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Hearing Test Application

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Abstract: *Hearing loss is one of the most common sensory impairments worldwide and often remains undetected until it begins to affect communication, learning, employability and quality of life. Conventional hearing screening relies on calibrated audiometers operated by trained clinicians in controlled environments. While clinically robust, such pathways are expensive, time-consuming and geographically inaccessible for many people, especially in rural or resource-constrained settings. Modern smartphones, however, combine high-fidelity audio output, capable processors and intuitive touch interfaces, making them promising platforms for preliminary, self-administered screening.*

This project presents Hearing Test App, an Android application that enables users to self-assess their hearing in a structured and repeatable manner and to track results on their own device. The app is developed in Java using Android Studio, follows an activity-based MVC structure and uses SQLite for local data storage to support offline usage and privacy. A user authentication module provides registration, login and password reset so that test histories remain personalised and protected.

Within the hearing assessment workflow, the app presents tones at multiple frequencies for each ear and allows users to indicate audibility via a simple interaction. Although the application is positioned as a screening tool and not a medical device, it adopts good practices from pure-tone screening to provide meaningful, relative indicators of hearing ability. Results are shown in an easy-to-understand summary and retained locally for longitudinal comparison. The design also anticipates future extensions such as device/headphone calibration, ambient-noise checks, audiogram-style visualisation, export of results and multilingual support to improve accessibility.

Keywords: Hearing test, Smartphone-based audiometry, Android application, Pure-tone screening, Mobile health (m-Health), Assistive technology

I. INTRODUCTION

Hearing is a critical sensory function that underpins spoken communication, social participation and learning across the lifespan. When hearing sensitivity begins to deteriorate, the earliest symptoms—such as frequently asking others to repeat, increasing the volume of television or mobile devices, or missing soft and high-pitched sounds—are often subtle and easily overlooked. In the absence of routine screening, mild or moderate hearing loss may progress unnoticed, with consequences for academic performance in children, workplace productivity in adults and psychosocial well-being in older adults. Despite the recognised importance of early detection, access to regular hearing checks remains limited for a large proportion of the global population, particularly in low-resource and rural settings.

Conventional hearing assessment is typically performed using calibrated audiometers in sound-treated rooms, administered by trained audiologists or hearing-care professionals. These clinical pathways provide high diagnostic accuracy and are considered the gold standard for threshold estimation and classification of hearing loss. However, they also impose several practical barriers: appointments must be scheduled in advance, travel to specialised facilities may be required, the equipment is expensive and maintenance-intensive, and qualified personnel are not evenly distributed geographically. For many individuals, especially those living far from urban centres or in health systems with limited audiology coverage, these constraints translate into infrequent or delayed hearing assessment. As a result, a gap persists between the need for early, repeated screening and the availability of conventional services.

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In parallel, the rapid penetration of smartphones has transformed how people access information and manage aspects of their health. Modern smartphones integrate relatively high-fidelity audio hardware, capable processors and standardised operating-system APIs for audio generation and user interface design. These characteristics have led to growing interest in mobile health (m-Health) applications that can support self-administered or community-delivered screening for various conditions. For hearing, smartphone-based pure-tone screening offers the possibility of reaching users outside traditional clinical environments and providing a first-level indication of potential hearing difficulty. Nonetheless, several technical and practical challenges remain, including device-to-device variability in output levels, lack of calibrated transducers, uncontrolled background noise and the need to communicate clearly that such tools are not substitutes for professional diagnostic assessment.

Within this context, there is a need for smartphone applications that balance accessibility with responsible design: they should provide a structured screening procedure, present unambiguous instructions, manage user data securely, operate without dependence on continuous network connectivity and clearly state their limitations as non-diagnostic tools. Existing mobile solutions often fall short in one or more of these aspects. Some require persistent internet access for authentication or data storage, which can be problematic in settings with poor connectivity. Others provide limited guidance on safe listening levels or do not preserve test histories in a manner that respects user privacy and allows longitudinal self-monitoring. Furthermore, not all applications implement per-ear, multi-frequency workflows that resemble basic pure-tone screening practices.

