

AUTOMATIC ASSESSMENT OF SHIP HANDLING SKILL

V. Mateichuk, A. Ben, S. Zinchenko, P. Mamenko, K. Kyrychenko, L. Pivovarov
Kherson State Maritime Academy

Abstract: The software for automatic monitoring of a vessel's control skills on the Navi Trainer 5000 simulator have been developed. The method are based on an automatic check of finding the controlled parameters of the state vector inside the area specified by the instructor, the output of the parameters outside the area entails the accumulation of penalty points and a decrease in the score. The method and algorithms were tested during lessons with cadets on the simulator. The proposed method and algorithms also allow to free the instructor from monitoring the technical details and focus on explaining the causes of errors during the lesson.

Keywords: automatic assessment, navigation simulator, evaluation of skills, navigation training.

АВТОМАТИЧНЕ ОЦІНЮВАННЯ НАВИЧОК КЕРУВАННЯ РУХОМ СУДНА

В. М. Матейчук, А. П. Бень, С. М. Зінченко, П. П. Маменко,
К. В. Кириченко, Л. А. Півоваров
Херсонська державна морська академія

Анотація: В даній роботі досліджені питання розробки програмного забезпечення для автоматичного оцінювання навичок керування рухом судна на тренажері Navi Trainer 5000. Метод заснований на автоматичній перевірці контрольованих параметрів вектору стану всередині заданої викладачем області, вихід параметрів за межі зони тягне за собою збільшення штрафних балів і зниження оцінки. Методика та алгоритми апробовані на заняттях з курсантами на тренажері. Запропонований метод та алгоритми також дозволяють звільнити викладача від контролю за технічними деталями та зосередитися на поясненні причин помилок під час уроку.

Ключові слова: автоматичне оцінювання, навігаційний тренажер, оцінка навичок, навігаційний тренінг.

Navigation simulators have been widely used to develop the skills of manually operating a ship. Multifunctional navigation simulators provide training for marine cadets. Main purpose of navigation simulators is to train navigators and reduce the impact of the human factor in the maritime industry [1–9].

The instructor's workplace of a NTPro 5000 navigational simulator is illustrated in Fig. 1.

In Fig. 2 on left side of the picture depicted the central rack of the simulator, which houses the server, models, switching equipment, uninterruptible power supplies, etc. The laboratories also have virtual bridges with visualization and control equipment, one of which is a full mission navigational bridge simulator shown in Fig. 2 on right side of the picture.

