A Preliminary Study on the Quality Evaluation of Expressway Network
Free Parking Toll Software System

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Abstract. This paper introduces the developing stage of toll road and the influencing factors of toll collection from the aspect of expressway and toll collection system. The main research object is the application and development of electronic non-stop toll collection system on highway in intelligent traffic. The development stage of ETC (Electronic Toll Collection) related technology is divided in detail. According to the classification basis and test type, the software testing is classified in detail. Taking the three models of software quality evaluation as the analysis object, the general software evaluation process in China is studied, and the development status of software testing in the transportation industry is expounded. Taking the software system of ETC lane terminal as an example, the quality of the system is evaluated, and the research provides data support for construction supervision and operation maintenance.

Development of Expressway and Toll System

The development of toll road promotes the development of expressway. In the world, the development of roads can be divided into two stages according to the upgrading of transport tools, carriage and automobile. The appearance of automobile and its large-scale use in road transportation is also an important turning point for the conversion of ancient toll roads to modern toll roads.

The development of expressway comes from the development of toll roads. The emergence of toll road legislation, from the management level to promote the extension of the road, gradually into a road network, is the rudiments of highway development. The development of toll roads is also affected by advanced modes of transport. For example, the emergence of railway from the source of cargo transport, attracted the goods on the road, reduced the financial sources of toll roads, and affected the rapid development of toll roads to highways. Due to the influence of railway transportation, toll roads gradually stopped expanding. The development of toll roads is also stimulated by economic impact. With the rapid development of economy, automobile has become a popular tool for family travel. The number of means of transport on toll roads has increased dramatically, providing a continuous source of financial resources for the construction of highways.

In the process of highway research, some basic concepts are commonly used: road points, points on highways that can be simplified to units, such as toll stations, can be used as points for different road markings. The road element is the highway between the adjacent road points. Road section: multiple road elements, the composition of the road. Road network: a number of road elements connected to the cross road network. Road network is a connected graph, the main road, auxiliary road, branch road, bifurcation road and many other roads constitute the traffic road, traffic hub, traffic network. According to the national highway plan, it is estimated that by 2020, the scale of China's expressway will reach 50000 km, and by 2040 it will reach 70000 km, forming a highway network extending in all directions.
**Development of ETC**

What is the level of national economic development? The mileage of expressway is an important symbol to measure the development level of national economic construction. What is the state's modern level of development? How to measure the level of national modernization development? With the development of expressway toll collection system, the degree of toll networking is an important embodiment. Expressway can be divided into two types of operating toll roads and loan repayment toll roads according to the way of charging.

ITS (Intelligent Transportation System) Intelligent Transportation system (its) is being researched and developed in most countries in the world, including our country, which is used to ensure traffic safety and improve traffic efficiency. Thus saves energy, improves the environment, and enhances the people to travel the experience the comprehensive transportation system. ETC electronic charging system is an important application in the field of ITS.

Since 1980s, the social economy of developed countries has developed rapidly, and the scale of road network has become more and more perfect, but they cannot keep up with the need of increasing traffic volume, and the phenomenon of road congestion and traffic jam is becoming more and more serious. Environmental pollution and traffic accidents are becoming more and more serious. Because of its many advantages, such as high efficiency and convenience, ETC is being explored and studied in many countries, and is widely used.

China began the research of ETC technology in 1990s. In the past 30 years, the development of ETC in China can be divided into three stages. Prophase (before 2007 as a new business began to be gradually applied to highway construction, and with the industry's experiments and discussions, in 2007 officially promulgated a series of related national standards. Medium-term (2008-2015): with the further exploration and experiment, the ETC network charge was first realized in some regions, and finally the ETC national networking charge was realized in September 2015. Later (after 2016): this period ETC system construction and promotion is no longer the focus of work, the biggest challenge will be how to further improve the quality of operations, improve the quality of service. With the increasing demand for lane function and performance, the workload and complexity of maintenance and maintenance are also increasing. How to ensure the quality and safety of ETC lane system has become an urgent problem to be solved. Moreover, the installation, upgrade and fault detection of lane terminal software have a large workload, long period, unstable accuracy, high requirements for the skills of the tester, resulting in high cost and long cycle of the whole network project.

**Network Charging System**

Xu Nanping, vice minister of science and technology, pointed out in 2017, "China's intelligent transportation transformation will start next year, intelligent transportation will usher in a golden age of innovation and development." To establish a network trust platform for the national network electronic toll settlement system, and to build a national highway network electronic toll clearing and clearing system and a customer service system, It is an important aspect to realize the nationwide cross-regional electronic non-stop charge service.

In accordance with the hierarchical structure, the system can be divided into national clearing and settlement center, provincial network charge and settlement center, provincial network settlement center, and can be divided into issuer and user. Only for the network charges is the whole province within the network charges. Therefore, there are some different classification methods among provinces, but all should include service network and value of stored value points, regional toll center, road toll center, toll station and toll lane, four levels.

