JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DIGIBEAT - A DIGITAL STETHOSCOPE

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Abstract*—The digital stethoscope combines modern technology with traditional diagnostic tools and represents a revolutionary development in healthcare. This abstract provides an overview of the main features, applications, and benefits of digital hearing aids. Digital hearing aids have evolved beyond their traditional hearing aid counterparts, providing healthcare professionals with a versatile tool to deliver improved patient care. These devices incorporate advanced acoustics, signal processing, and communication techniques to enable comprehensive acoustic analysis and enable applications in a variety of medical settings, incl and primary care, emergency departments, and telemedicine. Key features of digital hearing aids include real-time sound amplification, noise reduction, and the ability to record and store patient data. Additionally, audio and data can be transmitted wirelessly, enabling remote conversations and telehealth services. Digital stethoscopes can image heart and lung sounds in waveform and spectrogram form, facilitating accurate diagnosis. The advantages of digital headphones are numerous. They empower healthcare professionals to make accurate and informed assessments, especially in noisy environments or during telephone health consultations. The ability to record and store patient data supports long-term care and collaboration between physicians. Additionally, digital audio equipment enhances medical education and can help train future health professionals. In conclusion, digital hearing aids have the potential to change the way healthcare professionals diagnose and care for patients. Combining traditional hearing aids with state-of-the-art technology improves the effectiveness of these devices

***Index Terms*—Machine learning, E-commerce, Logistic re-gression, Decision tree, Random Forest algorithm.**

I. INTRODUCTION

The stethoscope, a fundamental and iconic medical instrument, has remained largely unchanged for nearly two centuries since its invention by René Laennec in 1816.Its enduring simplicity and reliability have made it an essential medical tool workers experience worldwide, helping to determine that cardiorespiratory conditions.

But in an era of rapid technological advancement and digital transformation, the traditional sound-only hearingaid is now poised for a radical change Digital Stethoscope Project represents a pioneering effort seeking to enter the digital age the listening device. By combining advances in digital signal processing, wireless processing, and artificial intelligence, the project reimagines the hearing aid as a cutting-edge diagnostic device , capable of providing rich, accurate, and easily accessible patient information and performance therefore addresses some of the limitations of traditional hearing aids. In this era of telemedicine, remote disease monitoring and increasing demand for data-driven healthcare, the Digital Stethoscope Project offers a state-of-the-art solution for current Healthcare employees can record, record and perform body movements with unprecedented clarity, and seamlessly collaborate with colleagues around the world . The blend of modern technology and traditional audio equipment creates a bridge between the familiar past and the possible future. This introduction sets the stage for the Digital Stethoscope Project, which aims to improve diagnostic accuracy, improve patient care and help deliver more efficient healthcare. The aim of this program is to delve into digital hearing aid technology, explore its capabilities and applications in cardiology. Using digital signal processing algorithms and state-of-the-art machine learning techniques, we can not only identify subtle cardiac abnormalities but also aim to provide valuable insights into the pathology of various cardiovascular conditions of the underlying knowledge We can take a striking example. The importance of this effort is its ability to overcome long-standing challenges in cardiac diagnosis, such as the topic of auscultation and variability through the use of conventional hearing aid.

II. METHODOLOGY

A. Background

Cardiovascular diseases (CVDs) remain a significant global health burden, requiring accurate and early detection for effective management. While traditional audio equipment is central to cardiac evaluation, it is hampered by subjective interpretation and sensitivity to ambient noise. In turn, digital hearing aids have emergedas a promising alternative, taking into account advances in sensor technology and signal processing. They offer sound enhancement, noise reduction capabilities, and automated assessment feasibility with machine learning.

This project seeks to harness the power of the digitalaudio device to revolutionize cardiac research. Through interdisciplinary collaboration, we aim to develop a modelthat provides objective, quantitative data to accurately identify cardiac abnormalities. Challenges include rigorous validation, standardization of indication management strategies, and seamless integration into clinical workflows. Overcoming these barriers can pave the way for greater adoption and improve patient care outcomes. By combining cardiology, biomedical engineering and data science, we want to push the limits of cardiovascular disease diagnosis. Our goal is to provide physicians with a powerful tool that enables them to diagnose and effectively manage CVDs.

