Serious Games for Multi-user Crew Collaborative Procedural Training and Education

Agostino Bruzzone, Marina Massei, Alberto

MITIM DIME Genoa University

Genoa, Italy
{agotino,massei,tremori}@itim.unige.it

Simonluca Poggi, Angelo Ferrando, Davide Poggi
MAST srl

Genoa, Italy
{simonluca.poggi,angelo.ferrando}@mastsrl.eu

Letizia Nicoletti
CAL-TEK, Italy
Cosenza, Italy
letizia.nicoletti@cal-tek.eu

Christian Bartolucci
Simulation Team
bartolucci@simulationteam.com

Giulio Franzinetti
Liotech ltd
London, UK
giulio.franzinetti@liotech.co.uk

ABSTRACT

This paper introduces the international research program RAMSES-SG ("ReliAble ship Management and Security Enhancement by Simulation based on Serious Games") and discusses a multiplayer, systems-based Serious Games for training technical nautical operations and ship procedures (i.e. refueling at sea, man overboard, mooring to a buoy, etc). The main goal is to improve the effectiveness of training for the management of complex operations that require multi-user, coordinated and collaborative approaches. The simulation framework operates on multiplayer training scenarios that reduce costs and increase the efficiency of training time at sea with real equipment. In addition, it may be possible to test complex scenarios where, due to safety or boundary conditions, it is not possible to perform actual exercises.

The approach allows the developers to create a distributed and multi-user, real-time virtual simulation for preliminary training and analysis of operational procedures (i.e. replenishment while underway, lowering an inflatable boat, firing position, ship preparation, etc.). This paper describes the open, general architecture as well as the preliminary results of the approach based on a pilot experiment. A description of the main features and tools (including the most suitable architecture and configuration) is provided. Additional topics explored in the paper include a brief review of related Serious Games and/or platforms (handled devices, smart phones, etc.), and explanations for reduction of cost, ease of use, and flexibility of the system. This paper benefits the I/ITSEC community and promotes its international diversity by sharing an Intelligent Agent-based Serious Games approach and architecture, developed for the training and education of maritime challenges.

ABOUT THE AUTHORS

Agostino Bruzzone is Full Professor at DIME (Mechanical Engineering Department) University of Genoa, Italy, where he teaches "Project Management" and "Industrial Logistics." Prof. Bruzzone also teaches Modeling & Simulation ("M&S"), for Biomedical Systems" and VV&A for the DIMS PhD Program (Doctorate in Integrated Mathematical Modeling and Simulation). He has used simulation techniques extensively in harbor terminals, for maritime trading and in sailboat racing. He has worked on research projects involving innovative modeling, IA techniques, and DoE (Design of Experiments). Currently Prof. Bruzzone is Director of the Technical Council of "Simulation Applications in Management, Planning & Forecasting" for the Society of Computer Simulation International. A founding member and President of Liophant Simulation, he has written more than 200 scientific papers including technical and professional reports in partnerships with major companies (i.e. IBM, Fiat Group, Contship, Solvay) and agencies (i.e. Italian Navy, NASA, National Center for Simulation, US Army). He's currently Project

Leader M&S at NATO – CMRE and Director of MIPET (International Master in Industrial Plants at University of Genoa.

Alberto Tremori is an Electrical Engineer with a PhD in M&S. He has extensive experience in technology transfer and management of R&D projects, particularly in M&S and Serious Games. He has participated in several international conferences and worked for major corporations (IBM, Xerox, IDC…). He is currently a faculty member of MIPET (Master in Industrial Plants) at the University of Genoa, Italy. He has been appointed by the Italian MoD to several NATO Research Groups. As a researcher engineer, he manages projects in M&S and acts as Technology Transfer Manager at the University of Genoa's DIME. He has authored several reports for the development of innovative applications of Serious Games (i.e. NATO ACT report -"Strategic Decision Making Training through Serious Games" and "Agile Intuition An innovative approach for educating Context Sensitive Coup d'Oeil").

