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AI-Empowered Software Integrated with Mobile Technology to Detect Harmful Noise

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Abstract

Harmful noise is a prevalent and growing health concern worldwide, affecting millions due to prolonged exposure to excessive noise levels. Traditional hearing protection methods, such as hearing aids and cochlear implants, have limitations regarding accessibility, scalability, and effectiveness. In Rwanda, the effects of hazardous noise levels are increasingly apparent, particularly in urban areas and during musical concerts, where excessively loud environments are common. Musicians and concert attendees frequently experience high decibel levels, significantly increasing their risk of hearing impairment. This research proposes an innovative solution utilizing AI-powered software integrated with mobile technology to detect and mitigate harmful noise. The software continuously monitors environmental noise in real time, identifying hazardous sound levels and providing personalized recommendations to users to prevent hearing damage. The development process involves data collection from various audio sources, preprocessing, model training using machine learning techniques, and seamless integration into a user-friendly mobile application. Preliminary results indicate a high accuracy of the AI model in detecting dangerous noise levels and offering actionable feedback. This solution aims to enhance auditory health by making hearing protection more accessible, proactive, and effective for diverse populations. Ethical considerations, including data privacy and bias mitigation, are rigorously addressed to ensure the software's integrity and foster user trust

Keywords: AI-Empowered Software, Harmful Noise Detection, Machine Learning, Mobile Technology, Health Protection, Data Privacy

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Introduction

The study focuses on AI-empowered software integrated with mobile technology to detect harmful noise in real time. This advanced system uses machine learning algorithms, sensor data, and signal processing to identify hazardous sound levels, classify noise sources, and provide alerts for noise reduction. By enhancing public health, workplace safety, and environmental monitoring, this technology informs policymakers and empowers individuals to protect their auditory health. Harmful noise exposure is a significant global health concern, affecting millions and leading to irreversible hearing impairment, particularly in industrial, urban, and recreational settings. Despite existing regulations, challenges remain due to inadequate monitoring and low awareness of noise hazards. The proposed solution offers real-time noise detection, enhancing awareness and providing proactive protection. Leveraging advancements in AI and mobile technology, this approach allows for personalized alerts, predictive analysis, and user education, enabling individuals to manage their auditory health effectively. Mobile devices equipped with AI algorithms can track noise exposure over time and offer actionable recommendations to prevent damage. As mobile health technologies gain traction, this AI-driven solution promises improved health outcomes, especially for underserved populations. By addressing gaps in traditional noise control methods, it provides a user-centric approach to managing harmful noise exposure. The study explores the potential of this technology to reduce noise-related health issues and improve quality of life in affected environments **[1]**.

Literature review

To the day harmful noise is pervasive and largely preventable public health issue. Despite the availability of various hearing protection devices, millions of individuals continue to suffer from hearing impairment due to prolonged exposure to hazardous noise levels. According to the World Health Organization **[2]**, approximately 1.1 billion young people worldwide are at risk due to unsafe listening practices. In Rwanda, the problem is increasingly visible, especially in urban settings and musical events where loud noise is common. Many people, including musicians and attendees, face high noise exposure without adequate knowledge or means to protect themselves. Informal industries and urbanization worsen the issue. Current solutions like hearing aids and cochlear implants are mostly reactive rather than preventive, and they are often expensive and stigmatized. The economic impact includes healthcare costs, lost productivity, and disability expenses **[3]**.There is a clear need for innovative, proactive approaches. This project proposes an AI-empowered software integrated with mobile technology to detect harmful noise that can monitor noise levels in real time, assess individual risk, and provide personalized recommendations to help prevent hearing loss. This Research into AI-based noise monitoring systems has demonstrated promising applications for real-time environmental noise assessment, particularly in urban settings, where deep learning techniques effectively classify noise sources. For instance, AI noise source identification systems, such as those utilizing AI, enhance urban noise management by accurately recognizing and categorizing various noise types, enabling effective monitoring and targeted mitigation strategies **[4]**. Various mobile applications have emerged to help users manage harmful noise exposure, offering features like noise level monitoring and educational resources on hearing health. These applications leverage machine learning algorithms to provide personalized alerts and recommendations, thereby promoting better auditory health **[5]**. Additionally, research has shown that machine learning techniques can distinguish between different noise types, such as industrial and environmental sounds, and assess their potential health impacts, highlighting the need for effective monitoring and intervention strategies **[6]**. These devices can track noise levels and offer actionable insights to users, further enhancing personal health

management **[7]**. Case studies have highlighted successful implementations of AI systems in different area to manage noise, often in collaboration with local governments, demonstrating the effectiveness of data-driven strategies for noise reduction.

