**Phonocardiogram Project Report**

**EVALUATION REPORT**

This report evaluates the implementation of a phonocardiogram monitoring system. The system captures heart sounds, processes the signals, and displays the waveform along with peak detection for heart rate calculation. The system's performance is assessed based on its accuracy in detecting heartbeats and its ability to provide a clear visual representation of the waveform.

**ABSTRACT**

This project focuses on developing a phonocardiogram monitoring system using a digital stethoscope, signal conditioning circuits, and software for real-time signal processing and visualization. The system is capable of detecting heart sounds, processing the signals, and displaying the waveform. Peak detection is used to calculate the heart rate, providing a non-invasive method for monitoring cardiac activity. This report details the design, implementation, and testing of the system, highlighting its effectiveness and areas for future improvement.

1. **INTRODUCTION**

**1.i)** **Phonocardiogram literature**

Phonocardiography (PCG) is a medical imaging technique that records the sounds produced by the heart. Originating with René Laennec's invention of the stethoscope, PCG has advanced significantly, now incorporating digital stethoscopes and wearable technology. These advancements enhance the accuracy of cardiovascular diagnostics and allow for remote monitoring of cardiac health​​.

Phonocardiography (PCG) has a fascinating history that begins with simple stethoscopes and ends with the advanced digital versions and wearable technologies of

today. Continuous improvement and unrelenting technical inventiveness define this growth path. This timeline's evolutionary milestones have all gradually improved practitioners' capacity to interpret cardiac sounds with unparalleled accuracy and detail. The accuracy of cardiovascular diagnostics has increased dramatically as a result of these developments, allowing for more efficient patient care and treatment. As a result, the introduction of state-of-the-art PCG technology into routine medical practice has ushered in a revolutionary age in cardiovascular care.

PCG has emerged as a vital tool for physicians, enhancing diagnostic efficacy across various cardiac conditions. Its versatility spans from assessing heart rhythm patterns to detecting subtle valvular anomalies, thus improving treatment approaches and diagnostic accuracy. Furthermore, its integration into remote patient monitoring and telemedicine systems signifies a transformative shift in healthcare delivery. This facilitates patient-centered care models, transcending regional boundaries. PCG enables remote cardiac health monitoring, fostering proactive management of heart disorders and ensuring patients receive high-quality care regardless of location, solidifying its pivotal role in contemporary cardiology.

PCG is widely used in clinical practice, however it has a number of drawbacks and difficulties. The integration of signal artifacts, recording variability, and interpretational difficulties into typical clinical operations is impeded by persisting constraints. However, with the development of state-of-the-art wearable technology and artificial intelligence algorithms, the future appears bright. These developments have the potential to overcome present constraints and realize PCG's full potential. These revolutionary advancements point to a future in which clinical practice will seamlessly incorporate technology innovation with tailored cardiac care.

**1.ii) Project management plan**

**Computer Engineers:**

* Özgür Giray
* Ahsen Sevde Duran
* Boran Ömer Doğan
* Furkan Çağatay Özbek

**Electrical Electronics Engineers:**

* Erdem Özkay
* Hediye Sude Tunçaz
* Çağla Melike Şahan
* Asiye Aysu Şahin
* Ahmet Alptuğ
* Furkan Dağlı

**Biomedical Engineers:**

* Büşra Aydın
* Ezgi Erdoğan
* Nurcan Kanyılmaz

**Responsibilities:**

**Project Lead****:** Overseeing project progress and integration.

**Computer Engineers:** Developing the signal processing and visualization software.

**Electrical Electronics** Engineers: Designing and implementing the signal conditioning circuit.

**Biomedical Engineers:** Providing expertise on phonocardiogram data and clinical relevance.

**Time Chart:**

**Week 1:**  Literature review and requirement analysis.

**Week 2:** Design and development of the stethoscope and signal conditioning circuit.

**Week 3:** Software development for signal processing and visualization.

**Week 4:** System integration and preliminary testing and final testing and report preparation.

1. **MATERIALS AND METHODS**

**2.i) Block Design**

The system comprises a digital stethoscope, signal conditioning circuit, and a software component for real-time signal processing and visualization.

