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Conducting a functionality test of a system serving to support analysis of errors committed by users of simulators

Badanie funkcjonalności systemu wspomagania analizy błędów popełnianych przez użytkowników symulatorów maszyn

DARIUSZ KALWASIŃSKI *

Presented is a procedure of conducting a functionality test of a system serving to support analysis of errors occurred during simulations. It also characterizes tools used during the tests. These tests will allow to determine functionality and effectiveness of the system in work of instructors who conduct trainings on simulators.

KEYWORDS: database, VR technique, simulator, analysis of errors

In the training of machine operators, simulators of stationary and mobile machines are increasingly used. Of course, they do not replace traditional training with the use of real machines, but they support the learning process in the area of increasing the operators' skills in performing specific control tasks (machine operation) or recording knowledge about accident events. In addition, a number of literature [1-4] and own research [5] indicate that the use of the simulator speeds up the training process and reduces training costs (ie consumption of materials, energy and maintenance costs of machines).

Simulators allow to present the causes and circumstances of the occurrence of accidents, and consequently - a series of errors made by users while operating the machines. To analyze these errors, appropriate computer tools are necessary. These are, for example, databases that allow you to collect and store information from simulation processes.

These tools are very successfully used in construction, i.e. to coordinate works on the construction site in terms of the demand for building materials, the amount of construction material used [6, 7] or collision detection between cooperating cranes while moving loads [8]. Quite often they are also used to collect information about the environment in which we operate (ie cities, districts, nature, workplaces), in order to create computer applications (eg in AR or VR technology) enabling browsing and walking around a specific area and analyzing geophysical phenomena [3].

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Tools for carrying out the test

Testing for functionality will be subjected to a system of instructor support (trainers training) in the field of error analysis made by users of machine simulators. The concept of this system is based on a computer application using a relational database and a module registering simulation parameters.

Crane simulator and recording module

The tests will use a crane simulator made in 2013 [10,11] at CIOP-PIB. It allows simulation of a wide range of activities (control tasks) that are also encountered in other machines of internal transport, and related to work and handling of loads. In addition, free access to the software part of the simulator will allow you to implement a module that registers simulation parameters for crane operation.

This module is an algorithm that records parameters (data) from the simulation course of the virtual crane operation and activities performed by its operator. These data are registered continuously from the moment the simulation was started (from turning the key in the ignition switch) to its completion (the key in the "off" position).

Each time the simulation is completed, the data is saved in an XML file. An example window of the module is shown in fig. 1.

The structure of the relational database

When determining the structure of a relational database, it was assumed that a computer application should support conducting data analysis in the aspect of errors made in the simulation process by users of the simulator. Data analysis should enable the determination of:

- when there was an error,
- situation leading to an error, e.g. as a result of improper steering task execution,
- type of consequence or possible consequence of the error.

Based on these assumptions, a relational database model was developed (fig. 2) in the created computer application. This model is a set of tables and patterns of relationships and relationships between them, in which specific data is stored. The tables will contain strictly defined information about the simulation process, loaded from an XML file.

Czas	Siedzisko	Most	Wózek suwn	Trawersa	Elektromagn	Wózek 1 z k	Wózek_koliz	Pracownik	Pracownik-h	Ładunek Prę	Ładunek Prę	Ładunek Prę	Bariera Prze	Joystick LP 1	Stacy
14	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.5,_2.6,_-16.1)	(2.8,_0.0,_12.2)	(3.1,_0.0,_10.3)	(-0.3,_0.0,_31.0)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
15	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.5,_2.6,_-16.1)	(6.9,_0.0,_11.9)	(4.4,_0.0,_10.3)	(-0.1,_0.0,_30.6)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
16	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.6)	(10.9,_0.0,_11.7)	(5.6,_0.0,_10.3)	(0.0,_0.0,_30.1)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
17	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.5)	(12.0,_0.0,_11.6)	(6.8,_0.0,_10.2)	(0.2,_0.0,_29.6)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
18	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.4)	(12.0,_0.0,_11.6)	(7.3,_0.0,_9.8)	(0.3,_0.0,_29.1)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
19	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.3)	(12.0,_0.0,_11.6)	(6.2,_0.0,_10.1)	(0.4,_0.0,_28.6)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
20	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.3)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.5,_0.0,_28.1)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
21	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.2)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.7,_0.0,_27.6)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
22	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-16.7)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_27.1)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
23	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.1)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.7)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
24	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.4)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
25	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.6)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
26	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.8)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
27	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.9)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
28	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.9)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
29	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.9)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
30	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.9)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
31	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.7)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
32	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.6)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
33	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.5)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
34	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.5)	(12.0,_0.0,_11.6)	(6.1,_0.0,_10.1)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
35	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.4)	(10.8,_0.0,_12.5)	(5.2,_0.0,_10.3)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
36	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.3)	(6.7,_0.0,_12.8)	(3.9,_0.0,_10.3)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
37	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.3)	(2.7,_0.0,_13.1)	(2.7,_0.0,_10.3)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON
38	(11.4,_6.2,_19.7)	(4.1,_-2.0,_18.7)	(4.1,_8.2,_18.7)	(4.1,_2.8,_18.7)	(4.1,_2.8,_18.7)	(12.1,_2.6,_-17.2)	(-0.3,_0.2,_13.6)	(1.5,_0.0,_10.3)	(0.8,_0.0,_26.2)	(2.2,_0.7,_4.0)	(1.5,_0.0,_24.3)	(2.2,_0.0,_22.3)	(4.0,_0.0,_14.3)	(0.0,_270.0,_0.0)	ON