This work addresses these gaps by designing and developing an Android-based Hearing Test App that enables users to perform self-screened hearing checks on their own smartphones and to store the corresponding results locally. The application is implemented in Java using Android Studio and follows an activity-based Model–View–Controller (MVC) structure, which separates user interface components, control logic and data management. User-specific information, including authentication credentials and test histories, is stored on-device using SQLite, enabling offline operation and avoiding reliance on cloud services. A dedicated authentication module provides registration, login and password reset functionality, ensuring that each user has a personalised profile and that test data are logically segregated.

The core of the system is a hearing test engine that presents pure tones at selected frequencies for each ear separately, at varying relative intensity levels. Users interact with a simple interface to indicate whether a presented tone is audible. While the app does not attempt to estimate absolute hearing thresholds in clinical units, it captures relative audibility information across frequencies and ears in a structured manner. Upon completion of a test session, the application generates a summary view that presents the results in an easy-to-understand format, accompanied by plain-language guidance that encourages users with concerning patterns to seek professional evaluation. Safety information regarding moderate listening levels, the importance of a quiet environment and the non-diagnostic nature of the tool is embedded in the test workflow.

From a system-design perspective, the project emphasises extensibility and maintainability. The modular MVC architecture is intended to support future enhancements such as device/headphone calibration routines, basic ambient-noise checks prior to testing, audiogram-style graphical visualisations of results, export of test summaries for sharing with clinicians or caregivers, and multilingual support to improve accessibility in diverse user populations. Because all data are stored locally, the application is also suitable for deployment in environments where network access is intermittent or expensive, while preserving user privacy by design.

The specific objectives of this work are: (i) to design a user-centred workflow for self-screened hearing checks that non-specialist users can complete with minimal instruction; (ii) to implement secure user management with registration, login and password reset; (iii) to support per-ear, multi-frequency tone presentation and response capture within a structured test protocol; (iv) to persist user profiles, test sessions and results using a local SQLite database; (v) to present results using clear, non-technical language that prompts appropriate follow-up; and (vi) to structure the codebase to accommodate future features related to calibration, noise monitoring, data export and localisation.

II. LITERATURE SURVEY

Research on technology-assisted hearing assessment and support spans three closely related areas: smartphone-based pure-tone screening, multi-domain/mobile health screening, and hearing-assistive systems built around smartphones.

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This section reviews representative work in each area and positions the present Android Hearing Test App within that landscape.

2.1 Smartphone-based pure-tone hearing screening

One of the earlier mobile implementations of pure-tone screening is the Ear Scale iOS application introduced by Liao et al. [1]. Their work targets rapid, clinic-friendly hearing checks that can be deployed in audiology and otology settings as well as in schools. The focus is on fast stratification of hearing status per ear rather than full diagnostic audiometry, making it suitable for mass screening. Although the available description is concise and does not detail calibration or validation procedures extensively, the contribution demonstrates the feasibility of implementing pure-tone screening on smartphones for large-scale use and emphasises short test duration and clear categorical outputs as key design priorities. This aligns with the present project's aim of offering a brief, structured screening workflow rather than a full diagnostic tool.

Patel et al. [2, 5] extend this line of work with HearTest, a smartphone-based application designed to approximate conventional pure-tone audiometry more closely. Their system implements the Hughson–Westlake method ("10 dB down / 5 dB up") on a defined phone–earphone pair (iPhone XR with Sennheiser CX3.00) and calibrates that pair against a clinical audiometer and insert earphones. In a pilot study involving normal-hearing participants, the authors report threshold differences within clinically acceptable limits (⩽10 dB HL) and mean absolute differences of approximately 4 – 5 dB HL compared to the reference audiometer. They also discuss masking and interaural attenuation considerations, particularly when testing participants with greater degrees of hearing loss. The methodological contribution is significant: it shows that pair-specific calibration, careful stimulus control and a standardised threshold procedure can bring smartphone-based tests closer to formal audiometry, while still framing them as adjunctive screening tools rather than replacements for professional exams.

