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# *Analysis of Intelligent Traffic System and Its Processing Algorithm*

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***Abstract:*** With the continuous development of modern cities, traffic jams have become a growing problem. This paper analyzes and discusses the Intelligent Traffic System (ITS) produced by solving traffic jams. The purpose of this paper is to study the composition algorithms of Intelligent Traffic System, including path planning algorithm, network routing algorithm, and speed guidance algorithm. These three different algorithms make up the Intelligent Traffic System. In this paper, the above three algorithms are introduced and analyzed, and some typical algorithms are selected for analysis and introduction. The challenges encountered in the practical application of Intelligent Traffic System are analyzed, including the limitations of technology, management and policy. The future application trend of Intelligent Traffic System in urban construction is forecasted. Finally, through the integration and application of Intelligent Traffic Systems, the efficiency and quality of urban construction and development can be significantly improved to support the realization of safer and environmentally sustainable Traffic systems.

***Keywords:*** Intelligent systems, Network topology, Routing, Intelligent transportation systems

## 1. Introduction

As the main driving force of urban development, transportation systems play an important role in people's lives. With the rapid development of technology, the means for individuals to travel getting larger. Driving cars becomes the most popular way for people to traveling. By the year 2023, there were 417 million cars in China, making China becomes the country which have the largest number of cars in the world. This leads to a result that traffic congestion is getting worse every day [1].

In order to solve this problem, measures are taken by the government. The authority is restricting people from buying cars, banning cars with certain license plates from traveling. However, those policy is not efficient enough to solve the condition that traffic jams often occur. Therefore, intelligent traffic system is studied by the researchers. Having a extensive research prospects, the intelligent traffic system (ITS) is wildly used around the world.

The history of ITS in China started from 1990s [2]. After the first appearance ITS World Congress in 1995, China has spent billions of pounds on the construction of intelligent traffic. The ITS can be a giant plus for the development of city, making it more efficient for the transportation of goods and does little damage to the environment.

Vehicle navigation system is a major part of ITS, and the routing algorithm is the key part of vehicle navigation system. The aim of routing algorithm is choosing the best way to go from the start

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point to ending point [3]. To do this, the routing algorithm needs information from current traffic situations and analysis those situations. A good routing algorithm could help users save time as well as avoid the traffic jams. However, the traditional routing algorithm is only based on the past traffic situations, making it unable to calculate where other vehicles go, resulting harder to avoid the traffic jams.

The intersection speed guidance algorithm is an important part of the whole city road network, and it is also the traffic hub of the whole city. At intersections, the flow of vehicles is complicated, the flow of traffic is disturbed, and there is a high probability of collision in time and space. If the right navigation can be given to the vehicles, there would be less likely to cause a traffic jam and lower the possibility of traffic incidents.

## 2. Analysis of mainstream algorithm of intelligent traffic system

The main algorithm to achieve ITS is divide into two categories, the routing algorithm and intersection speed guidance algorithm. The research about routing algorithm starts from 1950s, it was design to calculate the shortest path in a directed graph [4]. Routing algorithm can be considered as static routing and dynamic routing based on traffic conditions. Static routing was first put forward by American mathematician Bellman, after that it was studied by Dutch computer scientists Dijkstra who came up with the famous Dijkstra algorithm [5]. Until today, Dijkstra algorithm is be deemed to a heuristic algorithm for solving the shortest path problem. Many algorithms based on the optimization of Dijkstra algorithm come out ever since, which have enriched the static routing algorithm. Static routing can find the exact solution of the target in different constraint condition. However, it is too complex to calculate such a result. And the traffic condition is always changing suddenly, which makes the constraint condition change all the time. As a result, it is more worth studying dynamic routing algorithm.

The aim of dynamic routing algorithm is to find the best way to the target position in a dynamic transportation network [6]. Starting in 1960s, the dynamic routing algorithm is studied by many researchers, coming up with lots of way to solve dynamic path planning problem. OpasanonS optimized the dynamic network characteristics of multiple criteria based on existing dynamic routing algorithms, using Dijkstra algorithm combined with genetic algorithm [7].

