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Editorial: Physiological signal processing for wellness

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Editorial on the Research Topic
Physiological signal processing for wellness

In the rapidly growing field of wellness, a new frontier is emerging—where subtle physiological signals can be effectively used for personalized health management. The core of this revolutionary shift is the use of advanced algorithms to analyze the complex signals hidden in bodily cues, lay the foundation for novel approaches to improve health and wellness. In the present advanced technological era, wearable devices and health monitoring tools have progressed beyond their original functions, becoming smart tools that can accurately analyze real-time data streams. Imagine a situation where a smartwatch can detect even very small changes in heartbeat and provide individuals with personalized guidance to restore balance to their normal physiological state. This advancement exemplifies the significance of physiological signal processing—a field where wellness solutions are no longer reactive but are shifting towards intelligent and personalized strategies that are adapted to individual needs.

However, the field of physiological signal processing involves a wide range of applications, not just stress management. Researchers discover new ways to improve cognitive abilities, improve learning results, and recognize potential neurological disorders at an early stage through the examination of complex brain signal patterns and other physical indicators. Consider a scenario where athletes optimize their performance by utilizing real-time brain activity data, enabling customized training programs based on neural feedback. This has a practical impact for professional athletes and fitness enthusiasts alike, or where students receive customized learning approaches that align with their individual cognitive abilities, thereby improving their educational outcomes.

While the innovation and progression in the domain of physiological signal processing is exciting, it is important to acknowledge and address the ethical, privacy, and fairness concerns that arise from using these technologies. This includes considerations like the potential misuse of sensitive health data, algorithmic biases, and the need for robust data governance frameworks. It is also essential to ensure transparency and accountability in artificial intelligence-driven health technologies. Protecting personal information and data is critical to guarantee that the valuable perceptiveness obtained from physical signals are kept protected and used fairly. Additionally, it is important to take steps to guarantee that transformative technologies are available and fair, narrowing the gap between those who have access to them and those who do not, and enabling people from diverse backgrounds to gain the advantages of advancements in personalized wellbeing solutions.

This collection of research articles showcases innovative approaches aimed to improve the efficiency of physiological signal processing. These contributions explore new possibilities for analyzing both simulated and real signals obtained from various modalities.

Song and Lee conducted a comparative analysis of time-frequency transformation techniques for classifying ECG signals. The study examines various time-frequency transformation methods for electrocardiogram (ECG) signal classification, aiming to address the growing need for automated classification techniques in ECG interpretation. Using CNNs and the Ricker Wavelet function for image transformation, this study achieved a notable 96.17% accuracy in detecting premature ventricular contractions. This high level of precision points out the potential of advanced machine learning models to improve real-time ECG analysis and arrhythmia detection, particularly in critical care scenarios. The fine-tuning and hyperparameter selection indicate the importance of optimizing CNNs for ECG analysis in order to improve arrhythmia detection and diagnosis. Moreover, the research provides support for practitioners and researchers, highlighting the potential of CNNs in enhancing ECG interpretation accuracy and efficiency, particularly in emergency care settings. Further exploration of image-transformation methods and their application to wearable ECG monitors represent promising avenues for future research in this field.

Tiwari and Falk conducted a study on innovative metrics of heart rate variability, utilizing sub-band tachogram complexity and spectral characteristics, aimed at enhancing stress and anxiety monitoring in environmentally diverse settings. The authors propose novel methods for computing proxies of heart rate variability (HRV) to predict mental states like stress and anxiety in uncontrolled environments. They address challenges such as noise, artifacts, and confounding effects from other psychological and physical variables. Their proposed features, measuring spectral and complex properties of the autonomic nervous system, outperform benchmark HRV metrics and provide complementary information. These features, particularly those derived from the high-frequency band, are necessary for mental state assessment in real-world settings, as demonstrated across two separate datasets. Furthermore, the analysis of feature ranking indicates the significance of their novel metrics, particularly those derived from the high-frequency range, which demonstrated essentiality even in the presence of variables such as fatigue and physical exertion. This research brings out the promise of employing advanced HRV analysis techniques for accurate evaluation of mental states in practical settings, laying the groundwork for better monitoring of wellbeing and interventions in vital sectors such as healthcare and emergency services.

Varshney and Khan utilized a set of six phonetically distinct words with different phonetic characteristics to do an interesting study on the categorization of imagined speech. The study investigates the newly emerging topic of imagined speech, providing a pathway for command without auditory or tactile inputs. Acknowledging the shortage of publicly accessible datasets, the study presents an EEG dataset with six phonetically different and emotionally neutral imagined words. The study, which involved 15 participants, used a 64-channel EEG collection system to record EEG signals and analyze them for imagined speech classification. The results showed accuracy levels higher than chance. The significance of phonetic variation in capturing imagined speech nuances is highlighted by comparison with current datasets, which accelerates improvements in EEG-based recognition systems that have potential applications in other fields. For use in applications such as brain-computer interfaces and assistive technologies, this work increases imagined speech understanding and EEG-based recognition systems.

Sharan conducted a concise review on the automated discrimination of cough in audio recordings, offering detailed investigation into the subject matter. The COVID-19 virus has drastically changed the world, leading to lockdowns in many countries due to its high infectivity and long incubation period, prompting research on using artificial intelligence to differentiate between different types of coughs for early detection and diagnosis. This paper reviews different approaches to discriminate between types of coughs using smartphone microphones and discusses medical issues related to coughs worldwide. Researchers have explored deep learning techniques, including convolutional neural networks (CNNs) and neural architectures incorporating symptom and cough embeddings. It also covers various cough detection techniques, machine learning algorithms deep learning techniques, including convolutional neural networks (CNNs) and neural architectures, and the use of artificial intelligence to discriminate between types of coughs, including those related to COVID-19. The paper highlights the importance of using machine learning for timely and accurate testing of COVID-19 through cough audio. The researchers evaluated 204 papers. The team propose that more public data is needed to bring neural networks into medical practice, which can help in diagnosing COVID-19 through cough discrimination. This will reduce screening costs, increase accessibility, and improve testing to control the spread of the virus. While progress has been made in AI-driven cough discrimination, further advancements are needed to integrate these technologies effectively into medical practice, aiding in faster and more accessible COVID-19 screening.

Collectively, these studies illustrate the transformative role of advanced signal processing technologies in revolutionizing healthcare and wellness. They provide a foundation for developing more accurate, efficient, and personalized health monitoring systems. From predicting mental states in real-world settings to decoding silent thoughts and detecting heartbeat irregularities using deep learning, these advancements enrich our understanding of physiological signals. They also hold the potential to revolutionize healthcare delivery and patient care. By integrating AI-powered algorithms, wearable sensors, and novel datasets, these findings contribute to the evolution of healthcare systems. They promise improved diagnostics, early disease detection, and tailored interventions for individuals, ultimately leading to better health outcomes and better quality of life.

Author contributions

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