Construction and Application of Urban Intelligent Traffic Control System Based on Cloud Computing

Xiangming Zhou
College of Aviation & Tourism, Jiangxi Teachers College, China
2004027027@jxsfgz.com

Abstract. In today's society, severe traffic congestion is one of the main reasons hindering social development. However, China's existing urban transportation system has been basically completed, and it is impossible to make major adjustments. By combining the current fast-developing cloud computing and intelligent algorithms, the original traffic control system is optimized and improved. This system will start from two aspects to optimize the city's traffic system. On the one hand, it establishes an intelligent signal light device to sort out the city's traffic situation, thereby greatly improved the congestion at various intersections; on the other hand, it uses cloud data as the basis of vehicle-mounted mobile terminal users. Real-time traffic routed formulation, reasonable allocation of urban traffic resources.

Keywords: Traffic congestion; cloud computing; traffic control system; cloud data.

1. Introduction
My country's economy is booming, but the congestion problem of urban traffic, the main economic artery, has yet to be resolved. The phenomenon of "snails traveling" at cars has appeared at traffic intersections with many cities, and it is even more chaotic in emergencies, which not only causes extreme waste of energy, but also affects people's travel and restricts the rapid development of the regional economy [1]. The construction and application of urban intelligent traffic control system based on cloud computing is proposed to solve this problem.

2. System overview.
The urban intelligent traffic control system based on cloud computing is composed of two parts: a traffic signaled intelligent transformation all-in-one machine and a cloud computing control system. The traffic signal intelligent conversion integrated machine detects the number of vehicles that need to pass through the intersection with the visual inspection system and transmits the signal to the central processor [2]. The processor changes the time ratio of the traffic signal in real time according to the detected data. The classification status data onto each traffic intersection will be synchronized with the database of the cloud computing control system in real time; the cloud computing control system calls the data, customizes the optimal driving plan according to comprehensive calculation, and feeds it back to the user's on-board client to dynamically divert urban traffic flow. Through intelligent traffic control and real-time dynamic transmission, the dual means of avoiding congested roads by changing the driving
route of vehicles can realize the dredging, guidance and diversion of urban congested roads to achieve the purpose of ensuring traffic safety and smooth traffic [3]. The system process is shown in Figure 1.

![Flow chart of urban intelligent traffic control system](image)

**Figure 1.** Flow chart of urban intelligent traffic control system

3. Overview of the principle of vehicles passing through intersections

In order to facilitate the calculation of vehicle traffic efficiency, vehicles passing through the intersection should be sorted in batches.

3.1. The principle of "packaging" the fleet

The principle of fleet packing is to organize the backlog of red light vehicles passing through the intersection, and reduce the distance between the vehicles that will pass through the intersection to make it a densely-vehicle fleet. The best working condition for traffic signals is to allocate the traffic flow into a fleet, that is, to pack the fleet so that the vehicles pass through the intersection in batches [4]. The principle of the fleet-packed traffic will greatly increase the utilization rate of the green light time.

3.2. Green light traffic efficiency

The use efficiency of the green light time means that when the intersection is in a state where the green light is passable, the vehicles that need to pass are allowed to pass as efficiently as possible.

The calculation formula of the efficiency value \( Q_1 \) is:

\[
Q_1 = \frac{\text{Time} - (\text{Unused Time})}{\text{Time}}. \quad (1)
\]

In formula (1): \( \text{Time} \) is the time used when the light is green; \( \text{Unused Time} \) is the time greater or less than the standard distance between vehicles.

Time wasted \( F \) is calculated as:

\[
F = \text{Unused Time} - W - D \quad (2)
\]

In formula (2): \( W \) is the actual distance between cars; \( D \) is the standard distance between cars.

Saturation \( Q \) is calculated as:

\[
Q = \frac{H'}{H}. \quad (3)
\]

In formula (3): \( Q \) is the saturation, which refers to the ratio of the effective time used by the vehicle through to the display time of the green light; \( H' \) is the effective time used by the vehicle through the vehicle; \( H \) is the time displayed by the green light.

