Surface Task Force Assistant Decision-making Support System Based on ACP Method

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Abstract. Traditional assistant decision-making capability is based on reductionism; the conclusion has the fault of low reliability and pool environmental flexibility. The primary task for surface task force assistant decision making system is to assistant commander start with coordinating combat resources during the combat, focus on the characters of surface task force combat command decision making, featured as predicting the combat effect based on computational experiments and decision-making generation based on parallel execution, put forward framework of surface task force assistant decision-making system, discussed the critical technologies of realizing the system.

1 Introduction

Surface task force is a complete combat system composed of 2 or more ships. Due to system confront is the primary form of future local warfare at sea, the surface task group will be the primary composition of accomplish the war fighting mission [1]. War fighting system is a typical open complex macro system [2,3], from the view of system engineering, adversary commanders make efforts to influence on system functioning by managing combat resources, piloting the system evolving meet the best interest of itself (people, group, nation, etc.), to handle the complex war fighting system.

In the combat process, the primary task of combat assistant decision making is to assistant the commander manage combat resources. Traditionally, the methods of combat assistant decision-making are usually turn the non-structured problems into structured problems [4], solving them isolated. Take surface task force air defense problem for instance, if we disassemble question into integrated organized sub-questions such as threat evaluation [5], intention recognition [6], distribution of the capability of observation and search to the air [7], distribution of fire power, channel organization [8] and evasive action [9], building models and solving them separated, forging the capability of assistant decision-making for the whole question. However, practically, these sub-questions are related, and have mutual effect, for example, under different combat intention, the formation of the task group will be different; in different formation, the optimistic solution for firepower distribution will be different, which result in poor flexibility to battlefield at sea, poor reliability and difficulty to assess the effectiveness of decision-making output using assistant decision-making capability based on reductionism.

ACP method (Artificial System + Computational Experiments + Parallel Execution) [10,11] is a system of systems using computational method to research complex systems, which aims at assessing, fixing solutions throughout, accurately and promptly, realizing rolling optimization to the solution, achieve the ultimate effective control to complex system in the actual world using artificial system that parallel to actual world conduct non-stop “experiment”.

This thesis put forward a surface task force assistant decision-making system framework based on ACP method to promote the generation pattern of surface task force assistant decision-making capability, enhance the assistant decision-making capability of surface task force.

2 Surface Task Force Assistant Decision-making Support Framework Based on ACP Method

The ACP method is a new theory and method system of systems that fuse artificial society, computational experiment and parallel system theory to use computational method to study complex system.

The artificial society concept is issued by American Rand Corporation, whose connotation is to generate artificial life using computer, to build artificial society composed of artificial systems, to research the influence of different information technology, facility and capability. Which distinguish from traditional society simulation, artificial society adheres to the idea of "multiple society", believes that artificial society is a kind of reality, and is possibly one kind of alternative of real world [13].

Traditional decision-making model that lead by problems does not apply in computational experiments; this category of model cover from condition judgment, situation assessment, description of decision-making behavior of two-side commanders, application of power and weapons, and description of strike actions, thus have interaction based on agent's behavior and decision-making, "generate" artificial system that have same pattern with real world driven by data from real world. Sea battlefield system build with this theory is a sea battlefield artificial system "bred" by computer and agent technology through the interactions of artificial subjects, is a kind of bottom to top active comprehensive integrated research method. This method is similar to combat simulation in the appearance, however, traditional combat simulation breaks research subject into related sub-systems, for example red and blue sides, use computer and value technology build model and integrate, simulate and replay all kinds of status and develop features in actual sea battlefield; it is a kind of passive reduction combination research method from top to bottom.

Parallel system refers to a common system composed of a certain natural real-world system and corresponding one or multiple virtual or ideal artificial system. On the basis of artificial society and computational experiments, parallel system method for complex system management and control is further introduced into combat decision-making analysis and support, take actual sea battlefield and artificial sea battlefield generated by artificial society that have same pattern of real-world sea battlefield as research subjects, form a parallel system, and then analyze commander's different combat command decision-making in the task force combat command procedure; provide decision-making support through observe and control the deduce assessment of decision-making solution, apply it online or offline, real-time or delayed. Modern Mega new type computational method provides foundation for parallel system method application.

Surface task force combat assistant decision-making system of systems framework based on ACP method is shown in Figure 1.

