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EVALUATION OF VESSEL SIMULATION MODEL COMPATIBILITY WITH ITS EQUIVALENT IN REALITY

ABSTRACT

Complex simulation systems are often used in order to enhance the safety level on newly designed navigation areas and to facilitate their verification process. The application of these systems supersedes older methods based on manoeuvring basins, wherein models minified in particular scales were used. Modern methods are definitely cheaper and require less work. The paper presents the method of assessment of the compatibility of a ship simulation model with its real counterpart. Access to the simulator's components responsible for creating and editing bodies of water as well as ship models gives the possibility of their verification. Using cutting-edge navigation systems such as inertial systems, weather stations and GPS gives the possibility of obtaining indispensable information about ship's behaviour under certain hydro-meteorological conditions.

Keywords:

simulation, mathematical modelling, manoeuvrability.

INTRODUCTION

Application of such a tool as simulator goes considerably beyond its original appropriation. The complicated simulation systems are now-a-days applied often to increase a level of safety at newly designed navigational water areas and to simplify a process of verification thereof. Owing to a use of the advanced mathematical models on which the software is based, the systems may be applied as well to perform analyses of accidents at sea. However, to obtain simulation tests results authentically reflecting conditions at sea in reality, it is necessary to know how much adequate is behaviour

of the simulation models in course of the research process, if compared to their equivalents in reality. In Poland, for a dozen or so years there have been a few dominant centres conducting navigation analyses and creating projects in the field of the safety of navigation engineering, and especially in the field of designing navigational infrastructure and hydro-technical structures. For that purpose all naval schools use the navigational and manoeuvring simulators, frequently with an uncritical approach to the simulation ship models applied in the research process. The most reliable way for verification of the virtual ship model is carrying out tests in reality. Obviously, the problems are costs of such investigations and restrictions connected with a time necessary to perform the manoeuvring trials. The Institute of Navigation and Hydrography of the Polish Naval Academy arrange practice trainings for prospective Navy officers. The trainings, in a form of two months voyages, enable recording parameters of ship motions at diversified hydrometeorological conditions. However, to record the defined manoeuvring elements of the ship it is necessary to construct a survey platform, allowing to reach the measurement results analogue to the ones worked out by the simulator software. Possibilities in taking advantage of the additional simulation software components which enable creation of water area, covered by the research, also edition of vessels' models, offer a chance to imitate in the simulator environment a run of trials performed in reality. One of the required research process elements is creation of virtual water areas models. The Authors have produced so far, among the others, the models of Deepwater Container Terminal in the Port of Gdańsk, of the Motława River and the Vistula River Spit cross-cut [7]. In the paper there is presented the concept of carrying out trials both in reality and also the simulated ones, aimed at verification of one of the ship's models in the data base of the simulator of the Polish Naval Academy.

SURVEY PLATFORM

The survey platform is designed to enable recording the manoeuvring parameters and forces acting against a ship. Its structure and accessories allow recording all necessary parameters, with no necessity to use navigational equipment of the object under investigations. Due to a lack of specific navigational instruments on any vessels it is necessary for the measuring equipment to remain autonomous. Examples of the fittings are clinometers and anemometers, provided with data

recording function. The most essential platform element is an inertial system, which is capable to record the ship motion at 6 degrees of freedom. Mobility of the survey platform allows using it at any optional type of vessel. The following are the main platform members:

1. Meteorological station, capable to carry on recording of true wind velocity and direction, apparent wind velocity and direction, position — owing to the built-in GNSS [system] receiver, the course — with a use of two-axe compass, inclinations in effect of roll and pitch motions, atmospheric pressure, relative humidity, air temperature and dew point. Also transmission of the above mentioned data through interfaces NMEA2000 [6] and 0183 is feasible [4].
2. Inertial system, designed for measuring ship motion at 6 freedom degrees and the position through the satellite system receiver. The obtained results are transmitted through interface NMEA2000 and 0183 to the computer. There is a possibility to apply also an additional inertial system's sensor, which, when installed on the bow, enables determination of the drift angle in result of comparison of readings taken from two gauges.
3. Multiplexer NMEA NDC-4, which is capable to collect information from 4 sources and to transfer it to the survey computer through USB connector. Using of the mentioned equipment is necessary due to lacking in ports in series in now-a-day portable computers and a limited number of USB ports.
4. Router WI-Fi, assigned for transmitting the recorded parameters by radio to the measurement computer.
5. Data logger, which is to collect information from all the sensors and data concerning heights and directions of sea waves provided by meteorological station buoys located along the ship's route.
6. GNSS receiver [5].

