METHOD OF DETERMINING DISTANCE IN A FIELD OF NAVIGATIONAL RISKS BASED ON METRICS IN P-ADIC MEASUREMENT SYSTEMS

Ponomaryova V., Ben A., Safonov M., Nosov P.
Kherson State Maritime Academy
(Ukraine)

Introduction. By means of empirical evidence the occurrence of the threshold Mental motivation state (MMS) was proved to be directly dependable on the depth of the sea navigator's anticipation [1]. As identification of this parameter is quite cumbersome while performing navigational watch and running the vessel a time range was quite beneficial to be chosen as the best notion for handling this issue. Thus, for example, anticipation is calculated as 1/2 if the average time from the emergency of the threshold MMS to the accident was 50.0% of the total average time to complete the task [2–4]. Put it in another way, the navigator was unable to avoid a disaster not having enough time to do it. Suppose, this value is 5/6 uncovering that the strength of his anticipation is on the point to be enough on average for 80.0% of the task performing time after the transition to the threshold state. As for the rest 20.0%, in this case, it must be noted that an accident or task failure may happen with all likelihood. Moreover, while performing the analysis of the anticipation of sea navigators the most difficult situations to be identified are:

1. 15/16 success: maneuvering in confined spaces, such as in a port or on a river with narrow channels.
2. 8/9 success: Operations in storms and other extreme weather conditions, such as handling a ship in high waves and strong winds.
3. 7/11 success: managing a ship in reduced visibility, such as in fog, thick smoke, or nighttime conditions.
4. 4/7 success: navigation in areas with limited hydrometeorological conditions, for example, in ice conditions or in the zone of tropical hurricanes.
5. 3/8 success: managing a ship when moving in cramped and rough waterways, for example, in narrow straits or between rocks.
6. 3/9 success: port entry and exit operations such as docking, leaving and maneuvering in confined spaces between other ships.

It goes without saying that the threshold MMS for each navigator has to be possessing his own set γ_i from each of the four blocks as well as one out of five spoken above complications in sea. The data for the MMS map building are said to have been collected depending on the cadets' and experienced navigators' passing's the simulator training of definite tasks in the disciplines: "Navigation information systems" and "Ship control".

Primary Research Material. Using the Electronic Chart Display & Information System (ECDIS) [5,6] and intentionally created for coping with these very purposes computer program endorsed to succeed in having the identification of MMS in real time implying a high degree of confidence. Moreover, to deal with it a database of critical situations for two years for each sea navigator is highly appreciated to be obtained. Such a signal is about to empower the captain to replace the navigator or assist him in a difficult moment.

Besides, these types of situations when the MMS are highly likely to be accurately identified the entire problem may be eliminated quite quickly by using organizational skills making decisive contribution into ensuring safety. However, difficulties are noticed to be surfacing when the identified MMS occupies an intermediate value between the threshold situations [7–9]. There is obviously a need in getting data how close the current navigator' MMS to one of the threshold states while carrying out complex tasks. At the same time, control over the situation must be treated as an issue when there is definite lack of time to track the reactions of other navigators [10, 11].

During the experiment the results are evidenced to have been obtained allowing them to be approximated according to the proposed above research method. For instance, threshold MMS were known to exist when performing a task of medium difficulty level: arrival and leaving ports (89.0% = 8/9) as well as the Haydarpasha port in Istanbul was considered to be treated in the same way.

At the same time, the threshold MMS itself was identified to have a code: $\gamma_0 = 1;\ \gamma_1 = 3;\ \gamma_2 = 0;\ \gamma_3 = 1$ (1301).

After conducting an experiment with the 54 cadets being involved, the most typical situations were identified as the following: MMS_1=1220, MMS_2=2101, MMS_3=1311, MMS_4=1200 in accordance with the further to be speaking blocks: the core of the motivational structure; achieving difficult goals; predictive performance assessment; compliance with the being performed activities.

Let us determine the distance between typical situations MMS_1 ... MMS_4 and the threshold MMS * (1301).

1. Consider the following formula for calculations [12]:

$$\rho\left(J_{attr}, J\right) = \min_{i=1}^{n}\left(\frac{J_{attr,i}}{J_i}\right),$$

where $J_{attr,i}$ represents the *i*-th component of the attractor, and is the *i*-th component of the given situation.

2. Calculation of Dissonance:

$\rho\left(J_{attr}, MS_1\right) = \min\left(\frac{1}{1}, \frac{3}{2}, \frac{0}{2}, \frac{1}{0}\right)$, we cannot divide by zero, hence this value is excluded from calculations.

$$\rho\left(J_{attr}, MS_2\right) = \min\left(\frac{1}{2}, \frac{3}{1}, \frac{0}{0}, \frac{1}{1}\right),$$

$$\rho\left(J_{attr}, MS_3\right) = \min\left(\frac{1}{1}, \frac{3}{3}, \frac{0}{1}, \frac{1}{1}\right),$$

$$\rho\left(J_{attr}, MS_4\right) = \min\left(\frac{1}{1}, \frac{3}{2}, \frac{0}{0}, \frac{1}{0}\right).$$

3. Calculation Results:

For MMS1 (1220): Intersection with (1301) is empty, hence its attractor component equals 0.