Fig. 1. Window from the module recording simulation parameters

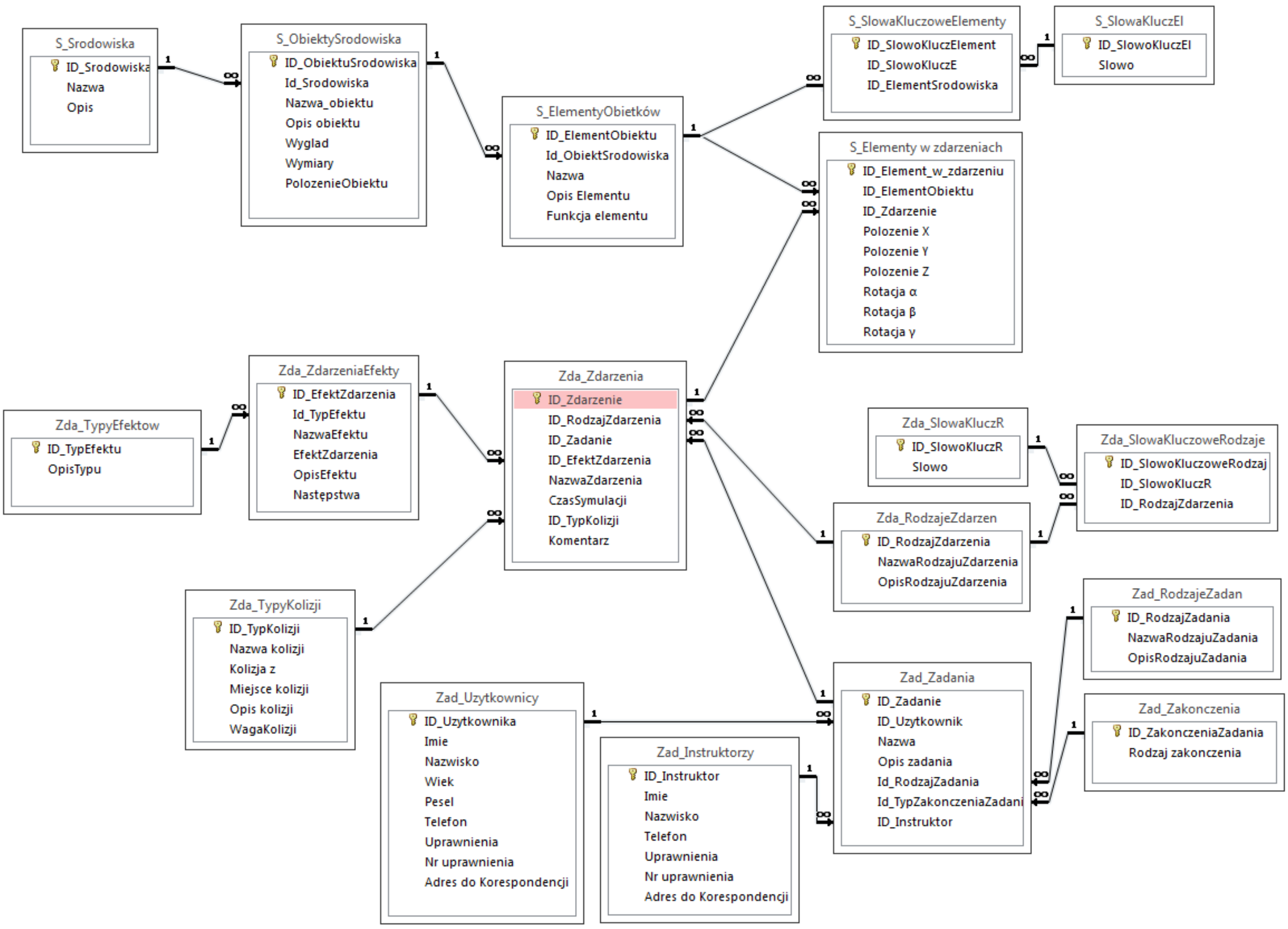

Fig. 2. Relational database model in the computer application being developed

Procedure for testing the functionality of the system

The tests will use a crane simulator and a system (including a computer application and a recording module) to assist instructors in the field of error analysis and questionnaires to evaluate the simulator and application. The survey scheme is shown in fig. 3.

