Application of forecast methods to determine the functional condition of the driver

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Abstract – this paper presents the results of the driver's functional condition study moving in such road conditions as city, plain and mountains. The indicators of the functional condition give an opportunity to estimate the tension and difficulty of the driver's work.

Keywords – psychophysiological indicators, driver, functional condition.

I. Introduction

Functional condition (FC) is a complex multicomponent characteristic of functional systems for an organism that directly or indirectly interact with the performance of activities. The indicators of the drivers body's FC give an opportunity to assess the tension and difficulty of the driver's work. Due to the increase of traffic intensity on the roads, the problem of ensuring traffic safety became relevant. To solve it there is not enough information that can be obtained only by traditional methods of studying the mode of movement, in which the driver acts in an implicit form [1].

II. Methods of FC research

Over the past half century, a large number of methods have been developed for the study of driver's psychophysiological qualities, such as [1]:

- electrocardiogram (ECG);
- electroencephalogram (EEG);
- electrooculogram (EOG);
- electro-galvanic reaction (WGH).

A number of researchers believe that the main factor describing the behavior of the driver on the road is his reaction to various stimuli. For such researches, methods of the skin-galvanic reaction determination and electrooculogram are less commonly used. Indicators obtained by such methods describe the reaction of the body to change the road environment, EOG records the movement of the eyes, so it is possible to determine the greatest stimuli attracting drivers attention.

Recently, attention is increasingly drawn to the study of FC drivers. Most scientists working on the problem of psychophysiology of drivers tend to the fact that human FC is a decisive factor determining its behavior when driving a vehicle [1]. We know many methods for evaluating human FC. Research of this kind is used in sports and space medicine. The basis for such studies is the methods for assessing the human heart rate variability based on an ECG (ECG) analysis.

Heart rate variability (HRV) is unevenness of the heart rate due to the influence on it of various regulatory processes in the body. Currently, there are several methods for evaluating heart rate variability. Among them there are three groups: time domain methods – based on statistical methods and directed on the study of general variability, frequency domain methods – the study of periodic components of HRV, integral indicators of HRV (include autocorrelation analysis and correlation rhythmography). Statistical methods are based on the measurement of RR intervals, as well as on the comparison of the calculated indicators. They give a quantitative assessment of variability.

FC analysis of a driver in movement makes it possible to determine the main factors that influence it in different road conditions, which can reduce the reliability of its work [1].

To assess the FC driver were selected two indicators. This is the regulatory systems activity index (RSA) and the stress index (SI), they are determined by the analysis of the electrocardiogram.

SI of regulating systems is determined on the graphic distribution basis of cardiointervals – histograms. In the norm, SI ranges from 80 to 150 conventional units. This indicator is very sensitive to the tone of the sympathetic nervous system. A small load increases it by 1,5 – 2 times, with considerable loads it can increase by 5 – 10 times [1].

It was important to obtain the value of SI in different traffic conditions. That is, FC was determined separately by the driver on the plain, in the mountains and when driving through the city. Such studies served as the basis for predicting the drivers FC when passing all sections with different conditions in one route. Separately collected data was stored in one general dependence for all conditions and was compared with the results of the experiment, which consisted in the continuous movement of the city, plain and mountains. Such studies, in their comparison, can illustrate the difference between the real dependencies that were observed and the prediction.

Forecasting was done by the method of weighted moving average and determined seasonal components. The weighted rolling average is calculated in such a way that the last values before the predicted period have the greatest weight [2]:

$$P_j = \frac{\sum_{i=1}^{n} k_i \cdot P_i}{\sum_{i=1}^{n} k_i}, \quad (1)$$

Where^ k_i- weight of significance over time periods *i.*

The seasonal component is determined by the formula:

$$I_s = \frac{y_t}{\bar{y}}, \quad (2)$$

Where: y_t – row lewel; y – middle level.

