International Journal of Science Academic Research
Vol. 04, Issue 11, pp.6658-6661, November, 2023
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

CONFORMAL WEARABLE HEALTH-CARE PLATFORM COMBINED WITH CARDIOLOGICAL ANALYSIS APPROACH

***Justin Seo**

Cranbrook Kingswood Upper School, 39221 Woodward Avenue, MI 48304, USA

Received 27th September 2023; **Accepted** 24th October 2023; **Published online** 30th November 2023

Abstract

This paper presents an integrated approach to wearable health-care platforms, specifically focusing on the incorporation of advanced cardiological analysis techniques. Wearable devices have revolutionized health monitoring, offering real-time data acquisition and continuous patient engagement. Our proposed system leverages the capabilities of wearable technology and integrates a sophisticated cardiological analysis approach to provide a comprehensive and dynamic assessment of cardiovascular health. The paper begins by detailing the architecture of the wearable health-care platform, emphasizing the selection of sensors for vital sign monitoring, activity tracking, and environmental sensing. The platform's design prioritizes user comfort, wear ability, and data accuracy, ensuring seamless integration into daily life while facilitating continuous health monitoring. The core of the paper explores the cardiological analysis approach, which includes the implementation of comparing algorithms for the real-time processing of electrocardiogram (ECG) data and seismocardiogram (SCG). Specialized signal processing techniques are employed to extract meaningful insights into cardiac health. The system aims to detect and analyze irregularities in heart rhythm, identify potential cardiac abnormalities, and provide timely alerts for proactive medical intervention. Furthermore, the integration of additional cardiovascular metrics, such as heart rate variability (HRV) and blood pressure, enhances the depth of cardiological analysis. The wearable platform facilitates the seamless collection of these metrics, enabling a more holistic assessment of cardiovascular health beyond traditional ECG monitoring.

Keywords: Health-care, Cardiological.

INTRODUCTION

Wearable devices including smart watch, glasses and band-type device can provide unique insights into our health and well-being. Conventional clinical diagnosis has many barriers in terms of accuracy and limitation of professions. Moreover, the current diagnosis method could provide static data, which is difficult to track the health-care status of patient in real-time. In contrast to traditional clinical testing, which is infrequent and may occur only a few times a year, wearables provide constant access to real-time physiological data. This enables the detection of deviations from an individual's typical baselines, marking a significant departure from the prevailing healthcare approach that primarily relies on comparing physiological measurements to population statistics. The value of wearable health devices has become particularly evident during the COVID-19 pandemic (Ates *et al.,* 2021). Cold symptoms are similar with COVID-19, which is common type of disease. The early diagnosis of cold symptoms holds significant importance in effectively managing and mitigating the impact of the common cold. Recognizing the initial signs, such as a sore throat, runny nose, cough, mild fever, and fatigue, allows individuals to take prompt action in addressing their health. Early identification enables individuals to initiate self-care measures, including rest, hydration, and over-the-counter medications, at the onset of symptoms. This proactive approach can often help alleviate the severity and duration of the cold, facilitating a quicker recovery. Moreover, early diagnosis plays a crucial role in preventing the spread of the virus to others, particularly during contagious phases. By promptly isolating oneself and adopting preventive measures, individuals contribute to public health by reducing the risk of transmission. Additionally, in the context of the current global health landscape, where respiratory illnesses like the common cold can share symptoms with more serious conditions, early diagnosis allows for proper monitoring and, if necessary, timely medical intervention. In this respect, wearable technology is essential strategy for the detection of symptoms as it could cover health-care monitoring in daily lives (Guk *et al.,* 2019). In this review, we focus on cardiac parameters, which is deeply related to our health. While traditional cold symptom detection primarily focuses on respiratory manifestations, emerging research suggests that monitoring certain cardiac parameters could provide valuable insights into the early stages of a viral infection, including the common cold. Changes in heart rate variability (HRV) and heart rate, for instance, have been identified as potential indicators of physiological stress and inflammation associated with viral illnesses. Elevated resting heart rates and alterations in HRV patterns may precede overt respiratory symptoms, offering an early signal of the body's response to an infection. Integrating cardiac parameters into the detection of cold symptoms can provide a more comprehensive understanding of the overall physiological impact of the viral intrusion. Wearable devices, such as smartwatches equipped with heart rate monitors, offer a non-invasive and continuous means of monitoring these cardiac parameters, enabling individuals to track subtle changes in their cardiovascular health (Figure 1). This approach not only enhances early detection but also aligns with the growing trend of personalized and proactive healthcare. By incorporating cardiac metrics, there is potential for more nuanced and timely interventions, contributing to a more holistic approach to managing and mitigating the effects of common colds and similar respiratory infections.

