https://doi.org/10.26160/2474-5901-2020-21-49-52

ASSESSMENT OF THE PSYCHOPHYSIOLOGICAL STATE OF THE METALLURGICAL OPERATOR DURING THE WORKING PROCESS IN REAL TIME

Vishnevsky D.A., Sotnikov A.L.

Keywords: performance, fatigue, heart rate, galvanic skin response, wearable device, psychophysiological state of the operator, human factor.

Abstract. Method for monitoring the psychophysiological state of a metallurgical operator in the course of labor activity by taking indicators of heart rate, galvanic skin response, body and environmental temperature, gyroscope data, GPS sensor data is presented. The data obtained is transmitted wirelessly from the wearable device in real time to the server for further processing. The principle of developing a decoding technique for psychophysiological changes in the operator's body during operation is given enabling timely take measures to normalize the situation on the spot, depending on the functional state degree of the operator's body systems.

ОЦЕНКА ПСИХОФИЗИОЛОГИЧЕСКОГО СОСТОЯНИЯ ОПЕРАТОРА МЕТАЛЛУРГИЧЕСКОЙ ОТРАСЛИ ВО ВРЕМЯ РАБОЧЕГО ПРОЦЕССА В РЕЖИМЕ РЕАЛЬНОГО ВРЕМЕНИ

Вишневский Д.А., Сотников А.Л.

Ключевые слова: работоспособность, утомляемость, частота сердечных сокращений, кожно-гальваническая реакция, носимое устройство, психофизиологическое состояние оператора, человеческий фактор.

Аннотация. Приведен способ контроля за психофизиологическим состоянием оператора металлургической отрасли в процессе трудовой деятельности путем снятия показателей: частоты сердечных сокращений, кожно-гальванической реакции, температуры тела и окружающей среды, данные гироскопа, данные GPS датчика. Полученные данные передаются с носимого устройства беспроводным способом в реальном времени на сервер для дальнейшей обработки. Приведен принцип разработки методики для расшифровки психофизиологических изменений в организме оператора во время работы, что позволит своевременно принимать меры по нормализации ситуации на месте, в зависимости от степени функционального состояния систем организма оператора.

Assessment of the body systems functional state of the operator in the metallurgical industry makes it possible to establish the character and severity of changes in physiological functions and human performance depending on the kind of work and the workload. Working capacity changes undergo several phases, including the main ones like the warming-in phase, the phase of stable working capacity tending to go down by the middle of the work shift due to fatigue and then rise again after the lunch break, as well as the phase of working capacity decrease by the end of the shift, due to fatigue growth. In a number of cases at the end of a shift a so-called "final rush" is observed, characterized by an increase in working capacity, but not indicative of a fatigue decrease [1].

In order to assess the functional state of body systems, it is proposed to introduce a psychophysiological control in real time using the developed device for individual monitoring of the psychophysiological state of the worker, which will

help to determine the magnitude and direction of changes in the considered indicators all through the work shift [2].

To do the research it is necessary to choose methods and means that allow obtaining data that most adequately and fully reflect the state of the body functional systems subjected to stress during the work. The developed device for determining psychophysiological parameters includes the following sensors: a heart rate (HR) sensor, a galvanic skin response (GSR) sensor, a digital body temperature measurement sensor, and a gyroscope.

The results of psychophysiological studies are processed by the method of variation statistics to determine the degree of their reliability.

The developed device for monitoring the individual psychophysiological characteristics of the worker over the working process and in real time requires a technique to be developed for analyzing the data obtained from the device about the psychophysiological processes of the body during the work. The developed technique must solve the problem of decoding psychophysiological changes in the worker's body during the work in its turn enabling to take timely measures to normalize the situation on the spot, depending on the degree of the functional state of the operator's body systems. The system based on the interaction of the developed technique and the developed device will allow to more accurately monitor the functional state of the working staff of the enterprise over the production process and will provide timely response to the negative consequences of the human factor impact on the production process both individual and within the whole enterprise, which may result on labor productivity. Also hereafter, basing on the processing of data arrays from the wearable device fleet at the enterprise, the system will allow predicting the next phases like warming-up, stable performance, reduced personnel performance, and thus will effectively and efficiently distribute the load on the human working staff of the enterprise, and will result in the long-term productivity of enterprises.

