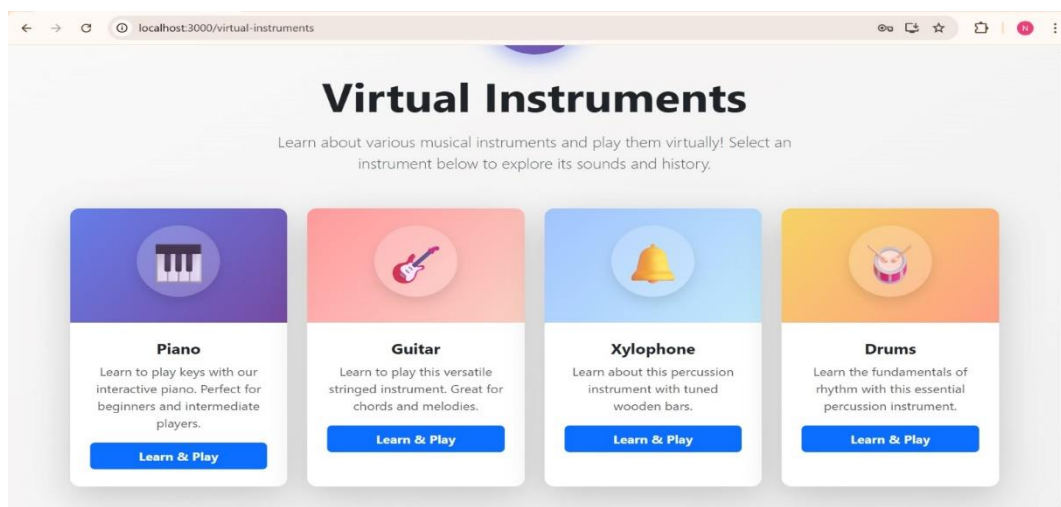
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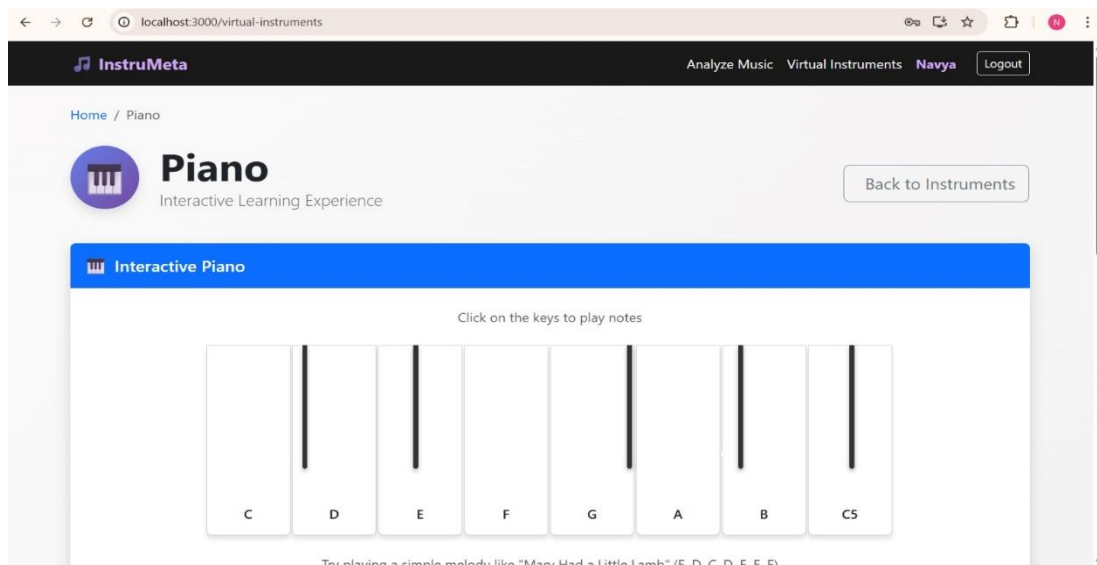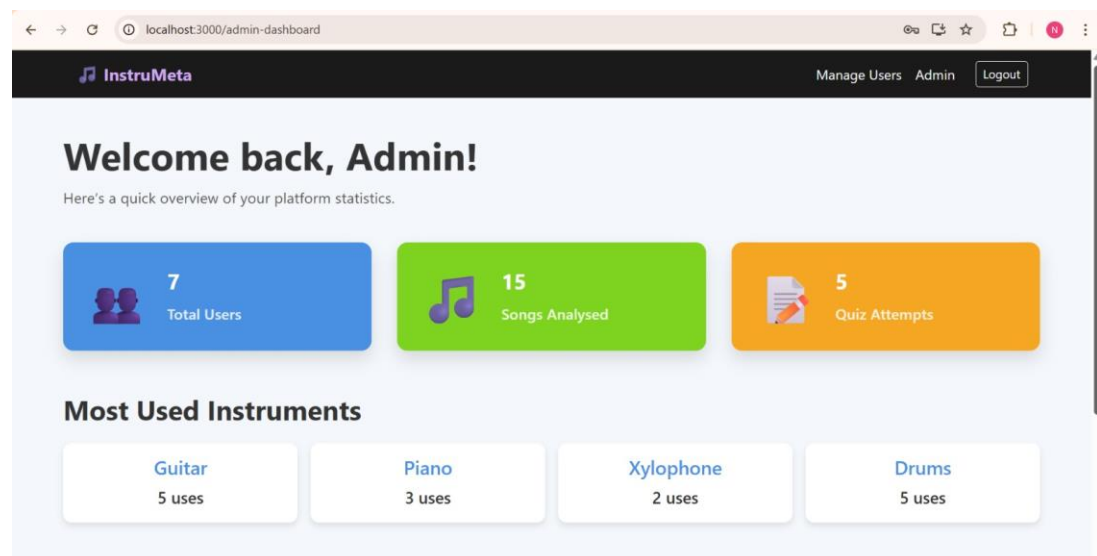

