Pattern recognition techniques and classification sets supporting behavioural tagging when using a limited number of body sensors

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Abstract— **Stress and physical activities are important aspects of life of people. Body reactions on stress and on physical activities can be very similar but long-term stress leads to diseases and damages the body [1]. Currently there is no method to differentiate easily and clearly between these two aspects in a time slot. We have confronted this problem while developing a mobile system for detection and analysis of stress. This paper presents an approach, which uses a long-term monitor with ECG/EKG capabilities and analysis of the heart rate data that is extracted from the device. The focus of the work is to find characteristics that are useful for differentiation between physical activity and stress.**

Keywords— **ECG, Stress, physical activity.**

I. Introduction

The self-awareness of health care and analysis of bio vital data is an upcoming topic in modern society. The understanding of stress has also changed in the last years. Generally, stress was considered as negative effect. More correctly would be to divide stress into different categories as physical stress and mental stress. Another important point is that stress should not be seen as the peak of a dramatic event. Sources of stress can be the events of a day that elevate activity and require fast response.

Stress can also have positive effects, for example, stress helps us to react and estimate dangerous situations faster so that we take decision whether to escape or to confront the danger.

Stress is a mechanism that allows us to react fast and effectively in presence of danger. Under stress body reorganises the biological functions to reach maximal performance while in danger [2]. This also happens in daily life when circumstances require a fast and effective response. As consequence in our daily life the body constantly stays in this mode. Some long-term consequences of constant stress are difficulties to give adequate respond to fisical, mental and emotional demands [3, 4, 5, 6] and even changes in the brain structure can be observed [7]. Among health problems caused by long-term stress are burnout and cardiac diseases [8, 9]. The consequences for modern society are increment of amount of people with limitations and growth of the treatment and healing costs.

Physical activities also have very similar effects as stress including change of heart rate, blood pressure, etc. The effects of physical activities can be divided in immediate alterations like changes in heart rate during physical activity, and the changes that appear in case of repeated physical activity. [10].

During our previous research [11, 12] and development of a mobile system for measuring stress based on ECG, HR and HRV, we had a problem separating stress and physical activities because the data of stress and physical activities where very alike. Stress and physical activity have similar changes in HR, vision, blood pressure, etc. [7, 13].

The current work is focused on the hypothesis that it is possible to differentiate physical activities and stress by comparing HR, HRV and the resulting characteristics.

The heart rate and the HRV can be simply obtained from a non-invasive mobile ECG. In the following section, the methodology and the data collection will be presented, followed by the possible options that can be used for differentiation between stress and physical activity. As the conclusion, we will mention future works.

II. Methodology

The approach proposed for this work consists of the measurement and the analysis of the data that is measured. The participants for the data collection will be submitted to a four-stage exam. First stage: the data will be recorded while the participant will be resting (RS); second stage: the participant will have to do some physical activity while the data is recorded (PS); third stage: the participant will have to take part in different stress tests (SS); fourth stage: the participant will be in a antistress, relaxing stage (AS).

While the four stages RS, PS, SS and AS the ECG and HR data of the participants will be collected and the participants will be under observation.

At the first stage, the participants will be resting. The data obtained from this stage will be used for comparing with other datasets. The duration of the RS is 5 minutes.

At the second stage, PS, the physical activity will be monitored. For this, participant will have to make different physical exercises on different insensitivity levels. For this an exercise bike will be used. At the beginning of the exercise there will be warming up, then intense exercise and cool-down. Each of these exercises will take 5 minutes. It is important for PS to consider the individual conditions of each participant.

At the SS the participants will be exposed to different cognitive demands. The stressors used for SS are the Stroop test [14], the Trier test [15] and arithmetical operations that have to be solved in limited time.

The selected participants are students, aged from 28 to 40. Neither of them is an athlete nor has some heart disease. The data will be gathered using the Bioharnes 3 from Zephyr. To improve the contact area and electrical properties of the electrodes, electrode gel is applied.

