



# AI based Smart Stethoscope

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**Abstract—** Recent progress in artificial intelligence (AI) and embedded system technologies has led to the creation of advanced healthcare devices that are portable, economical, and highly reliable. One such development is the AI-enabled smart stethoscope, which improves traditional auscultation by converting heart and lung sounds into digital signals and analysing them using machine learning techniques. In this system, a piezoelectric or MEMS microphone sensor captures acoustic vibrations produced by the heart and lungs from the chest surface. These bio-acoustic signals are first amplified using the MCP6002 low-noise preamplifier to increase signal strength. The amplified signal then passes through a band-pass filter ranging from 20 Hz to 2 kHz, which helps eliminate unwanted noise and interference. After filtering, the signal is digitized by the ADS1115 high-resolution analog-to-digital converter and forwarded to the ESP32 microcontroller for initial processing. The ESP32 subsequently transmits the processed data to a smartphone or cloud platform via Bluetooth or Wi-Fi. A machine learning algorithm analyses the received signals and classifies heart and lung sounds into categories such as normal heartbeat, murmurs, wheezing, and crackles. The device also enables visual waveform representation, detection of abnormalities, and secure cloud storage of patient data. Due to its compact design, rechargeable power system, and low cost, the smart stethoscope can be effectively used for early medical screening, telemedicine applications, and healthcare monitoring in rural or remote regions. This project highlights how the integration of embedded electronics and artificial intelligence can support real-time medical diagnosis and improve access to modern healthcare solutions

**Keywords—** Artificial Intelligence, Smart Stethoscope, Embedded Systems, Heart Sound Analysis, Machine Learning.

## I. INTRODUCTION

The stethoscope has long been an essential diagnostic tool used by healthcare professionals to examine the heart and lungs. Through the process of auscultation, doctors listen to acoustic signals generated by the cardiovascular and respiratory systems to identify abnormalities such as murmurs, wheezes, and crackles. However, conventional stethoscopes depend entirely on the physician's hearing ability and personal interpretation, which can sometimes result in variations in diagnosis depending on the skill and experience of the examiner.

With the growing demand for more reliable, portable, and affordable medical devices, modern healthcare systems require diagnostic solutions that can also support remote monitoring and telemedicine. Advances in embedded electronics, digital signal processing, and artificial intelligence have created opportunities to enhance traditional medical instruments with intelligent features.

The AI-based Smart Stethoscope represents an improved approach to conventional auscultation by combining sensor technology, signal conditioning circuits, and machine learning techniques. In this system, a piezoelectric or MEMS microphone captures heart and lung sound vibrations, which are then amplified and processed through an analog front-end circuit. The conditioned signals are digitized and analyzed using machine learning algorithms to identify potential abnormalities in cardiac and respiratory sounds.

The analyzed data can be transmitted to a mobile device or computer interface, where the signals are displayed as waveforms along with diagnostic information. Such a system enables healthcare



professionals to monitor patients more effectively and provides decision-support assistance during diagnosis.

This technology can be particularly beneficial for early screening, medical training, rural healthcare services, and telemedicine applications. By integrating AI with embedded medical devices, the smart stethoscope contributes to improving diagnostic accuracy and supports the ongoing transformation toward digital and connected healthcare systems.

### **Project Description**

AI-based Smart Stethoscope is designed to digitally capture and analyze heart and lung sounds for improved medical diagnosis. A piezoelectric sensor or MEMS microphone detects acoustic vibrations from the patient's chest. These signals are amplified using a low-noise preamplifier (MCP6002) and passed through a band-pass filter (20 Hz – 2 kHz) to remove unwanted noise.

The filtered signal is converted into digital form using the ADS1115 analog-to-digital converter and processed by the ESP32 microcontroller. The ESP32 then transmits the data to a smartphone or cloud server via Bluetooth or Wi-Fi. Machine learning algorithms analyze the signals and classify them into categories such as normal heartbeat, murmur, wheeze, and crackles.

The system also provides waveform visualization, abnormality detection, and cloud-based storage, making it useful for telemedicine, early diagnosis, and remote healthcare monitoring.

## **II. METHODOLOGY**

### **Components**

The proposed AI-based Smart Stethoscope system is built using several hardware and software components that work together to capture, process, and analyze heart and lung sounds. These components form the sensing, signal conditioning, data conversion, processing, and communication stages of the device, enabling accurate acquisition and intelligent analysis of bio-acoustic signals.

