

FUTURE TRANSPORTATION — HUMAN-LIKE TRANSPORTATION

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ABSTRACT

The traffic congestion has become a worldwide problem. The current solution is to make the transportation become smart. The origin and definition of smart transportation was expounded and the basic architecture of smart transportation was discussed. A new definition human-like transportation system based on smart transportation, similar to human body system, was put forward to establish the future transportation, which included receptors and nervous system, immune system, endocrine system, respiratory system, etc. This paper was aimed at providing an efficient development direction for the future transportation.

Key words: Smart transportation, Human body system, Human-like transportation system

1 INTRODUCTION

With the accelerating process of urbanization, the population and industry gather to the big city, which results in the appearing of the agglomeration benefits and the rapid growth of the transportation demand, the most important problem is that the limited transportation resources can not match the current transportation demand. Since the middle of 20th century, the problems of traffic accident, traffic congestion, traffic pollution and traffic noise have been springing up, which seriously impacts on the operation of the city and the lives of the residents. On the one hand, those problems delay the time and cause the pecuniary loss of travellers, on the other hand, those problems cause the waste of the resources and the pollution of the environment for the whole society. The traffic congestion has become a worldwide problem, which is an obstacle for the high-speed development of a city (Chen, 2017).

The current method of relieving the pressure of transportation is to make the transportation become smart, the integration of the internet and all kinds of traditional fields has become an irresistible trend. At present, the research of smart transportation is still in the early stage, which focuses on the concept (Cao, et al., 2015), system construction (Li, et al., 2014) and macro-decision (Schaffers, et al., 2011) of smart transportation. With the fast

development of the cutting-edge technologies of the internet of things, the cloud computing, the big data, the artificial intelligence and so on, the new opportunity of future transportation is provided to achieve the desired destination: safe, sufficient, and affordable. This paper was aimed at providing an efficient development direction for the future transportation.

2 SMART TRANSPORTATION—THE ORIGIN OF HUMAN-LIKE TRANSPORTATION

2.1 The origin and definition of smart transportation

In 1960s, the perception of the Intelligent Transportation Systems (ITS) was proposed in the United States. After 50 years of development, three largest research and development bases of ITS, including America, Japan and EU, were formed in the world. “A Vision of Smarter Cities” was proposed by IBM in 2010, which induced the flourishing development of the construction of smart city.

The transportation system is experiencing a change from the intelligent transportation to the smart transportation, which means the transportation can possess the abilities of analysis, thinking and innovation as human beings. As for the ability of thinking as human beings, which not only means the perception, the fusion, the analysis, the integration, the expression and the innovation of the existing resources for transportation system but also contains the new thought and the new discovery brought by the interaction between the transportation system and the transportation users.

At the same time, the emergence and gradual maturity of the new information technology such as the internet of things, the big data and the cloud computing provide the technological foundation and the application platform for the modern transportation system from intelligent transportation to smart transportation. First of all, the internet of things technology puts the essential elements of transportation together by the information exchange devices and the internet for information exchange, communication, aggregation and releasing, which achieves intelligent identification, location, tracking, monitoring and management of traffic elements. The big data technology provides the support to discover the useful information rapidly and mine or analyse the data from lots of arbitrary statistics (from internet of things). The cloud computing technology can achieve the effective integration and management for the big data with a high degree of dispersion and virtualization (Zhang, et al., 2014).

Above all, smart transportation can be defined as follows: the smart transportation aims to the overall perception, the communication exchange, the collaborative operation, the efficient service and the sustainable development of the various elements (including human, vehicle, road and environment) in transportation system based on the intelligent transportation system, which is a more efficient transportation system that not only accumulating the new technology of the internet of things, the big data, the cloud computing, the artificial intelligence and so on but also possessing the abilities of self-organization, judgement, innovation, etc.

2.2 The basic architecture of smart transportation

Smart transportation should include traffic data collection, smart decision-making, smart service, smart operation, external support, and corresponding data transmission and communication protocols (see Figure 1), where the traffic data not only includes the collection and the storage of the big data but also includes the data management and providing first-hand data for users who need it. It should be noteworthy that three core features of smart transportation system are the smart operation, the smart decision-making and the smart service. The smart operation enables the transportation system to deal with general and frequent traffic problems autonomously, where the traffic specific knowledge system is formed to solve traffic problems by self-regulation, which means the better features of adaptivity and robustness are possessed by the transportation system. The smart decision-making provides the decision support for the government departments, the traffic supervision departments, the operation companies and other relevant departments based on the big data mining and analysis, which is the key to the transportation science and the sustainable development. Moreover, based on the data mining and analysis, the smart service provides the customized service of multi-dimension and individuation of point to surface and point to point for users through traffic radio, special communication and network publishing way, etc. The smart service establishes the information feedback mechanism between the users and the decision-makers, which is a window of the public perception of the smart transportation. At the same time, the smart transportation provides the corresponding interfaces for other departments of smart city, so that the transportation system is no longer purely serving the vehicle itself but serving the users or the cities.