The effective time \( H' \) used by the vehicle to pass is calculated as:

\[
H' = H - (T - th) \quad (4)
\]
In formula (4): when T is the green light, no cars pass on the stop line; t is the neutral distance between the front and rear of the two cars when the traffic flow stops normally before the profile line; h is the indispensable neutral number number[5].

4. Traffic signals intelligent conversion machine.
The intelligent traffic signal conversion integrated machine is the hardware core of the city's intelligent transportation system based on cloud computing. It conducts vehicle grooming by dynamically changing the city's traffic signals. The realization of its functions is mainly based on two major modules [6]. A visual inspection system for detecting traffic flowed and an intelligent signal light control system for dynamic conversion to traffic signals.

4.1. Visual inspection systems.
The vehicle quantity detection device is the hardware foundation of the urban intelligent traffic control system. At present, there are many methods of detecting traffic flow, such as ultrasonic traffic flow information detection method, induction electromagnetic device method, and geomagnetic coil detection device [7]. Compared with other vehicle detection systems, the visual inspection system has the advantages of wide detection range, high detection accuracy, comprehensive information, and real-time status repair.

The vehicle visual inspection system is composed of a camera and an image analysis and processing device. During the waiting period of the red light vehicle, the camera captures the image, and the image processing device captures the characteristics of the real-time captured pictures. Now the feature is set as the license plate of the motor vehicle, and the length of the fleet is defined by the number and distribution of the captured license plate. The detection information is saved and the next detection cycle is entered.

4.2. Signal lights intelligent control system

4.2.1. Setting of travel time. Suppose the fleet consists of n cars, all of them are stationary, the position of the first car is at point B, and the position of the nth car is at the origin of the coordinate axis O. The length of the car is assumed to be b, and the unit is m; the distance of the car is c, the unit is Form. Suppose the uniform acceleration after the stationary start of the first car is a, and the unit is m/s.

When the car is running at a constant speed, the speed is V1, the unit is m/s; the time from starting at a standstill to reaching a constant speed is T1, the unit is s; the total distance L1 traveled by the first car in this process is respectively multiplied by the acceleration time And acceleration distance. Suppose the time T for the driver to follow the start, the unit is s. After the first car is started, the rest of the vehicles are also started [8]. When the nth car also accelerates and the speed reaches V1, all vehicles start. The distance between two adjacent vehicles can be calculated: L (V1 )=V×T. The hypothetical motion situation is shown in Figure 2. It can be seen from Figure 2 that the distance traveled by the first vehicle is called the starting distance I; the time spent driving is called the starting time, denoted as T1. From the two motion diagrams, the driving distance from point B to point B1 from static to point B1 at a constant speed is:

\[ L = BB_1 = (n-1) \times I (v_1) + nb + I_1 + [nb + (n-1)c] \]
\[ = (n-1) \times [I (v_1) - c] + I_1 \]
\[ = (n-1) \times (v_1T - c) + I_1 (1) . \]

It can be concluded that the starting time of the team is:
\[ T = \frac{\langle BB_{1} - I_{t} \rangle}{v_{1} + t_{1}} = \frac{\langle n - 1 \rangle}{\langle v_{1}T - c \rangle} \]

**Figure 2.** Motion diagram

According to the survey data area of most intersections and the time calculation, the traffic light time is set to 5 stages, namely 10 s, 25 s, 50 s, 90 s, and 120 s.

4.2.2. **Signal conversion designed.** The vehicle visual inspection system transmits the processed image data onto the terminal, and the data processing system performs further analysis [9]. The data processing system separates the fleet length information on the source information and performs identification and classification, and processes the classification results. The processing result is sent to the traffic indicating device to control the traffic flow [10].