- Piezoelectric Sensor / MEMS Microphone – Used to capture heart and lung sound vibrations from the chest.
- MCP6002 Low-Noise Operational Amplifier – Acts as a preamplifier to amplify weak bio- acoustic signals.
- Band-Pass Filter (20 Hz – 2 kHz) – Removes unwanted noise and interference outside the heart and lung sound frequency range.
- ADS1115 Analog-to-Digital Converter (ADC) – Converts the analog acoustic signals into digital data for processing.
- ESP32 Microcontroller – Performs signal preprocessing and wireless data transmission via Bluetooth/Wi-Fi.
- Bluetooth / Wi-Fi Module (built into ESP32) – Enables communication with smartphones or cloud servers.
- Rechargeable Battery / Power Supply – Provides portable power to the device.
- Smartphone / Computer Application – Used for waveform visualization, AI-based classification, and data storage.
- Resistors and Capacitors – Used in filtering and signal conditioning circuits.
- PCB / Breadboard and Connecting Wires – Used for circuit assembly and hardware integration.

### **Working**

AI-based Smart Stethoscope operates by capturing and analyzing heart and lung sounds digitally. A piezoelectric sensor or MEMS microphone is placed on the patient's chest to detect acoustic vibrations generated by the heart and respiratory system. These bio-acoustic signals are very weak, so they are first amplified using the MCP6002 low-noise operational

amplifier to improve signal strength while maintaining clarity.

After amplification, the signal passes through a band-pass filter (20 Hz – 2 kHz) which removes unwanted noise and retains the frequency range relevant to heart and lung sounds. The filtered analog signal is then converted into digital form using the ADS1115 analog-to-digital converter (ADC). This digital data is sent to the ESP32 microcontroller, which performs basic signal preprocessing and prepares the data for transmission.

The ESP32 then transmits the processed signal to a smartphone or cloud server via Bluetooth or Wi-Fi. Machine learning algorithms analyze the received sound patterns and classify them into categories such as normal heartbeat, murmur, wheeze, or crackles. The results are displayed on a mobile or computer interface along with waveform visualization, enabling doctors or healthcare workers to monitor and detect abnormalities more efficiently.

reliability of auscultation. The integration of components like the MEMS microphone, MCP6002 amplifier, ADS1115 ADC, and ESP32 microcontroller enables efficient signal acquisition, processing, and wireless transmission. With features such as machine learning-based sound classification, waveform visualization, and remote data access, the device can support early detection of cardiac and respiratory abnormalities. Its portable, cost-effective, and user-friendly design makes it particularly useful for telemedicine, rural healthcare, and personal health monitoring, contributing to improved accessibility and quality of medical diagnostics.

### REFERENCES

1. S. Kumar and R. Gupta, "Real-Time Heart Murmur Detection Using Deep Learning and Embedded Hardware," *IEEE Access*, vol. 10, pp. 67792–67804, 2022.
2. M. Bar, S. Jahan and R. Akter, "Digital Stethoscope with Smartphone-Based Visualization for Remote Auscultation," *International Journal of Biomedical Engineering*, vol. 12, no. 2, pp. 34–42, 2021.
3. K. H. Lee, M. Kim and T. Park, "Portable AI-Assisted Medical Devices for Telehealth Applications," *Sensors*, vol. 21, no. 18, 2021.
4. Y. Luo, X. Xiang and H. Zhao, "Automatic Classification of Lung Sounds Using MFCC and Deep Convolutional Neural Networks," *Computers in Biology and Medicine*, vol. 124, 2020.
5. A. K. Dwivedi and S. Sunkaria, "Detection of Cardiac Abnormalities Using Heart Sound Analysis and Wavelet Transformation," *Biomedical Signal Processing and Control*, vol. 45, pp. 20–28, 2018.
6. P. R. Chowdhury, D. Reaz and M. M. Ali, "Denoising of Lung Sounds Using Adaptive Filters and Wavelet Transform," *Journal of Medical Systems*, vol. 41, no. 12, pp. 1–12, 2017.
7. D. Springer, L. Tarassenko and G. D. Clifford, "Logistic Regression-HSMM-Based Heart Sound Segmentation," *IEEE Transactions on Biomedical Engineering*, vol. 63, no. 4, pp. 822–832, 2016.
8. PhysioNet, "Heart Sound and Murmur Dataset," available at: <https://physionet.org> (accessed 2025).

AI-Based Smart Stethoscope System



Figure 1: Block diagram

### III. CONCLUSION

AI-based Smart Stethoscope demonstrates how modern technologies such as embedded systems, signal processing, and artificial intelligence can enhance traditional medical diagnostic tools. By digitally capturing and analyzing heart and lung sounds, the system improves the accuracy and



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9. ICBHI Challenge, “Respiratory Sound Database,” available at: <https://bhichallenge.ethz.ch/> (accessed 2025).
10. Adafruit Industries, “ADS1115 16-bit ADC Datasheet,” available at: <https://adafruit.com> (accessed 2025). Espressif Systems, “ESP32 Technical Reference Manual,” available at:  
11. <https://www.espressif.com> (accessed 2025).
12. Texas Instruments, “MCP6002 Operational Amplifier Datasheet,” available at: <https://www.ti.com> (accessed 2025).