B. Methodology

1. Pre-processing :- Heart rate (50–80 beats per minute) and respiratory rate (12–20 beats per minute) were assumed as dissociations in this study. Subtrees of different lengths were tested so that the complete data for one heartbeat or one breath fit within a subtree. The heart and lung sound signals were divided into small trees. Different lengths of small rods were tested for optimal length, 1, 1.5, 2 seconds for heart sounds, 3, 4, 5 seconds for lung sounds and the other combinations are 0%, 20%, and 50% . it was adopted to split the original sample to increase the number of samples, and f to assess whether the overlapping method would provide better acceptability After splitting, principal component analysis (PCA) was performed with subsamples and thensubtracted the original signal based on PCA to obtain the difference signal (frames after PCA). These cardiac cycles produce normal or abnormal heart sounds are: diastole, systole, diastole, and systole. In the case of PCG, abnormal waves in these discs cause abnormal heart sounds. Here, this vibration refers to abnormal collisions. In particular, the heartbeat sound accounts for more than 80% of the total input signal and this signal will often dominate the classification results. However, what we need and care about is a separate soundtrack.

2. Feature Extraction :- As mentioned in the previous section, although the difference signals can be visually detected directly, they are too complex for a computer and therefore the difference signals must be characterized for easy detection. In this study, two types of features were extracted: time-domain features and frequency- domain features.

III. PROPOSEDSYSTEM

First, for temporal features, the original difference signals are too high and inaccessible. At a sampling rate of 2000 Hz, a 2 s acoustic frame will have 2 × 60 × 2000 (240,000)points, which is a high-dimensional vector. This high- dimensional vector can be processed to reduce its dimensions by MFCC and numerical subtraction. Statistical time-domain features were used to optimally smooth high-dimensional inter-signals while preserving the quality of the original signals This study selected 11 statistical features: mean, standard deviation, mean absolute deviation, median, first quartile, third quartile, interquartile range , smoothness, kurtosis, Shannon entropy; In terms of spectral entropy.

Second, frequency domain information on acoustic signal processing tends to exhibit differences more than time domain features because cardiopulmonary signals have a periodic nature and different sounds have different frequencies.

3. Classifier :- Classification algorithms are used to classify normal (normal) and abnormal (pathological) heart rhythms and normal and abnormal pulmonary rhythms. In this study, we adopted the concept of ensemble learning to develop the classifier model and tested several classical cluster learning techniques, including Bagging (bootstrap aggregating), AdaBoost (adaptive boosting), GentleBoost (gentle adaptive boosting). LogitBoost (adaptive logistic), and RUSBoost (random under-sampling boosting), trained each sampling method (e.g., 0% overlap in 1 s, 20% overlap in 1 s, etc.) 5 times to anticipate learning the most suitable for the database chosen for this study is, and a cluster learning method is randomly selected for each time to determine the final classification model based on the best model obtained by Bayesian optimization. The initial sample was divided into several subscales for training and the modelshowed the results of the subscales for the results. If an abnormal number of frames exceeds a certain threshold, the original sample is considered an abnormal cardiopulmonary sample, while the opposite is usually thecase where test results are expressed as grades of election results hear (e.g. 5%, 10%, 15%, … , 95%) and see what proportion of the results The result is positive Furthermore, if the length of the original sample cannot be divided by more than one small frame, the pattern is ignored and not counted.

4. Method selection :- A Random Forest model canbe a powerful addition to a digital stethoscope project, particularly for the purpose of classifying heart soundsand identifying cardiac abnormalities. Here's an overviewof how a Random Forest model can be used in a digitalstethoscope system.

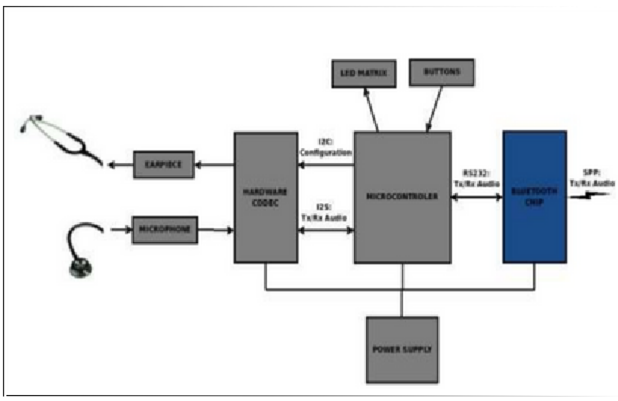


Fig. 1. Proposed System

The proposed system represents a way to address the challenges of traditional cardiac research. Seamlessly integrating state-of-the-art hardware components with advanced signal processing techniques and machine learning algorithms, it aims to provide clinicians with a powerful tool for accurate and efficient cardiac testing The foundation is laid By reducing noise so, frequency filteringand amplification algorithms, the system increases the clarity and reliability of captured heart sounds, allowing doctors to identify subtle details that indicate underlying cardiac conditions

