A Method for Designing the Architecture of Intelligent Transportation Systems in the People's Republic of China

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Abstract. Relevance of the research topic. With the rapid development of the social economy and technology, the number of existing cars and drivers has increased rapidly, and the construction of the urban road information management system has been relatively lagging behind, leading to the incompatibility of the existing traffic management model with the rapidly growing demand for transportation. Intelligent transportation systems (ITS) have been developed very complete and mature in many developed countries in the world and are widely used. With the development of technology, intelligent transportation systems will be increasingly used in urban traffic. The development of intelligent transport will be a promising direction for the development of transport in cities of the second and third echelon.

Keywords: Architecture, Intelligent transport systems, Development method, Software engineering.

1 Introduction

With the rapid development of the social economy and technology, the number of existing cars and drivers has increased rapidly, and the construction of the urban road information management system has been relatively lagging behind, leading to the incompatibility of the existing traffic management model with the rapidly growing demand for transportation. This created serious problems for the traffic department. Traffic congestion, increased parking time and an increase in traffic accidents not only affect the development of economic construction, but also interfere with people's daily lives. Therefore, building an intelligent traffic information system, enhancing the city's economic development potential, effectively improving the city's investment environment, developing urban modernized traffic management plans, and using advanced technical means to achieve scientific management have become the top priority of urban traffic management construction[1] .

Intelligent Transportation Systems (ITS) have been developed very complete and mature in many developed countries of the world and are widely used. China's intelligent

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transportation system is also developing rapidly. At present, advanced intelligent transportation systems have been built in major cities such as Beijing, Shanghai and Guangzhou. Among them, Beijing has established four major ITS systems: a traffic control system, a public transport control and dispatch system, an expressway control system, and an emergency management system. There are three main ITS systems installed in Guangzhou: the main traffic information exchange platform, the logistics information platform, and the static traffic management system. With the development of intelligent transport system technologies, they will be increasingly used in urban traffic. Therefore, the development of intelligent transport will be a promising direction for the development of transport in cities of the second and third echelon.

The process of implementing an intelligent transport system is extremely complex, and it is necessary to build a complete and open architecture, taking into account the needs of users and the implementation environment, satisfying existing needs and having a certain extensity [2,3]. Before the architecture of an intelligent transport system is built, we need to conduct a reasonable and detailed analysis of it. In the process of developing the architecture of ITS, an analysis of a complex ITS system is carried out using the method of system analysis in software engineering.

2 Materials and methods

Currently, there are two main ways to build the ITS architecture: a process-oriented construction method and an object-oriented construction method. The process-oriented construction method mainly uses the abstract model concept, decomposes and designs system functions according to the system internal information transfer relationships, and takes data as the center according to the principle of top-down refinement, and implements the physical model to meet the needs of users. The object-oriented construction method is developed on the basis of an object-oriented programming language. It mainly builds simulation from system composition, adopts object-oriented analysis and design idea, and uses UML modeling language to design and express the system. Each function of the system is abstracted into specific instances, attributes and objects of behavior, and the functions of the system are implemented through coordination between these objects [4].

Based on the comparison and analysis of process-oriented and object-oriented development management methods, it is determined that the Chinese ITS structure uses a process-oriented system development method and guides the analysis of the logical structure and the construction of the physical structure of ITS. Therefore, in this article, we only discuss the development method based on process-oriented architecture.

Process Oriented Method

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In the process of developing the architecture of ITS, an analysis of a complex ITS system is carried out using the method of system analysis in software engineering. According to the steps of the structured method, the structural analysis method is used to systematically analyze system requirements and system functions, the data flow-oriented structured design method is used to build the structure of the system, the user service function is gradually decomposed, and the function implementation is modular, thus obtaining the ITS architecture [5].

Below, we first briefly present the methods of structural analysis and design in software engineering, and then analyze their application in the architecture of ITS.

In software engineering, there are many different structural analysis methods for analyzing and modeling software requirements, but all of them must adhere to the following

principles: the information domain of the problem must be understood and represented, that is, the data model must be established; software must be defined by function, i.e. establish a functional model; it should express the behavior of the software as a result of external events, that is, establish a behavioral model; it is necessary to decompose a model that describes information, function and behavior, as well as display details in a hierarchical order; the analysis process must move from elementary information to implementation details.

Through the data dictionary, entity-relationship diagram, data flow diagrams, state transition diagrams, etc., a system data model, a functional model, and a behavior model are established. Entity-relationship diagram (ER, Entity-relationship diagram) is a diagram of the description of data objects in the system data model, attributes that describe data objects, relationships between data objects, etc., that is, through this diagram, data objects and their relationships in the system can be presented in graphical form, which is convenient for system analysts to express their understanding of system requirements; Data flow diagram (DFD, Data flow diagram) is a graphical representation of system logic functions that depicts the transformation that the information flow and data undergo from input to output does not require any specific physical elements, system analysis can be represented by a hierarchical flow diagram data, the lower the level, the more detailed the logical function represents it; A state transition diagram can depict the behavior of a system by depicting the state of the system and the events that cause the system state transition; A data dictionary is a set of definitions for all data elements used in a system, allowing people to have a general idea of the system's inputs and outputs, stored components, and even intermediate results of calculations.[6,7].

Based on the above system requirements analysis models, a software structure is developed, including data design, architecture design, interface design, and process design. It is usually

divided into two phases: preliminary design and detailed design, which is central to the technology in the software development process. The main task of the preliminary design is to correctly decompose the functions of the software through the analysis of specifications in the analysis of requirements, in order to divide the software into modules and design the structure of the modules to perform predetermined functions [8,9]. A detailed design basically designs each module in detail and defines the algorithms and data structures needed to perform the functions of each module. The transition from the system analysis model to the design of the system structure is shown in Figure 1.

