

Studies in Rhythm Engineering

M. Shamim Kaiser  
Mufti Mahmud  
Shamim Al Mamun *Editors*

# Rhythms in Healthcare

 Springer

# **Studies in Rhythm Engineering**

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M. Shamim Kaiser · Mufti Mahmud ·  
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Editors

# Rhythms in Healthcare

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# Preface

Modern sensing technology enables the acquisition of rhythmic data from the human body and daily activities using a variety of sensors. Technological advancements and a better understanding of machine learning algorithms are catching up with medical practice and research in the field of digital healthcare. The extent to which digital healthcare is actually used is determined by a variety of factors, including the types of diseases and functions that patients suffer from, as well as their age and gender. We can improve the effectiveness of present treatments and the prognosis of patients by adopting new digital technology. This could be cutting-edge technology or an application built on a solid understanding of the basic physiology and anatomy of the human body. Anomaly rhythms can be used to predict any disease-related form using core body temperature, gene expression, and hormone secretion measurements. Sensors embedded in smartphones and other devices can now collect data on physical activity, sleep, and heart rate. As sensors improve, the volume, quality, and variety of data that can be conveniently collected in daily life will increase. As a result, several components of the circadian rhythm can be quantified and analysed.

Implantable devices with a biomedical function (pacemakers, visual prostheses, cochlear implants, neural recording microsystems, and deep brain/sensory stimulators), wearable biosensors (tattoos, gloves, cloths, watches, bracelets, rings, and gloves, as well as glasses and helmets, coats, underwear, and pants), foot and body sensory control devices, wearable patches as well as pulse wave monitoring devices, and other invasive monitoring devices have garnered considerable attention, primarily from the healthcare industry. These devices extract physical signals such as heart rate, blood pressure, skin temperature, respiratory rate, and body motion to extract real-time clinically relevant information from physiological signals. This information is sufficient for determining health status and even for making preliminary medical diagnoses. In the last decade, health informatics has made significant conceptual and methodological improvements. These innovations are explained and how the healthcare system can benefit from them. It synthesizes research from prominent academic and industrial groups in this field, together with computational tools and approaches. It includes in-depth coverage of the most recent conceptual and methodological developments. This volume collates 10 chapters representing the state of the

art of biological sensing, intelligent data analytics, and, in many cases, their relationship with biological rhythms. These chapters are authored by experts representing eight countries from a wide geographical location.

In Chap. 1 titled, 'Is Biological Rhythm Associated with the Mortality of COVID-19?', Allahyari et al. examined the factors of the COVID-19 death rate in people without an underlying condition who are not taking medication in this study. They analysed data collected from people over the age of 18 who were free of any underlying disease using Artificial Neural Network (ANN). Finally, the clinical, pulmonary symptom, sociodemographic, and biological rhythm parameters influencing COVID-19 death rates were established. The authors concluded that, given the critical nature of biological rhythms and the insignificant relationship between contact with patients and COVID-19 mortality, psychological interventions, exercise programs, and social activities should be implemented on an individual and social level to reduce COVID-19 mortality and severity.

Chapter 2, titled 'Deep Learning in Biomedical Devices: Perspectives, Applications and Challenges' by Nova et al., discussed the major components of deep learning in biomedical devices and how they contribute to the analytics of data generated by a variety of sources, including photos, sensors, and signals. The authors holistically analysed the advantages and disadvantages of applications of deep learning in biomedical devices. They also discussed how to integrate technologies and improve decision-making with maximum precision, as well as how to upgrade healthcare components facilitating low-cost investments towards improved service quality and a changing lifestyle. Finally, some potential study directions are highlighted, together with their associated scopes and obstacles.

In Chap. 3, titled 'Effect of 3D-Multiple Object Tracking Training on Manual Dexterity in Elderly Adults with Dementia and Mild Cognitive Impairment', Santana-Vargas et al. demonstrated the transfer of cognitive training utilizing the 3-Dimensional Multiple Object Tracking (3D-MOT) technique to two manual dexterity tests administered to two patient groups with moderate cognitive impairment and dementia. Additionally, the minimal number of sessions required to generate a substantial improvement in test scores was found under training settings with a constant and fixed length cognitive stress.

Chapter 4, titled 'Rhythmic Pattern of EEG for Identifying Schizophrenia', by Saleh et al. uses electroencephalogram (EEG) signals to identify Schizophrenia (SZ). Using different patterns and variables related to dynamic functional and effective connectivity, they classified the brain connectomes of SZ patients using different convolutional neural networks (CNN) architectures including an extension of dynamic brain connection analysis using recurrent neural networks (RNN). The proposed approach demonstrated an accuracy of 94.12% in detecting SZ and indicated that partial coherence CNN performs similar to support vector machine (SVM) for classifying SZ and control subjects' EEG connectivity across all feature sets.