In addition, the inclusion of machine learning models improves the diagnostic capability of the system by facilitating real-time interpretation and segmentation of heart sounds They are trained on comprehensive datasets affecting cardiac diseases some of these models empower systems to deliver actionable insights Seamless connectivity to the arrow Ensures, facilitates efficient business process integration and enables better deployment. Wireless connectivity alternatives not most effective enable effortless statistics transmission to electronic fitness report systems but also facilitate far off tracking, offering unprecedented flexibility and accessibility in patient care. Furthermore, the machine's reliance on rechargeable batteries ensures uninterrupted operation, underscoring its portability and suitability for diverse medical settings. By adhering to stringent regulatory standards and hints, the system engenders agree with and confidence among users, ensuring compliance with critical protection and quality requirements.

In addition to its technical prowess, the proposed gadget embodies a dedication to continual improvement and innovation. Its scalability and adaptableness empower it to evolve alongside advancements in scientific era, ensuring lengthy-term relevance and efficacy. Through collaborative improvement regarding various knowledge spanning cardiology, biomedical engineering, software program development, and machine learning, the system embodies a synergy of interdisciplinary collaboration, riding development in cardiovasculardiagnostics and in the end improving affected person effects.

IV. ALGORITHM

A. Decision Tree

Decision Tree is a Regulated learning procedure that can be utilized for both characterization and Relapse problems, however for the most part it is liked for taking care of Order issues. It is a tree-organized classifier, where interior hubs address the highlights of a dataset, branches re despise the choice guidelines and each leaf hub addresses the outcome.

In a Decision tree, there are two hubs, which are the Choice Hub and Leaf Hub. Choice hubs are utilized to go with any choice and have different branches, while Leaf hubs are the result of those choices and contain no further branches. The choices or the test are performed based on elements of the given dataset. It is a graphical portrayal for getting every one of the potential answers for an issue/choice in view of given conditions. It is known as a choice tree in light of the fact that, like a tree, it begins with the root hub, which develop

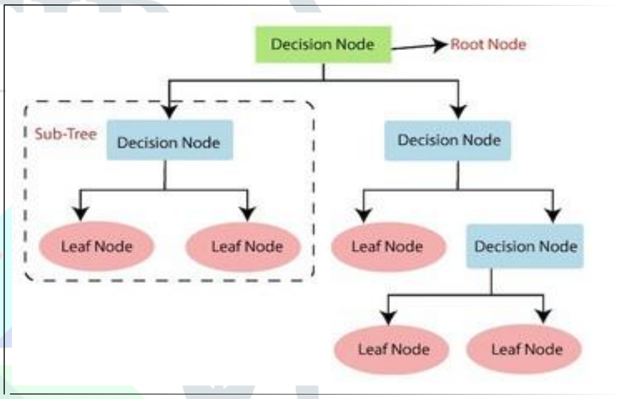


Fig. 2. Decision Tree

Step-1: Start the tree with the node of root.
Step-2: Track down the best quality in the dataset utilizingTrait Determination Measure (ASM).
Step-3: Partition the S into subsets that contains potentialqualities for the best ascribes.
Step-4: Produce the choice tree hub, which contains thebest quality.
Step-5: Recursively settle on new choice trees utilizing the subsets of the dataset made in step - 3. Proceed with this interaction until a phase is reached where you can'tfurther characterize the hubs and called the last hub as a leaf hub.

B. Random Forest

Random is a famous AI calculation that has a place with the managed learning procedure. It can be utilized for both Order and Relapse issues in AI. It depends on the idea of ensemble realizing, which is a course of joining numerous classifiers to tackle a perplexing issue and to work on the presentation of the model.

"Random Forest is a classifier that contains various choicetrees on subsets of the given dataset " Rather than depending on one choice tree, the arbitrary timberland takes the forecast from each tree and in light of the largerpart votes of expectations, and it predicts the last result.

