Research on the Construction Scheme of Jiangsu Taihu Intelligent Tunnel Based on Cloud Platform

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Abstract. Taihu underwater tunnel in Jiangsu province is an ultra-long and ultra-wide tunnel, both longer and wider than the Hong Kong-Zhuhai-Macao bridge. It is worth discussing how to guarantee the safety of underwater tunnel, give play to the application of intelligent transportation, make travellers get all-round comfortable service and managers get economical and efficient management. Starting from the cloud platform and taking Taihu tunnel as the background, this paper analyses the status quo of the tunnel at home and abroad, draws lessons from experience, and studies the structure and functions of the construction scheme of Taihu intelligent tunnel from the perspective of "safety, comfort and economy".

Keywords: Intelligent transportation; Underwater tunnels; Cloud platforms.

1. Introduction

In September 2019, the CPC central committee and the state council issued the outline for building a transport power. Put forward to build a "safe, convenient, efficient, green, economic" modern comprehensive transportation system, namely: strong self, strong country. We need to build first-class facilities, first-class technology, first-class management and first-class services, and build China into a transport powerhouse that is satisfied with the people, has strong security and is among the world's leading countries. The Taihu tunnel in Jiangsu province is in the Taihu undersea tunnel in the southern expressway of Jiangsu, close to Wuxi city. It is the largest underwater cofferdam highway tunnel dug under the lake in China, and the longest and widest underwater tunnel in China. At present, there are few undersea highway tunnels in foreign countries, most of which are railway tunnels, and the intelligence level is not high. The Hong Kong-Zhuhai-Macao bridge in China is a model project of intelligent transportation, with information release platform and intelligent supervision platform built. However, it is worth thinking about how to ensure the safety of underwater tunnel, improve energy saving efficiency and enhance people's satisfaction. Based on this, this paper aims to explore the application of intelligent transportation in Taihu tunnel in Jiangsu province based on cloud platform. This article is divided into six parts. The first part is the introduction, which mainly introduces the background of the project and my research outline. The second part is some research work about intelligent tunnel around the world. The third part is the demand analysis of Taihu Intelligent tunnel. The fourth part is the whole frame of Taihu Intelligent tunnel. The fifth part is the project plan of Taihu Tunnel. The sixth part is the summary of the full text.
2. Related Work about the Intelligent Tunnel Abroad

2.1. Status of Tunnels Outside China
The foreign super-long tunnel (more than 10 kilometers), which originated earlier, has a lot for us to learn from in fire control, management, emergency rescue and other aspects. The total length of Tonkin bay water tunnel is 15.1 kilometers. The Kawasaki side seabed where ships sail more uses shield tunnel. The tunnel was officially opened in 1997. The tunnel entrance was built on an artificial island. The island was originally a large rest area in the tunnel, with shops, hotels and an observation deck; the tunnel is provided with a fire room to protect the driver from the burning area; Special equipment should not be used in the tunnel to prevent accidents that may not be known how to use.

The Mont Blanc tunnel is a road tunnel connecting France and Italy, 11.6 km long. There was a major fire that killed 39 people and lasted 53 hours. After the accident, 37 emergency shelters with a capacity of 50 people were set up in the tunnel, with emergency telephones and fire-fighting equipment. An emergency rescue center was set up in the middle of the tunnel, equipped with three fire engines and 126 surveillance cameras.

The channel tunnel is the world's third longest undersea tunnel and the world's longest rail tunnel under the sea (39 km). The tunnel was officially opened on 6 May 1994. In order to prevent fire and other accidents in the tunnel, a small auxiliary tunnel was designed between the two main tunnels. This auxiliary tunnel is mainly used as an escape route.

2.2. Status of Tunnels in China
With a total length of about 6.7 km, the Hong Kong-Zhuhai-Macao bridge submarine tunnel is by far the world's longest, deepest buried in the seabed (the deepest is nearly 50 m), the largest single immersed tube volume, the longest service life, the largest number of tunnel lanes and the most difficult comprehensive technology. In view of the problems existing in the traffic information interaction mechanism between Guangdong, Hong Kong, Macao and the Hong Kong-Zhuhai-Macao bridge, a unified information release platform has been built to gather data and information from the bridge and port smoothness, public transportation, surrounding services, customs clearance guidelines, emergency announcements and other aspects. With the Hong Kong-Zhuhai-Macao bridge as the platform, and the application of the 5th generation wireless systems, big data, artificial intelligence and other new technologies, a number of pilot transportation projects such as unmanned driving and hd face recognition have been carried out to build the Guangdong-Hong Kong-Macao greater bay area transportation innovation platform.