Development of Software Testing

Software testing is to find software defects, enhance software correctness and satisfaction as the goal, run through the software life cycle, test planning, design, execution, record results and analysis and maintenance of a series of activities. There are many kinds of software testing methods, different classification can be obtained from different angles:

Classification according to test type by running program static test (desktop check, code review, code walk check), dynamic test (black box test, white box test) by software performance test, reliability test, stress test, Usability testing, load testing, security testing, configuration testing, conformance testing, compatibility testing, documentation testing, user interface testing, software testing by object component, embedded software testing, Web application testing. Service-oriented software tests are reviewed according to the requirements phase of different stages of development, design phase review, unit testing, integration testing, system testing, installation testing, regression testing, acceptance testing, validation testing, α/β test other test techniques combination test, variation test, model-driven test, random test, etc.

Software quality model is the basis of software quality evaluation. As for software quality models, McCall (1977), Boehm (1978) and ISO/IEC9126 (2001) are the most common models in foreign countries. The current mainstream is the quality model given by ISO/IEC 9126: 2001.

The general software evaluation process of GB GB/T 18905.1 mainly includes four steps: establishing evaluation requirements, prescribing evaluation, designing evaluation, and implementing evaluation. Each step includes a number of sub-activities. The research on software testing and its quality evaluation at home and abroad is mature in terms of standards, methods and techniques. It is feasible to establish the software test requirements and evaluation methods of expressway network toll collection system by drawing lessons from domestic and foreign and other industry related software evaluation experience. However, how to combine with expressway toll collection system and ensure the pertinence and maneuverability of standard and management methods is an urgent problem to be solved.

Development of Software Testing in Transportation Industry

The 12th Five-Year Plan for the information of Highway and Waterway Traffic and Transportation (referred to as the "Development Plan") promote the development quality and comprehensive, we can benefit of information and promote the development of modern transportation industry "as the guiding ideology of the 13th Five-Year Plan" information construction. At the same time of realizing the comprehensive application of cross-regional and inter-departmental information in the transportation industry, it is also put on the agenda to effectively improve the development quality of information technology.

To further ensure the quality of industry information systems, The General Office of the Ministry of Communications and Transport also issued the Circular of the General Office of the Ministry of Transport on the issuance of the interim measures for the Management of Information system Construction Technology of the Ministry of Transport (Scientific and technological words of the Department of documentation [2012] 302) "(short for" Circular ", same as below). Among them, Article 22 of Chapter V clearly states that "after the completion of the development of the information system, it shall pass through a third-party software testing institution approved by the Ministry of Industry and Information Technology, in accordance with the requirements of the project contract and the unit using the system," Follow the computer Software testing Specification and other standards to test the functionality, reliability, ease of use and efficiency of the software."

The "Development Plan" and the “Circular” show that the information construction in the field of transportation will enter a new stage of development during the 12th Five-Year Plan period. In this stage, how to ensure the construction quality of the whole industry information system has become an urgent concern and urgent problems in the industry. Software is an important part of information system, and it is also the key factor to exert and restrict the function and performance of information
system. In order to guarantee the steady and rapid development of traffic information construction, software evaluation has become an important way and means to ensure the quality of information system.

At present, although domestic and foreign or other industries have issued the relevant software evaluation standards, but these standards and specifications do not have the characteristics and requirements of the expressway network toll collection system, such as "more points, longer lines, and wide areas" and other industry characteristics and requirements. In addition, there are some requirements for the management of information systems in the industry. However, the existing requirements are still lack of information system software quality "how to test and evaluate" and "how to operate" and so on can be implemented, can be controlled evaluation requirements.

**Quality Evaluation of ETC System Charging Software**

Through the design and implementation of a fast testing tool for lane terminal software, this research can improve the efficiency and accuracy of the test, reduce the cost of labor, and improve the test coverage as far as possible. Through the application of this test tool in the ETC driveway terminal software system, it can help the business management and operation department to find the problem in time, so that it can quickly respond to the failure, even prevent ahead of time, thus further improving the operation quality and improving the service quality.

At present, the research on physical parameter related detection and protocol consistency correlation detection of special short-range communication has been deeply studied. However, the research on the function, performance and monitoring of the software information system, such as the ETC system charge software, is relatively few. For the ETC system production process, the overall quality of automatic monitoring, fault alarm, fault warning related research is evens less. The research of automatic monitoring, detection and alarm for the whole operation quality of ETC system is carried out. The significance of the ETC Lane Terminal Software Rapid Test tool is that:

The main contents are as follows:

1. It is applied to the testing of ETC system before it is put into operation, and the whole ETC system is tested in all aspects to ensure its good operation in official production.
2. In the process of production and operation of ETC system, the ETC system is monitored without affecting its normal business, so that the supervision and maintenance organization can grasp the running state of ETC system in time. Can carry on the maintenance treatment in time when the fault occurs, even before the fault occurs the target carries on the prevention, thus effectively improves the operation quality, enhances the user to use the feeling;
3. In the process of operation and maintenance, the software, hardware, network and other aspects of ETC system are continuously evaluated in many dimensions. It can provide accurate and quantitative data support for ETC system to run reliably and safely, to guarantee the quality of service, to reduce the cost of fault repair and to provide accurate and quantitative data support.

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