Proposed System

This system of detect harmful noise by monitoring noise levels using machine learning and providing warning of potentially damaging noise along with recommendation. The mobile application uses your device's microphone to measure noise levels and sends this data to our backend server for analysis. When we use this application, it can only correct noise level data, and no other personal information is stored. If this app detects harmful noise levels, we recommend moving at least 50 meters away from the noise source to protect your hearing and human stay in good condition or cornel the concert. This application requires the internet connection to send noise levels data to backend server for analyze and to provide accurate warnings and recommendations. This project applies to be implemented different algorithms supervised learning to detect harmful noise using Support Vector Machines (SVM), Neural Networks, and Random Forest algorithms. SVM offers 85–95% accuracy using audio features, ideal for smaller datasets. Neural Networks, including CNNs, mimic brain-like processing and achieve up to 99% accuracy with spectrogram inputs. Random Forests handle complex patterns with 90–96% accuracy. Unsupervised learning is also explored for uncovering hidden data patterns without labels. The study highlights common issues like underfitting (too simple models) and overfitting (too complex models), both of which harm model generalization.

System Approaches

This approach allows for the creation of controlled scenarios to test the predictive models under various conditions. Simulated data represents different noise environments, such as traffic noise, industrial noise, and recreational noise, helping to validate the robustness and accuracy of the predictive models **[8]**

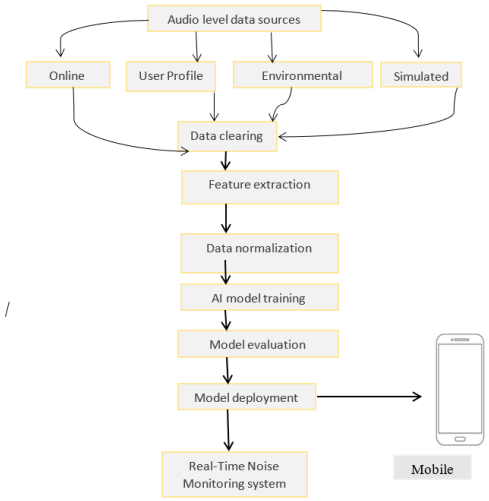

Figure 1: Data Acquisition Process Flow Diagram

System Design and Analysis

The system design and analysis phase involves defining the architecture of the AI-powered software and its components. This includes designing the data flow, specifying the machine learning models and algorithms to be used, and determining the integration points with mobile applications for real-time noise monitoring and feedback **[9]**.

The Real-Time Noise Monitoring System Architecture

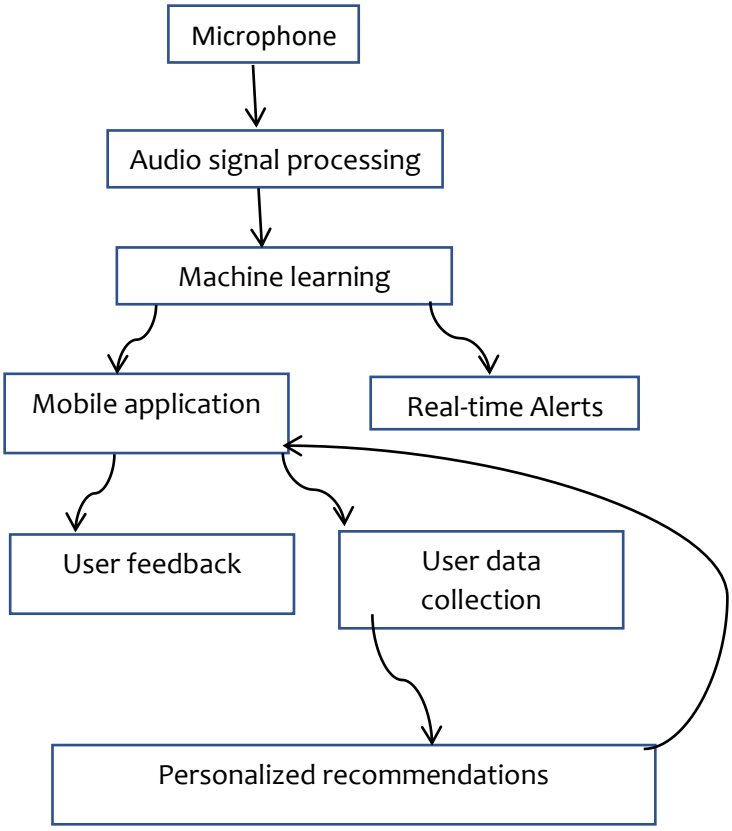

Figure 2: Flowchart diagram illustrating the Real-Time Noise Monitoring System Architecture

