AI+ Smart Transportation-Innovative Application of Urban Smart Transportation Scenarios

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Abstract. The transportation is the artery of urban economic development, and smart transportation is an important component of smart city construction. This project combines Internet of Things technology, big data analysis, computer vision and other cutting-edge computer technologies to collect real-time traffic data and analyze the current traffic situation. Through the design of intelligent signal lamp algorithm, the automatic control of intelligent signal lamp is realized according to different congestion situations, and intelligent flow diversion is realized, so as to relieve traffic congestion.

Keywords: intelligent traffic signal light · intelligent transportation system · big data technology

1 Introduction

In recent years, traffic congestion has become a common phenomenon in large and medium-sized cities because the speed of domestic infrastructure construction lags behind the growth rate of vehicles and the traffic situation is becoming increasingly severe [1]. Smart transportation is the product of the continuous development of urbanization and the inevitable result of the increasingly severe urban traffic problems and the shortage of land resources [2]. This paper uses the solution of AI+ intelligent transportation to establish a new intelligent transportation network. First, holographic perception of intelligent traffic, intelligent analysis of traffic trajectory, timely understanding of the current accurate traffic data; Through visual analysis of the traffic data collected on the road (pedestrian flow and vehicle flow), and combined with the traffic light dreading algorithm, the current road traffic situation is judged and the development trend of traffic in the future is predicted, so as to achieve controllable travel. Finally, according to the real-time acquisition of vehicle traffic status, the vehicle license plate and vehicle image on the road can be identified and collected intelligently, and the abnormal state of the vehicle can be alerted.

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2 Project Implementation Program

The project's solution relies on image analysis processing and deep learning algorithms. It covers areas such as image processing, machine learning and intelligent semaphore algorithms. It is divided into hardware touch screen, administrator side Web interface and large screen side Web interface, and provides 404 pages and open API interface. Ink Knife, Sketch, PS and other tools are used for prototype Design, and React, Ant Design and UNI-APP are used for development technology. The system has a background command and management terminal, a data visualization display terminal and a touch screen terminal. The Pytorch deep learning framework is used to train the model, and the model is deployed on Jetson Nano for calculation, and the data is collected with the camera, so as to jointly complete real-time traffic analysis.

In terms of application environment, the administrator side and data visualization large screen side need Chrome 49.0 or later, FireFox 52.90 or later, IE Edge or later, Opera 44.0 or later, Safari 10.0 or later.

3 Technical Solutions Used in the Project

3.1 Signal Acquisition, Holographic Sensing

The wireless network communication module is used to build the LAN wireless environment core computing module in Infrastructure mode, and the image information of each driving direction is obtained through the intelligent omnidirectional environmental sound acquisition module and the RTMP protocol, and the traffic road information is holographic sensed [3]. Accurate data and information acquisition can improve the accuracy and efficiency of administrators' decision-making and relieve the pressure of traffic congestion from the origin [4].

3.2 Flow Monitoring, Information Return

The YOLOv5 network structure is trained on COCO Dataset 2017 and deployed on Jetson Nano. At the same time, SORT algorithm and virtual coil algorithm are combined to monitor the traffic in real time and accurately send back.

3.3 Audiovisual Recognition, Sirens and Vehicle Tracking

MFCC acoustic features are extracted from UrbanSound8k Dataset to train the multi-layer CNN network and deploy it on Jetson Nano [5]. When the siren of an emergency vehicle is found, the system identifies and tracks the emergency vehicle according to the road condition image at that time, and sends the message back to the server. Easy for users to follow up and make decisions.

3.4 Abnormal Identification, One-Click *Warning*

After the system captures the image information, it uses the HyperLPR framework to identify the license plate number and send it back to the server. After the server receives it, it can compare with the missing detection information database to determine whether the vehicle has missed detection behavior, and remote one-key early warning; At the same time, the system maintains the unique identification of each vehicle to track abnormal vehicles, effectively alleviating the congestion caused by the traffic department's field treatment.

4 Core Function Design

4.1 Panoramic Road Information Perception

The wireless network communication module is used to build the LAN wireless environment core computing module in Infrastructure mode, and the directly connected omnidirectional ambient sound acquisition module is used to collect ambient audio signals in real time. The image information of each driving direction is obtained by RTMP protocol, and the road image is monitored in real time. Finally, after sampling, noise reduction and filtering, the collected signal is sent to the core computing module for operation.

4.2 Abbreviations and Acronyms Traffic Flow Monitoring and Analysis

The traffic flow of a certain intersection is obtained and the traffic flow dredging algorithm is invoked to relieve the congestion.

Algorithm selection: YOLOv5 network architecture (vehicle target detection) + Sort algorithm (real-time vehicle tracking).

The advantages of the algorithm: YOLOv5 can detect the target accurately and process the image quickly; Sort algorithm is composed of Kalman filter and Hungarian algorithm to estimate vehicle position and associate vehicle target respectively. Sort algorithm has low time complexity and is more convenient to track the target in real time.

Implementation steps:

a) Train YOLOv5 on COCO 2017 dataset and deploy it on Jetson Nano.
b) Obtain the video stream collected by the camera, and Jetson Nano detects the target in the video in real time.
c) Use SORT algorithm to track vehicles in real time.
d) The virtual coil algorithm is used to count the traffic flow in and out of the intersection in a certain direction and send it back to the server.

4.3 Intelligent Traffic Light Control Algorithm Based on Traffic Flow

Based on the change of traffic flow in each direction of the intersection, the signal time is dynamically adjusted.

