

# Exploring Different Sensor Technologies for Infrasonic Cardiac Monitoring: A Review

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## ABSTRACT:

Infrasonic cardiac monitoring is a non-invasive technique used to detect and monitor cardiac activity by analysing infrasound waves produced by the heart. This technique has several advantages over traditional methods, including the ability to detect changes in infrasound waves that may indicate abnormalities in cardiac function. Infrasonic cardiac monitoring has been used in clinical settings, research studies, and emergency situations and has the potential to revolutionize the field of cardiology by providing a non-invasive method of detecting and monitoring cardiac activity. While there are some challenges associated with this technique, ongoing research and technological advancements hold promise for addressing these challenges and improving the accuracy, reliability, and accessibility of infrasonic cardiac monitoring. This paper aims to provide an introductory overview of infrasonic cardiac monitoring, including its principles, methods, challenges, and future prospects.

**Keywords:** cardiac monitoring, infrasonic cardiogram, myocardial infarction

## INTRODUCTION:

Infrasonic cardiac monitoring is a technique used to detect and monitor cardiac activity using low-frequency sound waves, also known as infrasound. Infrasound waves have a frequency of less than 20 Hz, which is below the range of human hearing. Infrasonic cardiac monitoring is a non-invasive method that can provide valuable information about the heart's activity. The principle behind infrasonic cardiac monitoring is that when the heart beats, it creates sound waves that propagate through the body, including the chest wall. These sound waves have a low frequency and can be detected by specialized sensors placed on the chest. The sensors used for infrasonic cardiac monitoring are usually piezoelectric sensors, which can detect and convert the pressure waves produced by the heart into electrical signals. These sensors are placed on the chest in different locations to capture the sound waves generated by the heart's activity from different angles. Once the sensors detect the infrasonic waves, the electrical signals are transmitted to a computer or monitoring device, which processes and analyzes the data. The computer can then generate a visual representation of the heart's activity, known as an infrasonic cardiogram or an infrasonic electrocardiogram (iECG). Infrasonic cardiac monitoring can provide valuable information about the heart's activity, including the heart rate, rhythm, and any abnormalities in the cardiac cycle<sup>1</sup>. It can also be used to detect and monitor conditions such as arrhythmias, myocardial infarction, and heart failure. Infrasonic cardiac

monitoring is a non-invasive method for detecting and monitoring cardiac activity using low-frequency sound waves. It can provide valuable information about the heart's activity and can be used in a clinical setting or at home with portable monitoring devices.

## INFRASONIC CARDIAC MONITORING: METHODS

Infrasonic cardiac monitoring is a non-invasive method of detecting and monitoring cardiac activity using low-frequency sound waves. There are different methods of infrasonic cardiac monitoring, but the most common ones include:

### Piezoelectric Sensors:

Piezoelectric sensors are commonly used in infrasonic cardiac monitoring due to their high sensitivity and ability to convert mechanical vibrations into electrical signals. These sensors work by utilizing the piezoelectric effect, which occurs when certain materials, such as quartz or ceramic, generate an electrical charge in response to mechanical stress. In infrasonic cardiac monitoring, piezoelectric sensors are placed on the skin over the heart and detect the infrasound waves produced by cardiac activity. As the heart contracts and relaxes, it generates mechanical vibrations that are picked up by the piezoelectric sensor and converted into electrical signals.

These signals can then be analysed to determine the frequency, amplitude, and other characteristics of the

infrasonic waves produced by the heart. Piezoelectric sensors are advantageous for infrasonic cardiac monitoring because they are highly sensitive and can detect small changes in mechanical vibrations. They are also lightweight and relatively inexpensive, making them a practical option for use in clinical and research settings. However, there are some limitations to their use, including interference from external vibrations, signal drift over time, and the need for proper sensor placement to ensure accurate measurements.

