UDC 004.942:656.61.052

IDENTIFICATION OF SKIPPERS HUMAN FACTOR BY MEANS OF NAVIGATION INFORMATION SYSTEMS

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Abstract: *Given the recent trends and the growing negative impact of human factor on quality of freight transport by human transport, there is a problem related to the complexity of model of driver formal analysis. Individual features and models of drivers behavior force to expand the range of information and software and hardware for qualitative identification of decision-making processes taking place on bridge. The thesis presents experimental data on the identification of human facto elements by means of both navigation information systems (ECDIS) and specialized mobile medical equipment. Formal approaches to identification and structuring of these parameters are given, logic of determining the probability of model states the driver when making responsible decisions during navigation watch.*

Keywords: *control automation, transport systems, identification, human factor, psychophysiological parameters of driver.*

ІДЕНТИФІКАЦІЯ ЛЮДСЬКОГО ФАКТОРУ СУДНОВОДІЯ ЗАСОБАМИ НАВІГАЦІЙНИХ ІНФОРМАЦІЙНИХ СИСТЕМ

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Анотація: *Враховуючи останні тенденції та зростання негативного впливу людського фактору на якість вантажних перевезень засобами людського транспорту, то постає проблема, що пов'язана із складністю формального аналізу моделі судноводія. Індивідуальні особливості та моделі поведінки судноводіїв змушують розширювати діапазон інформаційних та програмно-апаратних засобів для якісної ідентифікації процесів прийняття рішень, що відбуваються на капітанському містку. У рамках тези представлено експериментальні дані щодо ідентифікації елементів прояву людського фактору засобами як навігаційних інформаційних систем (ECDIS), так і спеціалізованого мобільного медичного обладнання. Приведено формальні підходи щодо ідентифікації та структуризації цих параметрів, наведено логіку визначення імовірності станів моделі судноводія під час прийняття ним відповідальних рішень під час несення навігаційної вахти.*

Ключові слова: *автоматизація управління, транспортні системи, ідентифікація, людський фактор, психофізіологічні параметри судноводія.*

Introduction. An increase in the level of responsibility during navigational watch on the captain's bridge during cargo transportation by sea transport significantly affects the occurrence of stress among the officers [1–4]. To a large extent, the situation is aggravated by the fact that the number of information sources on the basis of which the navigator makes management decisions puts forward high requirements for the crew in terms of stress resistance and psychological reliability [5–7]. The safety of the crew, the survivability of the ship, the cost of cargo, the associated dangers and uncertainties cause an increase in interest in this problem, and focuses the attention of the scientific community on its solution [8–10]. In turn, there are the results of some studies that speak of risk reduction by means of automated and intelligent computer systems [11, 12]. All this determines the relevance of scientific research and requires the development of approaches to identifying the psychophysiological parameters of the navigator in order to improve the safety of navigation in general.

Main research material. Given that the greatest difficulty in identifying the information model of the navigator's behavior is individual reaction algorithm, we will use the formal-logical descriptions presented in [13].

In terms of cognitive systems, it becomes possible to formally describe complexly structured critical situations during navigational watch $z \in Z$. Thus, the main task is to build an algorithm for extracting patterns *V* between the current information about the navigation situation *K* and the navigator's stress response $a \in A, b \in B, ..., n \in N$, of the form:

$$V = \left(\{\underline{a}/A\} \rightarrow \underline{z}/Z\right), \exists\alpha\left(\{\underline{\tau}/T\}_{\alpha}, \underline{z}/Z\right) \in \Omega(Z) : \{\underline{a}/A\} \subseteq \{\underline{\tau}/T\}_{\alpha}.$$

Then if $\{a\} \cap \{b\} \cap ... \cap \{n\}$, то $\{a\} \cup \{b\} \cup ... \cup \{n\} = \tau$, which, in turn, characterizes this process as coherent, for which:

$$V\left(\{\underline{a}/A\}, \underline{z}/Z\right) = \left\{G \downarrow \left(\underline{a}/A\right)\right\} \otimes G \uparrow \left(\underline{z}/Z\right).$$

At the same time, it is important to separate individual patterns $V\left(\{a/A\}, \underline{z}/Z\right)$ from universal for all subjects of the organizational and technical system of maritime transport $V'(\{a/A\}', \underline{z}/Z)$, such that: $|\{a\}'| < |\{a\}|, \exists a \in \{a\}' A < A'$. Within the framework of the research objectives, let us consider a navigational critical situation in which the following input information data is observed (Fig. 1, a–d).