Screenshot 7: Instrument Recognition
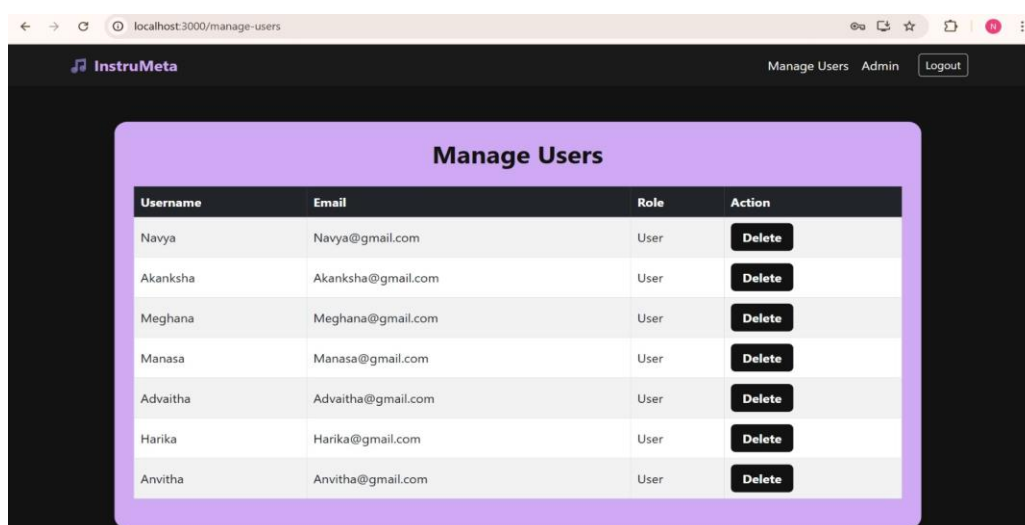

Screenshot 8: Instrument Recognition

Screenshot 9: Virtual Instrument Learning

Screenshot 10: Piano Virtual Learning

Screenshot 11: welcome admin

Screenshot 12 : Manage Users

7. CONCLUSION & FUTURE SCOPE

Conclusion

Instrumeta is an innovative web-based application that integrates four key functionalities: instrument recognition, movie metadata extraction, virtual instrument learning, and interactive music quizzes. By using CNN and RNN algorithms, the system efficiently recognizes musical instruments from audio samples and accurately extracts related metadata such as movie titles, genres, and singers. The platform also features virtual learning modules for instruments like piano, guitar, drums, and xylophone along with engaging quiz modules that test and reinforce users musical knowledge.

This multifaceted approach not only enhances user interaction but also bridges the gap between entertainment and education. Instrumeta offers a practical tool for music learners, enthusiasts, and researchers by combining machine learning with real-world multimedia content.

Future Scope

- Optimizing the system to handle larger datasets of audio clips, movie files, and user interactions while maintaining performance.

- Collaborating with music educators, industry professionals, or learning platforms to expand content and improve learning modules.

- Adapting the system to support multiple languages and cultural nuances in both music metadata and educational content.

- Enhancing the instrument recognition model to detect multiple instruments simultaneously in polyphonic audio.

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