#### **Microphones:**

Microphones are another type of sensor that can be used in infrasonic cardiac monitoring. These sensors work by converting acoustic waves into electrical signals and can be used to detect the infrasonic waves produced by cardiac activity. Infrasonic cardiac monitoring using microphones typically involves placing the microphone near the chest wall, either directly on the skin or over clothing. As the heart contracts and relaxes, it generates infrasonic waves that can be detected by the microphone and converted into electrical signals.

These signals can then be analysed to determine the frequency, amplitude, and other characteristics of the infrasonic waves produced by the heart. Microphones are advantageous for infrasonic cardiac monitoring because they are widely available and relatively inexpensive. They are also non-invasive and do not require direct contact with the skin, making them more comfortable for patients. However, microphones may be less sensitive than other types of sensors, such as piezoelectric sensors, and may be more susceptible to interference from external vibrations and noise.

#### **Accelerometers:**

Accelerometers are another type of sensor that can be used in infrasonic cardiac monitoring. These sensors work by measuring changes in acceleration or vibration and can be used to detect the mechanical vibrations produced by cardiac activity. In infrasonic cardiac monitoring using accelerometers, the sensor is typically placed on the skin over the heart and detects the mechanical vibrations produced by the heart as it contracts and relaxes. These vibrations are then converted into electrical signals that can be analysed to determine the frequency, amplitude, and other characteristics of the infrasonic waves produced by the heart.

Accelerometers are advantageous for infrasonic cardiac monitoring because they are highly sensitive and can detect small changes in acceleration or vibration<sup>2</sup>. They are also relatively easy to use and do not require direct contact with the skin, making them more comfortable for patients. However, accelerometers may be more susceptible to

interference from external vibrations and noise, which can affect the accuracy of measurements.

#### **Doppler Ultrasound:**

Doppler ultrasound is a type of sensor that can be used in infrasonic cardiac monitoring. This technique involves using sound waves to detect the movement of blood through the heart and blood vessels. Infrasonic cardiac monitoring using Doppler ultrasound typically involves placing a small, handheld device called a Doppler probe on the skin over the heart. The probe emits high-frequency sound waves that reflect off the moving blood and are detected by the probe.

These reflected sound waves are then converted into electrical signals that can be analysed to determine the frequency, amplitude, and other characteristics of the infrasonic waves produced by the heart. Doppler ultrasound is advantageous for infrasonic cardiac monitoring because it provides detailed information about blood flow through the heart and can detect abnormalities in blood flow that may be indicative of heart disease or other cardiac conditions. It is also non-invasive and does not require direct contact with the skin.

#### **UNDERSTANDING THE BENEFITS OF SENSOR TECHNOLOGIES FOR INFRASONIC CARDIAC MONITORING:**

Sensor technologies for infrasonic cardiac monitoring offer numerous benefits in the field of healthcare. These advanced sensors enable non-invasive and continuous monitoring of cardiac activity, providing valuable insights into a patient's cardiovascular health. By detecting and analyzing infrasonic frequencies, these sensors offer several advantages over traditional monitoring methods.

First and foremost, the non-invasive nature of sensor technologies for infrasonic cardiac monitoring eliminates the need for invasive procedures such as inserting catheters or electrodes into the body. Instead, these sensors can be easily placed on the surface of the body, typically on the chest or back, allowing for comfortable and convenient monitoring. This non-invasive approach reduces patient discomfort and the risk of complications associated with invasive procedures<sup>3</sup>.

Furthermore, sensor technologies for infrasonic cardiac monitoring offer continuous monitoring capabilities. Unlike intermittent measurements taken by traditional methods, these sensors provide real-time data, allowing healthcare professionals to monitor the cardiac activity over an extended period. This continuous monitoring is particularly beneficial for patients with chronic heart conditions or those at risk of developing cardiovascular problems, as it enables early detection of abnormalities or changes in heart function.

The ability of sensor technologies to detect infrasonic frequencies is another significant advantage. Infrasonic waves are low-frequency sound waves below the threshold of human hearing, typically below 20 Hz. These waves can provide valuable information about cardiac function and abnormalities that may not be easily detected using other monitoring techniques. By capturing infrasonic signals, these sensors can detect subtle changes in cardiac activity, enabling early diagnosis and intervention.

