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Analysis and Research on the Intelligent Control System of Comprehensive Traffic Signals

Jingxuan Wang[1,a,*]

[1]*School of Mechanical and Energy Engineering, Beijing University of Technology, Beijing, 100010, China*
a. yulaizhong@ldy.edu.rs
**corresponding author*

Abstract: The existing urban traffic signal control system exhibits certain inefficiencies, including prolonged waiting times and frequent traffic congestion. Research indicates that the integration of neural networks can enhance the effectiveness of intelligent traffic control systems, potentially improving overall traffic flow and reducing delays. Neural network is a highly parallel, nonlinear and highly redundant system. Meanwhile, the self-learning and self-organizing capabilities of neural network have unique advantages for those systems that cannot establish accurate mathematical models. According to the characteristics of complex, variable and random traffic conditions at urban intersections, this paper analyzes the traffic signal control by using neural network control method. This paper introduces a design method of intelligent traffic light based on dynamic time adjustment of traffic flow. By detecting the traffic flow on site, and then allocating the green time of each lane according to the neural network algorithm, the traffic flow dynamic adjustment can be realized, and the traffic capacity of the intersection can be effectively improved. This kind of intelligent control traffic lights can effectively control traffic, and has obvious effects on dreading traffic flow, improving road capacity and reducing traffic accidents.

Keywords: Traffic light, Urban neural network, electronic information

1. Introduction

The problem of urban transportation has always been a prominent problem in major cities around the world, and it is also an urgent problem to solve [1]. Intelligent, mobile and dynamic network control technology is very important in today's urban traffic management to raise the efficiency of road traffic and reduce traffic congestion. The seriousness of the urban traffic problem stems from the following causes. The first is urbanization. Second, the rapid increase in the number of urban residents; third, the contingent infrastructure fails to keep up with the development of urban construction. Fourth, urban management still leaves much to be desired. People are the reason why traffic is so serious in the city. The contradiction between the rapid growth of transportation demand and the shortage of transportation supply. So in order to work out the traffic problem in the city. The problem is simple. It is to increase the supply of transportation. But the reality is that transportation demand is growing at the same rate. It is outpacing the supply of transport. However, people are faced with the reality that the growth rate of transportation demand seems to be one. It’s growing faster than the transportation supply.

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Many experts have been studying whether to control the number of private cars or to support the development of private car industry. However, due to the encouragement of national policies, the needs of national economic development and people's demand for a high quality of life. However, the motorization of transportation is the general trend of The Times, and the long-term contradiction between transportation demand and transportation supply and limited construction capital. Both Jin and Urban Space show that it is impossible to solve urban transportation problems by increasing the supply of transportation construction. Therefrom. It seems that only by continuously improving traffic control capabilities and comprehensively digging existing traffic equipment and facilities can the city be alleviated. The city's increasingly prominent traffic problems. Aiming at the shortcomings of the existing work, this paper studies the urban traffic flow prediction based on deep learning, aiming to solve some areas. For the problem of sparse data, multiple traffic flow tasks are combined to forecast, and the complex spatio-temporal characteristics of traffic flow data are fully considered. Consider the differences between input features. The research content of this paper can not only provide a new solution for urban space-time big data prediction, New technological means can also be provided, which can be applied to the actual traffic management system to provide decision support for the traffic management department, such as traffic light control system, traffic route planning, etc [2]. With the continuous expansion of the application scope of artificial intelligence technology in urban intelligent transportation, an information technology industry with artificial intelligence technology as the core has been built, which fundamentally affects people's lives and changes people's living environment [3].

2. Theoretical basis analysis of neural networks

2.1. Basic theory

Neural network is a very commonly used term to describe biological nerves in physiology and anatomy [4]. In computer science, a network is a neural network that can mimic the behavior of an animal. This is a mathematical model that regulates the use of artificial neural networks to process data with each other [5]. The network continuously optimizes network performance by backpropagating the weights based on the error between the output and the actual target value. It's controlled by an artificial nervous system. Much of the parallel cross-connected knowledge has different interpretations in other fields.

That's science. They have different points of view. But these neural network experts from the University of Helsinki are now widely used. According to Konins, muscle social networks consist of simple adaptive units. An artificial neural network is a highly networked parallel network that simulates biological nervous systems to simulate objects in the real world. The body reacts. The neural network is new. Create a mathematical simulation. Neural networks play a role in many fields: image recognition, system recognition, intelligence. One of the most important virtues of the Internet is self-study. In the world of intelligent controllers, these features solve the problem of adaptation of these controllers. At berk, you are a way of using mathematical skills to learn the flushing response method. It has been a practical and practical success. According to the existing research, this neural network architecture can be perfectly applied to urban traffic system to solve the existing problems.