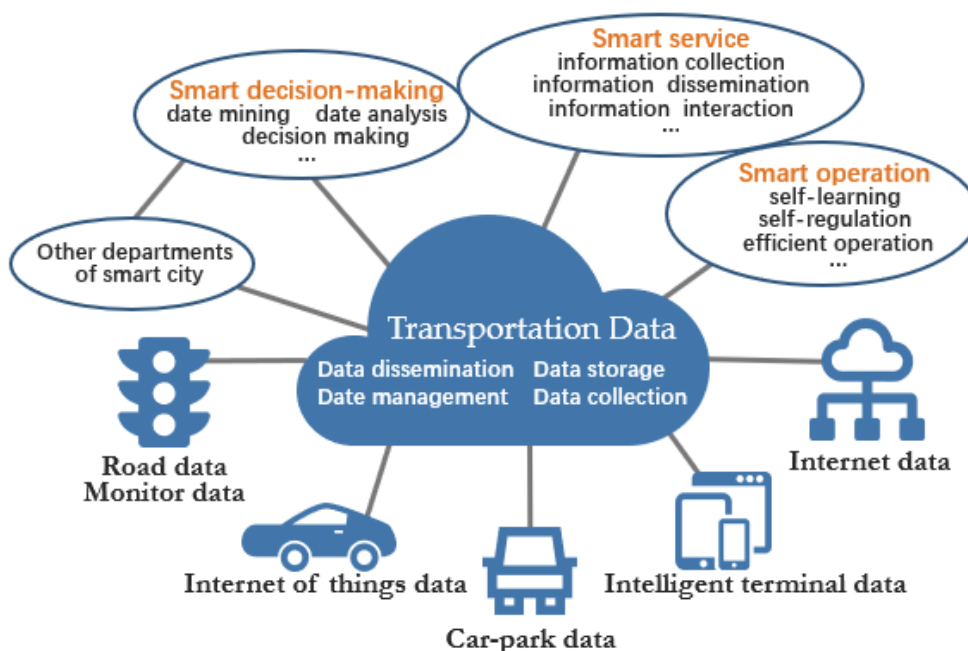


Figure 1. The basic architecture of smart transportation

2.3 The conception of human-like transportation

Smart transportation is to endow the wisdom to the transportation, which means endowing the transportation brain, thus the transportation has the abilities of perception, thinking, analysis, decision-making as similar as human beings. Nevertheless, the future transportation not only entrusts the transportation with the brain, but also possesses the abilities of immunity, self-adjustment and self-recovery, etc. The future transportation not only makes the corresponding response and feedback according to the change of the traffic volume and the external environment but also resists and recovers from the damage, which means the feature of human could be possessed by the transportation to some extent.

3 HUMAN-LIKE TRANSPORTATION

3.1 The meaning of human-like transportation

The road network is the most noticeable imprint made by human beings to nature (Seidler, 2004). The transportation increases social wealth and bring convenience for people's life. Nevertheless, the transportation destroys the natural landscape and the ecological system, there are lots of serious problems, such as the environmental pollution, the landscape fragmentation, the habitat degradation, the increased biological mortality reduction of biodiversity, the invasive species, the ecological barrier and the corridor effect, etc (Li, et al., 2009).

As an exotic object, the transportation will influence the original economical balance, the only way of solving the problem eco-friendly is to integrate the transportation into nature and let it become a part of nature. Specifically, what should we do is to vitalize the transportation, the smart transportation is the first step to achieve it. In fact, all of human production and construction activities are the process of understanding and discovering nature, none of things can really be invented. In the history of mankind, there were a lot of development stories that violated the laws of nature. Eventually, all of us were hoisted by our own petard. Only by following the laws of nature can the transportation keep a long-term stability. The future transportation is needed to connect nature, which means transportation comes from nature and returns to nature.

3.2 The construction of human-like transportation system

The future transportation is the transportation possessed the ability of life, which not only can feel the change of the outside and make corresponding response, but also has the functions of the immunity, the self-regulation and self-recovery to some extent. The human body has nine systems, including motor system, digestive system, respiratory system, urinary system, reproductive system, endocrine system, immune system, nervous system and circulatory system, the specific functions of the human body can be completed by the mutual combination among the various systems. The future transportation should possess some similar properties as human body, the specific functions can also be accomplished with certain system. Figure 2 shows the relationship between the human-like transportation system and the human body system. In addition, the construction and corresponding functions of transportation systems are briefly introduced as follows:

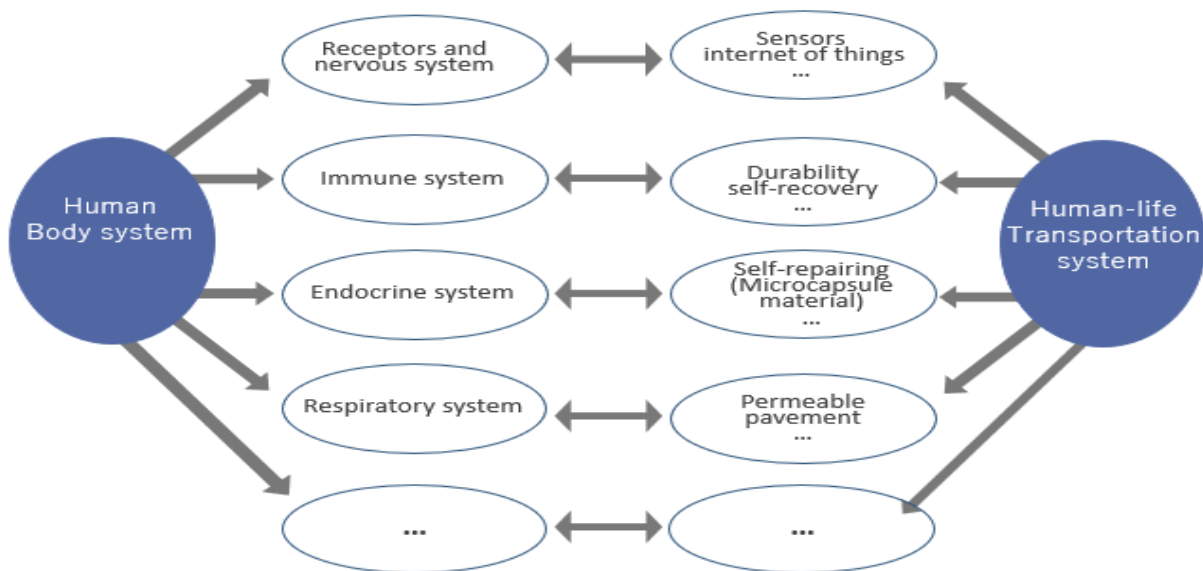


Figure 2. Relationship between the human-like transportation system and the human body system

- Receptors and nervous system: future transportation should install a large number of sensors on roads, vehicles and facilities along the roads, which can perceive the changes of the outside, this function is similar to the human's receptors. In addition, the sensors and the sub-systems of the transportation system can transmit information each other, some facilities possess the abilities of information collection, analysis, management and responding, which is similar to the human's nervous system.
- Immune system: The transportation system can resist the external change and the peripheral intrusion within a certain range to maintain the stability of the internal transportation system. In addition, the transportation has the ability of self-recovery when the transportation system is influenced by the external world to produce a slight injury. Those capacities of transportation are similar to the immune system of the human body. The transportation system is exposed to the complex loads and various environment fields all the time, the capacity of self-defense directly affects the durability

of the transportation system, which is also the basic requirement of transportation design. The self-recovery ability of transportation system can enable transportation to adapt to all kinds of complex environments and restore to its original state under multi-field effects. At present, the emergence of the self-healing materials provides a direction for the accomplishment of self-recovery ability of transportation system. In short, the target of current transportation is long-life, but the future transportation is internal-life.

- Endocrine system: the transportation system secretes the certain substances according to the changes of the system to control and regulate the transportation system. The endocrine system and the nervous system connect each other to ensure the balance of the entire transportation system. There will be various damages appeared when the changes in the transportation system exceed the limitation of the immune system, then the endocrine system begins to secrete special substances and repair the damages. For example, the microcapsule materials are added to the road constructions. When the cracks appear during the service stage, the wall of the microcapsule breaks and the restoration agent outflows to repair the cracks.
- Respiratory system: with the construction of the "sponge city", the breathing road has become an important part of it. The road can breathe freely, which means the road has the ability of the storage and release of water. At present, the researchers focus on the permeable pavement, which has been widely used in various city. The permeable pavement plays an important role in easing urban heat island effect, reducing surface runoff, supplying groundwater resources, intercepting infiltration of rainwater to contain city waterlogging effectively and so on (Zhang, et al., 2009). The breathing capacity of the transportation system can promote the connection between the transportation system and the outside world so that it can be better integrated into the nature.

Moreover, with the development of artificial intelligence, the future transportation should have more and more features similar to the human beings. As described above, this transportation system is only a preliminary conception of future transportation, the future transportation should contain more systems so as to achieve the effective coordination among users, vehicles, roads and environments.

4 CONCLUSIONS

The main and preliminary conclusions drawn from this paper are as follows:

1. The current method of relieving the pressure of transportation is to make the transportation become smart.
2. The smart transportation aims to the overall perception, the communication exchange, the collaborative operation, the efficient service and the sustainable development of the various elements (including human, vehicle, road and environment) in transportation system based on the intelligent transportation system.
3. The basic architecture of smart transportation including traffic data collection, smart decision-making, smart service, smart operation, external support, and corresponding data transmission and communication protocols.

4. The smart transportation is the origin of the human-like transportation, the human-like transportation not only makes the corresponding response and feedback according to the change of the traffic volume and the external environment but also resists and recovers from the damage, which means the feature of life could be possess by the transportation to some extent.

5. The human-like transportation system is similar to human body system, which should include receptors and nervous system, immune system, endocrine system, respiratory system, etc.

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