Moreover, sensor technologies for infrasonic cardiac monitoring are often portable and wearable, allowing patients to go about their daily activities without disruption. These sensors can be integrated into wearable devices such as smartwatches, patches, or clothing, providing continuous monitoring without restricting movement or lifestyle. This portability enhances patient compliance and enables long-term monitoring outside of clinical settings, leading to a more comprehensive understanding of cardiac health in real-world situations.

The data collected by these sensors can be transmitted wirelessly to healthcare professionals or stored in cloud-based platforms, facilitating remote monitoring and telemedicine applications. This feature is particularly beneficial for patients in remote areas or those with limited access to healthcare facilities, as it allows for remote diagnosis, timely intervention, and personalized treatment plans. Additionally, the integration of artificial intelligence and machine learning algorithms with sensor technologies enables advanced data analysis, facilitating the early detection of cardiac abnormalities and personalized risk assessment.

Furthermore, the use of sensor technologies for infrasonic cardiac monitoring can contribute to a more cost-effective healthcare system. By providing continuous monitoring and early detection of cardiac issues, these sensors can help prevent complications, reduce hospital admissions, and optimize the use of healthcare resources. Early intervention based on the data collected by these sensors can lead to timely treatment and management, potentially reducing the overall healthcare costs associated with cardiovascular diseases.

In conclusion, sensor technologies for infrasonic cardiac monitoring offer a range of benefits in the field of healthcare. These sensors provide non-invasive, continuous, and real-time monitoring of cardiac activity, allowing for early detection of abnormalities and personalized treatment plans. Their portability and integration with wearable devices enhance patient compliance and enable remote monitoring, while advanced data analysis techniques facilitate accurate diagnosis and risk assessment. By leveraging these technologies, healthcare professionals can improve patient

outcomes, optimize resource allocation, and contribute to more efficient and cost-effective healthcare delivery.

### **INFRASONIC CARDIAC MONITORING: ADDRESSING THE CHALLENGES**

The use of different sensor technologies for infrasonic cardiac monitoring presents several key challenges. One of the primary challenges is ensuring the accuracy and reliability of the sensor data. Different sensor technologies may have varying levels of sensitivity and accuracy in detecting infrasonic waves or chest wall movement. The sensors must be carefully calibrated and validated to ensure consistent and reliable measurements. Any inaccuracies or inconsistencies in the sensor data can lead to erroneous interpretations of the cardiac activity. Proper sensor placement is crucial for accurate monitoring. Different sensor technologies may require specific placement locations on the chest to capture the infrasonic waves effectively. Ensuring consistent and stable sensor placement throughout the monitoring period can be challenging, particularly in situations where the patient moves or engages in physical activities. Sensor displacement or movement can lead to artifacts and affect the accuracy of the measurements. Infrasonic cardiac monitoring is susceptible to various sources of noise interference, which can affect the quality of the sensor signals.

Environmental noise, such as ambient vibrations or low-frequency sounds, can interfere with the detection of infrasonic waves. Additionally, external electromagnetic fields or electrical equipment in the vicinity may introduce electromagnetic interference. Special care must be taken to minimize and filter out these sources of noise to obtain reliable and accurate sensor data. Different sensor technologies produce signals with unique characteristics<sup>4</sup>. The signal processing and analysis techniques need to be tailored to each sensor type to extract meaningful information about cardiac activity. Developing robust signal processing algorithms that can effectively filter and process the sensor data to obtain accurate measurements can be challenging.

Moreover, the interpretation and analysis of the infrasonic cardiogram require specialized knowledge and expertise, adding complexity to the analysis process. The sensors used for infrasonic cardiac monitoring should be comfortable for the patient, as the monitoring may need to be performed for extended periods. Sensors that are too bulky or cause discomfort can affect patient compliance and may lead to inaccurate or incomplete data collection. Ensuring patient acceptance and comfort while maintaining sensor accuracy is an important challenge. Infrasonic cardiac monitoring involves various sensor technologies, and standardization of measurement protocols and data formats is essential for interoperability and comparability of results. Establishing



standardized guidelines and protocols for sensor usage, data collection, and analysis can facilitate widespread adoption and enable more comprehensive studies and research in this field.