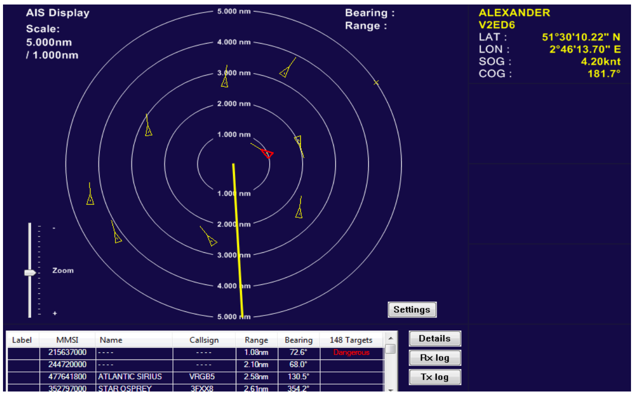
The data are reliable and were obtained during the passage of the vessel ALEXANDER on December 10, 2021. The recorded parameters of the navigation information systems are synchronized with the received data on the psycho-physiological state of the navigation watch officers (Fig. 2, a, b).

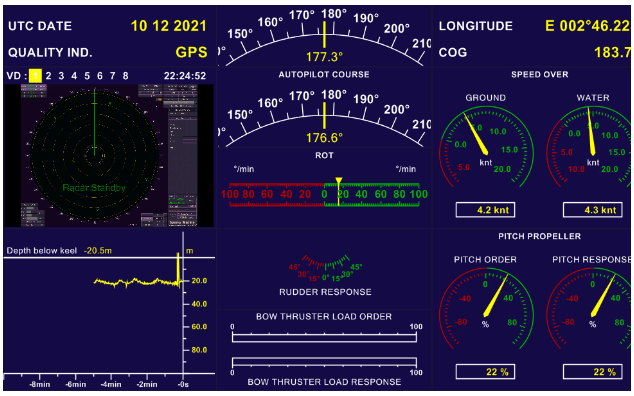
As you can see, the complexity of identifying the human factor of each navigator is that it is necessary to determine the difference between V and V', in each specific navigation situation. For this purpose, we define a system of identifiers *R*. Having obtained empirically, in the course of processing experimental data, the relationship between general and individual patterns, it will be possible to determine the likelihood of a negative human factor J_z and p_R, in situations of information generalization: $R = (\{\underline{a}/A\} \rightarrow J_z\, \underline{z}/Z),\; p^* \le p_R = p(\underline{z}/R) < 1, \upsilon_R = \upsilon(R) > 0$.

The normalization of probabilities leads to the conditions:

$$p(\underline{z}) + p(\neg\underline{z}) = 1,\; p(\underline{z}/R) + p(\neg\underline{z}/R) = 1,\; p(\neg\underline{z}/R) > 0,\; p(\underline{z}/R)/p(\underline{z}) > 1.$$

For a more detailed analysis and implementation of the proposed approaches into the study, it is necessary to use fuzzy logic and sets [14-16], which will allow accurate identification for each individual navigator.





