Paper ID: 47287
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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A NOVEL WEARABLE ECG-MONITORING SYSTEM FOR HUMAN SPACE EXPLORATION

Abstract

The purpose of this study is to develop an improved ECG instrumentation system that could be beneficial for human space exploration.

At present, there is little or no evidence showing that spaceflight-related factors are associated with increased occurrence rate of cardiac arrhythmias. Although events of dysrhythmias have been registered in some astronauts, it stays unclear if these arrhythmias occur because of pre-existing conditions.

One of the objectives for future human space exploration could be identification of the stressors that influence the frequency of arrhythmia appearance in a particular individual. Therefore, the personalized approach should be implemented in medical screening and diagnosis of individuals. Priority is given to minimally invasive or non-invasive methods with high accuracy for monitoring of physiological parameters during space travel. This creates additional constraints to the design of a health monitoring system.

The novel system consists of an adhesive patch-like wearable miniaturized device for ECG data acquisition and a novel data processing algorithm. It detects heart rate, certain types of cardiac arrhythmias (tachycardia, bradycardia, atrial fibrillation) and circadian variations. This adhesive patch-like wearable device is able to continuously record data for up to 7 days. It's cable-less design, small size and direct attachment to the skin surface allows to significantly reduce discomfort to the user.

System architecture design of the proposed instrumentation system is represented by data collection and data transmission blocks, memory and power circuits, user interface and data processing unit. The data acquisition is performed by low-noise amplifier, low power microcontroller unit is responsible for the data collection, storage and retrieval through the micro SD card and USB interfaces. The system has two buttons and two LED indicators to show the current status of the system. A built-in IMU detects user's movements. Recorded activity information is later correlated with the ECG data to identify potential sources of an arrhythmia episode if one occurs.

This novel system may create an opportunity to evaluate the cardiac health state during astronaut's pre-flight training, in-flight and during post-flight rehabilitation. These simple, but efficient ECG-patch instrumentation solutions could also be part of the medical examination process and in-flight documentation of individuals taking part in commercial spaceflight. The system may also be beneficial for sports medicine and regular clinical diagnostics and health monitoring. With the growth of clinically validated databases, such wearable devices also hold promise for integration into the healthcare system and in the reshaping of the clinical-patient interaction.