SYSTEM OF THE STUDY OF HUMAN BODY REACTION TO STRESS STIMULI

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The system of the study of human body reaction based on galvanic skin-response phenomenon was described. The results of signal analysis after 4 minor tests differing with intensity and duration of the stimulus were presented. A device for detecting stimuli is safe and non-invasive and it could find wide applications.

The constructed system responds to changes in the skin resistance, and changes in volume of inflow blood to the fingertips. Choice of this parameters was dictated by the ease of research, a minimum invasiveness, and the price of the components.

When vegetative system notes stimulus it sends the signal to change the activity of the sweat glands, this phenomenon is called galvanic skin-response (GSR) [1], delay from the appearance of the stimulus to the occurrence of this reaction is about 2 seconds. The sudden separation of sweat reduces the resistance of the skin, which records GSR sensor. Depending on the subject of research natural resistance of dry skin range from 1 kΩ to 100 kΩ.

Another parameter subjected to observation, which is the volume of inflow blood to the fingertips is dependent on many external factors, such as in example temperature and position of the limb. However, this parameter is always on the function of the heart muscle work, which determines its usefulness for this study. Contractions of hearth muscle are causing the increase of blood flowing through the fingertip, which causes the expansion of localized there blood vessels. That kind of changes are recorded by photopletysmograph [2].

Data collection and processing A/C was provided by measuring module from DATQ Instruments, model DI-158. The choice was dictated with good price and the corresponding parameters of the device.

That selected components are combined in a system whose circuit diagram is shown in Fig. 1. To supply system with power have been used two voltage converters, which are providing voltage level safe to examine and arrangement. The input signal which is stimulus is forcing the body response, which is registered by the sensors. Then, the analog signals from the sensors are sent to the respective channels of the measuring module, where they are converted to a digital signals and sent to the PC. That processed signal can be analyzed in eg. in Matlab, as was done in this case. On the screen of PC are displayed waveforms of signals from each measuring module channel, numbered similarly to the order shown on the diagram.

With such a construction of the device was made a test of its work. It consisted of 4 minor tests differing with intensity and duration of the stimulus. The first test was a twinge in hand with a pin, the second test was pinprick in 2 different most opposite places at the same time. The third test was to exposure object to long-term and rising intensity stimulus in the form of watching horror movie. Last test tested influence of intensity of stimulus to research results, to achieve that object was effected with impact stimulus inflicted with for example be applied to the object of much higher intensity than in the case of tests 1 and 2, so that the test stimulus was subjected to shock infliction for example with Book.

Obtained data were subjected to analysis by a script written in MATLAB. In the case of the signal from GSR sensor script was turning change of voltage onto change of the resistance, retrieving two samples apart from each other by 2 seconds and checking for differences in their values, if the second sample was reduced 8% relative to the first sample, it was considered the occurrence of the stimuli at this point.

The signal from the sensor PIK was analyzed in terms of observable exceeded over 2 V. As you can see, unfortunately, the sensor does not work properly. When simulation using the appropriate values of resistors and potentiometers was performed, it turned out that the sensor reacts to sudden decreases resistances above 50 kΩ. Unfortunately there that sudden and high decreases of signal were not registered on tests in tests with the real object. A possible solution to the problem could be using better quality operational amplifiers or choosing the more appropriate resistor values for the voltage divider.

The signal provided by photopletysmograph required more complex analysis. First script analyses signal to found spikes indicating the contraction of the heart muscle on the basis of which average heart rate in first 10 seconds of test was calculated (referenced pulse). In those first 10 seconds object haven't been effected by any stimuli. Then, on the basis of time difference between two consecutive contractions was calculated pulse of the moment. If it was more than 105% of the reference pulse is regarded as the occurrence of stimuli. When

two sensors recorded the occurrence of stimuli in the same or similar time (maximum difference of 2 seconds), the occurrence of stimuli was considered.

At the first test the object has been subjected to the action of two stimuli, both were detected. At 95th sec. of test was detected additional stimulus that did not take place. For this test the correctness of the analysis sets at 66%.

The second test in which the test was subjected to two simultaneous pinches, showed a significant increase of potential stimuli detected by the sensor GSR, but it translated into a much worse final result. As we saw in this case, the correction of analysis determined at the 33%. During this test at the 78th sec. occurred emotion quite different from stress, namely the respondent began to laugh as was also noted as a stimulus, as that was not the stressor, this reading was not taken to assess the total test.

A third test which relayed on a specific long-term stimulus revealed that despite of the absence of physical sensation of pain, subject felt stress for the entire video. This test was not taken into account because of the unusual character of the stimulus, the type of which the script was not adapted to analyze.