Qinling Zhongnan mountain highway tunnel is a four-lane tunnel with double holes located in Zhongnan mountain, Qinling mountains, Shaanxi province. The single tunnel is 18.02 kilometers long, and the double tunnel is 36.04 kilometers long. The special light belt that creates "blue sky and white clouds" in the tunnel is the first in the field of tunnel construction and lighting. Traffic accident intrusion warning system can set up a safe working area for all kinds of operators in the tunnel. The POC wireless intercom system is the first POC wireless intercom system applied to tunnel operation and management in China. It can issue rescue instructions to all first-line rescue personnel and on-duty personnel at the first time after the accident.

3. Characteristics Analysis of Taihu Tunnel in Jiangsu Province
The tunnel is in an underwater closed environment with large traffic flow. It will take about 6.5 minutes for the 10 km long tunnel to be fully closed. Once a major accident occurs, it will be difficult to rescue and the impact will be very serious. Therefore, it is the most important need to ensure tunnel safety, minimize accidents, and reduce the impact of emergencies on life and property. Figure 1 is the interior rendering of Taihu Tunnel. As shown in the figure, the tunnel is divided into three lanes. The tunnel wall is designed to be more suitable for the driver to drive the light, providing a more comfortable form environment.
Based on the situation of tunnel and surrounding road network, combined with the industry development and technology development status, and with reference to the experience of tunnel at home and abroad, it is concluded that the following aspects of tunnel safe operation management need to be considered.

- Implement the adjoint transportation service based on user location
- Realize the global road network management based on user identity
- Network information sharing and collaborative disposal under heavy traffic flow.
- Real-time monitoring and management of key operating vehicle information.
- Multi-source information release based on vehicle-road collaboration.

Normal operation of mechanical and electrical facilities is the basis for safe operation of the tunnel. Timely prediction and discovery of faults of energy-using facilities through power monitoring can effectively reduce traffic safety risks caused by the fault of facilities.

4. The Overall Framework

Based on the characteristics of Taihu tunnel, we proposed to build a non-inductive tunnel with internal and external coordination and vehicle-road coordination. The influencing factors of internal and external coordination are mainly divided into the following categories. The characteristics of vehicle-road collaboration are the full coverage of public network and private network, the precise positioning, space, object and precision perception of lane level, and the seamless connection without blind areas. Based on internal and external coordination and vehicle-road coordination, it can create a sudden sense of no vision/speed/driving behavior; no sense of depression; no anxiety; no fear of the unknown ahead of the tunnel. Based on this, to reflect the characteristics of people-oriented, transport oriented and green oriented, we propose a safe, comfortable, and economic framework based on intelligent infrastructure and intelligent cloud control center.

Figure 2 shows the architecture of the smart tunnel. We based on the Intelligent Infrastructure and Intelligent cloud center, the tunnel construction based on Tunnel IOT perception and interaction based on cloud computing, Comprehensive safety management of underwater tunnel, Rich media-based emergency services, Energy Internet based energy infrastructure efficiency improvement, in order to realize the safety, comfort and economy goals.
Safety, comfort, and economy are the prerequisites for the realization of intelligent transportation. "Safety" means maintaining normal state in daily life, predicting, and preventing abnormal state and handling efficiently in emergency. "Comfort" means environment coordination, visual comfort, and effective information. "Economy" means efficient and smooth road operation, reduced energy consumption of mechanical and electrical facilities, new energy application, digital asset operation, and reduced maintenance costs.

Intelligent infrastructure is divided into civil structure, traffic safety facilities, mechanical and electrical facilities. The civil structure includes east and outside environment coordination, lining coating, landscape transition, etc., which is not considered in this paper. Traffic safety facilities represent the graphic information of the information board, active luminous signs, reflective signs, fixed signs, variable signs, etc. Mechanical and electrical facilities are based on location, network, perception, interaction, control in one of the facilities.

In the traditional monitoring center, the manager and the user cannot share the information well, so the timeliness is low, and the user experience is poor. The road level hybrid intelligent cloud control is user-centered, let the user out of the monitoring center. Build a cloud control center that can be served by both inside and outside the industry, inside and outside the road network, public private network, social users and management users based on the local section, the adjacent section, the provincial center, the ministry of two customers and one crisis, the Internet, operators, meteorological bureau and other multisource data fusion, and push information mainly by the on-board terminal and mobile phone.