Marina Massei is part of Prof. Bruzzzone's and Prof.Mosca's team in DIME as project controller. She has been involved in the organization of international events (i.e. Summer Computer Simulation Conference 2003 Montreal, 2004-San Jose, 2005-Philadelphia) and as coordinator of a technical council specialized in advanced techniques (i.e. SIMPLEST). She is Associate Director of the McLeod Institute for Simulation Science located in university of Perugia, Italy. She worked on seminars on problem solving, project management, data analysis, and team work for undergraduates and postgraduates in courses organized by DIME and DIPTEM. She has carried out several projects on mobile simulation and virtual simulation.

Giulio Franzinetti is a graduate of the London School of Economics and Political Science where he qualified with a BSc Hons in Economics (Computer Science) having developed simulation models based on Queuing Theory using software packages that had been developed commercially and also by the university. He has founded Liotech Limited in London, a company committed to the development of simulation and Serious Games for a variety of applications. Giulio has worked in several consulting fields in London, Hong Kong, Milan, Luxembourg, India, Central Asia and African emerging markets.

Simonluca Poggi has worked as a consultant for many initiatives on ERP solutions for retail, inventory management, logistics and project management for DIME. He is actively involved in ST_VP Virtual HLA Real Time Simulation projects and also in projects for edutainment in marine applications. He has been active in Simulation Team and MAST in the modeling and simulation of human behavior and in the development of Intelligent Agents for a broad range of applications. He has acquired extensive experience in Vega Prima, Creator and the VBS World Platform for the development of simulations and training in complex environments. He has participated in several international conferences in Europe (e.g. HMS, EMSS, MAS etc.).

Davide Poggi is a researcher with MAST; he has a degree in industrial engineering and skills in interoperability standards and programming languages. He takes part in the SMACKDOWN project with NATO, MIT, and other international research centers.

Angelo Ferrando is a researcher working with MAST in the development of simulators and games. He is an expert in Computer Science and Programming. He participated in the SMACKDOWN project with NATO, MIT, and other international research centers.

Christian Bartolucci is a research engineer with Simulation Team and works on projects related to Maritime safety and security issues.

Letizia Nicoletti is currently a PhD student in Mechanical Engineering at the University of Calabria, Italy. Her research interests include modeling and simulation applications in complex systems; specifically harbors and the maritime sector. She also provides support to the organizers of international conferences in modeling and simulation.

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INTRODUCTION

This paper discusses an open architecture to address the simulation of complex environments and describes preliminary results of a previously conducted experiment. The crew training procedures mentioned here are critical tasks requiring crew cooperation and coordination. The simulation framework discussed in this paper operates multiplayer training scenarios that also help address safety and cost concerns linked to conventional exercises.

Technological advances today allow for the introduction of new educational support in the form of m-training (education and training through the use of mobile platforms), e-learning (web-based learning applications), and electronic response systems (Richardson, 2001; Judson and Sawada, 2002; Emmanouilidis et al., 2008; Clark and Mayer, 2011). Serious Games can be developed not only as tools for edutainment or entertainment, but also as instruments that are very useful in teaching and training in different domains, due mainly to the number of immersive virtual frameworks that have been developed for various game applications. It has become increasingly clear that the success of Serious Games affects the engagement of the player. Trainees often experience increased engagement through interactivity with virtual frameworks that promote realistic elements such as benefits of use, competition, emotional involvement, and graphic quality.

Maritime Serious Games are thought to be effective in training and education and could be improved by introducing multi-user approaches. For Maritime applications this allows instructors to train the crew on tasks that represent the most important activities or majority of onboard procedures.

RAMSES-SG will help understand which new advances, in terms of concepts, technology and platforms (handled devices, smart phones, etc.), could increase training effectiveness. We focus on how to investigate new advances to train effectively and to develop a supportive approach with Intelligent Agents ("IA"), thus facilitating both individual and team cooperation skills. This paper benefits the I/ITSEC community and promotes its international diversity by sharing a high-level description of ongoing research of an Intelligent Agent-based Serious Game approach developed to address maritime challenges.

The following section summarizes the main advantages and goals of the RAMSES-SG research program. The state of the art of serious games applied to the maritime sector is also summarized after the goals.

RAMSES-SG: SERIOUS GAMES FOR TRAINING

Several skill sets relevant to various fields could benefit from virtual training, however, the key to success is usually related to the systems' ability to engage the user. Immersive environments engage the user effectively, especially in gaming for the business sector; therefore there are good examples of successful applications based on factors such as usability, screenplay, responsiveness, and competition.

