ANALYSIS OF SIMULATION VISUALIZATIONS OF SHIPS' TRAFFIC

ANALIZA ZOBRAZOWAŃ SYMULACYJNYCH RUCHU STATKU

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Abstract: In the article the problem of comparison and compatibility of the results of simulation research have been conducted on various simulators of ship's traffic with two different methods of visualization (types of visualizations) is being examined. In both cases the similar mathematical model of ships' traffic has been applied which had been verified by the methods used in marine traffic engineering. The research have been conducting on the new designed LNG terminal in Świnoujście.

Keywords: visualization, LNG, traffic lane.

Streszczenie: W artykule rozpatrywany jest problem porównania i adekwatności wyników badań symulacyjnych przeprowadzonych na różnych symulatorach ruchu statku, wykorzystujących dwie różne metody wizualizacji (typy zobrazowania). W obu przypadkach zastosowano podobny model matematyczny ruch statków, który był weryfikowany metodami stosowanymi w inżynierii ruchu morskiego. Badania przeprowadzono na nowoprojektowanym terminalu LNG w Świnoujściu.

Słowa kluczowe: zobrazowanie, LNG, pas ruchu.

1. Introduction

Visualization of simulated data is being conducted on the basis of the picture generated by the system of computer graphic processing and projected on the simulator screen or with the use of a projector connected to the computer. At present three types of visualization are used [1].

- panoramic view in the form of projection from the top – two-dimensional plan with the similar or identical visualization of electronic chart (see Figure 1);
- projection view, three-dimensional simulation of view from the bridge realized by one monitor or the set of monitors (see Figure 2);
- radar visualization.

Fig. 1 Panoramic visualization with simulated simplified control panel and electronic chart.

The first kind of simulation often comprises more information than the one available on the bridge, and its compatibility with reality is the biggest at limited visibility. That type of visualization is very user-friendly because of the possibility of easy assessment of distance by the manoeuvring captain.

The second type of visualization is simulated three-dimensional environment which provides big compatibility with reality. The indicator comprises angle of sight up to 360° horizontally (270° most often, with the possibility of adjustment of direction of watching) and from 20° to 25° vertically.

In Institute of Marine Traffic Engineering, Maritime University of Szczecin, has been carried out the developmental project commissioned by Ministry of Science and Higher Education: „Case Study of the most efficiency solution of Polish marine

LNG terminal construction. Determine the optimum parameters of terminal and approaching waterways, and terms and conditions of its safe exploitations.”, as well as many scientific-research works before the project connected with construction of the outer port in Świnoujście and LNG discharging station. While carrying out these projects methods of computer simulation of ships' traffic with panoramic and projection visualizations have been used.

Fig. 2 3D projection visualization – multitask bridge simulator (MU in Szczecin)

In the article the problem of comparison and compatibility of results of simulation research conducted on various simulators, where two different methods of visualization (types of visualization) are applied, is being examined. In both cases the similar mathematical model of ships' traffic has been applied, which has been verified by the methods applied in marine traffic engineering [V].

2. Results of simulation research of the manoeuvre of LNG carriers entering the outer port in Świnoujście

Simulation research concerned the LNG carriers' manoeuvre of entering the projected outer port in Świnoujście. One of the results of the research was parameterization of layout of with of traffic lanes (see Figure 3). The research were being conducted on two types of simulators (two different types of visualization) for two models of LNG carriers:

1. Simulator with panoramic visualization – LNG carrier with loading capacity of $V_L=200000 \text{ m}^3$; overall length $L_c=300 \text{ m}$; breadth $B=50\text{m}$; draught $T=12,5\text{m}$.
2. Simulator with projection visualization – LNG carrier with loading capacity of $V_L=140000\text{m}^3$; overall length $L_c=277\text{m}$; breadth $B=43,4\text{m}$; $T=11,5\text{m}$.

Figure 3. Sections of examined sector of water lane with marked 140000 m^3 LNG carrier's traffic lanes, wind $12,5 \text{ m/s}$ N

The conditions of simulation research of LNG carriers entering the outer port in Świnoujście can be determined in the following way:

- number in series $n = 15$,
- the pilots did one passage in the series,
- research were started abeam on buoys 7-8,
- position $\pm 30\text{m}$ (from the centre of waterway), speed $4 \text{ knots} \pm 0,2$, course $170^\circ \pm 2^\circ$,
- two tows (bow and aft) on the 48 tonnes tugboats, 2 pushing tugboats with towing power of 30 tonnes,
- the wind speed $12,5\text{m/s}$,
- kind of manoeuvre and the wind direction:
 - LNG 140tys. m^3 : manoeuvre of entering with turning, N and W wind,
 - LNG 200tys. m^3 : manoeuvre of entering with turning, NW wind,
 - LNG 200tys. m^3 : manoeuvre of entering without turning, NW wind.

The examined area of the waterway (enter of the port in Świnoujście) was divided into 11 sections perpendicular to the axis of the waterline (see Figure 3).

Width of traffic lanes at the level of confidence coefficient 95% in separate sections of 140000 m^3 LNG carrier entering the outer port in Świnoujście and then

turning at winds N-12,5 m/s and W-12,5 m/s is given in Figure 4. Widths of traffic lanes for 200000 m³ LNG carrier entering the port with and without turning are given in Figure 5 respectively.