The functional scheme of the eventual survey platform is presented below.

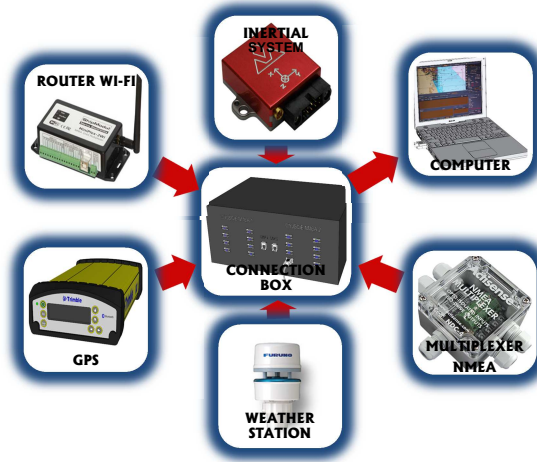


Fig. 1. Survey platform [own study]

TRIALS IN REAL CONDITIONS

According to the conception it is assumed that the tests are performed by two main stages. The first of them are manoeuvring trials carried out in real conditions. At this stage the vessel's manoeuvrability at various meteorological conditions is to be analyzed. For this purpose RP Navy vessel ORP 'Wodnik' is to be used; the basing parameters of the vessel are presented in Fig. 2.

ORP WODNIK			
	DISPLACEMENT	1800 t	DRAFT
ENGINE	2x1325 KW	BREADTH	12.0 m
LENGTH	72.2 m	MAX SPEED	16.8 knots

Fig. 2. Vessel characteristics [own study]

In reality the tests will be carried out in summer 2013. The research program includes travelling across water areas of diversified hydrometeorological conditions, with a special consideration to influence of different types of sea waves. It will enable to record both — influence of the short-crested North Sea and also the long oceanic sea. With a use of the survey platform there are to be recorded parameters of the vessel motion at 6 freedom degrees and the outside meteorological conditions within a specified time period. It is to allow further creation in the simulator environment the tests performed in reality. All the records will be taken nearby the meteorological buoys; therefore it is feasible to obtain information about the direction and height of sea wave within the water area covered by the research. It is intended to carry out recording of the ship motion parameters at open unconstrained water area, what would contribute to reducing of an influence of any factors making difficult to measure meteorological conditions including the variable wind field, arising in a result of actions of natural and androgenic objects or a wave in form of back wash, coming from canal sides or harbour quays.

SIMULATION TESTS

The second stage will comprise carrying out the analogue trials in simulation conditions. The studies are to be performed with a use of the navigational manoeuvring simulator owned by the Institute of Navigation and Hydrography in the Polish Naval Academy. The simulator is operated basing on the latest version of software NaviTrainer Pro 5000, created by Transas Company. Software of the instructor's panel allows recording parameters of vessel motions analogously to those obtained at the survey platform, used for carrying realistic tests. The simulation tests method assumes creation of conditions identical to the occurring upon recording the data on the true ship. To evaluate the vessel's manoeuvring elements it is necessary to create additional virtual models of water areas, selected for carrying out the tests in reality. It is possible with a use of the MODEL WIZARD application. Preparation of simulation tests should include creation of weather zones, wherein the selected weather elements can be defined. There is a possibility of setting time frames in second intervals for specific wind or wave occurrence parameters as well as changing thereof in second intervals. One of the essential elements is selecting a specific model of waving, depending on a type of water area [8]. The data base content includes models of the North Sea

waving (JONSWAP wave spectrum) as well as of the oceanic waves (Pierson Moskowitz wave spectrum) [7]. The primary analyses of ships behaviour, affected by various types of sea waves acting, were described in the Paper [1], wherein there are also described eventualities in using the simulator in this field. When an adequate scenario is prepared, there has to take place a stage of recording the data, which are to be recorded in the appropriate file every second.

