Academic Year of 2016, Submitted on January the 30th, 2017

Graduate School of Science and Engineering, Aoyama Gakuin University

Title: Anaerobic exercise performance improvement support using real-time analysis of autonomic nervous system activity

Student Name: Chihiro Yoshida
ID Number: 35615152
Degree: Master of Engineering
Course: Intelligence Information
Thesis Advisor: Guillaume Lopez

Abstract

In recent years, citizens of developed countries are more and more concerned by health improvement and diseases prevention. A movement called "Quantified Self" has been rising actively with the abundance of wearable devices that can track our daily activities and fitness-oriented smartphone application software. Tracking athletes psychological ability quantitatively, which has been said to be difficult, has recently become possible thanks to wearable technology growth. Thanks to these improvements, it is now considered that the quality of sports activity can be increased by grasping and analyzing indices related to psychological condition such as autonomic nervous system activity.

In this research the autonomic nervous system activity during anaerobic exercise is quantitatively evaluated using a wearable heart beat sensor and its relationship with the performance has been analyzed. Based on the results, an application software that can quantitatively track athlete's mental condition in which the athlete exert his/her best performance has been developed.

Using a wearable heart beat sensor place on the left side of the chest, heart rate variability has been measured during two types of anaerobic exercises: sprint (50m dash) and powermax (pump a cycle-ergometer pedals for 10secs). Each exercise were performed 2 to 3 times with rest intervals until heartbeat calms between each time. The balance of autonomic nervous system activity has been evaluated using the ratio of the low and high frequencies power density of heart rate variability, LF/HF, and the percentage of heart rate variability greater than 50msec, pNN50. As a result, in both types of exercise, the best performance corresponded to the lowest LF/HF value in 94% of the cases. Similarly, higher pNN50 value were confirmed for 82% of the best performances. Samples showing opposite results were mostly corresponding to exercises done in bad conditions such rainy, windy, or cold weather. Both low LF/HF and high pNN50 show that athletes should be relaxed to produce their best performance.

Based on above results, a smartphone application software connected wirelessly to the wearable heart beat sensor and that can feedback pNN50 value instantaneously has been developed. The application has been evaluated by users under sprint and powermax training conditions. As a result, when pNN50 value shown by the application was high, the training performance was higher in 90% of the cases, such succeeding in verify the utility of developed application software.