2.2. Application analysis

Neural networks play a role in many fields. Image recognition, system recognition, intelligence. One of the most important virtues of the Internet is self-study. Pay special attention to these features. In the world of intelligent controllers, these features solve the problem of adaptation of these controllers. At berk, you are a way of using mathematical skills to learn the flushing response method. It has been a practical and practical success. Different levels are applied in the traffic signal control system, and

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can deal with different traffic signal control problems. Algorithms for studying bacteria. Different types of traffic control systems respond to traffic problems. Fuzzy logic can be set up in such a way that they do not expect very big changes in the existing traffic control system. Use traditional mathematical algorithms to explain nonlinear or complex traffic control variables. And point to the difference between cars, traffic density, cars and cars. The nonlinear model of general traffic can be used for both strong nonlinear model and flow model.

Neural networks have several advantages over existing modeling techniques. Second, adaptability. Third, nonlinear prediction has greater capability. Fourth, it can effectively handle multiple inputs and multiple expenditures. After long-term research and research, the application of artificial neural network theory has made great progress. Advances have been made in artificial intelligence, automation, computer science, information processing, robotics, and modeling Be a surgeon. For example, cad-/ cam. Intelligent traffic signal control works on green loops, alignment and intersections and intersections in the control area. Because lighting conditions are higher, control points, access points, circuits, and surface control areas are all Provides structural flexibility for maximum capacity services. Keep delays on highways and intersections to a minimum.

Smart phone traffic navigation system is modern information technology, computer technology, data communication technology and sensors. Engineering techniques such as mechanical engineering, electronic control technology, automation theory, operations research and artificial intelligence are effectively integrated. It involves the entire flow of data, management and control to generate tremendous growth. Immediate, correct and effective integrated traffic management will provide effective solutions to reduce traffic and congestion on urban roads Problems such as accidents or pollution. Acoustic control of neural networks is a fundamental approach that applies to models outside of normal models, such as urban models. The highway is controlled by an insecure person and far from being linear, it has a high degree of adaptive adaptation and training.

The control device provides speed information and control signals through control strategies to maintain a dense nearby highway. Before building bp, it usually learn from the number of network layers, the number of neurons per layer, and formulas. In court or somewhere. Network structure decision: Multiple exercises result in a nonlinear projection of the defense network appearing as a known layer. However, as defense network capabilities decline, including a "safe" zone, the situation will get worse and worse. That's right. Not enough to get data from n to m dimensions. The system is badly designed. There, the brain operates through three-dimensional channels (input, hidden, output). Not just my brain, but my brain. If you have the number of neurons, you can figure out what you want, you can print out the human presence. Well, we are our hidden neuron system for obtaining Internet computing passion, the drum-neuronal model involves four signal directions: east, south, west, and north. This is the number of nodes in Layer. The number of nodes in the output layer is 1 (green time to determine the electrical direction). They can simply use hidden layers to strengthen neural networks and increase the number of nerve cells in this hidden area. The accuracy of model training makes it easier for applications to create than to add a new hidden layer to the network. Future research will focus on improving data collection and cleaning methods, expanding the size and diversity of datasets, adjusting and optimizing model parameters, and further improving model accuracy and generalization [6].

3. Challenges and prospects

3.1. Challenges

With the growth of urban population and the rapid increase of vehicle ownership, traffic congestion, environmental pollution, frequent traffic accidents and other problems have become increasingly prominent [7]. The current intelligent traffic light system still faces many problems. First of all, the

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system's weak anti-interference ability cannot guarantee normal operation in extreme weather, which may cause misjudgment due to weather, thus affecting the normal passage of the road. What's more, the basic information of traffic planning is not perfect. Due to the limitations of data collection in traditional traffic planning and the uneven development level of various districts, there are dead corners of information collection in urban road transport management, which makes it impossible to comprehensively analyze the comprehensive situation of urban roads. Moreover, the information resources of various management departments are not fully shared, and the standards of information collection are not uniform. Lack of in-depth data fusion and data mining, the consistency of basic information has certain limitations [8].

