Applying Modeling and Simulation to Enhance National and Multi-National Cooperation

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**Keywords:** Joint theater level simulation (JTLS), command and control, crisis management, national military command center (NMCC), computer aided exercises (CAX).

**Abstract:** The article presents case studies and practical applications enabling the readers to learn about military simulations and how they are used in defense and crisis management. It is the first in a series that will describe the application of modeling and simulation to enhance country-to-country, agency-to-agency and coalition-to-coalition cooperation and understanding and provides information on the availability of M&S applications, their potential benefits and associated cost. The content is relative to company news – updating the reader on the latest developments in the military simulation and training industry and assisting in developing a hypothetical plan for the implementation and use of various M&S applications. The coverage focus is generally on the command laboratory simulation but is defined in the context of crisis management center concepts.
Abstract: The High Level Architecture (HLA) provides a foundation for technical interoperability among disparate simulations, simulators, live systems, and simulation support tools. Achieving technical interoperability is a significant first step, but it is only part of the interoperability equation. This paper describes other interoperability challenges that federation designers and managers face. These challenges relate to the differences between modeling techniques employed by different simulation federates and the logical interpretation of data shared among federates. Using the Federation Development and Execution Process (FEDEP) as a guide, we identify the key areas where federation developers address simulation interoperability as they apply HLA to their domains particularly in battlespace simulation applications and cite potential sources of support for addressing these issues.
Commercial-Off-The-Shelf Software Becomes Mission-Critical to Success and Cost-Effective Space Missions

Paul L. Graziani

Keywords: COTS software, satellite, simulation, space surveillance network, space-based communications

Abstract: Many organizations can no longer afford to develop mission-specific software in-house. Commercial satellite software that can be used for multiple missions is playing a growing, cost-saving role in enabling not only successful but economical space activities. Commercial off-the-shelf (COTS) software that is stable, accurate, and well-supported is key in all phases of a satellite's life—from pre-launch analyses to ground support through to graveyarding. The paper shows the benefit of using COTS software in the big international projects, related to construction of reusable, generic software "building blocks" based on legacy software. In theory, new missions could then select among these building blocks to build systems in an object-oriented manner.
Abstract: Distributed simulation is an approach to building large-scale simulation models from a set of independent simulator nodes communicating via a network. The U.S. Army uses distributed simulation systems for both training and analysis. Those systems include both crewed simulators and computer generated forces (CGF) systems; the latter use software, rather than human crews, to generate the behavior of entities in the simulated battlefield. CGF systems must include algorithms for all of the tactical behaviors that are needed for the simulation. One such tactical behavior is "Fire Zone Defense". An algorithm for this behavior must select defensive deployment locations on the terrain for the individual entities (e.g., tanks) of a unit (e.g., a company) to effectively defend an assigned engagement area. The entities of the unit then move to those locations.

We developed a new algorithm for the behavior. It combines a geometric terrain analysis algorithm, which creates a weighted graph representation of the terrain, with a greedy optimization algorithm that operates on that graph. The algorithm was compared experimentally with a previously existing algorithm for the same behavior. The comparison used a metric that measured the cumulative observation of the engagement area from the selected locations of the defending entities. Under that metric the new algorithm consistently outperformed the existing algorithm, with an average ratio of performance over 2. The execution speeds for the two algorithms were approximately the same.
Keywords: missile, modeling, aerodynamic, fin mixer, fuzzy control, 3D simulation.

Abstract: This paper examines the main steps in the process of creating an antitank wire guided missile simulator. This principal task includes the following items: understanding the behavior of the simulated object, appropriate mathematical modeling and 3-dimensional visualization. The general features of a fuzzy controlled semi-automatic missile are studied and missile response against the mobile target is evaluated and discussed. The main characteristics of simulator for antitank wire guided missile designed with DirectX7 SDK are presented.
Fuzzy Control Based on Cluster Analysis and Dynamic Programming

Plamena Andreeva and George Georgiev

Keywords: Fuzzy Control, Knowledge Based Systems, Clustering algorithm, Decision-making, Learning in Fuzzy Environment, Dynamic programming.

Abstract: This paper focuses on fuzzy control of a class of nonlinear systems, which are characterized by model uncertainty and inequality model constraints. The associated Intelligent Information System (IIS) is designed to store the results from possible training made by an expert and distributed via network. The paper considers cluster analysis for such a system, based on Bezdek’s fuzzy cluster method (FCM). The proposed method is used to classify the input data and to extract the rules.

