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Optimization of Smart Bus Dispatching Algorithm Based on Passenger Flow Variation Characteristics and Strategies for Holiday Response

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Abstract: *This article mainly talks about how to optimize the intelligent bus scheduling algorithm according to the characteristics of passenger flow changes, and how to deal with holidays. First of all, it talks about the importance and present situation of intelligent bus dispatching. Then, the characteristics of passenger flow change are analyzed, including the law of daily passenger flow and the characteristics of holiday passenger flow. Then, the optimization direction of intelligent bus scheduling algorithm is discussed, including the design concept and key elements of the algorithm. Finally, the strategies for holidays are put forward, including forecasting and early warning, resource allocation and service optimization, in order to improve the operation efficiency and service quality of public transport and meet everyone's travel needs.*

Keywords: *passenger flow variation characteristics; Intelligent bus scheduling; Algorithm optimization; Holiday response strategies.*

INTRODUCTION

With the rapid advancement of global urbanization, the urban population has increased sharply and the urban scale has expanded continuously. Urban transportation is facing unprecedented pressure [1]. Public transportation, as an important part of urban transportation, bears a large number of travel demands, and its operation efficiency and service quality directly affect the traffic operation status of the city and the quality of residents' lives. Public transport has become one of the key methods to solve urban traffic congestion because of its large capacity, low cost and environmental protection [2]. However, the traditional bus scheduling method often relies on fixed timetable and empirical judgment, which is difficult to adapt to the dynamic changes of passenger flow, resulting in bus punctuality, long waiting time for passengers and particularly

crowded cars, which all reduce the attractiveness and competitiveness of public transportation [3]. As an important direction of the intelligent development of public transport, intelligent public transport scheduling uses advanced information technologies such as Internet of Things, big data and artificial intelligence to realize the precise scheduling and dynamic management of public transport vehicles [4]. Through the in-depth mining and analysis of passenger flow data, intelligent bus dispatching can grasp the temporal and spatial distribution law of passenger flow and predict the changing trend of passenger flow, so as to formulate more scientific and reasonable dispatching schemes, improve bus operation efficiency and service quality, and meet the increasingly diversified travel needs of the public [5]. This study wants to optimize our smart public transportation scheduling algorithm according to the characteristics of passenger flow changes, and also to think of some ways to deal with holidays. By carefully studying the daily travel rules of passengers and the characteristics of holidays, plus some advanced algorithm design ideas, we can make the smart public transportation scheduling algorithm smarter and more flexible. In this way, it can adjust the bus operation plan in real time according to the number of passengers and make the resource allocation more reasonable [6]. At the same time, formulating a comprehensive holiday coping strategy can deal with the peak passenger flow during holidays, reduce the pressure of bus operation, make passengers travel better, make public transportation more attractive and competitive, and help the sustainable development of the city's public transportation [7]. This research not only has important theoretical value, but also can enrich the theoretical system of Smart Public Transportation Scheduling and provide reference and inspiration for future research. It also has important practical significance, which can provide scientific scheduling decision support for public transportation enterprises, improve the operational efficiency and service quality of public transportation, alleviate urban traffic congestion and improve residents' travel environment [8].

2. The importance and current situation of intelligent bus dispatching.

2.1 the importance of intelligent bus dispatching

2.1.1 Improve the operational efficiency of public transport.

Intelligent bus dispatching can dynamically adjust the bus operation plan according to the real-time passenger number and road condition information, and reasonably arrange the number of vehicles and the number of departures. In the peak hours and areas with many passengers, arrange more vehicles, increase the number of departures and shorten the waiting time for everyone; In relatively idle periods and areas, the number of vehicles will be appropriately

reduced to reduce operating costs. Through this flexible dispatching mode, the use efficiency of buses can be improved, the empty running distance can be reduced, and the optimization of bus operation resources can be realized, so that the overall operation efficiency of buses can be improved.