Serious Games have been promoted by the international scientific and defense communities, as a cost and time saving tool to be used in combination with other advanced technologies for training crew members to face difficult conditions that occurring on Navy vessels. These simulation training innovations consist of "learning by doing" within a virtual context: this teaching technique has been tested to demonstrate positive results from lessons in which the trainees learn together in a complex, but safe environment (Massei and Tremori, 2010).

Serious Games applied to ship crew members represent an important innovation in training applications because they help trainees manage very complex situations as well as allow foreign navies to reduce costs. Serious Games are acceptable training tools, and their use in the definition of crew training needs for new ships through game play is important especially when considering vessels constructed for foreign navies that have limited time and resources to train crews abroad.

Therefore the research goals of the international research program RAMSES-SG are:

- *Safety and Security*: improvement of safety and security effectiveness in operations based on international cooperation with different stakeholders active in this field.
- *Variety of Operative Scenarios*: experimentation of Serious Games applied to several operational environments (i.e. marine operations, oil platform operations, etc.).
- *Cooperative training:* development of a cooperative multi-user environment for a training tool.
- *Integration of models:* integration of new models**,** platforms and simulators within a flexible synthetic environment made possible by the development of new infrastructure and architectures.
- *Human Factors:* improvement of realistic simulations through the study of human responses such as stress and fatigue.
- *State of the Art:* analysis of new solutions, procedures or revision of those in place in order to improve a multiuser Serious Game and analysis of potential gaps, limitations, and lack of the developed simulation solution.
- *Mobile Training:* introduction of mobile solutions to increase the training opportunities and reduce costs and times.

Since the last decade of the 20th Century some interactive and multimedia PC-based training courses have been prepared by scientists such as Brown, Mason, Biegel and Poland (1998) to improve US vessel handling. At the beginning of the 21st Century a training program was applied to deck officers by Hays and Vincenzi (2000) then Nicolescu, Leigh, Olenderski, Louis, Dascalu, Miles, Quiroz and Aleson (2007) who used the same guidelines and managed to simulate real movement of vessels through the application of new autonomous controllers. Intelligent Agents were brought into new generation simulators to interact with real players, as first proposed by Calfee-Rowe (2004) followed by Simonsen (2003) and Moon-Tudhope (2006). Human behavior aspects such as fatigue and stress were studied by Calfee-Rowe (2004), while others paid more attention to avoiding tasks which necessitated boarding a vessel. Intelligent Agents, as analyzed by Bruzzone, Massei, Tremori, Longo, Madeo and Tarone in 2011 allow simulations to imitate human emotions and actions in the maritime context.

An Intelligent Agent-based Serious Game is a promising application for the enrichment of analytical skills such as decision making (Tremori et al., 2012). Virtual reality combined with the introduction of Intelligent Agents can simulate crisis situations which the player must overcome through collaboration with the same Intelligent Agents thereby achieving a common objective while managing difficult operations (Bocca et al. 2007; Ginnis, Kostas, Politis and Kaklis, 2010).

RESEARCH OBJECTIVES

This section provides a more detailed description of the project objectives with focusing on the concept of a game based approach to collaborative training in Navy and maritime applications.

This paper emphasizes the need to develop a new educational program using Serious Game techniques for crew members of Navy vessels. These kinds of Serious Games have the potential to be reused and provided to the navies of other nations. For instance, in the RAMSES project, several scenarios involving Intelligent Agents and virtual distributed simulation are currently being developed by the authors to meet custom needs in the context of a marine environment. These include scenarios for Autonomous Underwater Vehicle (AUV) operations and Special Forces' surveillance and protection of ships and other marine infrastructure. Two prototypes have been produced and others are being developed.

Some of the innovations of this research include the possibility, through IA, to simplify the preparation and execution of training sessions, which in our research has corresponded to a reduction of training costs and time. Therefore one re-engineers the educational process using technological solutions that are able to generate, execute, and evaluate the training session in an easy way according to users' needs.

