Monitoring the Key Parameters of Circadian Rhythm for Life Style Observations

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Abstract

The human circadian rhythm regulates many bodily functions, including sleep-wake cycles, hormone secretion, and metabolism. Monitoring critical parameters of this rhythm, such as heart rate, blood pressure, and skin conductance, can provide valuable information about a person's health. Majority of the currently available methods are frequently invasive, time-consuming, expensive and not suitable for long time monitoring. This limits their applicability in real-world settings.

The proposed project overcomes these limitations by providing a non-invasive and convenient way to monitor the critical parameters of the circadian rhythm, which are pointed out to be HRV(cr1), Sleep-Activity-Cycle(cr2), BP(cr3), CBT(cr4) and GSR(cr5). The module collects high-quality data on the subject's physiological signals, such as ECG, PPG, Accelerometer, and GSR, by leveraging advanced sensors and processing technologies. These data are then transferred to our database, where machine learning algorithms can easily access and analyze them.

The primary goal of this project is to create a health index based on the collected data that reflects the subject's overall health status. The health index will provide valuable data on the subject's cardiovascular health, stress level, and sleep quality, among other things. The health index can be customized to meet individual needs and provide personalized health recommendations using machine learning algorithms.

The hardware module's design makes it simple to use and wear, making it ideal for continuous monitoring of the critical parameters of the circadian rhythm. Potential applications for the module include in-home monitoring of elderly or high-risk patients, athlete performance monitoring, and early detection of health problems.

Preface

The circadian rhythm is a natural rhythm in the human body that regulates several physiological functions such as sleep-wake cycles, hormone secretion, and metabolism. Monitoring critical parameters of this rhythm, such as heart rate and blood pressure, can provide valuable information about a person's health.

This project aims to create a hardware module equipped with sensors to monitor the critical parameters of the circadian rhythm. The module's ECG, PPG, Accelerometer, and GSR sensors record periodic data from the subject's body. Machine learning algorithms process the data and generate a health index reflecting the subject's health status. The accelerometer sensor data also tracks sleep activity, providing additional information about the subject's sleep quality.

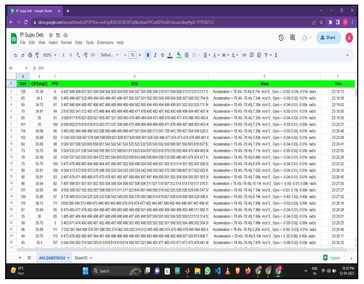
The project aims to provide a quick, accurate, and user-friendly way to track a person's health. The user-friendly and wearable hardware module makes it ideal for continuously monitoring critical circadian rhythm parameters. The module could revolutionize the healthcare industry by providing personalized health recommendations and early detection of health problems.

Content

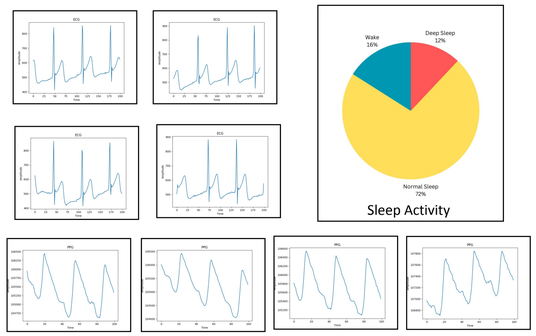
Using advanced sensors and machine learning algorithms, we have attempted to create a non-invasive and convenient way to monitor the critical parameters of the circadian rhythm. To accomplish this, we used a combination of hardware and software methodologies to record, process, and analyze periodic data of a subject.

A hardware module has been developed in the initial prototypes, which is outfitted with ECG, PPG, Accelerometer, and GSR sensors capable of recording the key Circadian Rhythm parameters of a subject. The module is designed to be worn on the left forearm, allowing for continuous monitoring of these parameters. The monitoring is done without interfering with daily activities. The form-factor of the developed hardware is designed to make the device user-friendly, and suitable for constant monitoring of the essential parameters even while a subject is asleep.

The raw data collected by the sensors was then processed using a microcontroller module and sent to our database for storage. The data has been further analyzed using machine learning algorithms to create a health index that reflects the subject's overall health status. Several parameters are included in the health index, including cardiovascular health, stress level, and sleep quality.



Data Recorded On a Single Subject



Initially the proposed project considers only two Diseases/Disorders , namely Diabetes and Cardiovascular disorder. There is one more category which is going to be use as the base category to formulate the final health index with good accuracy. There are n subjects in each category.

Diabetic	Cardiovascular	Healthy
Subject 1	Subject 1	Subject 1
Subject 2	Subject 2	Subject 2
Subject 3	Subject 3	Subject 3
…	…	…
…	…	…
Subject n	Subject n	Subject n

In the project's database, there are five key parameters [cr1, cr2, cr3, cr4 and cr5] , where each CR variable forms a matrix using the recorded datasets. After applying the machine learning in these five parameters on the **Healthy** category, the respectives weights "**WH**" are generated. Similarly, for **Diabetic** and **Cardiovascular** category, "**WD**" and "**WC**" are generated respectively. (These weights are trained to be globally accepted and generic using suitable set of database).

With these weights, the health index formulates the different dependencies of [cr1 , cr2 , cr3 , cr4 and cr5] in a following manner : f(H.I) = G(cr1, cr2, cr3, cr4, cr5) on these category to generate a generic health index "**HI**".

With the help of generic weights ("**WH**","**WD**","**WC**") and health index("**HI**") , specific range of an health idex for diabetic , cardiovascular and healthy category will be predicted.

Hardware Module

The picture on the left shows the wearable hardware module with the required sensors interfaced with the central microcontroller unit. The module is powered up by a rechargeable 3.7 volts battery(which is integrated with the module). The module also includes a buzzer in its power supply segment which triggers and alarms when the input voltage get reduced below its minimum requirement. The sensors are compatible to record ECG, PPG, Accelerometer and GSR pulses, tapped suitably at a predefined spot in the body. The other image demonstrates a real time scenario where the module was worn for the data collection. The left hand is specifically chosen because the ECG sensor electrodes can be conveniently taken to the chest nodes for obtaining the ECG pulses as per the medical standards. There will be no direct touch to the sensors and any other components that ensures the safety of the hardware and the arm. The developed prototype can be further fine tuned as we gradually progress and can be made commercially viable. The overall cost of the hardware is very low with respect to the commercially available health monitoring devices.

Conclusion

Finally, this project created a hardware module outfitted with sensors capable of monitoring the critical parameters of the circadian rhythm. The module provides a non-invasive, convenient, and accurate way to watch a person's health by leveraging advanced sensors and machine learning algorithms. The data-driven health index can provide valuable insights into the subject's overall health status, such as cardiovascular health, stress level, and sleep quality.

The module's potential applications include home monitoring of elderly or high-risk patients, athlete performance monitoring, and early detection of health problems. The module's design is user-friendly, making it suitable for continuous monitoring of the critical parameters of the circadian rhythm. This project has the potential to significantly impact the healthcare industry by providing personalized health recommendations and early detection of health problems, which can lead to improved health outcomes and lower healthcare costs.

Overall, this project demonstrates the potential of using advanced sensors and machine learning algorithms to monitor the critical parameters of the circadian rhythm, ushering in a new era of healthcare monitoring and management. With further development and testing, the hardware module has the potential to revolutionize how we monitor and maintain our health, providing more personalized and effective healthcare solutions.

SCAN QR to meet the Project Supervisor