In contrast to a tightly calibrated system like HearTest, Masalski [4] presents a broader perspective on pure-tone audiometry implemented in an Android app that has evolved over nearly a decade. Rather than focusing on a single validation study, this work reviews the distinctive features and practical challenges of mobile pure-tone testing, including calibration strategies, differences in workflow compared to clinic-based audiometry, the feasibility of bone-conduction tests with accessories, and the impact of ambient noise and test duration on reliability. The paper highlights that self-tests performed on uncalibrated consumer hardware can provide useful indicative information, but must be accompanied by clear caveats about their limitations and the need for professional follow-up. This emphasis on noise control, user guidance and careful interpretation directly informs the design of the present Hearing Test App, which explicitly positions itself as a screening-only, non-diagnostic tool.

Taken together, these studies show that smartphone-based pure-tone testing is technically feasible and, with calibration and controlled conditions, can approximate clinical audiometry for certain populations. At the same time, they consistently stress that such applications are best used for screening, awareness and triage, not for definitive diagnosis. The proposed app adopts this conservative stance while focusing on offline usability, per-user data management and extensible architecture.

2.2 Multi-domain mobile screening and assistive applications

Beyond pure-tone hearing tests, some systems combine hearing and other sensory assessments within a single mobile application. Elasayed et al. [3] describe a mobile app that integrates both hearing and vision testing as a study case. While only limited methodological and performance details are publicly available, the work is notable for its multi-domain screening concept and for targeting low-cost, commodity devices. This approach suggests opportunities for unified health screening interfaces that can conduct several basic checks in a single workflow, which is particularly valuable in low-resource settings and community health campaigns. For the present project, such work points to potential future extensions, where simple vision checks or other health modules could be added around the core hearing test, provided that the user experience remains simple and not overwhelming.

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Deepa M. et al. [6] propose a different but complementary direction: a mobile application designed to aid hearing- and speech-impaired users in everyday communication. Rather than focusing on threshold estimation, their system emphasises assistive features such as speech-to-text (STT), text-to-speech (TTS), alerting mechanisms and user-friendly interfaces tailored to accessibility needs. The paper is positioned as a system development contribution rather than a clinical validation study, emphasising practicality, affordability and local hardware constraints. Although the primary goal differs from that of a hearing screening tool, the work highlights the importance of accessible UI design, language support and integration with users' daily communication tasks. These principles are relevant to the Hearing Test App, particularly in terms of designing clear instructions, large controls and the possibility of adding assistive features in future versions.

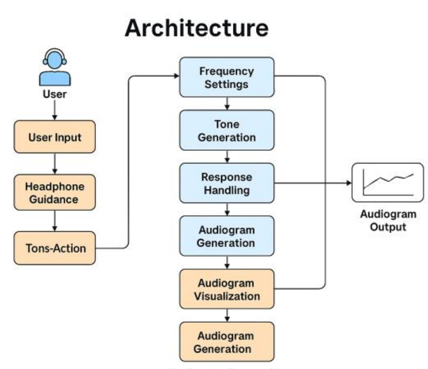
2.3 Smartphone-centric hearing-assistive ecosystems

A third strand of related research explores smartphone-centred ecosystems that support people with hearing difficulties in real-world listening environments. Chern et al. [7] introduce SmartHear, a smartphone-based system for classroom use that combines a remote microphone (e.g., the teacher's phone) and a receiver (the student's phone and headset). The system incorporates noise reduction, audio recording and live voice-to-text captioning, with flexible configuration of transmitter and receiver roles via Bluetooth or Wi-Fi. Evaluations report improvements in speech perception and perceived sound quality under challenging signal-to-noise ratios in classroom-like conditions. Although SmartHear is not a hearing-test application, it demonstrates how commodity smartphones can be orchestrated into assistive listening systems that address real-world communication challenges such as distance, noise and reverberation. This situates smartphone-based hearing tools within a broader assistive ecosystem that extends beyond screening into continuous listening support.

Li et al. [8] push the smartphone-assisted concept further by proposing a smart binaural hearing-aid architecture in which the smartphone performs deep-learning-based speech enhancement, while lightweight earpieces handle basic audio capture and playback. Heavy processing is offloaded to the mobile device, allowing more advanced speech enhancement algorithms than are typically feasible on small hearing-aid chips, while managing latency and power constraints through careful system design. The architecture supports frequent updates of the enhancement algorithms through the smartphone app and explores low-frequency wireless links to reduce body path loss. This work underlines two key ideas: smartphones can act as powerful, updateable processing hubs for hearing assistance, and real-world benefit depends on trade-offs between algorithm complexity, latency and battery life.