The advantages of the algorithm: the green duration of each direction changes according to the actual traffic flow, solving problems such as excessive traffic flow in a single direction and no traffic during the green time.

Implementation steps:

a) Initial state

At the initial stage of system startup, the sequence of green lights is set as direction 1 → direction 2 → direction 3 → direction 4 → direction 1, and the sequence is circular. Since the traffic flow at the intersection is not detected, the green time of each direction is first initialized as $T_{init} = \frac{T}{4}$, where is the baseline period of the green time. b) Green time update

After the green light turns on, a detection point is set to detect the traffic flow in all directions every Δt interval (indicating the detection point time interval). Under the condition that T_{k0} (represents the green time of the direction at the initial time) is unchanged, the detection times in the green time of the direction is $X = \frac{T_{K0}}{\Delta \mathrm{t}}$, and the green allocation time is not updated every time in X detections. To determine the direction k, the conditions for whether to update the allocated time during the m detection in the green time are as follows:

$$m \leq X \quad m \in N^{+} \tag{1}$$

In where, T_{km} represents the newly allocated green time in direction k after m detections, and T_{km-1} represents the newly allocated green time in direction k after $m-1$ detections. When the above conditions hold, the allocation time of green light will be modified according to the following formula:

$$T_{km} = \frac{N_{km}}{\sum_{k=1}^{4}} \times (T - \Delta t \times m) \tag{2}$$

In where, N_{km} represents the traffic flow in direction k during m detections, Δt represents the detection time interval, and $\boldsymbol{T}$ represents the reference period of green time.

b) Ending conditions of green time

If the calculation result (2) of a detection in the green time of direction k is less than Δt, the remaining green time of direction k will be updated to 0, that is, the green time of direction k will be off, and the yellow light time will be in the following Δt time. After the end of the yellow light time into the next direction of the green time, continue to cycle.

4.4 Audio Preprocessing, Emergency *Vehicle* Identification

Identify emergency vehicles (police cars, fire engines, ambulances) that are honking in a certain direction and turn on automatic signal control.

Algorithm selection: YOLOv5 network architecture (emergency vehicle detection) + Multi-layer CNN network (emergency vehicle siren recognition) + Sort algorithm (real-time tracking of emergency vehicles).

Advantages of the algorithm: The multi-layer CNN network is lightweight and convenient, and achieves 96% accuracy in identifying the siren of emergency vehicles.

Implementation steps:

a) MFCC acoustic features (widely used in speech recognition) are extracted on Urbansound8k dataset to train multi-layer CNN networks.
b) Analyze the environmental audio for the presence of emergency vehicle sirens in each period.
c) If yes, coordinate with YOLOv5 network to determine the direction of emergency vehicles.
d) Track emergency vehicles using the unique identification of each vehicle in the Sort algorithm.

4.5 Identification of Illegal Vehicles, Automatic Recording of Illegal Information

To catch the traffic stop line, missed detection, speeding and red light violations and one-click warning.

Algorithm selection: virtual coil algorithm (judging vehicle crossing line) + YOLOv5 (cutting vehicle image) + HyperLPR open source license plate recognition framework (identifying vehicle number plate).

Advantages of the algorithm: the virtual coil algorithm requires less computation and is easy to understand; HyperLPR has an accuracy rate of 95%–97% in bayonet scenarios. It is good at recognizing Chinese license plates and is more suitable for domestic scenes.

Implementation steps: Identify vehicles crossing the line and running the red light: When the signal light is red, the virtual coil algorithm is used to judge the vehicles crossing the stop line and the video recording is saved for manual second judgment.

Identification of missed vehicle detection: YOLOv5 is used to cut the image of vehicles crossing the stop line, and HyperLPR is used to identify the license plate number and compare it with the missing vehicle information database to determine whether the vehicle is expired.

5 System Creativity and Features

5.1 Big Data Analysis and Visualization

The system of real-time traffic data and vehicle information collected data through the technology of data analysis, based on the traffic situation within a specified time period or region to carry on the summary statistics, including vehicle information, illegal information, real-time traffic, traffic etc. By collecting data to analyze data and visually displaying it, it can assist the large-screen administrator to make traffic decisions and alleviate traffic load.

5.2 Abnormal Information Identification

There are many illegal behaviors and illegal vehicles on the road every day. Traditional manual screening and management requires a lot of manpower and material resources. Through real-time acquisition of vehicle traffic status and uploading videos or pictures to the background, vehicle license plates and images on the road can be identified and collected. Real-time alarm for vehicles in abnormal state.

5.3 Video and Audio Monitoring and Real-Time Analysis

In this paper, the Internet of Things technology is used to holographically perceive the real-time traffic situation, intelligently analyze the flow trajectory, timely understand the current accurate traffic data, and upload the data (including the traffic flow, the flow of people, the number of sirens, etc.) to the background control system to assist the traffic department in making decisions and relieve the traffic pressure.

5.4 Intelligent Signal Lamp Algorithm

In this paper, the intelligent signal light algorithm is designed to change the duration of traffic lights, reduce traffic load and increase commuting efficiency according to the real-time monitoring of different traffic data.

6 Conclusion

This system is dedicated to serving the government transportation departments, aiming at alleviating traffic congestion, improving the efficiency of handling illegal traffic incidents and traffic dispersal, guiding citizens to comply with traffic rules, establishing the conscious awareness of civilized travel, and further promoting the construction of urban smart transportation.

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