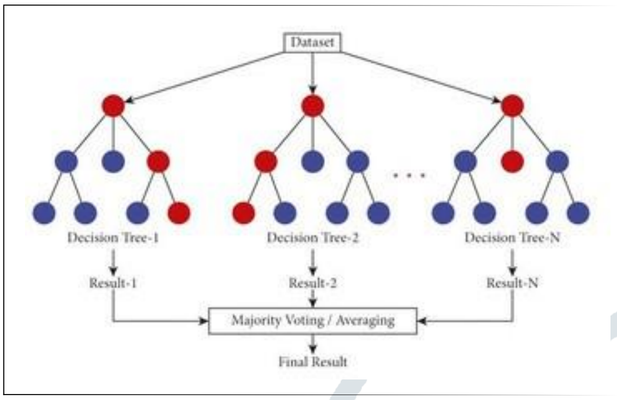


Fig. 3. Random Forest

Step-1: Select arbitrary K data of interest from thepreparation set.
Step-2: Fabricate the choice trees related with the chosepieces of information (Subsets).
Step-3: Pick the number N for choice trees that youneed to construct.
Step-4: Re-hash Stage 1 and 2.
Step-5: For new pieces of information, find the ex-pectations of every choice tree, and appoint the newinformation focuses to the classification that wins the larger part casts a ballot.

V. RESULTS

A. Dataset

For this project, we have used the following dataset from Kaggle. Dataset contains 5630 rows and 20 columns.

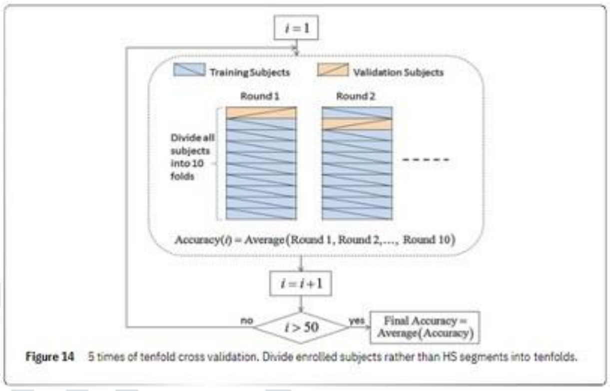


Fig. 4. Dataset

B. Connection of the Circuit

- Sensors:
  - Use electret microphones or piezoelectric sensorsas the sensors for capturing heart sounds.
  - Connect the positive terminal of each sensor toone end of a resistor (e.g., 10k ohms), and connectthe other end of the resistor to the analog input (A0-A5) of the Arduino Uno.
  - Connect the negative terminal of each sensor tothe ground (GND) pin of the Arduino Uno.
- Amplification Circuitry :
  - If you want to include amplification circuitry, you can use operational amplifier (op-amp) circuits like the LM386.
  - Connect the output of each sensor to the non- inverting input of the op-amp circuit.
  - Connect the output of the op-amp circuit to the analog input (A0-A5) of the Arduino Uno.
  - Provide appropriate power and ground connections to the op-amp circuit.

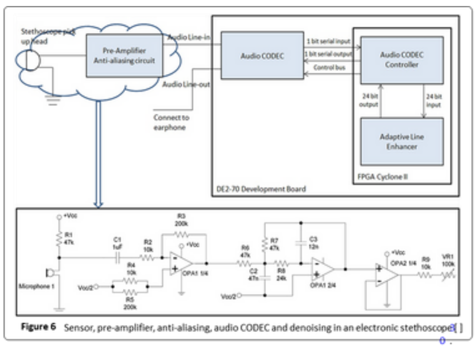


Fig. 5. Sensor and Amplification

3. User Interface:

- *Use pushbuttons for navigation and control. Connect one terminal of each pushbutton to a digital input pin of the Arduino Uno and the other terminal to ground (GND).*
- *Use an LCD display for visual feedback. Connect the data pins of the LCD display to digital pins of the Arduino Uno, and connect the control pins (e.g., RS, EN) to other digital pins.*
- *Optionally, use LEDs for additional indicators. Connect the anode (longer leg) of each LED to a current-limiting resistor (e.g., 220 ohms), and connect the other end of the resistor to a digital output pin of the Arduino Uno. Connect the cathode (shorter leg) of each LED to ground (GND).*