Although these assistive systems do not implement pure-tone screening per se, they demonstrate that smartphones are increasingly central to the hearing-care technology ecosystem, from classroom communication to advanced speech enhancement. For the present project, they highlight the long-term potential to connect a screening app with other assistive functions—for example, enabling users who identify possible hearing difficulties through screening to transition into assistive listening modes or to share results with clinicians.

III. METHODOLOGY



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The methodology adopted for the development of the Hearing Test App combines an engineering design process with user-centred considerations. The work began with a requirements analysis phase informed by a review of literature on smartphone-based hearing screening, mobile health applications and assistive technologies, as well as informal discussions with potential users. From this, a set of functional requirements was derived, including secure user authentication, per-ear multi-frequency tone presentation, on-device data storage and simple, understandable feedback, along with non-functional requirements such as offline operation, usability and privacy. These requirements guided the conceptual design of the system architecture and the selection of Android as the target platform, Java as the implementation language and SQLite as the local data store.

On the architectural level, the application was designed using an activity-based Model–View–Controller (MVC) pattern to ensure clear separation of concerns and future extensibility. The presentation layer consists of Android activities and XML layouts built with Material Design components to provide intuitive, accessible interfaces for registration, login, hearing test execution, result viewing and history browsing. The controller layer encapsulates the core application logic, coordinating navigation between screens, orchestrating the hearing test flow (ear selection, frequency sequence, volume adjustments and response handling) and translating user actions into database operations. The model layer is implemented through a dedicated database helper class that manages SQLite tables for users, test sessions and per-frequency test results, providing a clean API for creating, querying and updating persistent data while keeping all information on-device.

The hearing test engine itself was implemented as a structured workflow that presents pure tones of predefined frequencies separately to each ear and records user responses as relative indicators of audibility. Using Android audio APIs, sine-wave stimuli are generated at selected frequencies and durations, with channel routing used to achieve left- or right-ear presentation via headphones. For each stimulus, the user is prompted, through a simple interface with large tap targets, to indicate whether the tone was heard. The application iterates through a sequence of frequencies and levels, storing for each ear the minimum level at which the user reports audibility or, in simpler configurations, a binary heard/not-heard outcome per frequency. Safety instructions regarding moderate volume, correct headphone placement and the need for a quiet environment, as well as a disclaimer about the non-diagnostic nature of the app, are integrated into the test flow.

Implementation and evaluation followed an iterative cycle within Android Studio. Initial prototypes focused on getting core modules working independently: user registration and login, basic tone generation, and SQLite-based storage. These modules were then integrated and refined based on informal user trials that assessed clarity of instructions, responsiveness of the interface and the stability of data storage. Functional testing ensured that all major use cases—account creation, authentication, conducting a test, saving results and reviewing history—performed as intended without crashes or data loss. While the current version is positioned as a screening and awareness tool rather than a clinically validated device, the methodology and modular architecture deliberately anticipate future extensions such as device/headphone calibration, ambient-noise checks and enhanced visualisation of results.

IV. RESULT AND DISCUSSION

The primary outcome of this work was a fully functional Android application capable of guiding users through a structured, per-ear, multi-frequency hearing screening and storing the resulting data locally. Functional testing confirmed that all major use cases—user registration, login, password reset, initiation of a new test, completion of the test flow, viewing the immediate summary and browsing historical test records—operated as intended on the target Android versions and hardware. The hearing test engine successfully generated pure tones at the configured frequencies and durations, and correctly routed audio to the left or right channel based on the selected ear. Across repeated runs on the same device, the app consistently recorded and retrieved test sessions without crashes or data corruption, indicating that the SQLite-based persistence layer and its integration with the controller logic are robust for everyday use.

From a usability standpoint, informal evaluations with trial users suggested that the overall workflow was easy to understand and complete without external assistance. Participants were generally able to register, log in and start a hearing test on their first attempt, following the on-screen instructions. The use of Material Design components, large buttons and stepwise navigation reduced cognitive load and minimised navigation errors. Users reported that the separation between left-ear and right-ear testing, and the clear frequency-by-frequency progression, made the process feel structured rather than confusing. The summary screen, which presents results in a simplified, non-technical format along with plain-language guidance, was perceived as informative enough to raise awareness without overwhelming the user with audiological terminology. These observations support the design choice of prioritising clarity and accessibility over highly detailed parameter controls.