Twenty-one volunteers will take part in the research: 14 of them will support the crane simulator, and 7 instructors will carry out functional tests of the system (a computer application).

Volunteers will be familiarized with the purpose of the research and with the tools used. Also possible problems that may occur while operating the simulator will be discussed. Participants will perform on the simulator a specific control task related to operating the crane using real control elements and according to the developed training program.

The training program was developed as part of the task 04.A.33 "Computer tools using VR virtual reality techniques for interactive mapping of selected mechanical hazards to prevent accident events while operating the crane", implemented in the second stage of the Multi-Year Program in 2011-2013.

Each volunteer will perform three simulations of virtual crane operation. The first simulation, called "Trial", aims to familiarize the participant with the operation of the gantry simulator, i.e. learn about the virtual environment and how to control a virtual gantry, including cargo. This simulation should last about 10 minutes.

Next, the participant will perform two basic simulations of the virtual crane operation process. Each of them should last a maximum of about 15 minutes. Simultaneous intervals of approximately 5 minutes are provided between simulation sessions. However, in the case of a study involving two people, the sessions should be carried out alternately by the participants (one is conducting simulation and the other is resting).

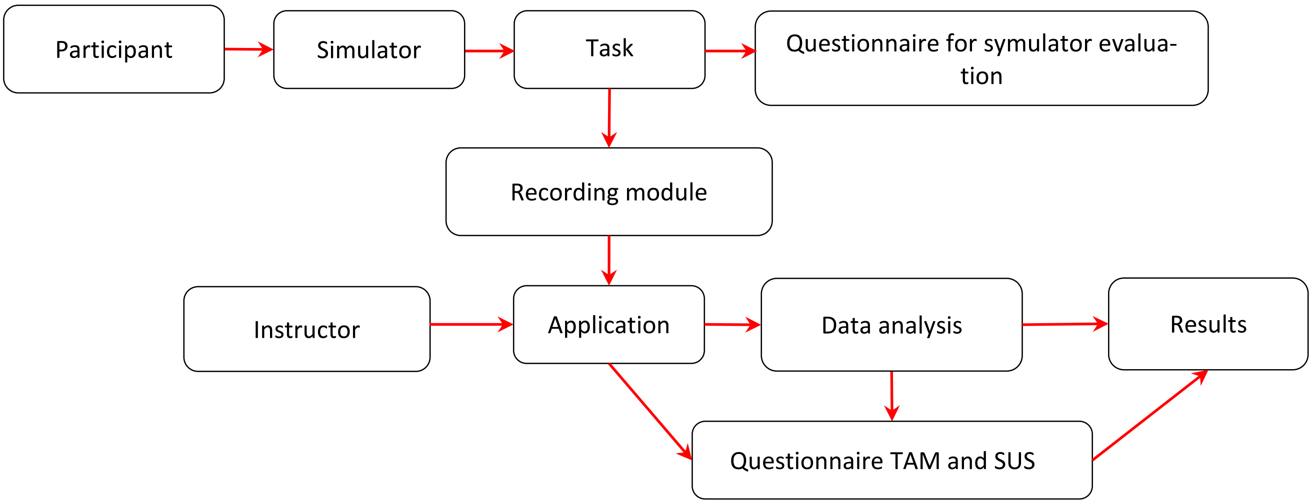

Fig. 3. Diagram of conduct during research

The simulation results of the simulator's basic operation (i.e. the position parameters of the elements moved and manipulated in the environment) will be saved in the XML file. After each main session the participant fills in the simulator function evaluation questionnaire.

The results of the simulation will be loaded into a computer application (database). The application prepared in this way will be subjected to functional tests. They will be carried out by instructors training crane operators. Based on their opinion and answers to questions from the questionnaires, the functionality and the possibility of using the application to assist with the analysis of errors committed by the participants while performing the control task on the simulator will be determined.