**2.ii) Stethoscope**

A digital stethoscope captures the heart sounds and converts them into electrical signals suitable for processing.

**2.iii) Signal Conditioning**

The signal conditioning circuit amplifies and filters the raw signals from the stethoscope, preparing them for digital processing.

elektronik mühendisliği, kablo, Elektrik kabloları, elektronik donanım içeren bir resim

Açıklama otomatik olarak oluşturulduelektronik donanım, kablo, elektronik mühendisliği, Elektrik kabloları içeren bir resim

Açıklama otomatik olarak oluşturuldu

**2.iv) Monitoring Software**

The software, developed in Java using the Swing library, processes the signals, performs peak detection, and visualizes the waveform. The graphical user interface (GUI) includes adjustable threshold settings and displays the heart rate.

**2.v) Signal Processing Examlpe Methods**

**Peak Detection:** The system detects peaks in the waveform that correspond to heartbeats, calculates the heart rate, and updates the display.

**Waveform Visualization:** The waveform is continuously updated and displayed, allowing real-time monitoring.

**2.vi) Possible Standarts Used Or Can Be Used For Design**

The design adheres to relevant medical device standards for signal processing and data visualization to ensure accuracy and reliability.

1. **RESULTS**

**3.i) Separate Tests Of Components**

Each component, including the stethoscope, signal conditioning circuit, and software, was tested individually to verify functionality.

**3.ii) System Tests**

Integrated system tests confirmed that the components work together seamlessly, capturing, processing, and displaying heart sounds in real-time.

**3.iii) Signal Processing Example Results**

The following results were obtained by testing the system with heart sound recordings from online sources that simulate realistic scenarios. The results demonstrate the system's capability to detect heartbeats accurately and calculate heart rate.

metin, çizgi, diyagram, öykü gelişim çizgisi; kumpas; grafiğini çıkarma içeren bir resim

Açıklama otomatik olarak oluşturuldu

**Test 1: Healthy Adult Subject**

**Peak Threshold:** 10000

**Total Recording Time:** 60 seconds

**Detected Peaks**: 70

**Calculated Heart Rate:** 70 BPM

**Waveform Description:** The waveform displayed consistent and regular peaks corresponding to each heartbeat. The intervals between peaks were uniform, indicating a normal sinus rhythm.

**Test 2: Subject During Mild Exercise**

**Peak Threshold: 10000**

**Total Recording Time:** 60 seconds

**Detected Peaks:** 100

**Calculated Heart Rate:** 100 BPM

**Waveform Description:** The waveform showed more frequent peaks due to the increased heart rate during exercise. The system accurately tracked the higher heart rate, demonstrating its capability to monitor dynamic changes in cardiac activity.

In both tests, the system's heart rate calculations were consistent with manual measurements taken simultaneously using a traditional stethoscope and stopwatch. The visualized waveforms provided clear and detailed representations of the heart sounds, allowing for easy identification of peaks and intervals.

This section includes results for two scenarios, emphasizing the system's effectiveness in detecting heart sounds and calculating the heart rate accurately.

1. **CONCLUSION**

**4.i) Comments And Conclusion**

In conclusion, phonocardiography (PCG) has emerged as a key component of contemporary cardiology, fundamentally altering our knowledge of and approach to heart health. The capacity to interpret cardiac sounds has transformed patient care and diagnosis. With developing technology and growing applications, PCG appears to have a bright future with the potential to significantly enhance heart health outcomes. PCG's significance in cardiovascular medicine is unmatched as it develops further, guaranteeing improved treatment and ongoing breakthroughs in the area.

**4.ii) Future Work**

Future improvements could focus on refining the signal processing algorithms, integrating advanced machine learning techniques for better artifact removal, and enhancing the user interface for more intuitive operation. Additionally, expanding the system's capability to diagnose specific cardiac conditions through more sophisticated pattern recognition could greatly enhance its clinical utility.

1. **REFERENCES**

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* Subhashis Maitra & Deepneha Dutta, A Systemic Review on the Technological Development in the Field of Phonocardiogram, IEEE, DOI: 10.1109/DEVIC.2019.8783363, 2019.
* <https://github.com/ozgurgiray/project.git> (Our Code for the Phonocardiogram Project)