Corresponding Author:** ***Justin Seo
Cranbrook Kingswood Upper School, 39221 Woodward Avenue, MI 48304, USA

Firstly, we address an importance of intimate and conformal contact of wearable devices. Then we will review about two cardiac parameters: i) electrocardiogram (ECG) and ii) seismocardiogram (SCG). With analysis of those two parameters obtained from wearable health-care device, we could provide accurate diagnosis of cold symptom in early stages.

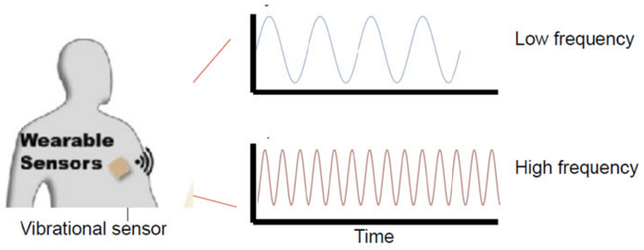

Figure 1. Various frequency range of body signal detected by wearable vibrational sensor

Importance of conformal interfaces for medical diagnosis

Conformal adhesion between medical device and biological tissueplay a crucial role in the field of medical diagnosis, offering significant advantages in terms of accuracy, efficiency, and patient comfort. One key importance lies in their ability to seamlessly integrate with diverse medical devices, such as sensors, imaging equipment, and diagnostic tools. This integration ensures a harmonious flow of information between different components, facilitating more precise and comprehensive medical assessments. Moreover, conformal interfaces contribute to enhanced data accuracy and reliability. The seamless connection between medical devices reduces the likelihood of errors or inconsistencies in data transmission, ultimately leading to more reliable diagnostic outcomes. This is particularly crucial in the field of medical diagnosis, where precision and reliability are paramount for effective decision-making and patient care. In addition to technical benefits, conformal interfaces also promote patient comfort and adherence to diagnostic procedures. Devices that conform to the body's contours are more likely to be non-intrusive and cause less discomfort, thus encouraging patients to undergo necessary diagnostic tests. This is especially relevant in scenarios where continuous monitoring or repeated testing is required, as patient compliance is essential for the success of diagnostic processes. Lastly, the importance of conformal interfaces extends to the realm of wearable and implantable medical devices. These interfaces enable the development of devices that can be seamlessly integrated into a patient's daily life, providing continuous monitoring and real-time data feedback. This can lead to early detection of health issues, allowing for timely intervention and improved overall patient outcomes. In summary, the importance of conformal interfaces in medical diagnosis is multifaceted, encompassing technical integration, data accuracy, patient comfort, and the advancement of wearable and implantable medical technologies.

Cardiac information from the skin

In order to address the need of real-time measurements and non-invasive data collection, wearable sensor platformhave been designed and developed for fulfilling those demands. Unlike conventional wearable type devices including smart watch and glasses, next generation of wearable platform is designed to enhance the conformal and intimate contact with our skin (Sang *et al.,* 2022). Conformality is essential aspect for clinical skin-integrated device as our skin surface human skins have a curve-linear property, meaning it is not evenly flat but with numerous curves, which induces unstable bio/abiotic interfaces, causing inaccuracy of device platform. In this respect, linear and bulkyshape of deviceis ineffective for collecting physiological data. Basically, wearable sensors are designed by using stretchable materials or mechanical designs. Moreover, the sensors are developed in small size to be attached on our body easily according to target bio signal.Skin-integrated medical device detects cardiological signals in the form of very small vibrational signals from our skin (Lee *et al.,* 2021; Gao *et al.,* 2022). Specifically, those attached wearable sensors gather information from “artery vain” located under the skin. Blood flow, occurring near the surface of the skin evokes the small range of vibrations. We could calculate the heart rate, heart rate variability and blood pressure by detecting this medical parameter. Factoring comprehensive assessments of symptoms, activity levels, and contextual factors are crucial when diagnosing and treating diseases. Wearable devices provide a vast amount of data collected through mechano-acoustic system. The sensors detect vibration frequency of heart beat, blood pressure, and respiration, providing valuable insights to cardiovascular and overall health.