In recent years Serious Games have allowed us to evaluate and mitigate ship risk, especially since safety analysis scenarios have been developed (Liwang, Ringsberg and Norsell, 2012). The creation of architectures, environments, and sophisticated models designed for specific military training purposes has increased the importance of interoperability (Kuhl et al., 1999). According to a study led in 2012 by Lee, Kim and Baik such architectures separate models from simulation engines; at the same time, computer generated forces and Intelligent Agents were developed by Bruzzone, Massei and Tremori in order to improve training in the defense sector.

Based on these elements, the authors consider that several research objectives should be specifically addressed representing the following critical elements:

- Interaction among multiple users in an intuitive framework.
- Good quality immersive environment.
- Characters directed by IAs in order to make the procedure and coordination easier in a simplified training mode.
- Accessibility and usability through the proper design of the GUI (Graphic User Interface) considering both hardware and software issues, and capitalizing on the opportunities provided by innovative mobile solutions (Massei and Tremori, 2010) in terms of potential expansion of the scope of training sessions and optimization of resources.

It is important to underline the concept of *collaboration* of different players (both real players and avatars managed by Intelligent Agents) because this is a key element in the realistic reproduction of any operative scenario. Operators requested to perform a single task are also required to have the ability to see this task from a bigger picture and are accordingly required to cooperate with other operators in the safest most secure and efficient way. In all the scenarios developed, or under development, in the RAMSES-SG project, this concept is one the key elements of the simulated scenario.

REQUIREMENTS AND NEEDS FOR SERIOUS GAMES IN MARINE DOMAINS

This section provides an overview of the needs of Serious Games applied to the marine sector as well as a high level description of the RAMSES-SG approach.

Effective training tools need to be developed keeping customers' needs in mind. For maritime training tools for a vessel or an off-shore platform, it is very important that crew members learn to cooperate since they have to face each other every day in critical operations and possibly extreme weather conditions, which make emergency management even more difficult. Consequently, the application of Serious Games is best for this domain if developed in the context of a multi-user solution. During the course of this research, the authors have focused their attention on the definition of a simulation architecture that would allow a multi-user game approach including complex interactions between ships.

Interoperable models require accurate investigation and consideration for their development in different applications (i.e. HLA High Level Architecture Standard) paying attention to the following aspects:

- Flexible fidelity: interoperating with different models implies the need to achieve different fidelity levels (i.e. highly detailed physics or simplified operations) during various training phases.
- Reusability: for different applications, thanks to interoperability, both models and even 3D graphic objects can be reused.
- User training needs: an open architecture is required to allow models to be adaptable to customer needs in order to cover new aspects of the mission environment.
- Geographical distributed requirements: to make simulators work together and trainees interact, over a wide area network.

Players can be trained in new plants, vessels and platforms during the construction phase with multi user games. This helps the crew develop readiness within a short time frame.

Testing a new scenario when the entire crew is available represents a major issue in this kind of simulation, because it is unusual that all of the trainees are ready to complete the training program together. In order to avoid these issues, it may be important to introduce IAs. IA tool developers should prepare training applications robust enough to support a number of sessions to provide trainees with relevant experience. To do so, they should address the following issues:

- Intuitive use of modality.
- High level of usability to include quick session activation and scenario installation.
- Agent driven scenarios to reduce human operators (pucksters) within Serious Games operations.

Fig. 1 Vessel Procedural Training based on SG for Mobile Platforms with Multiple Avatars

Addressing these issues should facilitate the ability to conduct additional training during free time as warranted. Multi-user, IA-driven Serious Games could be operated even when the whole crew is not present during the training session as IAs could execute tasks in place of the vacant operators.

The possibility of using mobile platforms (i.e. tablets and smart phones) to run such scenarios represents other added benefits to this approach. Figure 1 (above) provides an example of the use of mobile platforms for procedural training on RHIB (Rigid Hull Inflatable Boat) operations.

