Exploration of system modeling and simulation methods

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Abstract- With the rapid development of science and technology, simulation has become an indispensable means to study the laws of objective things. This paper introduces the concept, method and challenge of system simulation. The key of modeling in system simulation is put forward. Finally, the common modeling methods of information systems are introduced, and the advantages and disadvantages of different modeling methods and applications are compared and analyzed.

1. INTRODUCTION
The combination of modern simulation technology and high performance is becoming the third important method to understand and transform the objective world after theoretical and experimental research. The rise of simulation technology has changed the way we learn the laws of things. We used to learn things from experience, from history[1]. Now we learn things from experiments, from the future. Effective simulation system will become an important tool for future research work.

2. SYSTEM SIMULATION

2.1 The concept and method of system simulation.
The so-called system simulation is to establish a model, on which to experiment or quantitative analysis to obtain all the information needed to make a correct decision. This model is based on the analysis of the elements of the system and their interrelationships. It can describe the system structure or behavior process, and has a logical or quantitative relationship[2].

The three elements of system simulation are: actual system, system model and computer. The basic activities related to them are system modeling, simulation modeling and simulation experiment. As
shown in figure 1.

The system simulation process is to build a model and through the model running on the computer to test, modify and analyze the model. The basic steps of system simulation are shown in figure 2.

2.2 Role of simulation
Simulation is one of the most critical technologies in the 21st century. It can shorten the period of system development, save test funds, ensure the safety and pertinence of training and assist decision-making. Mainly used in aviation, aerospace, electric power, transportation, hydraulic, military and other fields[3].

In the aviation industry, the design and development cycle of large passenger aircraft has been reduced by 20 percent by using simulation technology, and pilots are trained on the ground using flight simulators at a cost of only one tenth of that of air flight training, and protected from the harsh environment. In addition, on the flight simulator you can set up some failures that you may encounter in the air but cannot set up, training pilots to troubleshoot and respond to the crisis.

In the aviation industry, the number of live fire tests was reduced by 80% by replacing live fire tests with simulation tests.
The prediction and evaluation of urban traffic planning and control schemes can be realized, through the operation of the simulation system. The simulation system can display traffic flow characteristics and quality.

During the construction of the hydraulic engineering, the system operation of the whole project is simulated. Though the simulation, the major defects in the design are found out, and the feasible method of operation and scheduling is obtained.

In the field of military equipment, military simulation technology has become the leading technology, calibration technology and analysis technology in the development and test of weapon equipment. The link-type instrument flight simulator was used by the US Army and navy air forces around 1930, when its economic benefits amounted to an annual saving of $130 million and 524 fewer pilots were killed. In the 1980s, for missile development, the number of flight tests was reduced by 30% (40%), the cost of development was saved by 10% (40%) and the period of development was shortened by 30% (40%).

2.3 Current research and development hotspot
Modern simulation technology is an important means to analyze and study the system operation, reveal the dynamic process and motion law of the system. It is also the most effective meta-synthesis method and a strategic technology to promote the progress of science and technology.

Modeling theory and method is the main power to promote the development of simulation technology, and is also the basis of the sustainable development of system simulation. With the development of simulation application, the research scope of system modeling theory and method is gradually expanded from quantitative system to qualitative system. The qualitative system is more practical than the quantitative system because of its short running time and low cost.

Distributed interactive simulation is the mainstream technology of computer simulation at present. It is a kind of simulation based on computer network. It adopts the same structure, Standard and Algorithm to established a comprehensive environment by interoperating different types of simulation applications and the real world. It is often used in the military field[4]. Taking the SIMNET as the starting point, it has experienced the stages of distributed interactive simulation (DIS), Aggregate level simulation (ALSP) and high level architecture (HlA).

Object-oriented simulation is one of the most interesting research directions in the field of simulation, and is also a very common method of system modeling and analysis. Object-oriented simulation is the application of object-oriented method in the field of computer simulation, which is intuitive, easy to understand, in line with people's natural way of thinking, easy to observe the model.

With the rapid development of big data, DDDAS (dynamic data driven application system) will become a trend in the future simulation development. It can improve the simulation precision of the system and enhance the analysis and prediction ability of the simulation. It can also achieve real-time control. The simulation system and the real system are connected into a closed system and affect each other.

With the change of the Times, the simulation technology has changed and developed greatly in modeling theory, structure and technology. With the further development of simulation technology, its application scope and prospects will be broader.

2.4 Difficulties and challenges in system simulation.
We know that all models, are simplified, that they describe one side of the problem, and no one model can model everything 100 percent. We're just keeping some of the issues we care about and cutting out some of the extraneous stuff. The higher the information level of the system, the greater the number of interaction channels and the higher the complexity of the system. At the same time, the nonlinear and emergent characteristics of complex system will also bring difficulty for modeling. The fidelity, reliability and accuracy of the simulation system are the practical requirements of the application field[5].

For complex system, it is impossible to establish a completely accurate model. Generally, the
method of divide and rule is adopted. First, set up simulation subsystems to study certain characteristic of the system, and finally, synthesized all simulation subsystems. However, in a large number of studies, due to the lack of standardization, the architecture of the respective system simulation is independent of the modeling standard, can not interconnect with the real system, and even can only run in the simulation environment in a scripted way, it leads to the poor practicability of the simulation system. The optimized simulation system architecture is also an important way to improve the simulation effect.

2.5 The enlightenment of simulation system brings us
By analyzing the history and experience of system simulation, we can conclude the following enlightenment: To achieve the ideal simulation effect, the model is the foundation. model is the machine that produces the experimental data, we should establish an appropriate model according to the aim of system simulatio; the object of simulation is becoming more and more complex, and the modeling method of complex system is needed to be studied; Improve the architecture of simulation system and make it standardized. Only in this way we can realize the interconnection of different levels and different types of systems. The interoperability is the basis of jointly completing simulation tasks; Modeling and simulation drive data requirement, and modeling and the data construction supported the simulation application[6].