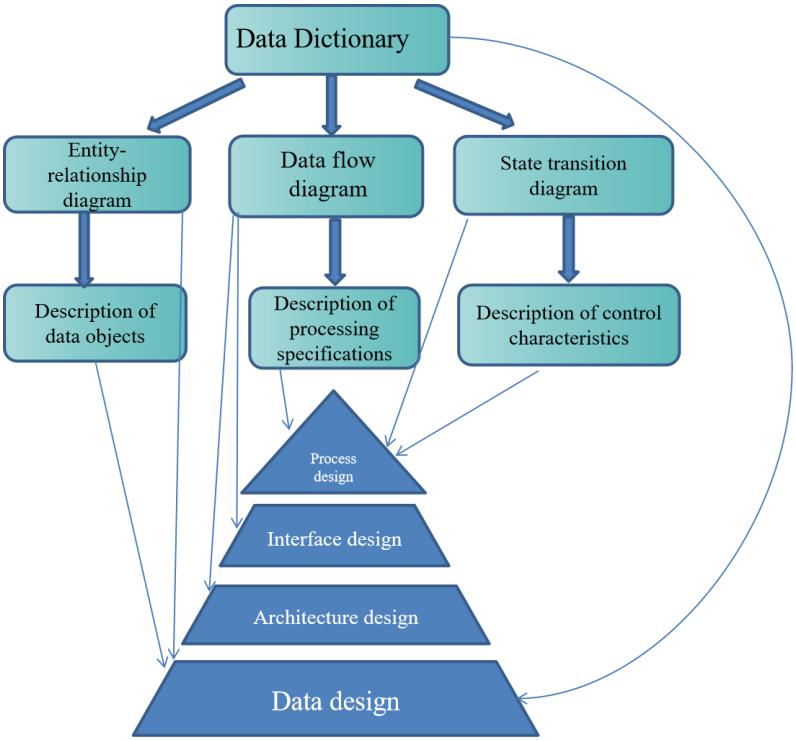

Fig.1. Transformation of system structural analysis and structural design in software engineering

Among them, data design transforms the data model in the analysis phase into the data structure required for software development; architecture design defines the relationships between elements in the main structure of a program, and this design represents the modular structure of a computer. program; interface design describes the methods of software internal communication, the mode of communication between software and collaborative systems, and the mode of communication between man and machine; process design transforms structural elements in software architecture into procedural descriptions of software components [10,11,12,13].

With the help of the above system structural analysis and structural design (commonly referred to as structural design method is a data flow based design method), a software structure design is obtained, which provides assurance of software coding and testing [14,15].

In combination with the purpose of building and using the ITS architecture using similar methods of structural analysis and design, the analysis of building the ITS architecture is as follows.

3 Results

The application of the process-oriented construction method in the ITS architecture is mainly reflected in the construction of the logical architecture of the ITS and the physical architecture. One of the goals of building the ITS architecture is to clarify the functional composition and information flows of a complex ITS system, that is, to clarify the

functional and structural composition of the ITS system. The corresponding situation of structural analysis and design is shown in Figure 1, where the content of the logical architecture mainly corresponds to the processing specification, data flow diagram, and data dictionary in the upper half of the figure, and the content of the physical architecture mainly corresponds to data design, architecture design, and interface design in the lower half. half of the drawing.

The application of the process-oriented analysis method in the logical architecture of ITS is mainly reflected in the functional analysis of user services, which is decomposed in order from top to bottom, which corresponds to the process of people's logical thinking about things. Since the ITS architecture is not a single software system, but includes several systems related to transportation, the development of the ITS logical architecture has characteristics different from software development, mainly as follows: After obtaining the logical function and the data flow table corresponding to each user service, we also need a process to combine similar functions to sort out the logical function hierarchy table, draw a data flow diagram (DFD) of each level, and give an appropriate data dictionary to describe the logical functions and data flow. In the process of functional analysis, each function is implemented in accordance with the service execution process, including the exchange of information between the system and the outside world, the response to a request, and other functions.

The physical architecture of the ITS is built on the basis of the logical architecture of the ITS, based on the basic principles of designing the software structure and dividing the logical functions into modules. The physical architecture of the ITS is converted from the elements of the logical hierarchy table and the data flow diagram, so by decomposing the logical data flow diagram, a system, subsystem, module and other elements of the physical architecture can be obtained, and a communication interface can also be designed.

4 Discussion

In the process of developing the ITS architecture, different countries use different methods, for example, the United States, the European Union and China use a process-oriented method, while Japan uses an object-oriented method. Although various building methods have been compared in detail in software system development, the difference in end goal between ITS architecture and software system development makes the advantages and disadvantages of each software system building method not fully equivalent to ITS architecture building. Therefore, there is no clear basis for choosing a method for constructing the ITS architecture.

5 Conclusion

1. The system analysis method in software engineering is used to analyze the intelligent transportation system architecture, and the direction of ITS architecture development is clarified. Through the analysis, the principles that should be followed in the development of the architecture are determined: the establishment of data models, functional models and behavior models.
2. The analysis process should move from essential information to implementation details.
3. The goal of building the ITS architecture is to clarify the functional and structural components of the ITS system.

4. The construction of the physical architecture of the ITS architecture is a modularization of the logical architecture.

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