

Method for Military Conceptual Modeling Based on Template Description

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Abstract. Military conceptual model can help achieve the consistent understanding between experts and developers and strengthen the normalization of military simulation modeling and reusability of simulation model. To solve the problems (loss of modeling elements, non-standard description and so on) appeared in existing methods, we put forward the template description method for military conceptual model. In this method conceptual model is divided into three parts and in each part template description format is given to solve the problems mentioned above. The result shows that model built by this method has the specificity of clear description, complete elements and is easy for communication between experts and developers.

Introduction

Military conceptual model is the description and presentation of basis conception and relationship on military simulation system. It can not only strengthen the standard of military conceptual modeling but also can improve the reusability of simulation model [1][2].

In recent years, people come to realize that there is a great significance to improve the quality of the military conceptual model. Currently some institutions have posed several definite developing methods for military conceptual modeling and have applied to some projects. However, a lot of problems are caused due to incomplete developing system and method, military conceptual model doesn't play an important role in improving the quality of military conceptual modeling.

Considering these questions, we come up with the template description method for military conceptual model which aims to make the content description of military conceptual model better and achieve the goal of reliability, reusability of simulation model.

Related work

The function-oriented modeling method has been dominated before 1990s which is represented by structured analysis and design method IDEF, function model is the core established by conceptual modeling. There are two problems existing in this method: (1) unable to express the timing process and support the procedure description, hard to describe the constraint on the time sequence between the various activities (2) the volatility of the function itself reduces the versatility of practical applications. These problems lead the function description of military conceptual model hard to solve and can't describe the relation between functions with poor logic.

This procedure-oriented modeling method defines the procedure as partially ordered sets composed by activities. There is a clear sequence between activities which result in the execution by the triggering events. Procedure can contain sub-procedure and sub-procedure can also contain sub-procedure. This modeling method has a representation of workflow, GANTT, IDEF3 and Petri net, etc. It has an emphasis on dynamic modeling features such as status, activities and so on, but it has poor description ability on static characteristics. Attributes and structure of model can be hard to describe with applying this method.

The object-oriented modeling method models by the view of structural model. Object system is decomposed into the relationship between the entities in the analysis phase while how to solve the implementation of the entities and their relationship is done in the modeling phase [3]. Based on

some object-oriented technologies and concepts, there has been proposed a variety of modeling methods where UML modeling has been widely recognized and used. There is a commercial tools support for this method with strong performance but it has a poor reusability and hard to master communication between experts and developers is also difficult.

The ontology-oriented modeling method is similar to the object-oriented modeling method. Nowadays the most popular view of ontology is posed by Gruber in the 1994: Ontology is a formal and explicit specification of the conceptual model. In layman’s terms, the modeling result of this method is to abstract a certain area of the real world into a group of concepts (such as entities, attributes, process and so on) and the relationship between the concepts [4]. Information processing in this area will be extremely convenient with the construction of ontology. There is an obvious problem with this approach that developers must be familiar with the field knowledge, otherwise, it will be difficult to grasp the characteristics and behaviors of system and hard to meet the needs.

Researchers have done a lot on the modeling techniques for conceptual model and then correspondingly some typical modeling methods and ideas are produced. Actually these methods and modeling ideas haven’t solved the problems such as imperfect description, semantic ambiguity, unclear logic and so on, methods for conceptual modeling needs to be further studied.

Template description method for military conceptual model

The template description method for military conceptual model divides the object system into three parts (Entity, Action, Effect) for disparate description [5][6]. Description template is given for each part which can solve the problems of loss of modeling elements, unclear logic, semantic ambiguity. Due to different focus on each conceptual model, separate description can better grasp the characteristics of the object system to meet user needs.

Entity conceptual model is the model described for the system entity. It is built to define the attributes, actions and relationship between each other. Entity conceptual model can be represented by the following:

ENCM = <BA, AA, DA, EA>

BA-basic attributes: including the name, assumption and structural relationship, etc.

AA-action attributes: descriptions for actions.

DA-data attributes: describe the data parameters of the model.

EA-effect attributes: describe the representation or export of the model.

Detailed description as the following:

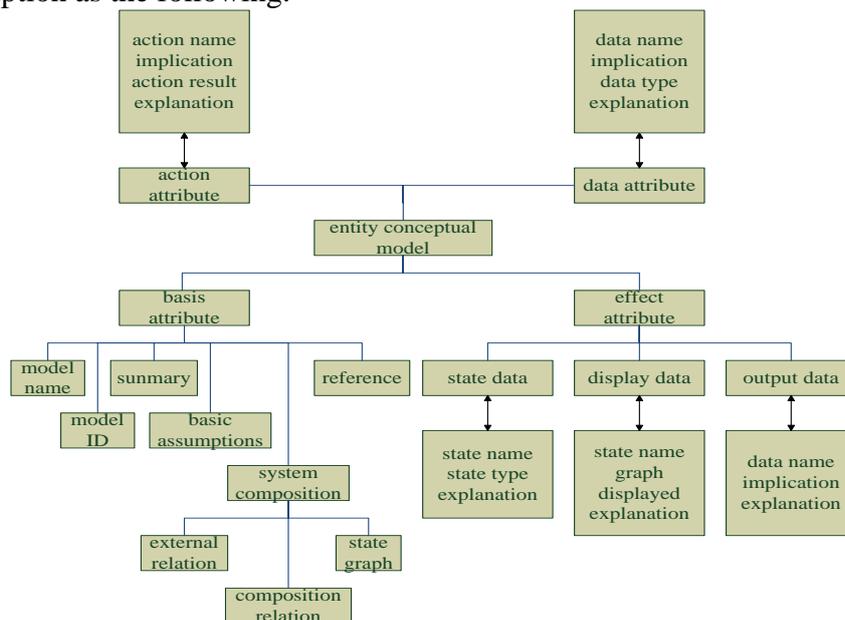


Fig1 entity conceptual model description

Action conceptual model is the abstraction for the military fighting and various action procedures, is the behavior of the entity actions. Action description includes the influence

conditions made on actions and action procedure, rules under the corresponding conditions. Action conceptual model can be represented by the following:

ACCM = <ACR, ACC, IND, OUTD, ID>

ACR-action rules: describe the assumption, algorithm, flow chart, etc.

ACC-action composition: includes the executive entity, executed entity, interactive information.

IND-input data: input data for action.

OUTD-output data: output data for action.

ID-intermediate data: intermediate data for action.

Detailed description as the following:

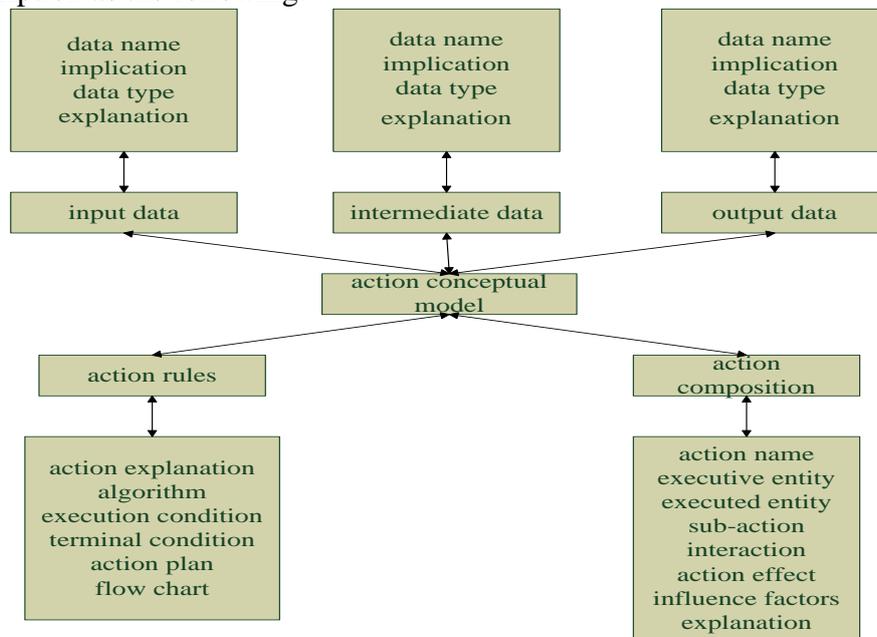


Fig2 action conceptual model description

Effect conceptual model is described to evaluate the effects caused by entity actions. Effects can be caused by one or more actions which function together while these actions can belong to one or more entities. Effect conceptual model can be represented by the following:

ECM = <IN, AC, CON, OUT>

IN-input: input data for executive entity and executed entity.

AC-action: the executive entity of the corresponding actions and the action names.

CON-content: describe the modeling process and some assumptions.

OUT-output: output data for model execution.

Detailed description as the following:

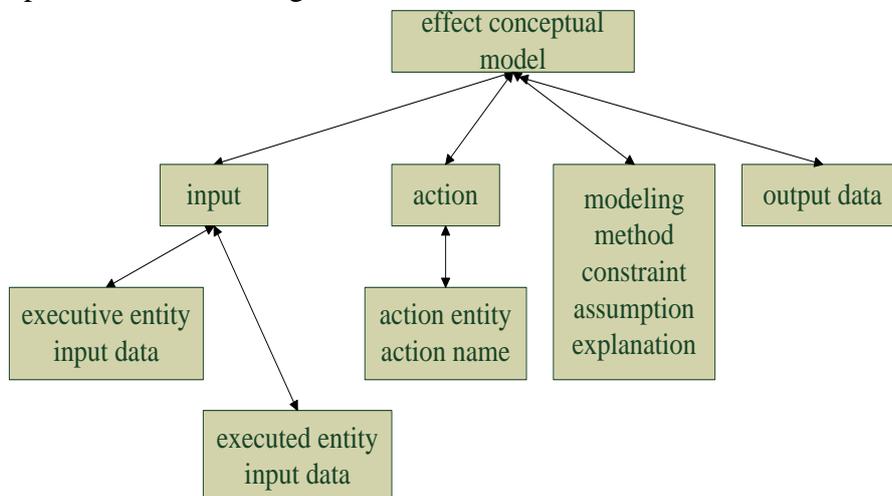


Fig3 effect conceptual model description

Examples

Based on the warning radar as an example, we divide the warning radar into three parts: Entity, Action and Effect with the method mentioned above and give detailed description for each part.