Data Throughput

The primary data for this project comprises audio level data, which indicates the intensity of sound rather than the content. This data is crucial for detecting hazardous noise levels and training the AI model to provide accurate recommendations. Online datasets several publicly available datasets provide audio level data. These include datasets from research institutions, governmental organizations, and industry databases. Examples include the Urban Sound 8K dataset, which provides sound intensity data for urban environments, and the CHiME dataset, which includes noise level data from real-world scenarios, their use case shows the actor or users of the system. It shows user interaction and relationship between internal systems and produced output results

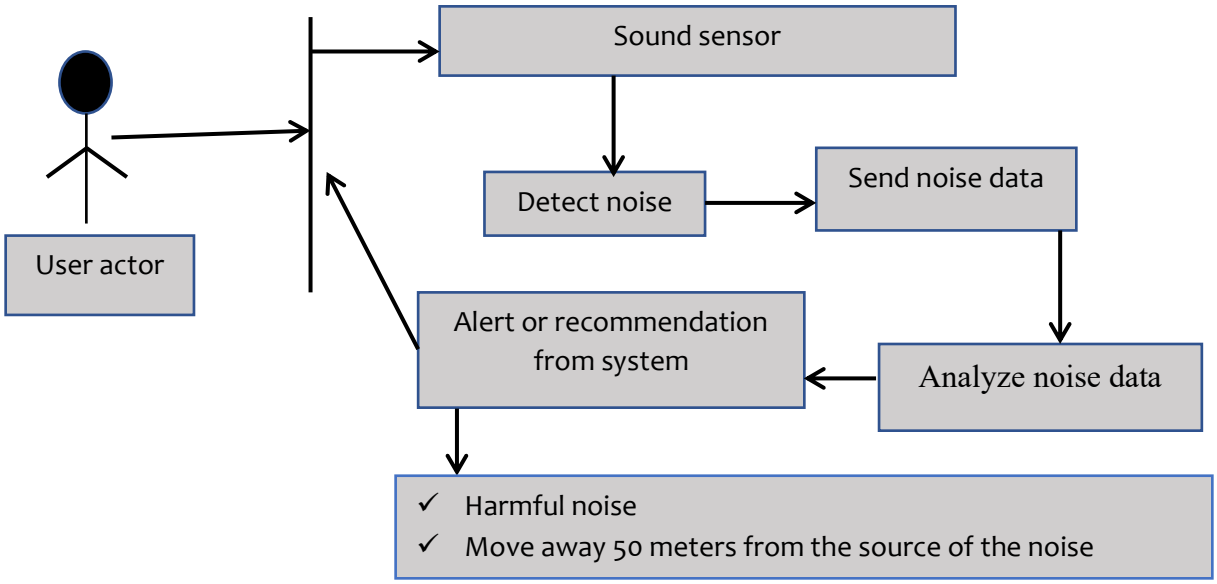

Figure 3: The user case diagram

This user-specific data is gathered through mobile applications, where users view their daily noise exposure and provide contextual information about their environment. Information includes the average daily noise exposure, types of environments frequented (e.g., workplace, recreational areas), and personal hearing protection measures used.

Simulation Results and Analysis

The AI-empowered noise detection application was tested in diverse environments, including residential areas, industrial zones and public spaces to evaluate its accuracy and effectiveness. The following key parameters were considered: Noise level detection accuracy The application precision in detecting noise levels was compared with a calibrated standard decibel meter sound level. Accuracy was assessed by calculating precision, recall, F1-score, and specificity. Real-Time Processing the AI ability to process noise data and generate alerts instantaneously was measured by analyzing the latency between noise detection and alert delivery. User interface responsiveness the application's performance and responsiveness on various mobile devices operating system were evaluated using metrics such as frame rate and touch response time. the home page, of mobile application which displays the home and a line graph illustrating noise levels over the noise level meters in decibels, and user profile buttons for accessing settings and viewing recent alerts