The psychophysiological processes that arose in the human body during activity are not individual, but strength and speed of these processes are individual and depends on a variety of both internal (age, gender, race, etc.) and external factors (pain, temperature, etc. etc.). In order to identify more accurately the functional state of the worker based on the psychophysiological processes occurring in the body of the device wearer, the technique should be based on a statistical analysis of the individual psychophysiological characteristics of the worker within the initial, adaptation period of the device. During this period the worker’s state both psychophysiological and physiological, must correspond to the optimal working regime, and not exceed the maximum allowable norms of psychophysiological activity during work. The correct and optimal operation of the system in the developed device and methodology depends on the initial adjustment for each carrier individually [3].

As an example, the figure shows a scale of heart rate indicators (beats / min); modes with a lower and upper heart rate limit in a given color field are presented in

a color scheme. Green, light green and yellow - normal operator heart rate, orange and red - dangerous heart rate values for the operator's health.

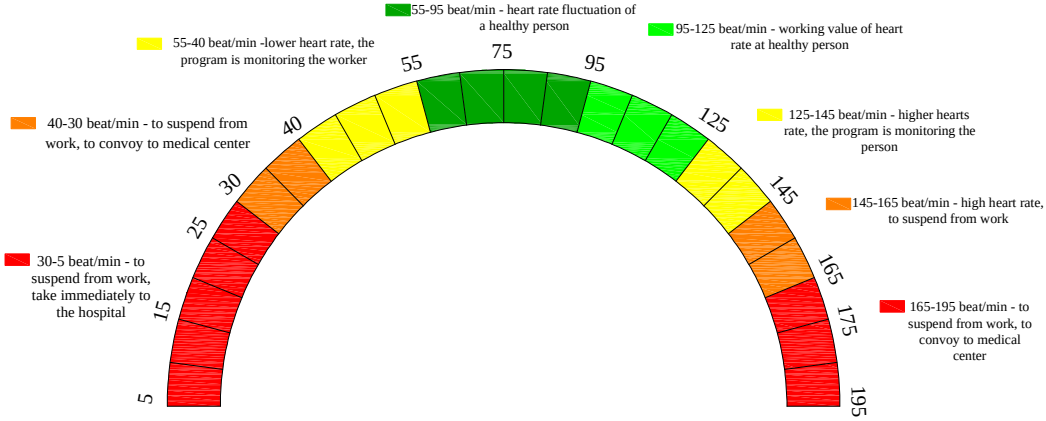

Fig. 1. Heart rate indicators scale, beats / min

The operator's heart rate is influenced by both internal and external factors. Some of them are allowable, and some have a negative impact on the psychophysiological state of the device user, which leads to a decrease in the operator's efficiency [4].

The development of a model for assessing the psychophysiological state of the operator will give a complete picture and logical relationship of the collected data from an individual device for taking psychophysiological indicators and the location of the employee in real time.

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Вишневский Дмитрий Александрович – кандидат технических наук, доцент, проректор по научной работе, заведующий кафедрой машин металлургического комплекса, Донбасский государственный технический институт, г. Алчевск, ЛНР, dimavish.79@mail.ru	**Vishnevskiy Dmitriy Aleksandrovich** – candidate of technical sciences, associate professor, Vice-rector on the Scientific Work, head of the Department of Metallurgical Machines, Donbass State Technical Institute, Alchevsk, LPR e-mail: dimavish.79@mail.ru
Сотников Алексей Леонидович – доктор технических наук, доцент, профессор кафедры механического оборудования заводов черной металлургии им. проф. В.Я. Седуша, начальник научно-исследовательской части, Донецкий национальный технический университет, г.Донецк, ДНР, 0713019870@mail.ru	**Sotnikov Alexey Leonidovich** – doctor of technical sciences, associate professor, Professor of the Department of Mechanical Equipment of Ferrous Metallurgy Plants named after prof. V. Ya. Sedusha, Head of the Research Unit, Donetsk National Technical University, Donetsk, DPR, 0713019870@mail.ru

Received 19.09.2020