For MMS2 (2101): There's one common position – the last symbol "1", hence the attractor component equals 1/4 or 0.25 (as there are 4 positions in total).

For MMS3 (1311): There are three common positions (first, third, and fourth symbols). Thus, the attractor component equals 3/4 or 0.75.

For MMS4 (1200): There's one common position - the first symbol. This results in an attractor component of 1/4 or 0.25.

4. Therefore:

MMS1 shares no common positions with the attractor (1301), so its influence on the attractor is 0.

MMS2 shares 25% of positions with the attractor.

MMS3 has the most significant influence on the attractor, with 75% of its positions coinciding with (1301).

MMS4 shares 25% of positions with the attractor, similar to MMS2.

Consequently, MMS3 has the most substantial influence on the attractor (1301), while MMS1 has no influence whatsoever. Both MMS2 and MMS4 have a moderate influence on the attractor.

Let us analyze the experimental data using the results of the survey of sea navigators in the form of MMS and the factors of ship management applying the NTPRO 5000. The obtained data of the navigation simulator permitted to make the model in the form of a graphic spatial trajectory of the ship and a cluster of points defined as MMS_{1-4} and MMS * be built.

So, let's build a model in which the parameter surge (longitudinal movement of the vessel) is to be named as a dependent variable. Regarding the parameters rpm_port (rotational speed of the main rotor), rpm_port_cmd (telegraph movement command), rud_port_cmd, rud_port (rudder position variable), bow_th_cmd, bow_th (bow position variable) thruster), cspeed, c_dir (current speed and direction), wind, wind_dir (wind speed and direction), wave, wave_dir (wave height and direction) they are to be stated as independent variables.

The optimal model contains the following independent variables: rpm_port, rpm_port_cmd, rud_port, bow_th_cmd, cspeed, c_dir, wind. Their coefficients are to be stated as being statistically significant, except for the coefficient of the cspeed which is variable one. Therefore, it is possible to be assumed that there is a linear dependence between the dependent variable surge and the independent variables of the model. In this way, it is high time to be able to compare the predicted data based on this model and the obtained experimental one of the surge parameters with the determination of the MMS zones (Fig. 1).

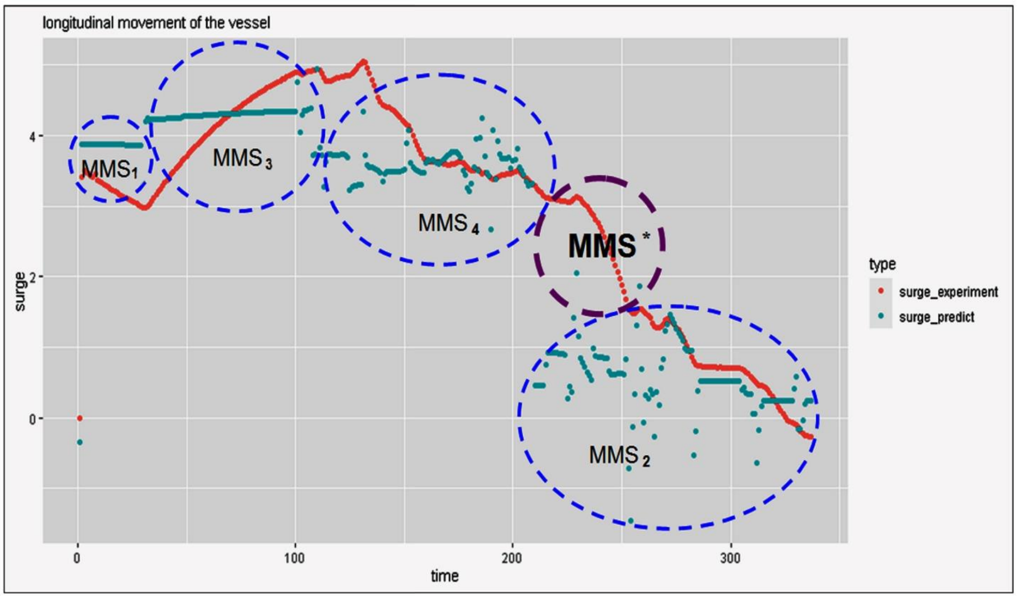

Fig. 1 – The space of MMS with regard to the trajectory of the vessel and the simulated forecast

Simultaneously, it is true to presume that the relationship between the variables completely has affirmed the significance level of the Fisher test [17], <2.2e-16:

$$surge=-3.8551577+0.015628rpm\_port-0.1729787rpm\_port\_cmd+0.0031148rud\_port-0.0028071bow\_th\_cmd+0.1405757cspeed+0.01431c\_dir+0.8410946wind$$

Thus, the obtained space enables to have the zone locations of MMS manifestation of the marine navigator in the location space identified. This very approach unveiled the opportunity to successfully highlight the location of the threshold MMS. This issue has bestowed an immense input into prevention of negative consequences leading to maritime accidents beforehand. In the course of experiments the cadets of the Kherson State Maritime Academy during practical training in the disciplines "Navigation Information Systems" and "Ship Management" were widely involved.