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Figure 4: The image shows the home page

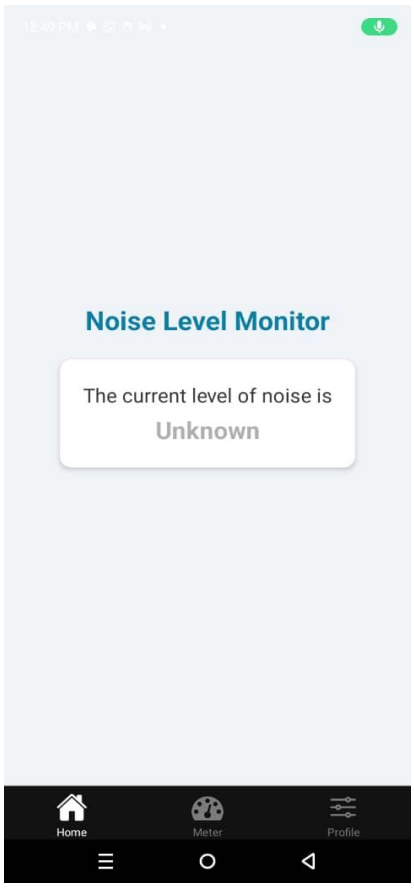
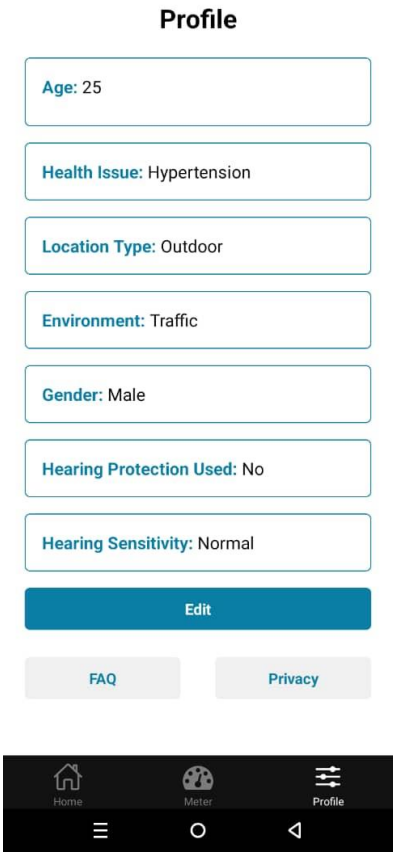


Figure 5:The image it shows the user profile interface, where users can input their age, noise



The noise meter is a crucial component that visualizes real-time noise levels and categorizes them based on their harmfulness. In this change the level of sound noise levels when the sound is below to 70 dB it shows Green (Safe) in recommendation its show in harmless noise. If the sound is the above 85 dB in the harmful noise in recommendation, the image shows the noise meter interface, which features a circular dial with a needle that moves in real-time. digital decibel readings are displayed below the dial