The first data gathered by wearable sensors is heart rate and heart rate variability. previous studies have shown irregular and high heart rates are signals of cardiovascular disease or negative health. The recent technological advancements enable wrist-worn devices to monitor heart rates. Photoplethysmography is used to detect blood volume under the skin. By employing peak detection algorithms, the median error ranges around 5%. The algorithms reduce the errors of photoplethysmography. Wearable sensors not only provide information about heart rate but also monetary respiratory functions. Irregularities and changes in respiration frequency can signal underlying health issues. Photoplethysmography is used to measure oxygen saturation, while other sensors measure maximal oxygen consumption. Additional data, such as respiration rate can be collected with smart clothing using accelerometer and magnetometer-based detection that measures chest wall movements. The collection of comprehensive contextual data through wearable sensors has significant implications for medical treatment. Continuous monitoring of health conditions enables the identification of the exact date and time when symptoms first appeared, or when an individual was infected. This chronological data is crucial in tracing the origin of disease spread and preventing further transmission. Furthermore, continuous measurements can help prevent sudden deaths, such as heart attacks. By analyzing the accumulated data, predictive models can be developed to identify individuals at risk and intervene before a life-threatening event occurs. Finallywide range of design of wearable sensors allows for personalized data collection and medication. Individualized insights can be gained, leading to tailored treatment plans and improved patient outcomes.

Electrocardiogram (ECG) and Seismocardiogram (SCG) analysis

The softness is vital character for wearable medical platform to ensure a conformal contact with the skin. Body generates bio signals in in the form of frequency ranging from low band

(0.1-1Hz) to high band (1.5-300Hz), which has important health-care information. When measuring vibration, the intimate contact with the skin will allow for more accurate signal detection. A soft, skin-integrated platform can detect these subtle differences more accurately than rigid and hard devices. The soft wearable devices discern different information (respiration, cardiac signal, and voice) based on frequency range. Human breathing ranges 12 to 20 breaths per minute, converting to 0.2 to 0.3 per second. For cardiac signals, a human heart during rest ranges 60 to 90 bpm, which is 1 to 1.5 beats per minute. Finally, the human voice has a frequency of 80 to 255 Hz. Thus, the drastic difference in range is the key to distinguishing vibration from different organs. The consistency of heart rate is the key factor when determining the health-care of a person. The distance between peaks of heart waves must be constant. However, a drastic difference between these intervals in a relatively short period indicates an issue in cardiovascular and overall health. For instance, peak-to-peak distance linger than average might be caused by abnormal contraction of ventricles, which originates from decrease of elasticity of myocardium. Thus, measuring the heart waves using wearable devices is crucial for our objective. One of the current methods for measuring heart waves is electrocardiography (ECG) (Prieto-Avalos *et al.,* 2022). The ECG records electrical signal generated by the heart. ECG can accurately detect heart activities, because cardiac cycle dominantly affected by electric signals from the neurons located in myocardium. The sinoatrial (SA) node generates the signal and contracts the right atrium. This marks the P wave of electrocardiogram. The largest peak in ECG is generated when the depolarization of ventricles occurs, and this marks the QRS complex. Finally, the electric signal for ventricular repolarization creates the T wave of electrocardiogram. Although ECG accurately measures the movement (cycle of contraction/expansion) of the heart, a minimum of 3 electrodes that are connected with lines are required to measure the vibration. This limitation can be inconvenient and limit the freedom of the patients. Thus, ECG has still challenge in terms of wearing-comfort and portability for real-time monitoring. To overcome these limitations, the soft wearable device uses seismocardiography (SCG) (Taebi *et al.,* 2019). SCG is defined as the measurement of the micro-vibrations of the whole body or of the chest, caused by heart activities.