Conclusion. The study conducted using the NTPRO 5000 simulator focuses on the analysis of maritime navigator data. The research underscores the importance of determining a threshold MMS for navigators, especially in critical situations like maneuvering under limited visibility. Employing the Electronic Chart Display and Information System (ECDIS) and specialized software, key MMSs were identified, notably MMS3, which has the most significant impact on the threshold attractor (1301). The primary dependent parameter is the ship's longitudinal movement, and the primary independent parameters include ship control elements such as rpm_port and cspeed. Based on this, a linear model to forecast maritime accidents was developed. Implementing this research during the training of cadets at the Kherson State Maritime Academy emphasizes its practical significance for maritime safety.

REFERENCES

1. Ihor Popovych, Ihor Halian, Olena halian, Pavlo Nosov, Serhii Zinchenko, Vitalii Panok. Research on personality determinants of athletes' mental exhaustion during the on-going COVID-19 pandemic. Journal of Physical Education and Sport, 2021, 21(4), стр. 1769–1780, 224.

2. Nosov P., Krapyvko G., Ben A., Safonov M., Zinchenko S. Disabling the dynamic positioning of the vessel as a cause of the negative influence of human factor in maritime transport. МНПК пам'яті професорів Фоміна Ю. Я. і Семенова В. С. (FS – 2019), 24–28 квітня 2019, Одеса – Стамбул – Одеса. Pages 309–315.

3. Zinchenko S. M., Nosov P. S, Mateichuk V. M, Mamenko P. P, Grosheva O. O. Automatic collision avoidance with many targets, including maneuvering ones. МНПК пам'яті професорів Фоміна Ю. Я. і Семенова В. С. (FS – 2019), 24–28 квітня 2019, Одеса – Стамбул – Одеса. Pages 343–349.

4. Зинченко С. Н., Носов П. С., Грошева О. А., Маменко П. П., Матейчук В. Н. Избыточность по управлению как количественная мера маневренности судна. Materials of the XI "Modern information technologies in transport, MINTT-2019" May 28–30, 2019 Kherson, Ukraine. С 97–99.

5. Nosov P., Ben A., Safonova A., Palamarchuk I. Approaches going to determination periods of the human factor of navigators during supernumerary situations // Radio Electronics, Computer Science, Control № 2(49). – 2019. Pages 140–150. doi: 10.15588/1607-3274-2019-2-15.

6. Nosov P. S., Palamarchuk I. V., Safonov M. S., Novikov V. I. Modeling the manifestations of the human factor of the Maritime crew // Dnipropetrovsk National University of Railway Transport named after Academician V. Lazaryan (Dnipro) № 5 (77). – 2018. Pages 82-92. doi:10.15802/stp2018/ 147937.

7. Popovych, I., Blynova, O., Nass Álvarez, J. L., Nosov, P., & Zinchenko, S. (2021). A historical dimension of the research on social expectations of an individual. Revista Notas Históricas y Geográficas, 27, 190–217.

8. Popovych, I. S., Cherniavskyi, V. V., Dudchenko, S. V., Zinchenko, S. M., Nosov, P. S., Yevdokimova, O. O., Burak, O. O. & Mateichuk, V. M. (2020). Experimental Research of Effective "The Ship's Captain and the Pilot" Interaction Formation by Means of Training Technologies. Revista ESPACIOS, Vol. 41(№11). Page 30.

9. Носов П. С., Тонконогий В.М. Використання компонентів мислення експертними системами, як фактору адаптивного впливу в автоматизованих навчальних системах // Тр. Одес. политехн. ун-та. – Одесса: ОН-ПУ, 2005. – Спецвыпуск. – С. 101–105.

10. Plokhikh V. V. (2021). Assessment of subject's readiness for urgent actions using the variations of sensorimotor response tasks. Insight: the psychological dimensions of society, 5, 46–65. http://doi.org/10.32999/2663-970X/2021-5-4.

11. Popovych, I., Arbeláez-Campillo, D. F., Rojas-Bahamón, M. J., Burlakova, I., Kobets, V., & Bokshan, H. (2021a). Time perspective in the professional activity of specialists of economic sphere. Cuestiones Políticas, 39(69), 424–445. https://doi. org/10.46398/cuestpol.3969.27.

12. Khrennikov, A. (2004). Modeling thinking processes in p-adic coordinate systems. Fizmatlit. – 296 p.