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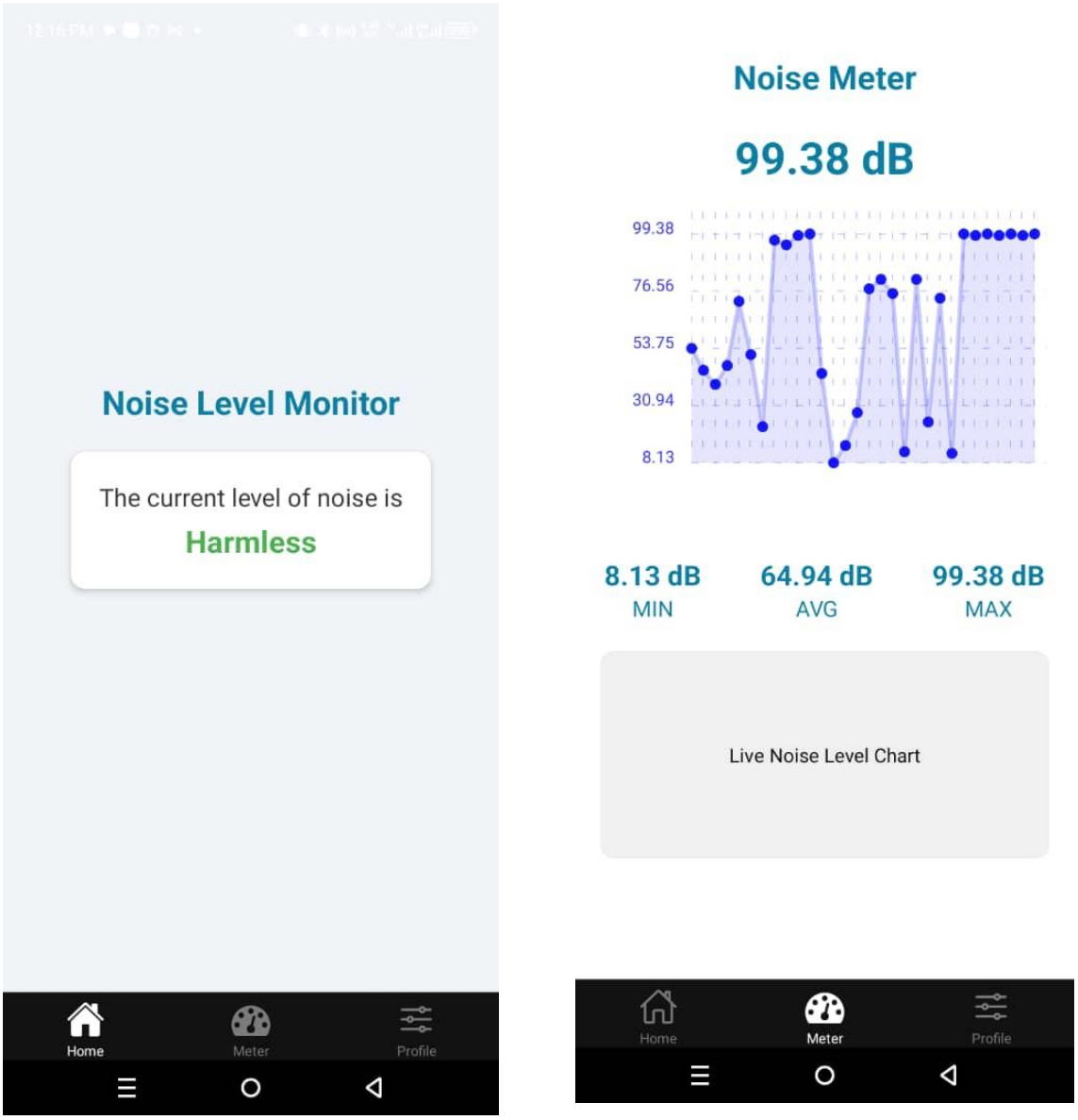

Figure 6: The Noise Meter Interface

In this case, the noise level is categorized as **"Harmless"**, meaning it falls within a safe range that does not pose any risk to hearing or health. The interface is designed to be simple and easy to understand, allowing users to quickly check their noise environment range is no effected noise. The harmful noise alert message reads, warning Noise level is currently above 85dB. This level can be harmful with prolonged exposure. Consider moving to a quieter area or using ear protection. The alert includes options to dismiss the notification or view more details.

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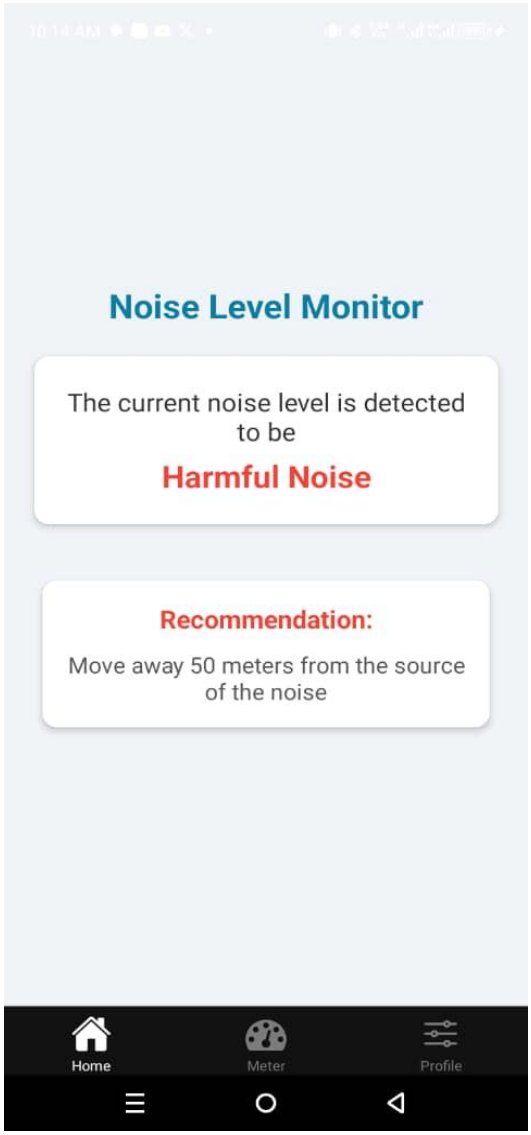