III. Data analyses /discussion

Previous research have shown that physical activity can be detected wrongly as stress. This makes it important to find a method to differentiate between stress and physical activity. The approach that is presented still has to be tested and validated with a significant test group. The method uses two different principles to determinate physical activity. The first idea is detection of fast changes in the heart rate [10, 16, 17]. One of this examples is shown in Fig. 1 where a peak appears and it shifts up the RR intervals at the second 320. These changes are expected to depend on the intensity of the physical activity. The other approach uses the Fourier spectrum analysis. The behaviour of HF and LF will be analysed. The Fig.1 shows the spectrogram.

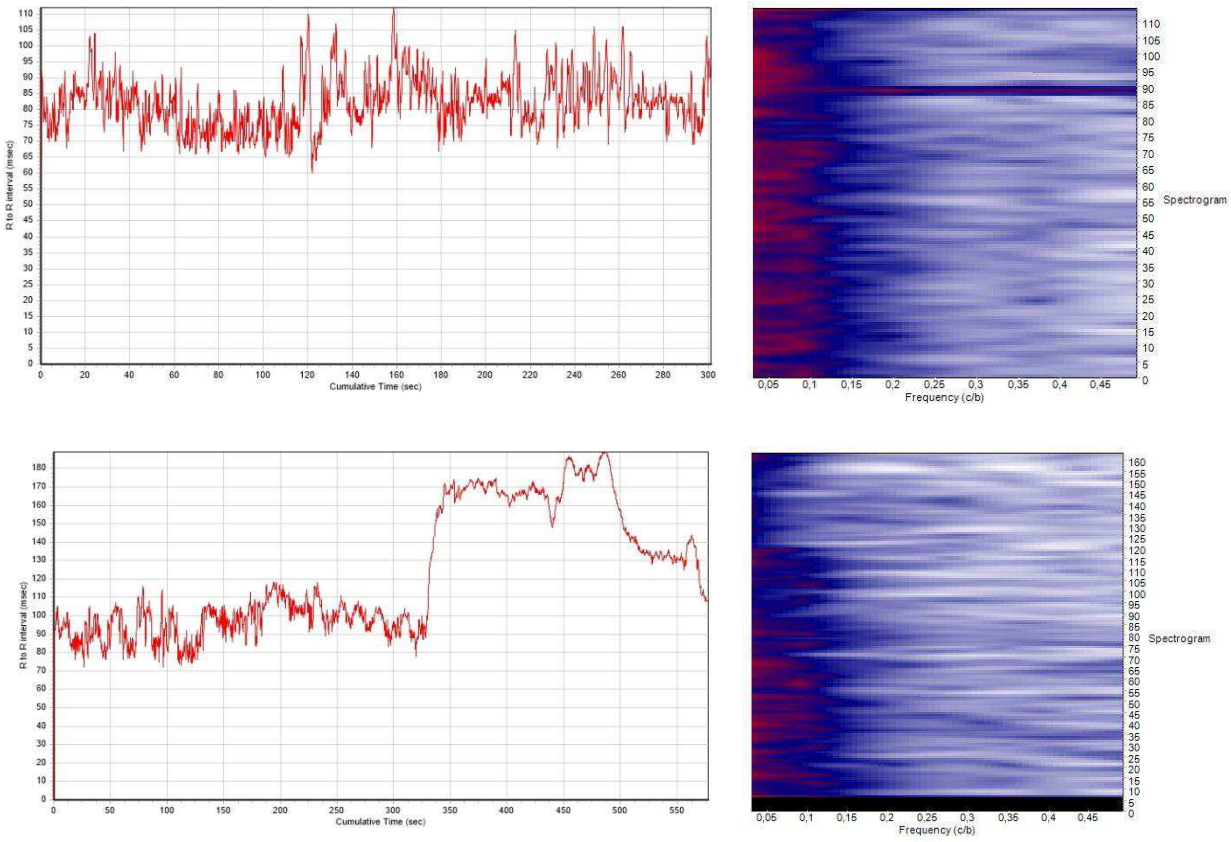

Fig. 1 the first pair of graphics show the data of a participant while resting and avoiding any physical activity except of walking or standing up. The second pair of graphics show the same participant during physical activity of 10 minutes. On second 320 there is a clearly visible jump marks the period when the physical activity was the hardest.