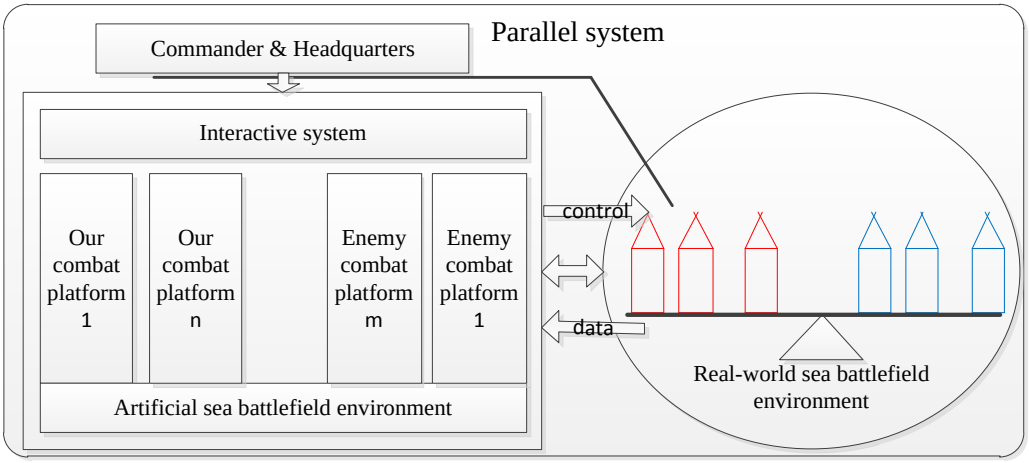

Figure 1 Surface task force combat assistant decision-making system of systems framework based on ACP method

This system is drive by data; on one hand it collects real-world sea battlefield status evolution data as input of artificial sea battlefield, on the other hand combat platform entities from both sides based on agent will receive the same data as corresponding actual combat platform, assistant decision-making system can receive the intervene of commander from interactive system in the

meantime. Related actions of combat platform entity can be concluded or predicted according to real world, it also can be formed by executing commander's combat plan or instruction. The evolution speed of artificial sea battlefield can be adjusted or controlled, realizing synchronous evolution between artificial sea battlefield and real-world sea battlefield when without intervene, once the commander intervenes, asynchronous evolution will take place partially, thereby to facilitate selection of optimized plan and instruction through predicting evolution of sea battlefield.

3 Critical Technology of Surface Task Force Combat Assistant Decision-making System Based on ACP Method

The key of realizing surface task force combat assistant decision-making based on ACP method is building an artificial sea battlefield which have the same pattern with actual sea battlefield, the critical technologies are following:

(1) Time and space data model construction that support dynamic evolution of sea battlefield

Time and space data is referred to space data that have time element and vary as time extends, the data has the characters of mega volume, non-liner, time-varying and obvious spatial distributed, which is primary use to describe the dynamic evolution of real-world. Traditional geography information system process static space data, which can only reserve a snap-shot of real world, when the data varies, usually obsolete data will be replaced with new data to form another snap-shot, the obsolete data will no longer exist, thus it is impossible to process the dynamic evolution of space subject [14].

Natural environment of sea battlefield not only have influence to commander's decision-making, but also shape an important factor with its evolution, thus it is necessary to design a proper, facing to application time and space data model to accurately reflect space data and track dynamic vary of space data, to realize the organic integration, efficient management and flexible application of space data and time information.

(2) Combat entity model construction based on Agent theory

Combat entity is a summarization to each component in actual war system, including identified personal, weapon and equipment, combat units, headquarters, economical entity, social organizations, natural environment and operational plan and so on, which is subject or object of all war actions and their effects, is the core element for description of war system [15].

The aim of model construction based on agent is to construct an entity model that has the same pattern with actual world in computer system, which has the ability to aware, solve and communicate with outside, its action can be intervened or auto select according to outside situation. After agents on each level are constructed, artificial sea battlefield which has the same pattern with actual sea battlefield can be generated from bottom to top, provide foundational environment support for analysis and assessment based computational experiment and assistant decision-making based on parallel execution through the interaction and influence of individual agent in subsystem to acquire superior system action.

(3) Combat entity operation model construction and effect assessment face to computational experiment

The primary function of combat entity operation model construction is to intact reveal the combat entity operation principle using dominance method, to completely reveal all actions of combat entity in artificial sea battlefield, and use pre-programmed action sequence data to drive agent, to achieve the objective of the plan or intervene the objective of combat entity operation.

From the view of system implementation, specific language to describe actions of combat entity is required to support the actions of agent in artificial sea battlefield. On this basis, model construction for action effect of combat entity is required, to merge all kinds of integrated actions in sea battlefield based on partial actions of combat entity, which facilitate the commander assess the feasibility of combat method when need the system to provide assistant decision-making, which based on the system observes previous partial action effect of combat entity and influence to sea battlefield.

4 Conclusions

This thesis put forward a surface task force combat assistant decision-making system framework based on ACP method based on systemic description of characters surface task force combat command decision-making, described the operational procedure and critical technology of system, to provide thorough feasible assistant decision-making for surface task force in sea battlefield. This system adopt a new assistant decision-making capability generation mode, which can theoretically improve the solution quality, reliability and flexibility to sea battlefield, however, the actual effect need to be tested through further studies.

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