Intelligent Tidal Lane System Based on Vehicle Attribute Recognition Algorithm and Related Laws and Regulations

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Abstract — In this paper, an intelligent tidal lane combined with artificial intelligence technology which can adapt to the change of the number of vehicles is designed. The recognition of vehicle position and the direction of vehicle front and rear are recognized by using the vehicle attribute recognition technology based on artificial intelligence. In order to alleviate the morning and evening peak of traffic flow, holiday travel or emergencies caused by two-way lane traffic imbalance, the tidal lane can automatically switch the direction of tidal lane according to the number and direction of vehicles on the two-way road. In addition, we study and analyze the construction of laws and regulations of tidal lane, explore the problems and put forward some suggestions to protect the interests of travelers and maximize social benefits.

1. INTRODUCTION
In the development of urbanization, the number of private cars has been increasing, and urban public transport has been developing constantly, which has greatly shortened the commuting time between villages and towns, and laid a good social material foundation for the development of economy and society. With the rapid increase in the number of private cars and the rapid expansion of urban area. The congestion of one-way road usually happens in the morning and evening peak of working days or holidays [1]. In order to deal with traffic jam, we change the direction of tidal lane according to the number of vehicles in the lane, so as to change the correct driving direction of the road, and maximize the use of road resources in this paper. At present, the existing tidal lanes make a fixed switching scheme according to the historical traffic flow data of roads. Generally, the tidal lanes are opened or closed in a fixed period of time, or controlled by remote control or manual change of signals and movable guardrails in the form of manual observation. This way of manually identifying tidal lane control often makes lane switching ahead of time or lagging behind, and failed to switch entry direction at the best time of tidal lane switching, and could not respond quickly to traffic congestion caused by emergencies. In this paper, we developed an intelligent tidal lane combined with artificial intelligence technology which can adapt to the change of the number of vehicles. In addition, it is an
indispensable part of the current social construction work by improving traffic laws, regulations as well as reasonably improving urban public transport [2]. A perfect traffic laws and regulations system is also an important force to promote the development of the socialist legal system [3-6]. Therefore, it is of far-reaching significance to examine the system of traffic laws and regulations in China, explore the loopholes in relevant laws and regulations, and make reasonable amendments.

2. BACKGROUND

The research on tidal lane technology started earlier in foreign countries, and has achieved a lot of research results. The technology of tidal lane has been implemented on the roads of several cities, and the implementation rules is relatively mature[7], For example, M. collotta et al. utilized dynamic traffic lights based on wireless sensor network and fuzzy logic control technology to control tidal lane[8]. S. Liu et al. made use of multi-class traffic flow estimation model to control traffic signal direction [9]. In June 2003, the first tidal lane in China located in the Waihuan tunnel of Shanghai. Since 2010, several cities have tried to use the tidal lane to manage the tidal traffic flow. In January 2013, the first tidal lane in Hangzhou was opened (see Figure 3 on left). In October 2016, Shenzhen launched Buji Road which is the first automatic tidal lane with special control vehicle "zipper car" (see Figure 3 on right). The tidal lane specifically consists of two parts: "zipper car" and special assembled fence. The isolated assembled fence will be automatically shifted to a lane by using the "s" type "zipper car" for one-time operation. The tide lane is a comprehensive system which integrates mechanical, electronic, control and vehicle technology. In terms of algorithm, Li Leping et al. proposed a vehicle detection algorithm based on traffic monitoring video [10], and Cao Junye et al. proposed a vehicle detection algorithm based on analysis of turning traffic flow characteristics [11], which makes tide lane more intelligent. In addition, an adaptive traffic signal control method is proposed [12]. In [13], a programming method based on MCU is proposed to control the intelligent traffic l

![Figure 1](a) Traditional tidal lane facilities; (b) Automatic tidal lane facilities based on "zipper car"
At present, the traditional tidal lane facilities are mainly composed of signs and road markings. However, signs and road markings are not easy to be observed and the tide time is relatively fixed. The automatic tidal lane facilities are composed of a tidal lane "zipper car" and special assembled fence. The operation speed of the tide lane "zipper car" is 5km/h-10 km/h, which requires manual control, and the operation speed is time consuming. Therefore, the delay of opening or closing the tidal lane will result in the waste of road space resources, which is not conducive to the full play of the tide lane in alleviating traffic congestion. The tide lane based on artificial intelligence can automatically switch the direction of lanes through real-time detection of the traffic flow of two-way lanes, which greatly shortens the switching time of tidal lanes, and has obvious advantages over the traditional automatic tidal lane facilities in the direction of signal control and signal switching time, which can effectively alleviate the urban traffic congestion. It can be rapidly applied to tidal roads in many cities.