### 2.1. Analysis of routing algorithms

From 1950s, routing algorithms has attracted researchers' attention. It has come to use in many area such as communication area and traffic domain.

Dijkstra algorithm is a classic routing algorithm [8]. It was used to calculate the shortest path between two points in the weighted graph. The design of Dijkstra algorithm is based on greedy strategy. The greedy strategy is a myopia mode which only considers what is best for a short period instead of the whole picture. At the begin of Dijkstra algorithm, the estimate for the source node is set to 0. Creates a collection of unprocessed nodes. As the algorithm begins, it would calculate the length of path from the source node to all the other nodes from the collection which is mentioned above. And then the node with the lowest estimate length of path among the unprocessed nodes is selected. The selected node is removed from the collection and considered as the current node. After that, the current node is regarded as the source node, starting to do the process again. Finally, all the node is removed from the collection. The estimated shortest path from the source node to each node is the desired shortest path length.

Another classic routing algorithm is Floyd algorithm [9]. It was proposed in 1962 by Robert Floyd who is a professor at Stanford University and also the winner of the Turing Award. This algorithm is also known as interpolation point method. It is also used to find the shortest path between two points

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in the weighted graph same as Dijkstra algorithm. The main idea of Floyd algorithm is to setting intermediate node k to update the shortest path between pairs of nodes. For every two nodes i and j, the algorithm requires to calculate all the possible path and check whether the path through node k is shorter than the known direct path. In this way, the shortest path can be found form i to j. The algorithm keeps running until all nodes are checked. At the end, the shortest paths between per node are represented.

The drawback for Floyd algorithm is that it took too a lot of time to calculate, and requires triple loop traversal, which causing time complexity too high.

### 2.2. Analysis of network routing algorithms

As time goes by, technology becomes more and more advanced. In order to make automobile receive information about traffic conditions, sending information from internet becomes extremely important. Efficient routing technology has become a key part of the development of network technology. In order to send the data to be sent in the network with the highest efficiency, it is necessary to plan the optimal path of the data information to be sent. Network routing technology is to realize the integrated management of the network in the process of interconnection of different networks, in order to achieve the above functions. Network routing algorithm is designed to make information forwarding more convenient.

The primary design purpose of network routing algorithm is the optimal of information transmission, and the optimal criteria will be different in different networks and situations. At the same time, the design must be simple, if the time complexity is too large, the system will pay a certain additional cost, which will lead to delay.

### 2.3. Analysis of speed guidance algorithm

In the process of driving a car, there are always various factors that lead to random changes in the speed of the vehicle. This often happens at signalized intersections. Because there are traffic lights at intersections, and vehicles often change lanes at intersections, it is difficult for drivers to make correct choices due to the limitations of real-time traffic information, which leads to the behavior of cars slowing down or stopping. This also means that if the vehicle can be guided at a reasonable speed at the intersection, the mobility of the car can be effectively increased, thereby reducing traffic congestion.

The speed guidance algorithm mainly starts from obtaining the current traffic situation and analyzes some road characteristics, such as average speed, vehicle density, or the length of vehicles queuing at traffic lights. After obtaining this information, the vehicle can be guided to allow the vehicle to pass the intersection at the fastest speed.

The speed guidance algorithm can also be divided into two categories in the intelligent transportation system, one is the control of traffic lights, and the other is the guidance of vehicles. Because traffic lights are the main reason for the change of vehicle speed, the optimization of traffic lights is essential to control the traffic flow through the intersection quickly. The other is the guidance of the car, the driver can obtain the understanding of the surrounding vehicles through the algorithm, so as to choose the lane with less traffic flow or less queuing time.

## 3. Research status at home and abroad

### 3.1. Routing algorithm

Routing algorithm is widely used in the fields of automatic driving, robot obstacle avoidance, underwater detection and so on [10]. In addition to the traditional algorithms that have been

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introduced, people now have some novel algorithms. Current routing algorithms tend to be intelligent algorithms, with ant colony algorithm being more prominent [10].