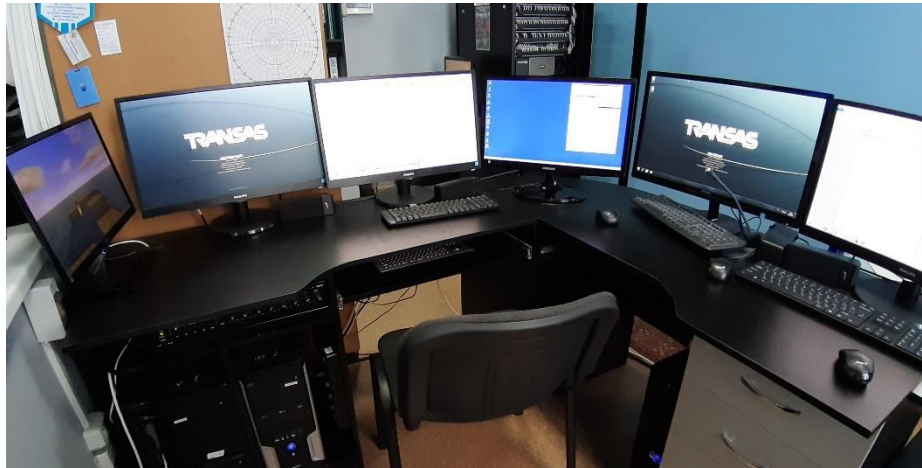


Figure 1 – Instructor's workplace of a NTPro 5000 navigational simulator

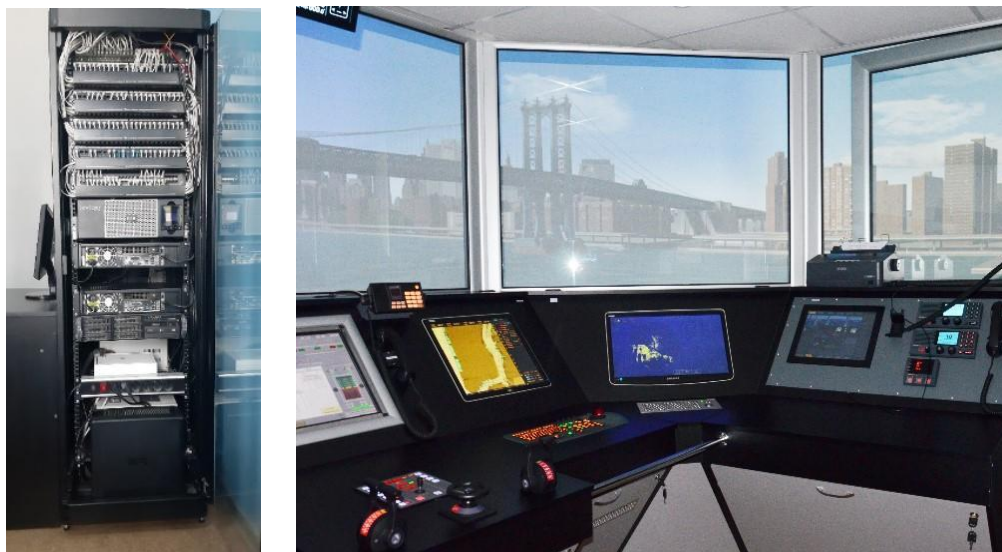


Figure 2– Central rack of the simulator (left side) and Full mission navigational bridge simulator (right side)

Information is exchanged between the Navi Trainer 5000 simulator and automatic evaluation software via Com port using the NMEA Navi Trainer 5000 simulator interface [10–13].

The NMEA standard contains the requirements of a serial data communications network to inter-connect marine electronic equipment on vessels. The standard describes a low-cost moderate capacity bi-directional, multi-transmitter/multi-receiver instrument network to interconnect marine electronic devices. It is multi-master and self-configuring, and there is no central network controller. Equipment designed to this standard will have the ability to share data, including commands and status with other compatible equipment over a single channel (Table 1).

In Fig. 3 shows a screenshot of the standard Configuration Editor simulator program, which shows that the NMEA_LOG_GYRO_ARPA interface has been added to the ALPHA2-DPA virtual bridge (Full mission navigational bridge simulator), which provides information exchange between the Navi Trainer 5000

simulator and automatic evaluation software. The configuration fragment of this interface is shown in the screenshot at the bottom right of the Configuration Editor window [14–18].

Table 1 – Navigational devices

<i>Source</i>	<i>Data</i>	<i>Source</i>	<i>Data</i>
GPS	Latitude, Longitude	Compass	Magnetic Compass Course
Log	Speed through water	Wind	Relative speed of wind
Sounder	Depth	Arpa	Target's information
Gyro	Gyrocompass Course	etc.	