Figure 7: Harmful Noise Alert

Conclusion and Future Work

The integration of AI-powered software with mobile technology presents a promising solution to detect and mitigate harmful noise. By leveraging real-time noise monitoring, predictive analytics, and personalized feedback, these technologies can empower individuals to better understand and manage their noise exposure. The accessibility and portability of mobile devices ensure widespread adoption, making such systems practical for diverse populations and settings, including workplaces, urban environments, and personal use. The potential of this approach lies in its ability to enhance awareness, encourage preventive behaviors, and ultimately reduce the prevalence of noise-induced hearing damage, which is a growing public health concern. While promising, the successful implementation depends on addressing challenges such as user compliance, data accuracy, and privacy concerns. Furthermore, AI and mobile integration can enhance harmful noise detection, supported by the research findings. For future work should focus on refining AI models to effectively detect and reduce harmful noise using AI-powered mobile software, several recommendations are proposed. For users, developers should create intuitive interfaces, integrate gamification and personalized feedback, ensure accurate data via quality sensors and algorithms, and promote awareness through educational content and health partnerships. For students, campaigns and interactive tools should raise awareness of noise risks and encourage safe listening, especially during school events. Future researchers are encouraged to enhance prediction accuracy with advanced AI, integrate health metrics like stress and sleep, and conduct long-term studies. For industry, partnerships and pilot studies can help expand the software's impact and drive improvements.

References

[1] W. H. O. (WHO), " "Deafness and hearing loss.," no. Available at: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss (Accessed: 29 May 2024).,," 2018..

[2] W. H. O. (WHO), ""Prevention of deafness and hearing loss.," no. Available at: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss (Accessed: 29 May 2024).,," (2017) . .

[3] W. H. O. (WHO), ""World report on hearing. Available at: https://www.who.int/publications/i/item/world-report-on-hearing (Accessed: 29 May 2024).,"," (2020) . .

[4] M. &. S. K. Svanberg, . *AI for Urban Noise Management. Journal of Environmental Management, 250, 109500. DOI: 10.1016/j.jenvman.2019.109500.,* (2020).

[5] A. &. V. K. I. Brown, "The Role of Local Governments in Urban Noise Management: Case Studies from Europe. Noise & Health, 19(87), 114-122. DOI: 10.4103/nah.NAH_59_15.," (2017). .

[6] Y. &. W. L. Zhang, "Machine Learning Techniques for Sound Classification: A Review. IEEE Access, 7, 23415-23429. DOI: 10.1109/ACCESS.2019.2892334.," (2019). .

[7] H. &. K. S. Park, "Wearable Devices for Real-Time Noise Exposure Assessment. Sensors, 20(15), 4295. DOI: 10.3390/s20154295.," (2020). .

[8] J. O. Smith, "Introduction to Digital Filters: With Audio Applications. 3rd edn. San Francisco: W3K Publishing,," (2018)..

[9] I. B. Y. a. C. A. Goodfellow, " "Deep Learning. Cambridge: MIT Press.,"," (2016) .

[10] [13] G. e. a. Pouryaghoub, *"Noise-Induced hearing loss among professional musicians.," Journal of Occupational Health. [Online] 59 (1), 33–37., ,* (2017) ..

[11] H. H. A. a. A. A. Hafezi, " "'Real-time noise monitoring and hearing protection using IoT and AI', Journal of Environmental Health Science and Engineering, 20, pp. 567-578. doi: 10.1007/s40201-022-00789-5.,"," (2022) . .

[12] B. B. F. J. J. D. J. L. a. G. E. N. Blanchfield, "The severely to profoundly hearing-impaired population in the United States: Prevalence estimates and demographics',," *Journal of the American Academy of Audiology, 12(4), pp. 183,* (2018) .