5. **Development of a dynamic driving plan based on cloud computing**

5.1. **Rating of traffic conditions at intersections.**
The cloud computing control system grades the traffic conditions at intersections by acquiring the data uploaded from the collection points in the database. The traffic conditions at the intersection are rated according to the average value of the last 5 traffic flows at the intersection, and the calculated values are divided into A0, A1, A2. There are different levels such as A3 and A4. A0 means that the road is very smooth; A3 is more crowded; A4 means that the road is impassable or a traffic accident occurs on the road.

5.2. **Customization of dynamic driving schemes for ordinary vehicles.**
The best route for the vehicle are the smoothest route between the start point and the end point in the urban transportation network. Since the traffic conditions of each section of the transportation network change in real time, the best driving route also changes in real time. Therefore, we propose a method of dynamic change of the driving plan, that is, a dynamic adjustment plan of the driving route on the way. The cloud computing control system first customizes the geographical shortest path according to the destination entered by the user on the vehicle client and automatically obtains the user's geographic location [11]. By calling the collection point and uploading the real-time traffic data onto the database, the cloud computing will automatically Change the driving plan to avoid congested roads.

6. **Conclusion**
With the advancement of science and technology, the urban traffic system is constantly updated. With the advent of the information age, the urban traffic control system will inevitably enter the era of intelligence. In the future, urban traffic control systems will no longer simply direct the passage of vehicles and pedestrians, but will also combine new technologies such as the Internet and cloud computing to regulate, induce, and divert urban traffic to ensure traffic safety and smooth flow, and collect urban traffic Data, use big data to predict urban traffic conditions, and provide important data onto smart cars and even driverless cars.
References

[1] Research on starting time of fleet and crossing time [J]. Li Paichang, Ma Sheqiang. Journal of Chinese People’s Public Security University (Natural Science Edition). 2012(03)

[2] The method of dynamic vehicle driving route selection based on urban traffic control system [J]. Yang Zhaosheng, Li Quanxi. Highway Traffic Science and Technology. 1999 (01)

[3] Research on Intelligent Traffic Signal Control System Based on Visual Sensing Technology [D]. Wang Ting. Lanzhou University of Technology 2018

[4] Mathematical model and simulation of urban road network traffic flow[J]. Zhong Jianxin, Wang Zhaosheng. Journal of Anhui Vocational College of Electronics and Information Technology. 2018(01)

[5] Research on the framework of a new generation of urban traffic flow guidance system[J]. Wang Shaofei, Zhang Weibing, Zhang Jixian, Chen Xinhai. Highway Traffic Technology. 2015(06)

[6] Application research of multi-source traffic information fusion technology in Chongqing Intelligent Traffic Guidance System [J]. Song Hong, Chen Ning, Peng Jianguo, Jiang Cheng, Liu Yuyin. Traffic Standardization. 2013 (01)

[7] Modeling and Simulation of Route Selection and Assignment of Urban Traffic Guidance System[J]. Zhang Chunming, Lu Jianxin. Computer Simulation. 2012(12)

[8] Development and simulation of macroscopic traffic flow simulation system for expressway network[J]. Zhang Shengrong, Qian Hongcheng, Sun Xin, Yang Zhenzhen. Computer System Application. 2011(07)

[9] Research on the impact of traffic information on vehicle routing [J]. Guo Ya. Science and Technology Communication. 2011(10)

[10] Research on Beijing VMS layout planning setting [J]. Zhang Rongguang, Qiao Liang. Road Traffic and Safety. 2010(03)

[11] Research on the influence of guidance information and route choice [J]. Zhou Min, Guo Ya. Journal of Guangdong Transportation Vocational and Technical College. 2009(04)

[12] Application of Grey Relational Decision Model in Optimal Route Selection[J]. Fan Li, Sun Yan. Journal of Transportation Engineering and Information. 2008(02)

[13] Intelligent adaptive route selection system based on GIS and grey fuzzy decision theory [J]. Zhang Furen. Journal of Traffic and Transportation Engineering. 2007(05)