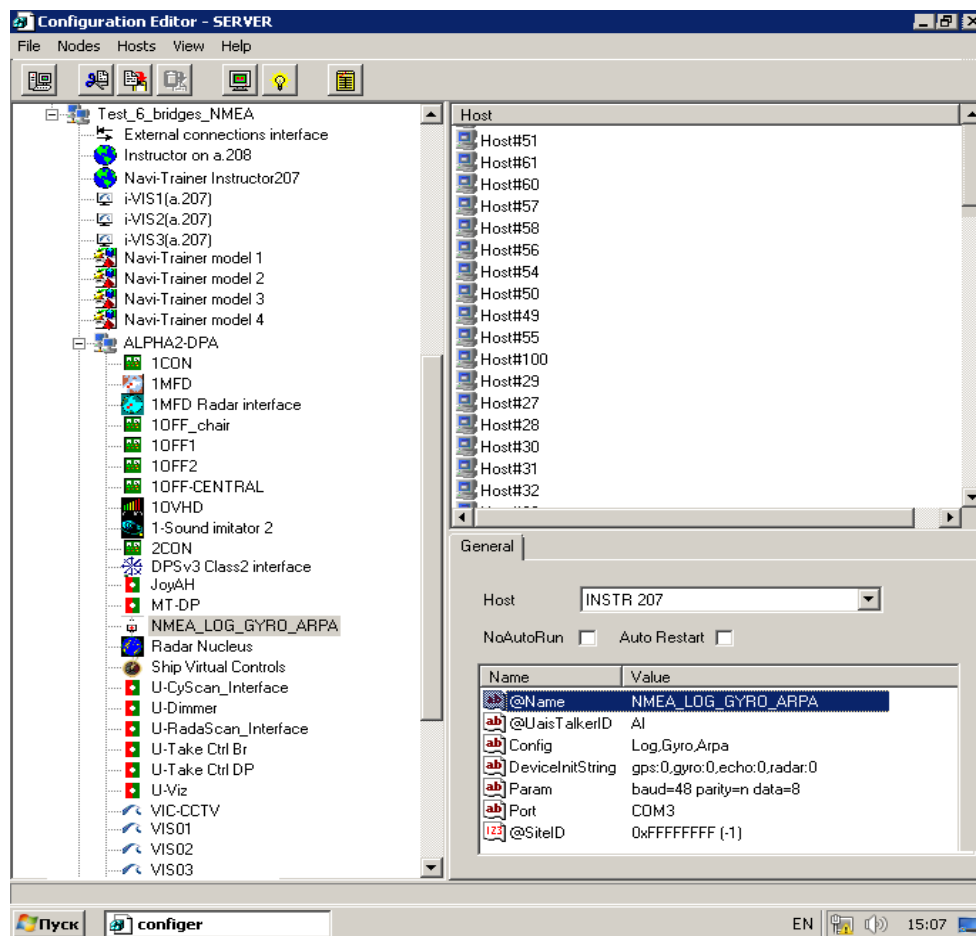


Figure 3 – Configuration Editor

As can be seen from the above fragment, NMEA receives information via the COM3 port from the LOG (Linear Speedometer), Gyro (Gyro-compass) and ARPA (automatic radar plotting aid [16, 17]. Data via serial COM port is transmitted from the simulator equipment to the software in the form of NMEA messages, for example:

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$VDVHW,78.9,T,,0.20,N,,*45
$VDVBW,0.20,0.30,A,0.2,0.2,A,1.10,A,1.1,A*50
$VDVLW,0.00,N,0.00,N,0.00,N,0.00,N*5F
```

In order to determine the position of the ship to the polygon of the non-crossing zone, it is necessary to determine where the position of the ship is relative to each side of the polygon by expression (1)

$$(x_i - x_0)(y_{i+1} - y_0) - (x_{i+1} - x_0)(y_i - y_0), \quad (1)$$

where $i = 1 \dots n$ – the order number of the vertex n-angle polygon,

x_i, y_i – coordinates of vertex i ,

x_0, y_0 – ships coordinates.

If expression (1) has the same sign for all sides of the polygon, then the point with the coordinates of the vessel is in a zone of NO-GO Area, if the expression signs for all sides of the polygon are different, then the point with the coordinates of the vessel is outside the non-intersection zone, if the sign of expression (1) is zero, then the point with the coordinates of the vessel lies on the corresponding segment of the polygon.

Verification of the correctness of the automatic evaluation software was conducted during the lessons using the simulator equipment.

Conclusions. The results of the experiments confirm that the developed software for the automatic assessment of navigational skills of the navigation simulator vessel allows to automatically evaluate the cadets during the training. Using the automatic evaluation software will save teachers time in assessing cadets' skills. The automatic evaluation software is able to accurately record the smallest deviations of the ship's movement parameters from the optimal ones, which the teacher cannot do during the training.

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Vadym Mateichuk Senior Lecturer (Ship Handling Department), Kherson State Maritime Academy. ORCID: <https://orcid.org/0000-0001-9328-0651>; mateichykv@gmail.com.

Andrii Ben Vice Rector for Research of Kherson State Maritime Academy. ORCID: <https://orcid.org/0000-0002-9029-3489>; a_ben@i.ua.

Serhii Zinchenko Associate Professor of Ship Handling Department, Head of the Electronic Simulators Laboratory (Ship Handling Department), Kherson State Maritime Academy. ORCID: <https://orcid.org/0000-0001-5012-5029>; srz56@ukr.net.

Pavlo Mamenko Master (MSC Shipmanagement Limited), Senior Lecturer (Ship Handling Department), Kherson State Maritime Academy. <https://orcid.org/0000-0001-7358-9299>; pavlo.mamenko@gmail.com.

Kostiantyn Kyrychenko Ph.D., Senior Lecturer (Ship Handling Department), Kherson State Maritime Academy. ORCID: <https://orcid.org/0000-0002-0974-6904>; kvklecturer@gmail.com.

Leonid Pivovarov Captain of large tankers (SCF UNICOM Management Services), Senior Lecturer (Ship Handling Department), Kherson State Maritime Academy.