Addressing these key challenges related to different sensor technologies for infrasonic cardiac monitoring requires ongoing research, technological advancements, and collaboration between researchers, clinicians, and engineers. Overcoming these challenges will contribute to the development of reliable and accurate infrasonic cardiac monitoring systems, enabling better diagnosis and management of cardiac conditions.

### **CASE STUDY ON INFRASONIC CARDIAC MONITORING: A BOON FOR HEALTHCARE**

Infrasonic cardiac monitoring has been used in healthcare for several years as a non-invasive method of detecting and monitoring cardiac activity. This technique has been used in various countries, including the United States, Canada, Germany, and Japan. Infrasonic cardiac monitoring has been used in clinical settings, research studies, and emergency situations. One example of the use of infrasonic cardiac monitoring is in the detection of myocardial ischemia, a condition that occurs when there is a lack of blood flow to the heart. Infrasonic cardiac monitoring can detect changes in the infrasound waves produced by the heart, which can indicate a decrease in blood flow to the heart. Another example of the use of infrasonic cardiac monitoring is in the detection of arrhythmias, which are abnormal heart rhythms. Infrasonic cardiac monitoring can detect changes in the infrasound waves produced by the heart, which can indicate the presence of arrhythmias. Infrasonic cardiac monitoring has also been used in the evaluation of the effects of different medications and therapies on cardiac activity.

This technique can provide valuable information about the effectiveness of different treatments and can help guide clinical decision-making. Infrasonic cardiac monitoring has been used in various countries and settings to detect and monitor cardiac activity. This technique has been used in the detection of myocardial ischemia, arrhythmias, and the evaluation of different treatments. However, further research is needed to address the challenges associated with this technique and to improve its accuracy, reliability, and accessibility.

### **THE INFRASONIC CARDIAC MONITORING: THE WAY AHEAD**

The future prospects of using different sensor technologies for infrasonic cardiac monitoring are promising, with several potential advancements and opportunities. As technology continues to advance, there is a trend towards miniaturization

of sensor devices. This opens up the possibility of developing wearable devices for infrasonic cardiac monitoring. Miniaturized sensors integrated into clothing or wearable accessories can provide continuous and unobtrusive monitoring, allowing individuals to track their cardiac activity in real-time. This can enable early detection of abnormalities and facilitate personalized healthcare. Research efforts are focused on improving the accuracy and sensitivity of sensors used in infrasonic cardiac monitoring. Advancements in sensor technology and materials may lead to more sensitive and reliable sensors, enabling better detection and measurement of infrasonic waves. Higher accuracy and sensitivity will enhance the diagnostic capabilities of infrasonic cardiac monitoring, enabling more precise detection and monitoring of cardiac conditions. The integration of infrasonic cardiac monitoring with AI techniques holds significant potential.

AI algorithms can process large volumes of sensor data, identify patterns, and detect subtle abnormalities that may be indicative of cardiac conditions. Machine learning algorithms can continuously learn from the data collected by the sensors, leading to improved accuracy in detecting and predicting cardiac events<sup>4</sup>. AI can also assist in automating the analysis and interpretation of the infrasonic cardiograms, reducing the burden on healthcare professionals and enabling faster and more accurate diagnoses. Infrasonic cardiac monitoring can be combined with telehealth technologies to enable remote monitoring of patients. With the use of wireless communication and cloud computing, patient data can be transmitted in real-time to healthcare providers for remote monitoring and analysis. This approach can be particularly beneficial for patients in remote areas or those with limited access to healthcare facilities. Remote monitoring can facilitate early intervention and timely management of cardiac conditions, improving patient outcomes. Combining multiple sensor modalities can provide a more comprehensive assessment of cardiac activity. For example, integrating infrasonic sensors with other technologies such as electrocardiography (ECG), photoplethysmography (PPG), or accelerometer sensors can provide a holistic view of the cardiovascular system. By fusing data from different sensors, it may be possible to obtain more accurate and detailed information about the heart's activity, enhancing the diagnostic capabilities of infrasonic cardiac monitoring. Future advancements may focus on developing long-term monitoring solutions that can capture cardiac activity over extended periods. Long-term monitoring can provide valuable insights into the progression of cardiac conditions, response to treatments, and overall cardiac health. Additionally, sophisticated data analysis techniques may be developed to mine large datasets collected from multiple

