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On

"Modeling Command & Control and Belief based Decision Making of a Company Commander Using Agent Technology"

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CERTIFICATE

This is to certify that the work contained in this dissertation entitled **"Modeling Command & Control and Belief based Decision Making of a Company Commander Using Agent Technology**" submitted in the partial fulfillment, for the award for the degree of **Master of Technology** in Computer Technology and Applications at **Delhi Technological University** by **SANJAY BISHT, Roll No. 14/CTA/10** is carried out by him under our supervision and guidance. This matter embodied in this project work has not been submitted earlier for the award of any degree or diploma in any university/institution to the best of our knowledge and belief. He has completed his work with utmost sincerity and diligence.

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ABSTRACT

Realistic military simulations are needed for analysis, planning, and training. Military conflicts can have many attributes that are consistent with complex adaptive systems – such as many battlefield entities interacting with some degree of autonomy, each of which is continually making decisions to satisfy a variety of sometimes conflicting objectives. There continues to be increasing interest from a broad range of disciplines in agent based and artificial life simulations. Intelligent agent technology is a valuable software concept with the potential of being widely used in military simulation applications. Agent technology have been found to be suitable for modeling tactical behavior of the battlefield entity & their team coordination. They provide a powerful abstraction mechanism required for designing simulations of complex and dynamic battlefields. Combat forces are composed of large number of non-linearly interacting parts that are organize in a strict command and control hierarchy. During battlefield simulation, these entities generally represent individualistic behavior, taking operational order from higher control and executing relevant plans. However, since a complex battlefield scenario typically involves thousands of entities, their coordinated team behavior should also be considered to make the simulation more realistic. Recent studies of agents has shown their usefulness to represent the team behavior which otherwise is difficult to model using Object oriented methodology. Their ability to model the tactical decision-making behavior of simulated battlefield entities gives them an edge over other techniques. War gaming is a costly affair. Moreover the time-intensive data collection/scenario generation process, coupled with long run times, often limits analysts to a small set of simulation runs. There is a need for increase the simulation speed, enhanced realism in game and reduced human interference.

Computer Generated Forces (CGF) comes to the rescue here. CGF have been used in training as well as tactics development. CGF can potentially replace humans in Combat simulation systems to reduce cost of training

exercises. But the conventional tightly scripted in CGF behavior modeling often limits the representation of complex behavior.

Complex behavior variations, such as choosing where or whether to cross a road, cannot be expressed within the scripted scenario. Therefore the CGF acting as command agent in war games should be equipped with more realistic behavior representation, tackling all type of complex behaviors. This will enhance the realism of the war-game & hence enhance the learning value of the players. For this ,CGF should be able to synthesized their beliefs derived from the lower level sub ordinates combat units. This updated synthesized belief will generate real time reactive response to any unforeseen circumstances.

The goal of this study is to enable control of interactive war games through use of high-level commands using agents to command each subordinate level of the hierarchy in the simulation in accordance with military doctrine - including reacting to enemy actions, terrain, and reporting back up the command chain. This paper presents a role-based BDI framework to facilitate representation of military hierarchy, modeling of behavior based on agent current belief, teammate's belief propagation, and cooperation and coordination issues. This BDI framework is extended and based on the commercial agent software development environment known as JACK Teams. This BDI framework builds teams using a simplified, abstract framework called team-oriented programming (TOP) and allows team based tactical operation of military doctrine to be captured in an effective way and be played out in simulation scenario with minimal effort. It also enable handling of dynamically changing combat situation , reasoning on team goal failure at the team level, as well as automatic sharing and aggregation of belief between team and sub teams for accessing of current situation .This work also demonstrates the use of intelligent agent-based team behavior modeling, team belief propagation based situation awareness and generation of expert based appropriate reactive response (past expertise stored in team belief) using two infantry attack scenario exhibiting a infantry company attack against a platoon and infantry platoon attacking an enemy section.

PAPER PUBLICATION

- Aparna Malhotra, Sanjay Bisht, S.B. Taneja. Using Intelligent Agents to Simulate Battle Tank Tactics, International Conference on Cognitive Sciences (ICCS), 2004, Organized by NIIT at IIT, Delhi.

- Aparna Malhotra, S.B. Taneja, Sanjay Bisht. Simplifying the Tactical Modelling of Armour scenarios using Teams of Agents, 3rd International Conference on Quality,Reliability and Infocom Technology (ICRQIT'06), 2 - 4 Dec, 2006, New Delhi.

- Devasheesh Banerjee, Sanjay Bisht ," An Agent based team oriented tactical simulation" , 3rd International Conference on Quality, Reliability and Infocom Technology (ICRQIT'06), 2 -4 Dec, 2006, New Delhi.

- Sanjay Bisht, Aparna Malhotra, S.B. Taneja. Modelling and Simulation of Tactical Team-behaviour, published in Defence Science Journal, Nov, 2007.