In nature, ants can always find food exactly, even though they don't know where it is. Research has shown that ants release a pheromone as they forage, and that the more ants travel the same path, the thicker the pheromone becomes. Through this positive feedback mechanism, the best way to find food can be found. Based on this idea, people developed the ant algorithm. It has been widely used in underwater exploration and other fields.

### 3.2. Network routing algorithms

The way computers are connected is called a Network Topology. Network topology refers to the physical layout of various devices interconnected with transmission media, especially where computers are distributed and how cables pass through them. So, the network topology of linked computers can be considered as a weighted graph, routers in each computer can be used as nodes, the cost of communication between routers, including the delay of different computers, distance can be seen as the weight of an edge. In this way, Dijkstra algorithm can be used to find the best way to connect to the network. The mode is called link state routing algorithm or LS [11].

When the LS starts running, each router has to find all the neighboring routers it can connect to. In order for a router to find other routers, it must first send a message to each link, and the other routers will reply with a signal to identify themselves after receiving the signal. Once the router has found all of its neighbors, it sends another message asking other routers to tell it how much it would cost to connect to them, and the other routers respond to the request and send the information.

Link packets are created every time a set period or when a large number of calls occur on the network. The premise of creating a link group is to collect the entire network information of the neighboring router. Each link group contains the identity information of the sender, serial number, and adjacent node information.

The core part of link state algorithm is state packet distribution. The link group uses the flooding method to send information. In the flooding method, each information node copies the information received and sends it to other nodes besides the information source, and the whole process continues. A serial number is set for each link group, and the serial number is increased when new packets are sent. The information about each packet is recorded by the router. In this way, you can determine whether it has received the information before the new packet arrives. If a message is received that was not received before, it is accepted and sent along another route, otherwise it is discarded.

After this, the link state algorithm is basically built. Then we can use Dijkstra algorithm to find the shortest path. The link state algorithm has strong convergence and is suitable for large-scale networks. However, the storage space required is large, and the work to calculate the shortest path is also huge.

### 3.3. Speed guidance algorithm

As mentioned in the figure above, the speed guidance algorithm can be divided into interference of traffic lights and guidance of vehicle speed. Most of the current algorithms for changing traffic lights are based on coordinated intervention of an entire trunk line. If the traffic lights at a single intersection will cause vehicles to stop several times in front of several intersections, but increase traffic congestion. If multiple intersections on a trunk line cooperate, setting a reasonable signal change cycle will reduce traffic congestion.

Xiao YQ et al. proposed a new method based on the construction of vehicle networking, which can process vehicles at each intersection with a weight. In this way, vehicles with larger length or more urgent vehicles can be treated preferentially, and traffic jams can be solved well [12].

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Among the speed guidance algorithms, green wave speed guidance is more prominent. Green wave speed guidance is to smooth the speed of the car during operation, so that the car reduces the number of stops or does not stop [13]. This algorithm needs to cooperate with the change of the traffic light, if it is green, it is necessary to judge whether the vehicle can pass the intersection at the current speed, if it cannot pass, then determine whether it can pass by accelerating to the highest safe speed, if not, it can only slow down and wait for the next green light period to judge. When the red light is red, it will judge whether the intersection can be reached at a constant speed. If not, it needs to slow down or stop and wait.

## 4. Conclusion

The development of intelligent transportation system still has to face the challenges brought by the future socio-economic development and institutional transformation. When the enterprises in charge of industrial production are rapidly modernizing, the social demand for urban transportation will show an accelerating trend, coupled with the continuous expansion of the scale of the city, the demand for people to drive into the city center will be more and more, which is also a huge challenge to the transportation system. However, with the passage of time, the intelligent traffic system is bound to become more and more perfect, and the traffic problems caused by the rapid development of the city are bound to be solved one day. The transportation system is a complex industry integrating many fields such as computer industry and communication industry, which requires the cooperation and cooperation of the government, enterprises and universities to play its due role, and its development will also drive the progress of these industries.

Therefore, the establishment of intelligent transportation system will drive the comprehensive development of regional economy and technology, and will also have a good improvement of the local service industry. The increase of travel efficiency will bring great economic benefits to all walks of life. In the future, intelligent transportation systems will become more perfect with the progress of science and technology, and will also solve the challenges brought by urban development.

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