Fig. 4 Widths of traffic lanes on the level of confidence coefficient 95% while 140000 m³ LNG carrier entering the outer port in Świnoujście with turning

Fig. 5 Widths of traffic lanes on the level of confidence coefficient 95% while 200000 m³ LNG carrier entering the outer port in Świnoujście

3. Analysis of simulation research

Analysis of results of simulation research consists in statistical comparison of widths of traffic lanes for the examined types of information visualization in simulators. Such a comparison of widths of traffic lanes can concern only ships of the same size. Standarization of ships' size has been come down to converting traffic lanes of 140000 m³ LNG carrier in quantities appropriate for traffic lanes of 200000 m³ LNG carrier.

Bearing in mind that width of traffic lanes is function of ship's breadth and assuming that in examined ranges of ship's breadths ($B_1=43,4\text{m}$; $B_2=50\text{m}$) the function is linear, we can put that in the following way:

$$d_{lu} = \frac{d_1}{B_1}(B_2 - B_1)$$

where:

d_{lu} – standarized width of traffic lane;

d_1 – actual width of ship's traffic lane;

B_1 – real ship's breadth;

B_2 - ship's breadth to which width of traffic lane is being standarized.

Widths of traffic lanes average, maximum and standard deviation have been given in Figure 6 and Figure 7. They are widths of 200000 m³ ($B=50\text{m}$) LNG carrier traffic lanes and standarized widths of 140000 m³ (to breadth $B=50\text{m}$) LNG carrier traffic lanes.

Fig.6 Widths of traffic lanes of 140000 m³ LNG carrier (standardized to $B=50\text{ m}$) and 200000 m³ carrier entering the outer port in Świnoujście in various navigational conditions.

Widths of traffic lanes for separate manoeuvres and ships have been compared with the use of normal distribution parameters.

Series have been examined if there is a lack of essential statistic differences between them. It turned out that the differences between them are irrelevant

statistically and comparative analysis can be done. From Figure 6 arises that average and maximum lanes do not differ from each other. The difference for the average lane is about 36 m, whereas the difference for the maximum lane is about 50 m.

It should be noted that three means among examined series have almost identical values, whereas maximum values differs about 30 m, which is the value a bit bigger than the half of the ship. The series characterized by the biggest parameters of width of traffic lane proves that captains applied a bit different techniques of passage and it did not have connection with the kind of visualization.

The similar conclusions arise from static moments presented in Figure 7.

Fig. 7 Graphs of parameters of width of traffic lanes depending on the type of visualization

The above figure presents statistic moments of examined series depending on the type of visualization. In the Figure 7 the results obtained on 3D projection visualization simulator are marked by the symbol "FMS", whereas the results obtained on panoramic visualization in the form of projection from the top (2D) simulator are marked by the symbol "PC". The results obtained on the 3D simulator are almost identical statistically. Average values and standard deviations take similar values. The results obtained on 2D visualization simulator differ a bit. The difference is about 30 m which is 15 % of the average traffic lane. This is the acceptable value since each captain can do the particular manouvre in a bit different technique. Analysis of the figure given above proves that one series conducted on 2D visualization simulator has similar parameters regarding the

average traffic lane and its standard deviation to the series obtained from 3D visualization simulator.

The above analysis pointed out that there is lack of essential differences in precision of manouvring of ship depending on the applied visualization. It is confirmed by not very essential differences of widths of traffic lanes, which are the measure of precision of manouvring. Both in research and in manouvring of a ship in limited visibility 2D visualization is equivalent to 3D visualization.

4. Conclusions

Statistic analysis of results of simulation research of LNG carriers with loading capacity of 140000 m³ i 200000 m³ entering the port, which have been conducted in various navigational conditions and on simulators with various types of visualizations, has established that:

- there are no essential differences in widths of traffic lanes on account of various hydrometeorological conditions,
- there are no essential differences in widths of traffic lanes on account of applied visualizations of a manouvring simulator,
- small differences between series arose due to a bit different technique of manouvring in the particular hydrometeorological conditions, they were not dependent on the kind of visualization,
- 3D and 2D visualizations can be acknowledged as equivalent, they can be used interchangeably both in research and in manouvring of a ship.

Further research will aim to finding the differences in plainness and comfort of manouvring of a ship during the manouvre of mooring depending on the applied visualization.

References

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Prof. dr hab. inż. kpt. ż. w. Stanisław Gućma. Urodzony w 1945 roku na Zamojszczyźnie. Tytuł naukowy profesora nauk technicznych otrzymał w 2002 roku. Pracując w Akademii Morskiej w Szczecinie – okresowo pływa na statkach różnych bander, uzyskując w 1998 roku dyplom kapitana żegluga wielkiej. Jest rektorem Akademii Morskiej w Szczecinie. Stworzył pierwszą w Polsce szkołę naukową z zakresu inżynierii ruchu morskiego. Kierowany przez niego Zespół opracował założenia obecnie realizowanych wielkich inwestycji w Polsce i Szwecji, takich jak: Budowa Terminalu Promowego w Gdyni, Przebudowa Terminalu Promowego w Swinoujściu, Budowa Terminalu LNG w Swinoujściu (Gazoport), Przebudowa portu w Ystad.

Dr inż. kpt. ż. w. Wojciech Ślęczka urodził się w 1970 r. we Frysztaku. Pełni funkcję Prorektora ds. Morskich Akademii Morskiej w Szczecinie. Bierze czynny udział w pracach naukowo-badawczych zespołu Inżynierii Ruchu Morskiego. Efektem tej działalności jest opublikowanie ponad 20 prac o charakterze twórczym oraz współautorstwo około 40 prac zleconych o charakterze naukowo-badawczym.