3.2. Solution

In extreme weather conditions, the system is turned off and normal traffic lights are used instead. The system is constantly updated and optimized using machine learning to function in more complex and variable road environments. Examine whether components of the system can be cut to reduce the financial burden. Urban road traffic congestion is becoming more and more serious, and traffic congestion has spread from point to line, from local to large scale. This. It not only affects the efficiency and quality of urban life, but also brings many social problems such as environmental pollution and energy waste. Serious constraints on urban development. Some studies have shown that vehicle emissions pollute the urban environment more than factory emissions [9]. It's getting worse. At the same time, the energy consumption of transportation is surprising, especially in crowded, congested traffic. In the general environment, the continuous starting and braking of the vehicle will cause a large amount of energy consumption.

The exhaust emissions and noise generated are six times more than that of normal driving. The speed is increased 1000 times within 88km/h, and the gasoline consumed is 60L more than the normal driving. At the same time, the city traffic support. Crowding will cause a large number of accidents, especially at intersections, which are accident-prone areas, than in the case of heavy traffic. The normal accident rate is more than 100 times higher. To sum up, the effective control of urban intersections has a significant impact on the traffic safety of the whole city and even the entire social environment. The integrated signal light control system is composed of camera, big data processing device and plc signal light control system [10]. When the traffic is busy, the sensor begins to work, the traffic situation is passed into the big data processing device through the camera, and after processing, the information is returned to the plc signal light control to adjust the traffic on the main road and the auxiliary road. In my opinion, the existing traffic structure can be upgraded and optimized based on the urban neural network system. We can solve these problems by constructing neural networks.

4. Conclusion

The number of cars will continue to increase if People's Daily life level is not further improved, which will result in even more cars. With the continuous development of intelligent traffic management system, the coverage of all kinds of road traffic facilities is increasing day by day. For example, traffic jams are becoming more and more serious, causing more and more traffic jams in modern big cities. It is very important to make the most effective use of roads in urban traffic management. However, many problems have arisen during the application process, such as the inability to calculate the waiting time at each intersection that changes with the size of the traffic flow. Overall, the intelligent traffic light control system is more reasonable and human-oriented in the allocation of green light times at each intersection than traditional traffic control methods, and to some extent alleviates traffic pressure. Through reasonable design and effective optimization, intelligent transportation can

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effectively alleviate urban traffic problems, promote the rational use of urban space, and make positive contributions to urban sustainable development.

References

[1] *Jin J, Ma X, Kosonen I. An intelligent control system for traffic lights with simulation-based evaluation. Control engineering practice, 2017, 58: 24-33.*

[2] *Zhengxing X, Qing J, Zhe N, et al. Research on intelligent traffic light control system based on dynamic Bayesian reasoning. Computers & Electrical Engineering, 2020, 84: 106635.*

[3] *Collotta M, Bello L L, Pau G. A novel approach for dynamic traffic lights management based on Wireless Sensor Networks and multiple fuzzy logic controllers. Expert Systems with Applications, 2015, 42(13): 5403-5415.*

[4] *Udovyk I M, Shvachych G G, Pasichnik A M, et al. Intelligent system of traffic light control with dynamic change phases of traffic flows on controlled intersections. Science Review, 2019 (1 (18)): 11-17.*

[5] *Jagadeesh Y M, Akilesh S, Karthik S. Intelligent street lights. Procedia Technology, 2015, 21: 547-551.*

[6] *Wei H, Zheng G, Yao H, et al. Intellilight: A reinforcement learning approach for intelligent traffic light control. Proceedings of the 24th ACM SIGKDD international conference on knowledge discovery & data mining. 2018: 2496-2505.*

[7] *Collotta M, Bello L L, Pau G. A novel approach for dynamic traffic lights management based on Wireless Sensor Networks and multiple fuzzy logic controllers. Expert Systems with Applications, 2015, 42(13): 5403-5415.*

[8] *Liu Y, Liu L, Chen W P. Intelligent traffic light control using distributed multi-agent Q learning. 2017 IEEE 20th international conference on intelligent transportation systems (ITSC). IEEE, 2017: 1-8.*

[9] *Jácome L, Benavides L, Jara D, et al. A survey on intelligent traffic lights. 2018 IEEE International Conference on Automation/XXIII Congress of the Chilean Association of Automatic Control (ICA-ACCA). IEEE, 2018: 1-6.*

[10] *Bhat A G, Roy K, Anchalia P P, et al. Design and implementation of a dynamic intelligent traffic control system. 2015 17th UKSim-AMSS International Conference on Modelling and Simulation (UKSim). IEEE, 2015: 369-373.*