Results of the last test confirmed intensity of stimulus has direct effect on analysis correction. We could see that the correctness of determining the incentive amounts to 66%. The GSR signal analysis chart for this assay shows the larger decreases of skin resistance.

Finally work of the system along with the script analyzing rated at 62%.

Assembly is provided with components available in almost every electronics store. System operates at low voltages and it is 100% safe and non-invasive. Construction has a considerable potential for modification and expansion, as an addition output data of the system are stored in a form suitable for processing by the popular programs for numerical analysis. Final score of analysis could be better with parts that are difficult to available but not necessarily more expensive, but it is still above 50%. The analysis script has a large impact on finding the stimulus thus improving it will definitely has a positive influence on the final result, with none or very low amount of additional costs.

A device for detecting stimuli could find wide application in the medical sector, security, administration and finance. Currently manufactured devices as true are characterized by a high degree of accuracy, but still has a small percentage amount of mistakes and the price is far too high to be able to speak even a small percentage of error. Therefore, an appropriate consensus between accuracy and the price could open up a whole new horizon in such matters as for example admission to work.

1. Jaworski, R. Poligraf na tropie zabójcy / R. Jaworski. – Wrocław, 2013.
2. Martini, F. Essentials of Anatomy & Physiology / F. Martini, E. Bartholomew. – San Francisco, 2003.

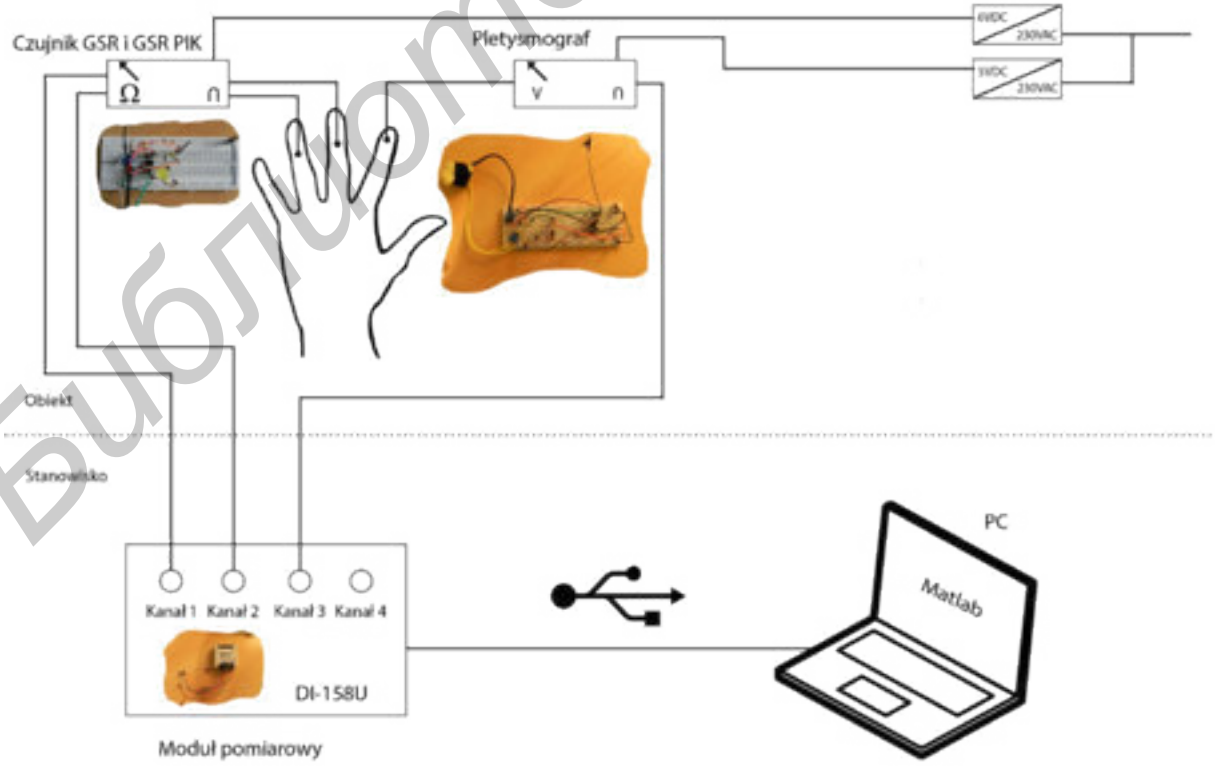

Рис. 1 – Circuit diagram of the research body's response to stress stimuli