The questionnaires were prepared according to the Technology Acceptance Model - TAM [12, 13] and the System Usage Scale - SUS [14, 15]. The tests will be carried out in accordance with the Expert Inspection and User Testing for Virtual Environments method [16] and based on the following schedule:

1. Discussing the purpose of the study and familiarizing participants and instructors with the tools (simulator, computer application and questionnaires).
2. Simulation of virtual crane operation according to a specific control task.
3. Completing the simulator rating questionnaire by users.
4. Saving data from each session to an XML file and loading data into the application.
5. Conducting a computer application test in the aspect of determining its functionality when analyzing errors made by simulator users.
6. Filling the application evaluation questionnaires.

Total time of the test conducted in accordance with presented schedule is approx. 120÷130 min.

Conclusions

On the basis of the described computer tools (i.e. the recording module implemented in the crane simulator, relational-object application and questionnaires for their evaluation) and formulated guidelines for the procedure, tests will be carried out. They will allow to determine whether the developed system (application + module) can be a tool supporting the work of instructors in the analysis of mistakes made by simulator users used during training.

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REFERENCES

1. Portouli V., Bekiaris E., Boets S., Henriksson P. „Comparative evaluation of training methods in improving drivers' understanding about the functionalities and potential limitations of ADAS". *Proceedings of European Conference on Human Centred Design for Intelligent Transport Systems*, France (2008): pp. 217–226.
2. Lozia Z. "Driving simulators as a tool for road traffic safety research". *Conference VIRTSAFE*, CIOP-PIB (2005).
3. "Virtual reality goes to school". *New York Times*, 2012. http://www.nytimes.com/2012/05/20/automobiles/virtual-reality-goes-to-school.html?_r=1.
4. Juang J.R., Hung W.H., Kang S.Ch. "SimCrane 3D: A crane symulator with kinesthetic and stereoscopic vision". *Advanced Engineering Informatics.* 27 (2013): pp. 506–518.
5. Kalwasiński D. "Praktyczny test symulatora suwnicy w aspekcie symulacji wrażenia dotyku" (Practical test of overhead crane simulator in the context of the sense of touch simulation). *Mechanik.* 7, (2014): pp. 285–294 [CD].
6. Vasenev A., Hartmann T., Dorée A.G. "A distributed data collection and management framework for tracking construction operations". *Advanced Engineering Informatics.* 28 (2014): pp. 127–137.
7. Dimtrov A., Golpavar-Fard M. "Vision-based material recognition for automated monitoring of construction progress and generating building information modeling from unordered site image collections". *Advanced Engineering Informatics.* 28 (2014): pp. 37–49.
8. Tantisevi K., Akinci B. "Transformation of a 4D product and process model to generate motion of mobile cranes". Elsevier B.V. *Automation in Construction*. 18 (2009): pp. 458–468.
9. Zhang J. et al. "Design and development of Distributed Virtual Geographic Environment system based on web services". *Elsevier Inc., Information Sciences*. 177 (2007): pp. 3968–3980.
10. Kalwasiński D., Filipek D. "Narzędzie komputerowe do wspomagania szkoleń operatorów suwnic" (Computer tool to support

trainings of overhead crane operators). *Mechanik.* 7 (2013): pp. 297–306 [CD]
11. Kalwasiński D. „Koncepcja wykorzystania rzeczywistości wirtualnej do odwzorowania zdarzeń wypadkowych występujących podczas użytkowania suwnic” (Concept of use of virtual reality to present accidents occurring during the use of overhead crane). *Przegląd Mechaniczny.* 1 (2014): pp.19–22.
12. Venketsh V., Davis, F.D. “A theoretical extension of the technology acceptance model: Four longitudinal field studies”. *Management Science.* 46, 2 (2000): pp. 186–204.
13. Mangin J.-P.L., Bourgault N., Leon J.A.M. “Testing the application of the Technology Acceptance Model in the French Quebecer Banking Environment”. *International Atlantic Economic Society.* Res (2011): 17:346–365, DOI 10.1007/s11294-011-9305-4.
14. Hartson H.R., Andre S.T., Willinges C.R. “Criteria for evaluating usability evaluation methods”. *International Journal of Human-Computer Interaction.* 15, 1 (2003): pp. 145–181. DOI:10.1207/S15327590IJHC1501_13.
15. Brooke J. “SUS – A Quick and Dirty Usability Scale” w: P.W. Jordan, B. Thomas, B.A. Weerdmeester, A.L. McClelland (red.). *Usability Evaluation in Industry.* 189, 194 (1996): pp. 4–7.
16. Bach C., Scapin D.L. “Comparing inspections and user testing for the evaluation of virtual environments”. *International Journal of Human-Computer Interaction*. 26, 8 (2010): pp. 786–824

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