individuals, leading to improved understanding of cardiac physiology and the development of personalized treatment strategies. The future prospects of using different sensor technologies for infrasonic cardiac monitoring are exciting. Advancements in sensor technology, miniaturization, AI integration, remote monitoring, and multimodal sensor fusion are expected to enhance the accuracy, convenience, and diagnostic capabilities of infrasonic cardiac monitoring. These advancements have the potential to revolutionize cardiac healthcare, enabling early detection, personalized interventions, and improved management of cardiac conditions.

## CONCLUSION

In nutshell, the use of different sensor technologies for infrasonic cardiac monitoring holds great promise for the field of cardiology. These technologies offer non-invasive and potentially continuous monitoring of cardiac activity, providing valuable insights into heart health, rhythm, and potential abnormalities. While facing certain challenges, ongoing advancements and future prospects indicate a positive trajectory for the application of these sensors in clinical practice. The development of miniaturized and wearable sensor devices represents a significant leap forward in infrasonic cardiac monitoring. These devices offer improved patient comfort and convenience, enabling long-term monitoring and real-time data collection. Wearable sensors have the potential to revolutionize cardiac care by allowing individuals to monitor their heart health in everyday settings and facilitating early detection of cardiac conditions. Advancements in sensor accuracy and sensitivity are crucial for reliable infrasonic cardiac monitoring.

Continuous research and development efforts are aimed at improving the detection and measurement capabilities of these sensors, ensuring accurate and precise data collection. As sensor technologies continue to evolve, their enhanced accuracy will contribute to more accurate diagnoses, personalized treatment strategies, and improved patient outcomes. The integration of artificial intelligence (AI) with infrasonic cardiac monitoring opens up new horizons for data analysis and interpretation. AI algorithms can analyze large volumes of sensor data, identify patterns, and detect subtle abnormalities that may indicate underlying cardiac conditions<sup>6</sup>. This integration holds the potential to enhance the diagnostic capabilities of infrasonic cardiac monitoring, enabling faster and more accurate detection of cardiac events. The future of infrasonic cardiac monitoring also lies in the realm of remote monitoring and telehealth. By leveraging wireless communication and cloud computing, patients can be remotely monitored in real-time, with data transmitted to healthcare providers for analysis. Remote monitoring

enhances accessibility to cardiac care, particularly for individuals in remote areas or with limited access to healthcare facilities. This approach allows for timely interventions, early detection of complications, and personalized care, ultimately improving patient outcomes.

Furthermore, the fusion of different sensor modalities offers a comprehensive assessment of cardiac activity. Combining infrasonic sensors with other technologies, such as ECG, PPG, or accelerometers, provides a holistic view of the cardiovascular system. This multimodal sensor fusion approach has the potential to yield more accurate and detailed information about the heart's activity, enabling a deeper understanding of cardiac physiology and paving the way for personalized treatment strategies. In conclusion, the use of different sensor technologies for infrasonic cardiac monitoring is an area of active research and development.

Despite challenges such as sensor accuracy, placement, and noise interference, ongoing advancements and future prospects paint a promising picture. As technology continues to evolve, the potential for miniaturized sensors, AI integration, remote monitoring, and multimodal sensor fusion will revolutionize cardiac healthcare, leading to early detection, improved management, and better outcomes for patients with cardiac conditions.

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