The entity conceptual model of the warning radar is described as the following, due to the limitation of paper space, contents of the corresponding parts has some reduction.

Table1 entity conceptual model of warning radar

Basis attribute	Model name	Warning radar		
	Model ID	Radarno.1		
	Summary	Functions as the following: search and track in particular area		
	Basic assumption	Working frequency: 2.5~3.5GHz; Maximum detection range: at least 100KM		
	External relation	Connection diagram between warning radar and other entities		
	Composition relation	Structure diagram of warning radar system		
	State graph	State transition diagram of warning radar		
	Reference	North Atlantic Treaty Organisation. Conceptual Modeling (CM) for Military Modeling and Simulation (M&S) [S]. North Atlantic Treaty Organisation, 2012:		
Action attribute	Action name	Implication	Action result	Explanation
	Automatic search	Set the key search area and search for targets	Find the targets appeared in the key search area	The angle of the search area ranges from 6 to 2 degrees
	Object identification	Classify and distinguish the targets	Object reports	Draw the target true-and-false report
...
Data attribute	Data name	Implication	Data type	Explanation
	Radar name	Name of warning radar	String	None
	Deploy longitude	Longitude requirement of the radar deploy	Double	East longitude is positive, (-180, 180]
...
Effect attribute	State data	State name	State type	Explanation
		Radar flag	Int	0 is off, 1 is on
		Radar working state	Int	0 is abnormal, 1 is normal
	
	Display data	State name	Graph displayed	Explanation
	Output data	Data name	Implication	Explanation
		Data point	The time target is found	Zero relative to the simulation
Serial number		The temporal serial number of target	It is given by the warning war	
...		

Action conceptual model of warning radar is described below. Here we just describe the action called action one for brief analysis.

Table2 action conceptual model of warning radar

Action composition	Action name	Action one		
	Executive entity	Warning radar		
	Executed entity	None		
	Sub-action	(1)target search(2)warn and report		
	interaction	None		
	Action effect	Forecast the missile, identify and report to the command center		
	Influence factors	Incoming target may make the warning radar miscalculation		
	Explanation	Search in the predetermined area and then capture, track and identify the target, continue to provide the updated parameters for the missile after its launch		
Action rules	Action explanation	Two ways: the first is automatic trigger and the second is command trigger		
	Algorithm	Use dynamic warning and search algorithm		
	Execution condition	Execute after receiving the command from a superior		
	Terminal condition	Terminate when meeting the following conditions: command for turning off; destroyed		
	Action plan	Process includes the following steps(1)mission planning(2)target acquisition(3)track and identify(4)effect evaluation		
	Flow chart	Action one flow chart		
Input data	Data name	Implication	Type	Explanation
	Target ID	The ID of target found	Int	Produced by scenarios
	Target flag	Distinguish between friend or foe	Int	0 is foe and 1 is friend

Intermediate data	Data name	Implication	Type	Explanation
	Scheduling interval	Interval of scheduling time	Double	Self-change with the target
	Work pattern	Work pattern of radar detection	Int	0 is automatic trigger and 1 is command trigger

Output data	Data name	Implication	Type	Explanation
	Target ID	The real ID of target	Int	Produced by scenarios
	Angle of pitch	Target angle of pitch	Double	pitch

Here takes the effect evaluation of warning radar detection as a example, effect conceptual model is described as follows.

Table3 effect conceptual model of warning radar

Input	Executive entity	Input data		
	Warning radar	Longitude, height		
	Executed entity	Input data		
	missile	Location, trajectory		
	Stealth aircraft	Speed, location		
Action	Action entity	Action name		
	Warning radar	Target detection		
	Target aircraft	Locomotion		
	Target aircraft	Stealth		
Modeling method	Contact time is one of the main indicators, capacity of target tracking, success rate of target recognition are several of the most important indicators for target effectiveness assessment			
Constraint	According to the automatic recognition, suppose the number of identifying the target successfully is n in N, the rate of recognition user concerned is n/N			
Assumption	Certain assumptions			
Explanation	Warning radar needs to evaluate the effect with/without interference			
Output data	Data name	Implication	Type	Explanation
	Detection probability	The probability of detecting the target successfully	Double	None
	Target capacity	The target capacity detected by warning radar	Int	At most 100

We take the warning radar as an example and build the conceptual model from three parts. Though the content we can find that model built with the template description method for military conceptual model can solve the problems existing in the conceptual modeling phase (imperfect description, semantic ambiguity, unclear logic and so on). Model meets the need of users while it is easily understood by developers. It is convenient for them to communicate with each other and plays a good role.

Conclusion

In this paper, we summarize the existing modeling methods for conceptual and point out the drawbacks. Considering the problems existing in the conceptual modeling, template description method for military conceptual model is proposed from the whole of object system which is aimed at bringing up a new thinking for the research on military conceptual modeling.

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