Simulation Modelling Practice and Theory 72 (2017) 69–87

Contents lists available at ScienceDirect

Simulation Modelling Practice and Theory

journal homepage: www.elsevier.com/locate/simpat

Generating real-time objects for a bridge ship-handling simulator based on automatic identification system data

Philipp Last[a,c,*], Martin Kroker[b], Lars Linsen[c]

[a] University of Applied Sciences, Werderstr. 73, 28199 Bremen, Germany
[b] Rheinmetall Defence Electronics (RDE) GmbH, Brüggeweg 54, 28309 Bremen, Germany
[c] Jacobs University, Campus Ring 1, 28759 Bremen, Germany

ARTICLE INFO

Article history:
Received 1 September 2016
Revised 7 December 2016
Accepted 19 December 2016

Keywords:
Maritime safety
AIS
DIS
Distributed simulation

ABSTRACT

Most accidents at sea are caused due to decision errors made by crew members. Hence, nautical education plays an important role. A common approach for training crew members is the usage of ship handling simulators. Our paper aims at increasing the closeness to real-world scenarios of simulator-based education for nautical personnel by integrating real objects into the simulation process. This integration aims at improving the learning experience leading to higher safety on sea. Since the introduction of the Automatic Identification System (AIS), which has to be installed on professional operating vessels, vessel movements can be tracked. Thus, we are using AIS data for the data integration process. Within this context several practical problems are addressed which arise in the design of a software architecture which uses live AIS data. This includes the availability of specific AIS data attributes, the AIS reporting intervals, and the mapping of AIS data to the Distributed Interactive Simulation (DIS) interface. Presented results have been successfully implemented in a software architecture which integrates a live AIS data stream into the simulation process of a full mission bridge simulator.

1. Introduction

Despite the usage of latest maritime technologies and systems, operating a vessel is nowadays still a complex task. The latest maritime accident review created by the European Maritime Safety Agency reports a rather large number of vessel incidents in 2015 [1]. Hundreds of incidents are reported just for European waters including sinkings and collisions. Since vessel incidents often involve a loss of human life and represent an economic damage, e.g., by losing cargo or whole vessels, research to reduce the amount of incidents is required. Incident reasons are manifold and have already been identified within several studies. Chauvin et al. evaluated human factors and conclude that most collisions occur due to decision errors by crew members. These decision errors are, e.g., caused by environmental factors such as poor visibility and the misuse of instruments or deficits in ship-to-ship communications [2]. They conclude that decision errors are, among others, a result of a lack of experience of crew members. This is confirmed by Banda et al. who analyzed the influence of the human factor. They identified a lack of experience as an issue which raises a need for the improvement of navigational training [3]. The usage of ship handling simulators allows for a safe training of respective situations such as bad sight caused by fog while excluding the risk of actually harming people, vessels, or the environment.

* Corresponding author at: University of Applied Sciences, Werderstr. 73, 28199 Bremen, Germany.
E-mail address: p.last@jacobs-university.de (P. Last).

http://dx.doi.org/10.1016/j.simpat.2016.12.011
1569-190X/

Fig. 1. Example of a bridge ship handling simulator ANS 6000 manufactured by RDE GmbH.

A bridge ship handling simulator is a replication of a ship bridge including all relevant instruments such as the radar system or the electronic chart display and information system (ECDIS). The bridge view is generated using several projectors or screens. The simulation process itself is described by a system model which represents a simplified version of the vessel's and environmental dynamics. Exercises are controlled by one or more instructors who operate additional workstations. Fig. 1 shows a bridge ship-handling simulator of type *Advanced Nautical Simulator* (ANS) 6000 manufactured by RDE GmbH which is used by the University of Applied Sciences, Bremen, to educate nautical personnel. The workstations for the instructors are located separately and are therefore not visible.

The size of a maritime simulator depends on its purpose and may range from common desktop PCs with a monitor to a single cabin up to a full bridge replication as shown in Fig. 1. An example for mentioned smaller maritime simulation systems are vessel traffic service (VTS) simulators. With respect to offshore simulation the offshore simulator centre AS (OSC) provides different kinds of simulation systems such as ship handling, subsea or crane simulators which are used to train nautical personnel [4].

Since new vessel technologies have been introduced within the last 10 years, the possibility of integrating real maritime data into these simulation systems opened up. The most promising data source is the Automatic Identification System (AIS) which allows tracking vessel movements since the geographical position is transmitted. Besides, further data such as the vessel type are provided by AIS systems. Our paper aims at improving the simulation process of ship handling simulators by adding real AIS data to the simulation process.

1.1. Motivation

Ship handling simulators are used for different maritime application scenarios. Examples are the investigation of vessel accidents [5], the identification of hydrodynamics for current and future vessel types [6], the evaluation of new bridge devices [7], or user controlled experiments, e.g., evaluating subject parameters such as the heart rate to estimate stress or the mariner's workload [8–10]. Further experiments while using a ship handling simulator have been conducted aiming at identifying the effects of alcohol exposure while operating a vessel [11,12]. However, the main application scenario of ship handling simulators is the nautical education for mariners, such as pilot training or training of collision avoidance situations [13,14].

With respect to maritime simulators new methods and tools are currently developed to increase the situational awareness of mariners to prevent accidents. Within this context Sanfilippo proposed a system to increase situational awareness in offshore training by using a subsea simulator. Different data such as audio, video or bio-metric data are obtained during the simulation process. These data are used to evaluate human factors and to develop new approaches to increase situational awareness of the training attendees [15].

All mentioned application scenarios have in common that appropriate simulation exercises have to be manually prepared according to the exercise goal. These preparations include the selection of a sea area where the exercise takes place, the definition of environmental parameters such as day time, wind, wave heights, etc., and the placement of the simulated vessel as well as further artificial vessels represented by 3D models. Since only the simulated vessel will be controlled by exercise participants all artificial vessels would have to be controlled by the exercise operators. To disburden the operators the exercise creator usually defines itineraries which are assigned to the artificial vessels. This includes the manual definition of waypoints and event points. Event points specify where an artificial vessel should, e.g., de- or increase its speed or change course. Finally, the created exercise has to be tested and refined. It is not uncommon that the required time to complete an exercise exceeds more than one hour. Thus, the manual creation of training scenarios including testing is a