3. DESIGN OF INTELLIGENT TIDAL LANE

3.1. Hardware
The intelligent tidal lane control equipment includes intelligent tide lane monitoring device and tidal lane direction indicator. In this equipment, the cameras fixed at both ends of the road and micro embedded hosts are utilized to automatically identify the number of vehicles at both ends of the road. By calculating the number of vehicles in different periods to automatically control the indication signals of LED lights embedded in the middle of tide lane. The intelligent tidal lane control equipment is shown in Figure 2.

![Figure 2. Intelligent tidal lane control equipment](image)

For example, in Figure 3, when the intelligent tidal lane control equipment at the intersection detects that there are more vehicles going eastward than those driving westward, the color on the left side of the tide lane indicator light turns green, and the color on the right side changes to red, indicating that vehicles travelling eastward can pass through. When the drivers (such as a blue vehicle) see that the embedded traffic light in the front tidal lane is green, it means that the drivers of blue vehicle can enter the tidal lane and the drivers of red vehicle cannot enter the tidal lane.

![Figure 3. Example of intelligent tidal lane control vehicle driving state (The tidal lane is opening to the east)](image)

In Figure 4, when the intelligent tidal lane control equipment at the intersection detects that there are more vehicles going westward than those driving eastward, the color on the left side of the tide
lane indicator light turns red, and the color on the right side changes to green, indicating that vehicles travelling westward can pass through. When the drivers (such as a red vehicle) see that the embedded traffic light in the front tidal lane is red, it means that the drivers of red vehicle can enter the tidal lane and the drivers of blue vehicle cannot enter the tidal lane.

Figure 4. Example of intelligent tidal lane control vehicle driving state (The tidal lane is opening to the west)

It can be seen that the intelligent tidal lane we proposed can automatically change the direction of tidal lane through artificial intelligence technology without manual intervention, which has positive significance to alleviate urban traffic congestion.

3.2. Algorithm
Yolo V3 network model is adopted for vehicle attribute recognition network model [14]. This model can detect the vehicle attribute information such as the front, rear, vehicle color and type by training a large number of manually labeled vehicle attribute dataset. However, due to the deep model and large consumption of computing resources, the image data fails to be processed in real time on embedded devices. In order to reduce the amount of calculation and save the memory, this paper proposes a model compression method to reduce the compression of vehicle attribute recognition model which can reduce the computational complexity and improve the computational efficiency. This method converts floating-point data into bit data in the forward propagation process, which can save about 32 times of memory and 16 times of calculation. The model compression method is shown in Figure 5.

Figure 5. Schematic diagram of model compression method

3.3. Laws and regulations

3.3.1. Strengthen publicity of traffic laws and regulations:
To improve the relevant legislation of traffic laws and regulations, it is necessary to standardize the publicity and education system of traffic civilization, strengthen the publicity of traffic laws and regulations, and form an atmosphere of obeying traffic rules and knowing basic traffic laws and regulations in the whole society. First of all, it is necessary to establish and improve the traffic socialization mechanism with diversified participation, and promote the socialization of traffic participants by relying on the coordinated interaction of various social forces. For example, to attract the public to provide volunteer services as traffic managers and enhance the public's sense of responsibility by means of social publicity and participation; Secondly, the publicity of traffic laws and regulations can be carried out through a variety of ways. Courses of common knowledge related to traffic laws and regulations can be opened in primary and middle schools, and the assessment ratio of
traffic laws and regulations can be increased in driving schools and other specialized schools. At the same time, it can also be widely publicized through public media, we media and other means to shoulder social responsibility, strengthen the publicity of traffic laws and regulations, and promote the formation of law-abiding atmosphere. Finally, should strengthen the traffic regulations propaganda team leadership mechanism, propaganda team shall, in the public security department or the combination of the traffic administrative department of the organization, to lead and guide the traffic laws and regulations of the propaganda work, give play to the role of traffic laws and regulations propaganda commanders, establish the scientific, legal, effective propaganda command, to ensure the social propaganda effect maximization.

3.3.2. Building a traffic law system with traffic safety at its core:
To improve traffic laws and regulations, we should adhere to the core concept of ensuring traffic safety, safeguard public travel safety, and protect their right to life and health. First of all, the relevant legislative organs or functional departments should establish detailed standards, norms or laws and regulations, adjust measures to local conditions on the basis of legalization, and conform to the current situation of the local natural geography, human environment, etc. Second, relevant departments should strengthen the supervision of the transportation sector, traffic facilities, traffic tools of relevant enterprises of production operations shall be supervised, ensure it meet the national standards and local standards, to annual appraisal of enterprises, and according to the provisions of the state, according to the actual circumstances of the various public transport enterprise, of its compliance with safety standards evaluation; Finally, for urban traffic related enterprises, they should actively fulfill their social obligations, produce legally and with guaranteed quality, regularly carry out internal business training, and strictly enforce accident management system.