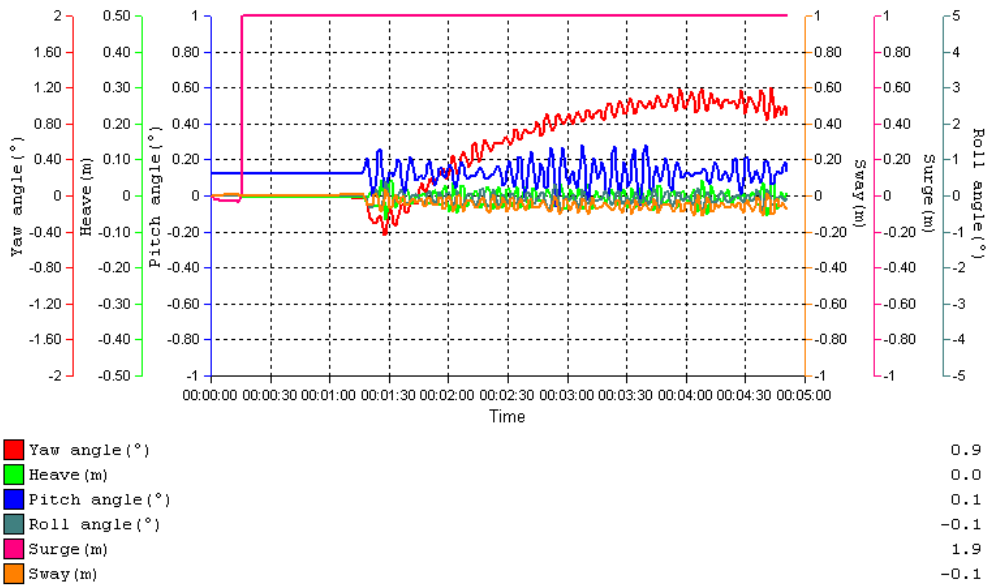


Fig. 3. Registration of ship motion parameters [own study]

CONCLUSIONS

1. The Authors intend to take advantage of the gathered knowledge for creation of application, supporting automation of the simulation models edition process, through selecting of the appropriate coefficients which define drift, rolling and pitching of the ship in specified conditions.
2. Knowledge of limits in using the tested vessel will contribute to realism of the training and improvement of navigation safety through the heightened standards of teaching.

3. The verified simulation model of the vessel may be used as a standard watercraft in many manoeuvring trials in different projects in broadly understood navigation at sea.

The constructed for the research purpose survey platform may be used as an aid in tests concerning determination of vessels' manoeuvring elements, also for ships crews, providing them with wide spectrum of navigational information.

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STRESZCZENIE

Złożone systemy symulacyjne są często używane dla poprawy poziomu bezpieczeństwa na etapie projektowania nowej infrastruktury nawigacyjnej, jak również dla ułatwienia procesu ich weryfikacji. Stosowanie tych systemów zastępuje starsze metody oparte na pomniejszych modelach fizycznych i basenach modelowych, w których je testowano. Nowoczesne metody są zdecydowanie tańsze i wymagają mniej pracy. Artykuł przedstawia metodę oszacowania zgodności modelu symulacyjnego statku z jego rzeczywistym odpowiednikiem. Dostęp do komponentów symulatora odpowiedzialnych za tworzenie i modelowanie akwenu oraz modele statku daje możliwość ich sprawdzania. Jest to możliwe dzięki użyciu najnowszych systemów nawigacyjnych, takich jak systemy inercjalne, stacje meteorologiczne i GPS, które umożliwiają otrzymywanie niezbędnej informacji o zachowaniu się statku w konkretnych warunkach hydrometeorologicznych.