IAs represent an enabling technology that drives the whole simulation to control interaction among real players and to replace some of them with virtual ones (i.e. Computer Generated Forces controlled by computers). Such computer controlled entities are able to modify their behavior during the game according to their perception of the evolution of the situation. The authors have significant experience with several successful projects in the area of human behavioral models and Computer Generated Forces managed by IAs (Bruzzone, Tremori and Massei 2011, 2013) and particularly those applied to Serious Games (Bruzzone Massei and Tremori 2009, 2011). After a great deal of analysis related to human behavior data and multi-user mode development, it is possible to extract best-practice and new strategies. In addition, bottlenecks and critical aspects can be identified thanks to data collection and experimental study of extreme situations. Intelligent Agents can improve the learning program effectiveness and allow for the investigation of human behavior through the analysis of virtual training sessions. For example, training cadres and instructors can learn to increase or decrease scenario difficulty levels by introducing problems into a scenario. This provides an opportunity to test problem solving ability and ability to react and cooperate. The introduction of constraints and specific events within the game during a given training session also allows for Subject Matter Experts (SME) and customer/user feedback. Some of the procedural training scenarios considered for development are: managing emergency deriving from an helicopter accident, extinguishing a fire on a military vessel, refueling at sea between two vessels, launching of an inflatable boat used by special military forces, etc.

Based on the experience in the early phases of RAMSES-SG, basic behavioral models have been set to define the behavior of other operators in the different situations. These agents are affected by human factors (fatigue, stress, fear…) that could influence their performance and improve realism of the cooperative procedures in case of a stand-alone game.

To summarize, we can consider that several types of training cases related to different operational procedures within the maritime environment, are characterized by common elements such as the supervision phase, statistics, reporting and team preparation. Therefore they should be developed to suit different users and different case studies. Trainers and instructors should also be provided with a final report generated by the Serious Games with which they can evaluate individual trainee and team performance. These reports could provide the results of system analysis of the training process since its inception and to pay particular attention to critical issues that have been observed during the sessions. Finally, the evaluation phase effectiveness is ensured by a debriefing and After Action Review (AAR) tools. Verification, Validation and Accreditation (VV&A) are obviously very important in order to ensure training effectiveness. VV&A should be developed during the course of the life cycle of the Serious Games (Tremori et al. 2009).

ARCHITECTURE AND MODELS

This section describes the architecture of RAMSES-SG, with a focus on the main characteristics of the different aspects of the games and scenarios including interoperability, multi-user capability and agent-based simulation with human behavioral models.

The architecture that is shown in Figure 2 (Serious Games within an Interoperable Architecture) is an example of how different elements could be integrated as discussed above.

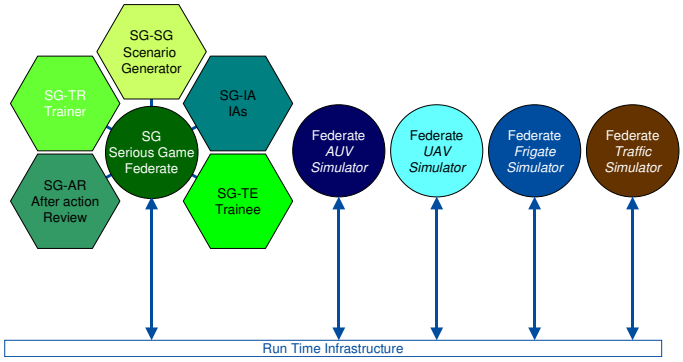

Figure 2. Interoperable Architecture

The architecture elements are the following:

- SG-TE, Serious Games Trainee, through which players could relate to each other and access the game.
- SG-TR, Serious Games Trainer, through which instructors supervise operations, and inject events during the game.
- SG-AR, Serious Games After Action Review supporting performance analysis and searches for information useful for the debriefing activities.
- SG-IA, Serious Games Intelligent Agent, in which the IA manage entities within the game during execution.
- SG-SG, Serious Games Scenario Generator allows trainers to create complex scenarios.
- SG, Serious Games, the core engine whose aim is operation coordination, performance measurement, and interoperability improvement between simulators and models.
- Other simulators and models that interoperate with the SG as in the case of an AUV Simulator (see Figure 3), UAV Simulator, Frigate Simulator, and Marine

Figure 3. Virtual Scenario including UAV (Unmanned Aerial Vehicle) and AUVs (Autonomous Underwater Vehicles) and Ships

Traffic Simulator including other Intelligent Agents (IA) that direct the different confederates and drive events and actions that impact the entire HLA Federation.

- RTI, Run Time infrastructure, which is the support infrastructure to operate within an HLA Federation.