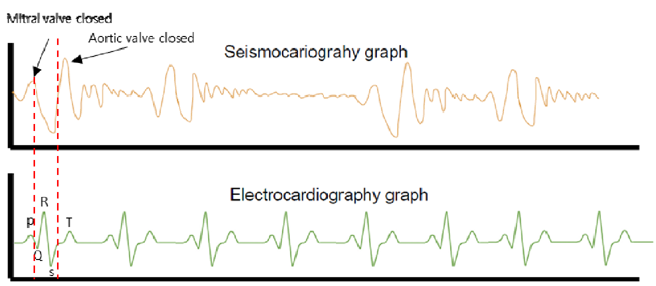

Figure 2. Synchronize of ECG and SCG

The SCG signals are associated with the cardiovascular activities, particularly the opening and closing of heart valves. Successfully measuring SCG correlates to useful information in cardiovascular activity. In the SCG, the first peak, S1 peak, is marked by the closing of the mitral valve. The second peak, S2 peak, takes place as a result of opening of the aortic valve. In association with ECG, S1 peak (closing of mitral valve) should occur before the QRS complex, or before contraction of the left ventricle takes place. After the contraction occurs, S2 peak must take place so that the high blood pressure is released throughout the body. Experiments have shown that the SCG closely matches electrocardiography and provides a very precise measurement of cardiac activity (Figure 2). Moreover, SCG constantly showed accurate results even when measured in heavy activities, implying that the SCG sensor fulfills the role of a real-time non-invasive sensor that functions regardless of condition.

Conclusion

In conclusion, the integration of a conformal wearable health-care platform with a cardiological analysis approach marks a significant leap forward in the realm of personalized and continuous healthcare monitoring. This innovative combination not only enhances the accessibility of health data but also provides a comprehensive understanding of an individual's cardiac health in real-time. The conformal nature of the wearable platform ensures comfort and seamless integration into daily life, fostering increased user compliance and long-term adherence to health monitoring. The cardiological analysis approach further adds value by leveraging advanced algorithms and real-time data to detect subtle changes in heart health, enabling early intervention and preventive measures. This synergy between wearable technology and sophisticated cardiological analysis has the potential to revolutionize healthcare by shifting from reactive to proactive health management, ultimately leading to improved overall well-being. Additionally, this convergence of conformal wearables and cardiological analysis not only benefits individual users but also contributes to the advancement of medical research and healthcare analytics. The wealth of data generated by these devices, when aggregated and anonymized, can provide valuable insights into population health trends and contribute to the development of more effective public health strategies. The seamless integration of technology into healthcare not only empowers individuals to take charge of their well-being but also establishes a foundation for a data-driven and proactive healthcare ecosystem. As we continue to embrace and refine this synergistic approach, we are poised to witness transformative changes in healthcare delivery, with the potential to enhance both individual and population health outcomes.

Acknowledgement

I would like to thank Alan Lee for his guidance, encouragement during process of this review paper

REFERENCES

Ates H.C., Yetison A.K., Güder F., Dincer C. (2021) “Wearable devices for the detection of COVID-19” *Nature Electronics* 2021, 4, 13-14.

Guk, K., Han, G., Lim, J., Jeong, K., Kang, T., Lim, E. K., & Jung, J. (2019). Evolution of Wearable Devices with Real-Time Disease Monitoring for Personalized Healthcare. *Nanomaterials* 9(6), 813.

Sang, M., Kim, K., Shin, J., & Yu, K. J. (2022). Ultra-Thin Flexible Encapsulating Materials for Soft Bio-Integrated Electronics. *Advanced science* 9(30), 2202980.

Lee, S. H., Kim, Y. S., & Yeo, W. H. (2021). Advances in Microsensors and Wearable Bioelectronics for Digital

Stethoscopes in Health Monitoring and Disease Diagnosis. *Advanced healthcare materials* 10(22), 2101400.

Gao, J., Fan, Y., Zhang, Q., Luo, L., Hu, X., Li, Y., Song, J., Jiang, H., Gao, X., Zheng, L., Zhao, W., Wang, Z., Ai, W., Wei, Y., Lu, Q., Xu, M., Wang, Y., Song, W., Wang, X., & Huang, W. (2022). Ultra-Robust and Extensible Fibrous Mechanical Sensors for Wearable Smart Healthcare. *Advanced materials* 34(20), 2107511.

Prieto-Avalos G, Cruz-Ramos NA, Alor-Hernández G, Sánchez-Cervantes JL, Rodríguez-Mazahua L, Guarneros-Nolasco LR. Wearable Devices for Physical Monitoring of Heart: A Review. *Biosensors* 2022 May 2;12(5):292.

Taebi, A., Solar, B. E., Bomar, A. J., Sandler, R. H., & Mansy, H. A. (2019). Recent Advances in Seismocardiography. *Vibration* 2(1), 64–86.

****