4. EXPERIMENT
This paper combines tidal lane technology with intelligent transportation technology based on artificial intelligence. It can accurately identify road traffic flow through vehicle attribute recognition algorithm, and can quickly respond and take dynamic processing measures according to real-time traffic situation. It can effectively make the tide lane switch at the best time, and make the appropriate adjustment scheme of the tide lane.

In this paper, 200 real scene video datasets collected from the true scene are used for testing, including 106 videos shot by natural light during the day, 25 videos are shot in the morning and evening, and 69 videos are shot at night. The recognition results based on the vehicle attribute recognition technology is shown in Figure 6. It can be seen that the vehicle attribute recognition algorithm can identify vehicle position, front and rear direction of vehicle, vehicle color (white, black, gray, green, red, blue, brown, yellow) and vehicle type (car, SUV, truck, bus). The tidal lane direction indicator is shown in Figure 7.
The experiments are performed on the 200 real scene video dataset. The accuracy rate of vehicle position recognition reaches 98.6%, the accuracy rate of vehicle front and rear recognition reaches 97.6%, the accuracy rate of vehicle type recognition reaches 93.4%, and the accuracy rate of vehicle color recognition reaches 87.7%. By using our modelling compression method, the average computing time per frame (1024 × 768) on rk3399 chip is 86ms, while that of traditional Yolo algorithm [14] is 1108ms.
5. CONCLUSION
In this paper, we developed an intelligent tidal lane device by using vehicle attribute recognition method. The tidal lane can automatically switch the direction of tidal lane according to the number of vehicles on the two-way road. It can also alleviate the morning and evening peak, holiday travel or emergencies caused by two-way lane traffic imbalance. In addition, relevant laws and regulations on tidal lanes are discussed, which can promote the development of intelligent tidal lane and alleviate the pressure of urban congestion.

ACKNOWLEDGMENT
This work was supported by Department of Education of Guangdong Province, Department of Shenzhen Human Resources & Social Security, Shenzhen Polytechnic under contract 2018GkQNCX014, 6019271005K and CXGC2020A0012.

REFERENCE:
[1] Liao Luchao, Jiang Xinhua, Zou Fumin, et al. Automatic identification method of traffic congestion based on Traffic Video [J]. Highway traffic science and technology, 2014, 31 (1): 110-117
[2] Zhou Jiangping. Traffic legislation and the latest traffic authorization law of the United States [J]. Urban transportation, 2006 (01): 80-85
[3] Shan Qiwen. Research on the regulation of urban public transport economic law in China [D]. Anhui University, 2011
[4] Wang et al., 2012
[5] Zhang Zhi. Problems and paths of urban public transport legal system construction [J]. Chongqing Administration (public forum), 2017,18 (05): 43-46
[6] Zhang Shuai. Legal status quo and reflection of urban traffic civilization construction [D]. Southeast University, 2017
[7] D. Ma, X. Luo, W. Li, et al. Traffic demand estimation for lane groups at signal-controlled intersections using travel times from video-imaging detectors[J]. IET Intelligent Transport Systems, 2017, 11(4): 222-229.
[8] M. Collotta, L.L. Bello, G. Pau. A novel approach for dynamic traffic lights management based on Wireless Sensor Networks and multiple fuzzy logic controllers[J]. Expert Systems with Applications, 2015, 42(13): 5403-5415.
[9] S. Liu, H. Hellendoorn, B.D. Schutter. Model predictive control for freeway networks based on multi-class traffic flow and emission models[J]. IEEE Transactions on Intelligent Transportation Systems, 2017, 18(2): 306-320.
[10] Li Leping, Gao Yang. A high accuracy video vehicle detection algorithm for traffic monitoring [J]. Computer measurement and control, 2015, 23 (3): 852-854
[11] Cao Junye, Qu Dayi, Wang Chengzhen, et al. Application of lane change setting based on analysis of turning traffic flow characteristics [J]. Science, technology and engineering, 2016, 16 (18): 290-293
[12] Xiao Mei, Liu Kai, Zhang Lei, et al. Adaptive traffic signal control at intersections based on pedestrian crossing detection [J]. Journal of Chongqing Jiaotong University (NATURAL SCIENCE EDITION), 2016; 35 (5): 120-126
[13] Zhang Wei. Programmable intelligent traffic light control system based on MCU [J]. Electronic design engineering, 2016, 24 (4): 171-174
[14] Joseph Redmon, Ali Farhadi. YOLOv3: An Incremental Improvement, in the processing of 2018 IEEE Conference on Computer Vision and Pattern Recognition, 2018:43-46.