The RAMSES-SG team developed the Games included in RAMSES-SG project by testing different tools, in particular: VBS2 and VBS World, Unity, VEGA, Delta and Thinking Worlds. Intelligent Agents are being implemented by SG-IA in order to allow for a Serious Games (SG) evolution and platform devoted to training scenario execution, the GUIs (Graphic User Interfaces) for trainee (SG-TE) and Instructor (SG-TR) architecture. SG-SG allows for the generation of the scenario. The training scenario is executed and initialized by SG, and trainees learn to manage difficult operations, while cooperating within the game with other players, thanks to a user interface (i.e. virtual simulation) that is made possible by SG-TE. Implementation of several kinds of actions and decisions that are influenced by cooperation with other players within the game are made possible through SG-IA. Serious Games-IA allow for different scenario development according to what happens in reality where events are the consequences of crew members' decisions.

Currently the authors are developing a module devoted to providing the simulator with a system through which trainers are able to evaluate trainee performance based on data provided by SG-AR. The Serious Games allows for cooperative training when a user trains alone thanks to the presence of Intelligent Agents and distributed simulation architectures. It is possible to train crew members outside specific training structures with a federation of different simulators cooperating among trainees and instructors who might live in different countries. Learning process requirements are ensured by the integration of SG-TR, SG-TE, and SG operation/physics and behavior fidelity level which are made possible by the collection of required data. The result is an advanced framework that allows trainees to pursue effective learning results through an understanding of the importance of cooperation with other players (virtual and real ones) and the organization of information.

The game provides the players with a set of possible actions that they have to carry out cooperating with others.

Indeed effective operation management should be achieved only by cooperating with other players, both those real and virtual IAs, and by sharing information with them. Performance indicators that are related to specific operations need to be introduced in order to facilitate operation monitoring, while the scenario is created by SG-AR. At the beginning of the game the trainer should define the set of complex operations to be simulated and should be able to insert some variations and some additional difficulties during the training session. Management of specific functions and roles are learned by trainees thanks to the choice of a specific scenario (i.e. management of fire-fighting procedures if an emergency over a military frigate occurs). The ability to conduct virtual simulation over several complex operations is allowed by the SG and other possible interoperable simulators that are linked together in the HLA federation. The behavior of the virtual crew is made possible with a high level of detail and realism thanks to SG-IA combined with Intelligent Agents. The exercise is concluded when time is up or when operation procedures are effectively carried out. These aspects allow trainees to learn to face difficulties within the Maritime domain. They will learn from their mistakes.

VV&A AND EXPERIMENTATION

Simulation fidelity and training utility have to be ensured through the correct development of Verification, Validation and Accreditation (VV&A) developed during the entire simulator life cycle. Simulators developed alongside the VV&A process ensure whether a model is correct according to the use for which it has been developed and whether it satisfies the customer's needs.

In the early phases of the project the authors used their experience of naval and maritime issues, that of subject matter experts both from the military and industry (Italian Navy, Turkish Naval Academy and naval engineers) and that of experts in modeling and simulation (i.e. other research centers, NATO M&S COE…). The authors are making a great effort to collect data and information about the different real operational procedures. This data collection is supporting the creation of conceptual models and, accordingly, is ensuring an easier Validation phase. Furthermore VV&A steps are simplified by creation of virtual scenarios where it is easy to detect, for instance, anomalous behavior of on of the Intelligent Agent based avatars cooperating with the player. Virtual reality is simplifying verification and validation

steps by observing the different procedures intuitively. IA VV, as already stated, is used in this first stage and comprises of basic behavior, previously accredited in prior projects (PIOVRA, Sibilla and Cumana Capricorn, etc.). Serious Games help customers become more involved and help ensure that simulators meet developers' requirements. During the verification phase, developers control 3D representations in the model (as shown in figure 3), such as those regarding Rigid Hull Inflatable Boats, helicopters, sailors and cargoes that are representative of the real world. The considerations also have to be extended also to internal ship parts that have been detailed in term of physical characteristic and aesthetic aspects. The validation phase focuses on reproduction of physical laws, technical facilities, human behavior and operations within the simulator.

Simulations may correctly represent human responses, such as fatigue, stress, as well as technical features such as maximum speed, displacement, weight, and the most important of physical laws, motion, gravity and friction. During validation it is also important to focus on experimental results of analysis derived from the game and to the fidelity of interactions among the players.

