FORMAL-LOGICAL APPROACHES TO DESCRIPTION OF HUMAN FACTOR INFLUENCE ON THE VESSEL CONTROL

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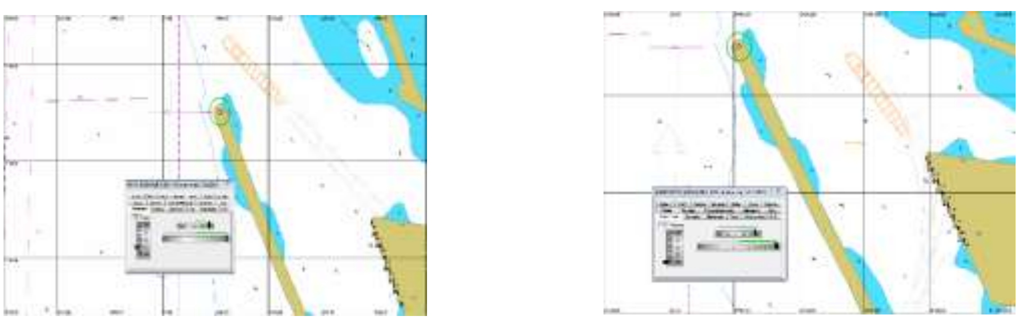
Introduction. Taking into account the peculiarities of performing mooring operations, the most preferable to be used approach is said to be the SS one. The deterministic process of it is envisaged to take place [1,2]. Then, the mooring of the vessel s can be described by the following $\left(w,t \mid w \in W, t \in T\right)$, where $w = \left\langle \Theta_A^w, \Theta_O^w, \Theta_F^w, R_O^w \right\rangle$. Therewithal, variations of the mooring trajectory of the operations are able to be described by a variety of $S_w = \left\{\left(w,t\right) \mid t \in T\right\}$.

Research model and method. General number set of mooring situations are defined as $S = \bigcup_{w \in W} S_w$, where $s = \ , s \in S$ and time can be reported by a sequence of actions in the path of trajectory $\left(t_0,...,t_k\right)$, $\forall u \in \left\{0,...,k-1\right\}$, $\left(t_u \mid u \in N\right)$, $\left(t_u, t_{u+1}\right) \in R_w$ is considered to be a typical one in the initial stages [3,4]. Nevertheless, an action plan is being formed at the time of t_{u+1}. As a rule, the initial plan of the development of the trajectory of actions has been formed [5]. However, all possible factors forming its Δ_p are not taken into consideration [6,7].

To be precise, exactly these factors will make major contribution towards the supposition of the development of trajectories. We are to mention that it is the information- plan of its carrying out $\beta_1, \beta_2, ..., \beta_n$ that is formed initially being fragmented as $\Delta_{\beta(t_u)}$. Situation identification $\delta \subseteq S \times S$ depends greatly on restrictions such as $\left(\left(w,t\right),\left(w',t'\right)\right) \in \delta$ and supposes $\left(s,s'\right) \in \delta$ as a part of class-forming set Δ_δ.

So, hereby, the result of the variable formation of the trajectory can be described as being very different (Fig. 1. a and b).



a *b*

Figure 1 – The variable formation of the trajectory

In the Figure 2 the changes of strategies of maneuver carrying out $\beta_1 \vee \beta_2$ are vividly reflected. They are being dependable on the limitations of $w', t' \in \delta$ when cadet is involved in choosing the direction and speed of the ship to prevent vessel collision.

Let's describe the cadet action plan β aiming to keep the ship in the place while performing mooring operations and pulling it towards the pier using engines. It is given by the predicate $\circledast\left(\beta, p, u, v\right)$, where p is the way to the complete mooring operation and $\left[u,v\right] \in T$ is time intervals allotted for the maneuver carrying out. The time span is to be taken as no more than one hour as the overheating of the thruster is highly likely to happen [8-10]. Then the trajectory of the mooring task $\circledast$ will be described by the following dependencies:

$$\circledast(\alpha, p,u,v) \Leftrightarrow (v=u+1) \wedge \left(Af\left(p(u), p(u+1)=\alpha\right)\right),\ \alpha \in \Theta_A;$$

$$\circledast(\beta;\beta', p,u,v) \Leftrightarrow \left(\exists n \in [u,...,v]\right) \wedge \left(\circledast(\beta, p,u,v)\right) \wedge \left(\circledast(\beta', p,u,v)\right);$$

$$\circledast(\beta \mid \beta', p,u,v) \Leftrightarrow \left(\circledast(\beta, p,u,v)\right) \wedge \left(\circledast(\beta', p,u,v)\right);$$

$$\circledast(\beta \parallel \beta', p,u,v) \Leftrightarrow \left(\circledast(\beta, p,u,v)\right) \wedge \left(\circledast(\beta', p,u,v)\right);$$

$$\circledast(\beta^*, p,u,v) \Leftrightarrow \left([u=v]\right) \vee \left(\circledast(\beta;(\beta^*)\, p,u,v)\right);$$

$$\circledast(s', p,u,v) \Leftrightarrow \left(s \in (w, p(u))\right).$$

Thus, the experimental study of the mooring operation provides a sufficiently high possibility to identify the effectiveness of the action plan $\circledast(\beta, p,u,v)$ (Fig. 2-5):

Figure 2 – Time: 07.33.30. When speed is getting to be decreased (reverse small stroke) fixed pitch right rotation rotor lets you shift the stern towards the berth. Having the bow thruster as an assistant bow is replacing to the pier

Figure 3 – Time: 07.36.30. The vessel is practically motionless and is located near the berth protection fender

Figure 4 – Time: 07.38.50. Give the head and stern mooring lines

Figure 5 – Time: 07.46.00. Tighten up the head and stern mooring lines, make all fast

During the semester an experiment was conducted having 74 cadets involved in participating and performing the typical operation of vessel mooring various degrees of fatigue.

Conclusion. The experiments are noticed to demonstrate clear evidences of hypothesis confirmation of the formation of class-forming structures in the form of trajectories of transitions being under fatigue factor influence and circumstantial implicit evidences. They can be such as posture abnormalities, speed of movements, and physiological indicators of the cadet. It must be emphasized that proposed logical formal approaches enabled the stages of formation of action trajectories to be differentiated in the form of a plan as well as provided a beneficial possibility to describe an impact of individual behavioral strategies on the final result. The obtained results give valuable grounds for quality retraining of navigators in cases of negative manifestations of behavior patterns and strategy shaping of action plans in the form of maneuver.

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