3. DATA MODEL
Modeling is the foundation of simulation, and simulation is the process of model test. The model plays a decisive role in the simulation effect.

3.1 The concept, elements and development of a data model
Data model is a set of symbols and texts that are used to accurately represent the real world for effective communication. Data model is the storage and operation of data in database, and it is the base of database system. In a word, the data model has the characteristics of simulating the real world, being easy to understand, and being easy to realize on the computer.

According to different information levels, the data model can be divided into three levels: conceptual model, logical model and physical model. Conceptual model is to model the system according to the point of view of users, and it is the language of communication between data designers and users. Logical model is to model the data according to the viewpoint of computer, and it is the data of the concept model. Logical model realized transition from the information world to the computer world. A physical model is an abstraction of the lowest level data, describing how the data is represented and accessed within the system.

The data model consists of data structure, data operation, and integrity constraints. Data structure reflects the static characteristics of system data, data operation reflects the dynamic changes of data, and data integrity constraints reflect the semantic constraints that data must comply with[7].

With the rapid development of Internet, Internet of things, social network and other technologies, the traditional data model can not cope with the explosion of data. In order to solve the problems of storage bottleneck and management complexity caused by massive data, the big data model represented by NoSQL and NewSQL database system has become a new research hotspot.

3.2 common data modeling method in Information System
E-R model
Since the late 1970s, the first non-traditional data model ——E-R model has appeared. E-R model is different from the traditional database-oriented data model, but is oriented to the real world. E-R diagrams are intuitive and conceptually represent the Organization of information in a database, so to be able to draw an E-R diagram means that the problem is thoroughly understood and can then be combined with the specific type of DBMS based on the E-R diagram, evolve it into a data model that the DBMS can support. E-R method is a common system analysis and modeling method, which is widely used in the field of information system.
IDEF1X modeling method

IDEF1X method is an information modeling method developed on the basis of E-R method. IDEF is one of a series of IDEF methods developed by the Air Force's Computer-aided manufacturing and is a data modeling technique used by many parts of the U.S. federal government. In the IDEF family of methods, IDEF1 was one of the earliest standards to be researched and developed, mainly for developing "information models". The information model established by IDEF1 can provide accurate and concise information requirement support for functional entities. Idef1x is an extension and improvement of IDEF1.

It enhances the graphic presentation, enriches the semantics and simplifies the development process. Main features of IDEF1X: 1. The semantic structure necessary to support the development of the conceptual Schema; 2. A concise and consistent structure for different semantic concepts; 3. Easy to teach, can be used for effective communication between research groups of different disciplines; 4. It has been well tested and proved in application. Its model generation can be automated. But for non-technical personnel, this method does not follow the principles of good design graphics, more difficult to master and use.

UML Modeling method

UML is short for Unified Modeling Language. It is based on object oriented technology, can be well defined in the Modeling process, easy to implement, powerful expression function, has become a standard for object-oriented modeling. The highlight of UML is the presentation of visual model, which uses graphic symbols to define and describe the static and dynamic structure of the system and the relationship between them. In the process of using, users only need to use the corresponding graphical symbols combined together to form a UML diagram can describe a system. The main features of UML are: (1) UML is a common modeling language, which shields the differences between different object-oriented programming, standardizes the concepts and marking methods, and eliminates unnecessary differences between different modeling languages, widely used by users who model object-oriented objects. (2) UML modeling ability is stronger than other object-oriented modeling methods, not only for general system development, but also for parallel and distributed system modeling. (3) UML is a modeling language, not a development process. UML is applicable to object-oriented technology to describe any type of system, and it is applicable to different stages of system development, from requirements specification description to testing and maintenance after the system is completed.

XML modeling method

XML (Extensible Makeup language GAE) is a semi-structured data model. A data model that hierarchically organizes data using human-readable tags, XML is easy to understand, is technically independent, and uses simple syntax to represent complex program problems. The main properties are as follows: 1 extensibility. XML is a primitive language for designing markup languages, not a specific markup language with a fixed set of tags, as is the case with HTML. 2. Flexibility. XML provides a structured data representation that separates the user interface from structured data. 3. Self-description. XML documents usually contain a document type (DTD) declaration, which makes it easier for the machine to understand the meaning of the data.

3.3 analysis and comparison of common data modeling techniques

Different data modeling methods are suitable for different users with different requirements for data models. According to the structure characteristics of command and control system and the requirement of simulation model, UML is a suitable modeling method at present.

| Model methods | Advantage | Disadvantage |
|---------------|-----------|--------------|
| E-R model     | intuitive and easy to understand | storage data type is single |
| object-oriented model | IDEF1X  | IDEF1X has been well tested and proved in application. |
|                |           | Not Following the principles of good graphics design, it is more |
|   | UML | XML |
|---|-----|-----|
|   | UML simplifies the modeling approach. In the data model of object-oriented design, it is more detailed and complete. | XML structured documents and data, can be more accurate search, more convenient transfer of software components, better description of some things. |
|   | Standardization makes it use a large number of programming terms and ignore the database, and the programming terms are relatively superficial. | It is not suitable for Web data description, and the standard generic markup language software is very expensive. |

4. CONCLUSION

Improving the architecture of simulation system is the requirement of current simulation technology application. When constructing the data model, we should pay attention to the standardization of simulation architecture and realize the interoperability of subsystems. The development of simulation technology can not be separated from the promotion of application demand. As a comprehensive science, simulation technology will play a more important role in the construction of industry and National Defense along with the development of related fields.

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