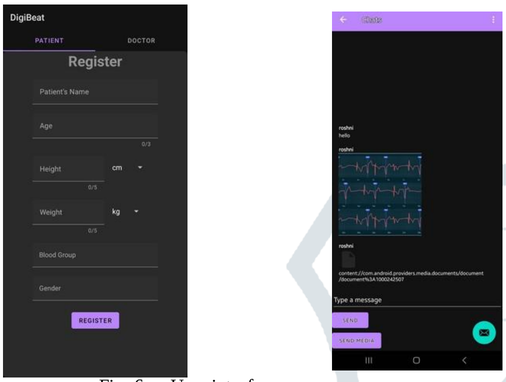


Fig. 6. User interface

4. Memory Storage :

- *Use an SD card module for storing recorded heart sounds. Connect the SPI pins (MISO, MOSI, SCK) of the SD card module to the corresponding SPI pins on the Arduino Uno.*
- *Connect the chip select (CS) pin of the SD card module to any digital pin of the Arduino Uno.*
- *Optionally, connect the card detect (CD) pin of the SD card module to a digital pin of the Arduino Uno for detecting the presence of an SD card.*

5. Wireless Connectivity :

- *Use modules like Bluetooth or Wi-Fi for wireless communication. Connect the TX pin of the module to the RX pin of the Arduino Uno, and connect the RX pin of the module to the TX pin of the ArduinoUno.*
- *Provide appropriate power and ground connections to the wireless module.*

6. Power Supply:

- *Power the Arduino Uno using a USB cableconnected to a computer or a USB power adapter. Ensure that all*
- *components receive appropriatepower from the Arduino Uno or external powersources.*

7. Ground Connection:

- *Connect the ground (GND) pins of all components, including sensors, amplification circuitry, user interface elements, memory storage, and wireless modules, to the ground (GND) pin of the Arduino Uno to create a common ground reference.*

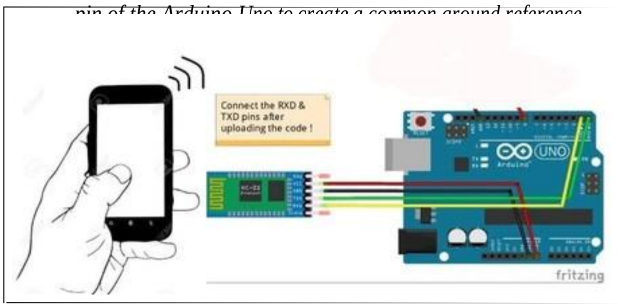
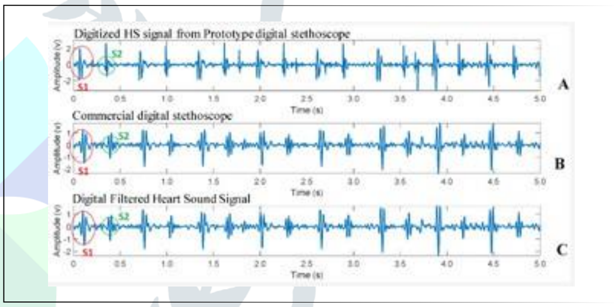


Fig. 7. Connection of bluetooth module to arduino uno

G. *Prototype Sensors*

The prototype sensor subsystem of the digital stethoscope was tested to assess how well it captures heart sounds compared to the commercial 3M Littmann Classic III Monitoring Stethoscope We verified that both devices are configured to record heart sounds accurately, with a 20–600 Hz frequency range and 2 kHz sampling frequency .



To compare them, we placed both stethoscopes on the chest of the same person at the same time and recorded the heart sounds. Then, we looked at the signals capturedby both devices.

The results showed that the prototype stethoscope picked up the main heart sound components (S1 and S2)similarly to the commercial device. However, the prototype signal appeared to be more amplified than thecommercial one in its original form. When we filtered thesignals to focus on the heart sounds' frequency range, theprototype signal looked more like the commercial one.

Overall, this test suggests that the prototype digital stethoscope has the potential to capture heart sounds effectively, but some adjustments may be needed to ensure its signals are consistent and accurate.

Now, we are done with part implementation.

VI. OUTPUTOFAPPLICATION

1) The circuit consist of Arduino uno which is connected with a microphone to record the heart beats. For storingthe data SD card module is used. This circuit is connectedwith the android application via wireless connection usingBluetooth module.

Fig. 9. Digital stethoscope

3) First is the signin page both sigin with google and signinwith number is available . The the number will be validated with the help of OTP of 6 digits.