In Chap. 5, titled 'Prior Prediction and Management of Autism in Child Through Behavioral Analysis Using Machine Learning Approach', Rahman et al. used machine learning (ML) algorithms, such as Decision Trees (DT), Multinomial Naive Bayes (MNB), Random Forests (RF), SVMs, Adaboosts, Multilayer Perceptron

(MLP), K-Nearest Neighbour (KNN), and Logistic Regression (LR), to predict autistic behaviour. They proposed an autism management system based on knowledge fusion of features obtained through mobile apps used by parents to track their children's development. On a dataset of 500 children using a weighted voting strategy, they obtained 97% accuracy outperforming other state-of-the-art classifiers.

Chapter 6 titled, 'DNN and LiDAR Sensor Based Crowd Avoidance Method for Nurse-Following Robot in Healthcare', by Islam et al. details a novel deep neural network (DNN)-based method to track the target individual in the real-world situations. They have validated the method using a robot that can track a target nurse using a colour histogram matching technique and can then follow the target nurse around the room. Using omnidirectional camera and DNN-based posture estimator, they demonstrated that if the nurse is obstructed by pedestrians or a large crowd, the robot can avoid those pedestrians or the large crowd and follow the target nurse once more with minimal effort.

In Chap. 7, titled, 'Investigation on Heart Attack Prediction Based on the Different Machine Learning Approaches', Bokshi et al. reported the outcome of an exploratory study of multiple ML methods such as SVM, LR, RF, NB, DT, and KNN in determining the most effective ones in predicting heart attack using the Cleveland dataset. Along with interpolation-based rectification of missing values, a hyperparameter tuned ANN was also used for the prediction job. The methods were compared and validated using precision, sensitivity, and specificity.

Chapter 8 titled, 'Wearable Devices for Monitoring Vital Rhythm and Earlier Disease Diagnosis of Treatment', by Sultana et al. investigated how wearable vital sign sensing smart sensors can be utilized to diagnose diseases by monitoring those signs. The study found that adopting the appropriate technological solutions could improve early disease identification and control using sensors for continuous vital sign monitoring.

In Chap. 9, titled 'Post-quantum Signature Scheme to Secure Medical Data', Sultana et al. proposed a signature scheme based on Merkle tree and two finalists of SHA-3 (Keccak and Skein) for blockchain technology to secure medical data from quantum attacks. Thanks to the combination of the Merkle tree, Skein and Keccak algorithms, the proposed solution can be readily incorporated into blockchain with improved overall performance that would give a strong security against the quantum threats and fast key creation with authentication process requiring less memory.

Finally, Chap. 10, titled 'Medical Image Analysis using Machine Learning and Deep Learning: A Comprehensive Review', by Nahar et al. provides a relatively short overview of the latest ML and DL approaches for detecting four of the most popular types of brain diseases, including Tuberculosis including lung cancer, pneumonia, and COVID-19.

Focusing on the various aspects of the most recent developments in healthcare domain and approaches for determining health status, the chapters included in this

volume are aimed to serve as reference for researchers and students working in the field of health-informatics, health-sciences, and applied computer science.

Dhaka, Bangladesh  
Nottingham, UK  
Dhaka, Bangladesh

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Mufti Mahmud  
Shamim Al Mamun

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**Dr. Mahmud Mufti** is Senior Lecturer of Computing at the Nottingham Trent University, UK. He received Ph.D. degree in Information Engineering from University of Padova, Italy, in 2011. Recipient of the Marie-Curie postdoctoral fellowship, he served at various positions in the industry and academia in India, Bangladesh, Italy, Belgium, and the UK since 2003. Expert in computational intelligence, data analysis, and big data technologies, Dr. Mahmud has published over 80 peer-reviewed articles and papers in leading journal and conferences. Dr. Mahmud serves as Associate Editor to the cognitive computation, IEEE access, big data analytics, and brain informatics journals. Dr. Mahmud is Senior Member of IEEE and ACM, Professional Member of the British Computer Society, and Fellow of the higher education academy, UK. During the year 2020–2021, he is serving as Vice Chair of the

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# Chapter 1

## Is Biological Rhythm Associated with the Mortality of COVID-19?



Elahe Allahyari, Seyed Javad Emadi Chashmi, Mufti Mahmud,  
and Ahmad Ahmadi

### 1 Introduction

Coronaviruses include a group of viruses that cause respiratory, enteric, hepatic and neurologic diseases. The symptoms of coronaviruses range from mild illness (e.g. common cold symptoms) to severe diseases (such as Middle East Respiratory Syndrome [MERS] and Severe Acute Respiratory Syndrome [SARS]) [1]. In December 2019, a novel variant of the virus, coronavirus disease 2019 (COVID-19), was identified in Wuhan, China [2, 3]. The disease is transmitted through human-to-human direct contact, and its main symptoms include a dry cough, fever and asthma [4–6]. Due to its rapid spread and consequent fatalities, the World Health Organization (WHO) named it a public health emergency and world pandemic in March 2020 [7, 8]. According to statistics published by the WHO (2020), at the beginning

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