The app also met its design goals related to privacy and offline operation. All user credentials, test sessions and results are stored exclusively on the device using SQLite, and no network communication is required for core functionality. This behaviour aligns with the motivation to support resource-constrained or low-connectivity environments and to avoid unnecessary exposure of personal health-related data. In practice, this meant that the app remained fully usable in airplane mode and in locations without mobile data or Wi-Fi. At the same time, the use of on-device storage and simple authentication mechanisms underscores that the system is designed as a personal screening tool, not as part of a cloud-based telehealth platform. Any future integration with external services (for example, synchronising results to a clinician portal) would need to carefully address consent, encryption and regulatory considerations.

At the interpretive level, the results highlight both the promise and the inherent limitations of smartphone-based hearing screening implemented on commodity hardware. The app reliably executes its internal logic—tone presentation, response capture and result storage—but it does not incorporate calibrated coupling to clinical audiometric reference levels or systematic control of ambient noise. Consequently, the outputs should be understood as relative indicators of hearing ability under the specific device–headphone–environment combination, rather than as calibrated thresholds in dB HL. This is consistent with the conservative stance adopted in the design: the app presents itself as a preliminary screening and awareness tool, explicitly advises users to seek professional evaluation if results or self-perceived difficulties raise concern, and embeds safety reminders about moderate listening levels and quiet surroundings. In future work, more formal user studies with larger and more diverse populations, integration of device/headphone calibration procedures and basic noise-level checks could enable stronger statements about measurement reliability, while preserving the core strengths demonstrated here: accessibility, offline capability, privacy preservation and a user-friendly, extensible architecture.

V. CONCLUSION

This project presented the design and development of an Android-based Hearing Test App intended as a self-screened, preliminary hearing assessment tool. The application combines secure user management, a structured per-ear multi-frequency hearing test workflow and local data persistence using SQLite, all implemented within an activity-based MVC architecture. Functional testing demonstrated that core features—registration, login, password reset, test execution, result summarisation and history viewing—operate reliably on commodity Android devices without requiring network connectivity. By keeping all data on-device and using a simple, guided interface, the app addresses key objectives of accessibility, privacy and ease of use for non-specialist users.

The work also underscores the practical potential of smartphones as platforms for extending access to basic hearing screening in contexts where clinical audiometry is difficult to obtain regularly. Although the app does not attempt to provide calibrated audiometric thresholds or formal diagnoses, it offers users a consistent, repeatable way to monitor relative changes in hearing performance over time, using the same device and headphones. Embedded safety messages and clear disclaimers reinforce its role as an awareness and screening tool rather than a substitute for professional assessment. In this way, the system occupies a pragmatic middle ground between the absence of any screening and full clinic-based evaluation, supporting earlier recognition of possible hearing difficulties and encouraging timely consultation with audiologists or ENT specialists when indicated.

At the same time, the project has acknowledged limitations. The current implementation does not include device- or headphone-specific calibration against clinical reference equipment, nor does it measure or control ambient noise levels during testing. As a result, absolute comparability between different devices and environments cannot be guaranteed, and results must be interpreted cautiously and qualitatively. Furthermore, the evaluation has so far focused on functional correctness and informal usability feedback rather than large-scale clinical validation with diverse user groups and documented hearing profiles. Addressing these aspects would be essential for any future attempt to move closer to clinically reliable threshold estimation.

Future work can build on the existing architecture in several directions. On the technical side, integrating calibration routines for specific device–headphone pairs, implementing ambient noise checks before and during testing, and adding audiogram-style visualisations would enhance both reliability and interpretability. Features such as exporting results (e.g., as PDF/PNG) for sharing with clinicians or caregivers, multilingual support to reach a broader population, and optional cloud backup or clinician portals (with proper security and consent mechanisms) are also promising extensions. Beyond pure screening, the app could be expanded to interface with assistive functionalities—such as simple sound alerts, speech-to-text aids or links to educational resources about hearing health—thereby positioning it not only as a screening tool but as an entry point into a broader mobile hearing-care ecosystem.

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