An example of fuzzy control for autonomous mobile system in 3D space is explored and the results from the decision using the method of dynamic programming in fuzzy environment are shown. The synthesized algorithm guides an autonomous vehicle in 3D space which pursues an object and evades an obstacle. The fuzzy control is based on determination of a maximizing decision by using dynamic programming. The maximizing decision is defined as a point in the space of alternatives at which the membership function of a fuzzy decision attains its maximum value. The purpose of the presented algorithm is to demonstrate a fuzzy method for determination of the trajectory of the dynamic object.
Dynamical Behavior of Fuzzy Logic Based Velocity Control Autopilot with Respect to Changes in Linguistic Variables Membership Functions Shape

*Petya Koprinkova and Valentine Penev*

**Keywords:** velocity control autopilot, fuzzy controller, membership function

**Abstract:** In the present paper the influence of membership functions shape on the dynamics of fuzzy logic based autopilot controller is investigated and discussed. Bell-shaped membership functions with two parameters are discussed.
The Computer Aided Exercise – An Alternative of the Conventional Exercises in the Armed Forces

Nikolay Vraikov and Alexi Naidenov

Keywords: CAX, Command Post Exercise, distributed simulation

Abstract: In the article officers from the General Staff of the Bulgarian Armed Forces present their viewpoint on the issues of simulation systems and their application in training and conduct of computer assisted exercises. A classification of simulation systems is presented in terms of scope and designation. Further, the authors focus on the nature and specifics of the command post computer assisted exercises. The process of their preparation, organization and conduct is set forth, as well as the roles of individual participants. Special attention a devoted to the functional and technological structures, as well as to the information flows during a conduct of a exercise of that type in the Bulgarian Armed Forces.
The Modular Simulation Language (MODSIM) - A Powerful Tool for Computer Simulation

Juliana Karakaneva

Keywords: MODSIM, object management, event management, CAX

Abstract: The focus of this article is on the implementation of specialized software for simulation experiments as an important aspect of modeling efficiency. The attention is directed towards the process-based computer simulation, which is supported in the Modular Simulation Language MODSIM. Model project creation, as well as management of objects, processes and events are described consecutively. The MODSIM simulation model advantages are outlined.
Some Problems in Modeling and Simulation Area in the Bulgarian Armed Forces

Jordan Parvanov

Keywords: Distributed interactive simulation (DIS), Computer Assisted Exercises (CAX), HQ training

Abstract: One of the most important lessons learned over the years is that the preparation of the officers deciding how the units should proceed is crucial. The aim, of course, is to have maximum professionalism on the level of command and control of the forces participating in each specific operation and in the behavior of each participating unit. Simulations have the potential of allowing swift and efficient staff training on different levels in the chain of command. Giving the staff access to updated information on the composition of the units and other assets available, as well as geographical data of the mission area, would provide the decision-makers with an invaluable instrument. A HQ planning operation can use databases and computers to assemble and process this information. Programming and processing information on the behavior of the different actors together with additional data creates the possibility for simulations that may produce alternative outcomes of the different actions taken by the HQ. This allows for a wider spectrum of alternative options, which will help the HQ to make better decisions. Simulations will also facilitate the processes of force generation, assessment and evolution, as well as certification of forces and assets made available for a particular operation.

The purpose of this paper is to give an overview of the current state of modeling and simulation in the Bulgarian Armed Forces and of what we have to do in the near future to meet challenges in this discipline. All the ideas concerning future developments are not the formal position of the Bulgarian MoD but only reflect the author’s experience and knowledge in modeling and simulation. As a participant in already conducted Computer Assisted Exercises (CAX) in the BAF, I would like to identify and explain some problems, which occur during the development of these exercises and the creation of our models.
Integrating Web, Desktop, Enterprise and Military Simulation Technologies to Enable World-Wide Scalable Televirtual Environments

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Abstract: We present an approach to the next generation televirtual (TVR) environments that integrate collaboration with distributed computing and modern modeling and simulation technologies. We follow the 3-tier architecture with the Web Object (Java/CORBA) based middleware, VRML/Java3D/DirectX based front-ends and JDBC/PSS/OLEDB based back-ends and we are testing our design and the integration concepts by prototyping a multi-user authoring and runtime environment to support WebHLA based distributed military simulations. We present first our taxonomy of collaboratory frameworks and our integration paradigm, based on the WebFlow system at NPAC. We then list the critical enabling technologies that are being integrated and finally we summarize the current status of our prototyping experiments.
Distributed Simulation and Modeling Environment

Valentine Penev, Tatiana Atanasova and Ivanka Valova

**Keywords:** Distributed simulation, virtual reality, HAL

**Abstract:** In this paper a distributed environment which shares the computational resources is proposed. Distributed Simulation system uses models, visual representation and calculation of object movements. The network distribution allows remote access to heterogeneous data sources and functionally divided operation of the system. The status of the environment and its parts are updated and sent over the network so that all participants are fully aware of the environmental situation. Different optimization algorithms are used for tasks of simulation, computation, and visualization.
Military Simulation: Techniques & Technology

Roger D. Smith

Abstract: This package illustrates some of the interesting concepts that are explored in the course "Military Simulation Techniques & Technology".