Cloud control platform usually adopts self-built or rented, public cloud, private cloud, or hybrid cloud to achieve intra-industry business system data integration and cross-institutional platform data sharing. The cloud control platform system is composed of provincial-level cloud control platform, section-level/region-level cloud control platform and network security facilities. New technologies such as cloud computing, big data, artificial intelligence and edge computing will be utilized to build a unified cloud control platform, so that the cloud control platform will have more comprehensive perception capability, stronger computing capability, smarter control capability and more accurate service capability. Among them, information interaction includes network information exchange capability, business interface, data interface bandwidth, delay and security capability, ETC. Meanwhile, it supports information interaction of ETC vehicle-mounted terminals. In addition, cloud control platform also has a large number of data collection, resource virtualization, data processing, data exchange, objects, machine learning, analysis and cloud security capabilities.

5. Construction Plan

5.1. Tunnel IOT Perception and Interaction Based on Cloud Computing
Taihu tunnel is an underwater tunnel with a length of nearly 11 kilometers. Once a traffic accident occurs, it is the foundation of safe operation and management to find and predict and release the operation status according to the event status. At present, Taihu tunnel data processing methods are basically based on data collection, return to the road section center, monitoring center, processing and prediction, and information release. There is a long interval between information acquisition and event release. At the same time, a large number of video sensors, traffic flow detectors, microwave vehicle detector and other kinds of sensors are arranged in the tunnel, and these sensor modules are used to judge the distance and speed of the target object. With the increase of traffic data volume, users' real-time demand for traffic information is also improving. If these data are transmitted to the background center, bandwidth waste and delay will be caused, and the service based on location recognition cannot be optimized. The intelligent traffic control system is run on the edge server to analyze the data in real time, publish the calculation results in real time, respond quickly and improve the response efficiency of events.

5.2. Comprehensive Safety Management of Underwater Tunnel
For the managers of underwater tunnel, how to ensure the tunnel safe and smooth, minimize the accident rate and the impact of emergency on life and property is the most important demand. The security control scenarios are divided into daily forecast and early warning, event control, maintenance management and special weather control. Managers hope to improve the ability of event prediction and early warning,
from the post-event disposal to the prevention of events. Emergency occurs, the managers in addition to the state of the tunnel control awareness, facilities, and auxiliary decision-making needs, managers in the event you first need to accurately understand the influence of accident vehicle and personnel information, and according to the situation immediately notify the surrounding road network management and travel to the public, and notify the public security, traffic police, medical and fire departments, according to the plan organization traffic restrictions and guidance.

5.3. Rich Media-based Emergency Services
When a sudden accident occurs in the tunnel, vehicle drivers in the tunnel urgently need effective safety guidance measures to safely avoid the occurrence of accidents. The command and dispatching center can quickly obtain the accident information and judge the road area affected by the accident according to the type, location and scale of the accident, so as to carry out the road condition information service for the personnel in the range. Using the mobile terminal to the front end vehicle of the same lane in the accident place, give an early warning, and prompt the vehicle to make preparations in advance; For vehicles that have entered the tunnel, a deceleration warning is issued to prompt vehicles to slow down. Travelers outside the tunnel also hope to be able to get effective traffic guidance, timely avoid encounter events. For the passengers who have not yet entered the tunnel, a detour message will be issued to prompt the passengers to detour. At the same time, drivers and passengers on the interchange highway push accident information, so that the travel personnel can choose the appropriate road for driving.

5.4. Energy Internet Based Energy Infrastructure Efficiency Improvement
With the continuous development of power electronic equipment, the active power electronic device can be adopted, which has strong ability to resist harmonic interference and improve power factor. At present, the main power electronic devices in China are active power filter, power quality correction device and static reactive generator. With the continuous development of power electronic equipment, the active power electronic device can be adopted, which has strong ability to resist harmonic interference and improve power factor. Figure 3 is the interface diagram of power quality optimization.

6. Conclusion
To sum up, in the big data, such as artificial intelligence, the 5th generation wireless systems high speed development today, based on the cloud platform of Taihu lake in Jiangsu the application research of the tunnel from the internal and external coordination, coordination of vehicle road, non-inductive, cloud brain, holographic net, the 5th generation wireless systems, comfortable and so on many dimensions of research, from the perception, management, security, energy-saving four point of inductive research, meet the demand of the traveler all-round comfortable service, managers economic and efficient demand management measures and the safety of the tunnel. There are still many areas to consider for underwater tunnels, and in the future, we will continue to refine our structures and research.

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