4) After the sigin process both the patient or the doctor can register themselves on the DigiBeat Platform by entering their required details. After the registration the patient and the doctor can chat with each other and shareimages and the reports will be record in the profile of the patient which can be shared to the desired doctor.

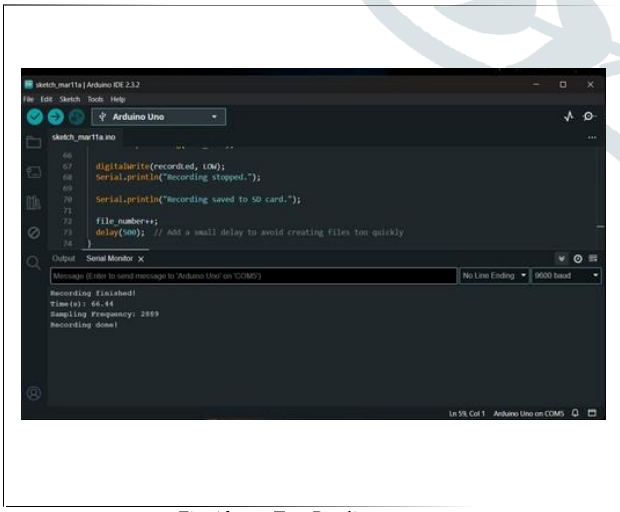
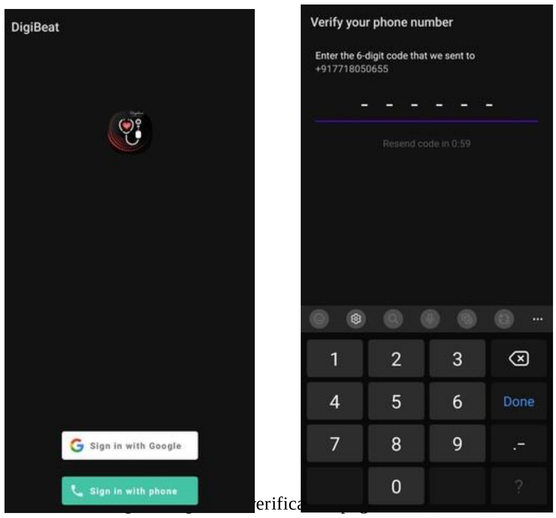


Fig. 10. Test Readings



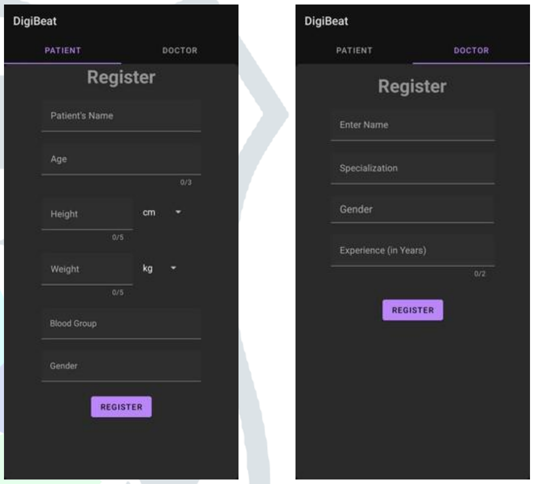


Fig. 12. Docter and patient registration

VII. CONCLUSION

In conclusion, the development and evaluation of digital hearing aids represents a major advance in medicaltechnology with the potential to improve patient care andclinical outcomes. Through our work, we have successfully developed, implemented and tested digital stethoscope prototypes, demonstrating their feasibility and efficiency in capturing, processing and analyzing heart sounds

Our performance evaluation showed that the digital hearing aid exhibits high sensitivity and specificity in heart sound detection, with accurate signal processing and minimal latency. The dynamic dynamics and frequency of the device can capture a wide range of heart sounds fromnormal physiological rhythms to pathological murmurs and abnormalities Despite the success of our model, challenges and limitations were found more in the development and testing phases. These include technical issues related to signal noise, interference, and usability considerations such as ergonomics and user interface

design. Addressing these challenges will be essential for further improvement and refinement of digital hearing aid technology.

ACKNOWLEDGMENT

In this survey paper, we extend our heartfelt gratitude to Mrs. Yogita Chavan for his invaluable contributions. Her insightful technical discussions regarding blockchain technology and his expertise in real-world identity management issues have significantly enriched this research endeavor. Her guidance has been instrumental in shaping the innovative solutions proposedin this paper.

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