Training regarding a complex and combined operation such as the inspection of ships thought to have pirates on board, may be executed through the use of an RHIB and a helicopter. The authors explored this mission environment in a pilot experiment. The experiment was run with the support of a team of 15 engineering students with little or no experience in maritime operations. They played the game to operate the RHIB (see Figure 4) in two different sessions on different days. Output of these experiments was analyzed using an Analysis of Variance (ANOVA) two-tailed technique to define the difference between the results of the two sessions.

In detail we considered Av_i as the average and Var_i as the variance of the target function *i* and n_j the number of trainees of the *j* session.

If we pass the text texp>tref

with $texp = abs(Av_1-Av_2)/(Var_{12}*sqrt((1/n_1)+(1/n_2))$

where

$Var_{12} = sqrt(((n_1-1)*Var_1\text{^}2+(n_2-1)*Var_2\text{^}2)/(n_1+n_2-2))$

and $tref = tstudent\ (alfa, DoF)$

where

$DoF= n_1+n_2-2$

we can set the probability of difference among sessions' results.

In our case

For the two target functions (time to complete operation #1 and errors during session #2) we have:

$Av_1 = 7.76$ $Var_1 = 2.25$

$Av_2 = 4.1$ $Var_2 = 1.15$

and

$n_1 = n_2\ 15$

So for Target Function 1 we can define a probability of difference between session 1 and 2 of 99.9995% and for Target Function 2 of 99.8930%.

These preliminary results are significant and provide an idea of how it is possible to improve the learning curve using such kinds of collaborative, multi-user games. Indeed results, summarized in Figure 4, outline, although with a simple set of experiments, improved performance during the second session resulting in more accurate operation (less errors).

In this simple case it is clear that, interacting with the SG has successfully influenced the learning process evaluation and helped virtual crew members' coordination during training sessions.

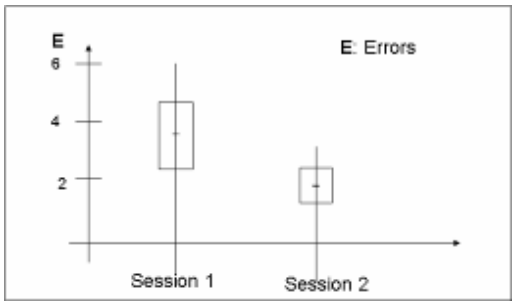

Figure 4. Synthesis of the experimental results

The team of SMEs will be involved in completing the accreditation phases and in fixing the final issues about the different Games before setting up presentation meetings with the Italian Navy or other navies or agencies (i.e. Turkish navy or NATO ACT).

CONCLUSION

The research that is the focus of this paper highlights the potential for Serious Game techniques applied to training in the field Modeling & Simulation. Such simulators are needed in the Maritime domain. SG allows multi-user modes and choices of scenario difficulty according to the users' needs.

This approach makes it possible to understand difficulty levels better, to evaluate crew members, improve the learning process and assess cost reduction. It also becomes possible to learn about the motivators for general improvement of trainees' performance within the real operational context both during daily operations and in cases of complex emergency situations.

Intelligent Agent integration and interoperability are key aspects that are slated for future development and improvements. In particular the authors are now working on meeting customer requirements and improving the model fidelity through the creation of a new set of virtual entities.

Prototype development and specific case study development should produce valuable feedback during this research. In particular simulator developers are now working toward the application of this work to include scenarios involving complex operations on offshore platforms.

A future challenge for RAMSES-SG could be the installation of the architecture described in this paper on a mobile platform. Following this development the technological and educational performance of this platform has to be verified. Another contribution of this research may be SG portability improvement so that users can conduct training sessions using handheld devices such as PDAs and mobile phones.

This paper introduced the international research program RAMSES-SG ("ReliAble ship Management and Security Enhancement by Simulation based on Serious Games") and discussed multiplayer, systems-based Serious Game research for training technical nautical operations and ship procedures. The main goal of this effort was to improve training effectiveness in complex operations management that required multi-user, coordinated and collaborative capabilities.

The paper described the open, general architecture as well as some of the benefits of this approach based on preliminary experimental results. A description of the main features and tool architecture was provided. This paper shared research issues involved in developing an Intelligent Agent-based Serious Games approach developed for the Maritime domain.

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