III. Results

The first step was to determine the dependence of change and SI from the time spent driving in urban settings. The research was conducted in Lviv on a street-road network length of 4.3 km. 25.8 km overall distance. The results are shown in Fig. 1. The highest value of the stress index reaches the point of 175, and the smallest – 90.

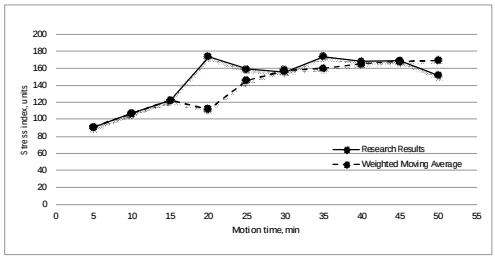

Fig. 1. Results of studies in the city

Studies on plain conditions were conducted on the Lviv-Stryi route 62 km long. This area passes the area, which fully corresponds to the definition of the plain. The results are shown in Fig. 2. The highest value of the stress index reaches the point 180, and the smallest – 95.

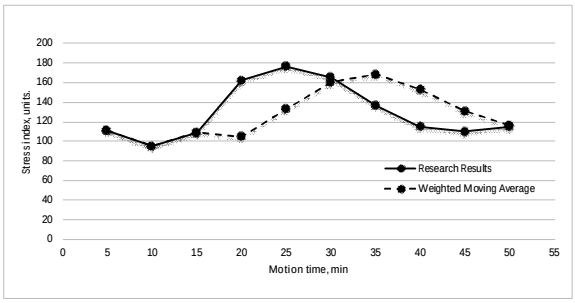

Fig. 2. Results of studies in plain terrain

In order to determine the impact of mountain conditions on the change in the functional state of the driver were conducted research on the route Skole – Lower Gate 58 km long. The results are shown in Fig. 3. The highest value of the stress index reaches the point 410, and the smallest – 240.

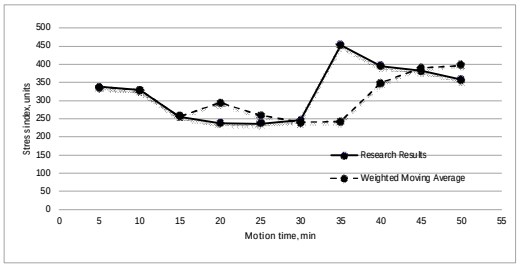

Fig. 2. Results of research in mountainous terrain

In order to compare the values on individual segments with prediction, additional research was conducted. They consisted in the fact that the driver was moving along the route which goes through all three conditions of movement. During the movement, the conditions changed from city to mountain and vice versa. The length of the route on both sides was 530 km. He passed through the following settlements: Lviv – Stryi – Dolyna – Khust – Mukachevo.

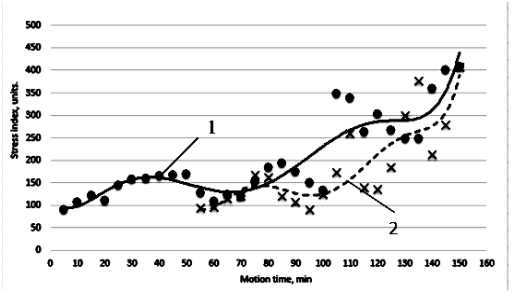

Fig. 4. Forecasting of change of index of driver's tension during traffic in urban, plain and mountainous conditions. 1 – actual data; 2 – data obtained using the prediction method

Conclusion

According to the results of the work, the driver of the engine has been determined in different road conditions (mountain, plain, city) and the dependence on the duration of the movement is determined. According to the research, it is established that during continuous continuous movement in the mountainous area drivers are in a state of stress and exhaust much faster than in urban and plain conditions, while the voltage index increases by more than 2 times. With the help of the method of the weighted average moving and seasonal component, a change in the driver's stress index, which moves along the route "city – plain – mountain", is predicted to be relative to 15-25% relative to the results of research on a similar route under continuous motion, which is within the normal range.

References

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