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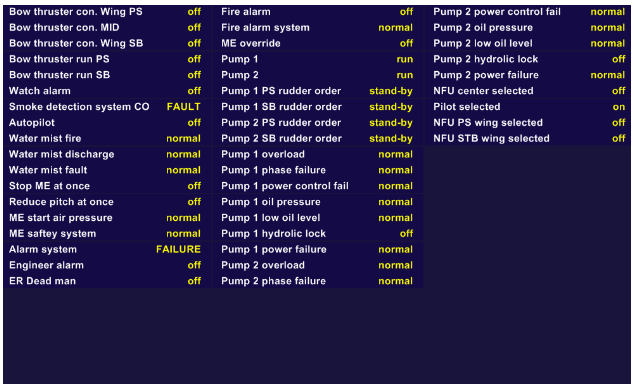
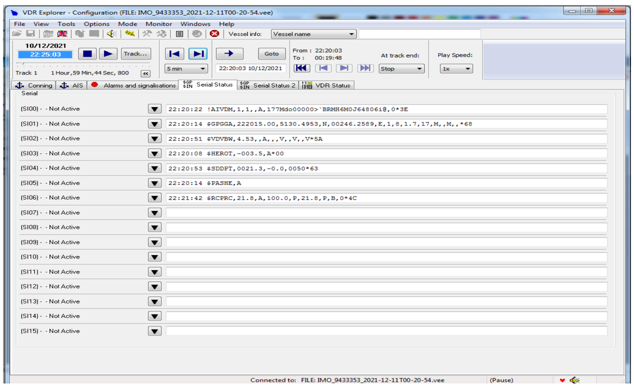
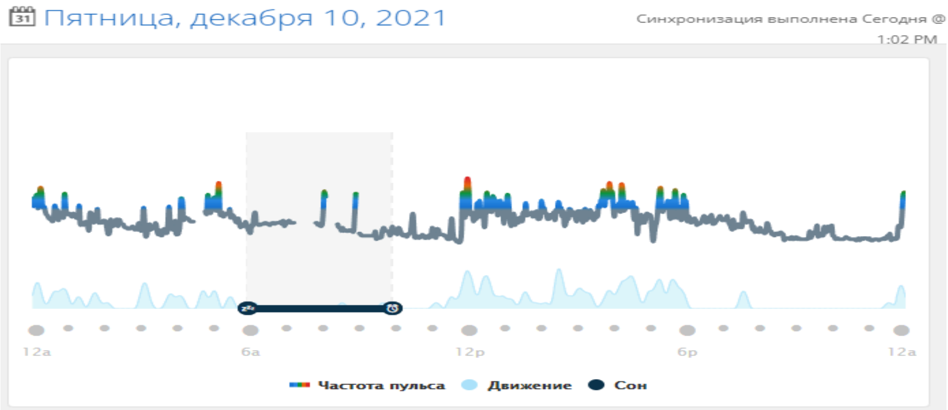


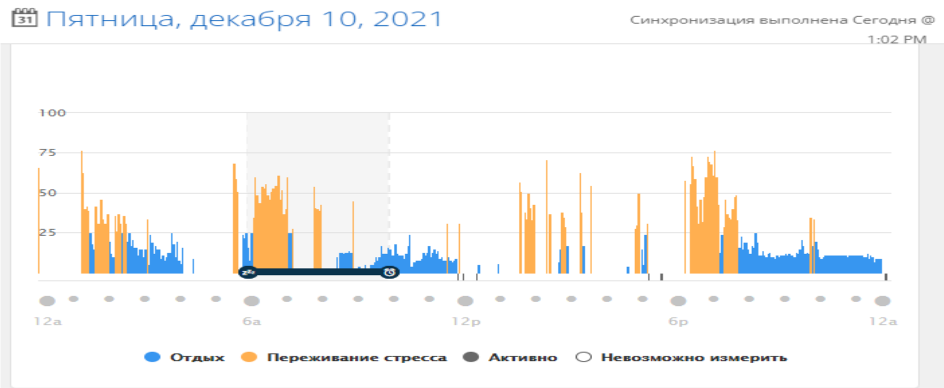


c d

Figure 1 – Navigation data ECDIS, AIS, ARPA, GPS of the ship



a



b

Figure 2 – Psychophysiological state of navigation watch officers

Conclusions. Thus, in this publication, approaches have been proposed for identifying the manifestations of the human factor in relation to the data of navigation information systems in general terms. The formal representation of identification processes in terms of cognitive systems made it possible to find interface points in complex human-machine interactions when controlling a ship navigator.

Further research is proposed to be carried out on the basis of a complete collection of navigational and psychophysiological data in order to determine the fuzzy rules of relations V and V'. The received materials are aimed at reducing the negative manifestations of the human factor of navigators in difficult navigation situations.

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