2.1.2 Make our travel experience better.

Intelligent bus dispatching can provide passengers with more accurate and timely bus information, which is convenient for us to arrange travel reasonably. Through the tools of bus travel app and electronic bus stop sign, passengers can find out the real-time information of where the bus is going now and how long it will take to arrive at the station, so the time for waiting at the station is less. At the same time, intelligent dispatching can also adjust the crowded degree of the car according to how many people take the car, so as to avoid too many people in the car and make everyone sit more comfortable. Moreover, it can make buses and other means of transportation, such as subway, connect better and provide us with more convenient travel services, so that everyone's travel experience will become better.

2.1.3 Promote the sustainable development of urban traffic.

Bus is a kind of green travel mode, which has the advantages of carrying more passengers, low energy consumption and less pollution. The popularization and application of intelligent bus dispatching can make buses more attractive and competitive, which can guide more people to choose to travel by bus and reduce the use of private cars, thus reducing the energy consumption and environmental pollution of urban traffic and alleviating urban traffic congestion. At the same time, intelligent bus dispatching can also provide decision support for urban traffic management departments, help them formulate more scientific and reasonable traffic policies and development plans, promote the coordinated development of urban traffic, and achieve the sustainable development goal of urban traffic.

2.2 Status of Intelligent Bus Dispatching

Now, many cities have done some exploration and practice in intelligent bus dispatching. On the one hand, by installing GPS positioning equipment and on-board sensors, real-time monitoring and position tracking of buses can be realized, and the driving state and position information of vehicles can be grasped in time. On the other hand, using big data analysis technology, the historical passenger flow data is mined and analyzed to understand the temporal and spatial distribution law of passenger flow and provide a basis for dispatching decision. At the same time, some cities have launched a bus travel app to provide passengers with real-time bus information inquiry service, which is convenient for everyone to arrange travel reasonably. However, there are still some

shortcomings in the current intelligent bus dispatching. For example, the intelligence level of scheduling algorithm needs to be improved, and its adaptability to passenger flow changes is not strong enough, especially in special periods such as holidays, it is difficult to accurately predict passenger flow changes and make timely and effective scheduling adjustments. In addition, the data sharing and cooperation mechanism between different departments is not perfect enough, which affects the overall effect of intelligent bus dispatching.

3.Analysis of Passenger Flow Variation Characteristics

3.1 Daily passenger flow law

The daily passenger flow has obvious spatial and temporal distribution characteristics. From the time point of view, passenger flow presents the characteristics of morning and evening peak hours. During these peak hours, the travel needs such as going to work and going to school are concentrated, which leads to a significant increase in the number of passengers on the bus. During off-peak hours, there are fewer passengers and they are relatively stable. In addition, there will be some differences in passenger flow in different seasons and weather conditions. For example, in hot summer or cold winter, some passengers may choose other modes of transportation, which will reduce the number of passengers on the bus. From a spatial point of view, the distribution of passenger flow has a great relationship with the functional layout of the city. Places like business districts, schools and hospitals usually have a large number of people, while the number of people in the suburbs is relatively small. The passenger flow of different routes is also uneven, with more passengers on some popular routes and fewer passengers on some unpopular routes.

3.2 Characteristics of holiday passenger flow

Compared with the usual passenger flow, the holiday passenger flow is very different. First of all, holiday passenger flow usually becomes particularly large. During the long holidays such as Spring Festival and National Day, people have more time to travel, play and shop, so the number of people taking buses has greatly increased. Secondly, the distribution of holiday passenger flow in time and place is more complicated. In addition to the morning and evening peaks, there may be several crowded hours at noon and afternoon. Moreover, the purpose of everyone's travel is more diverse, some are commuting, some are traveling or visiting relatives, which makes the passenger flow between different regions move more frequently. In addition, during the holidays, the crowds in some popular scenic spots and commercial centers will be particularly concentrated, which will bring great pressure to the operation of buses.

4.Optimization Direction of Intelligent Bus Dispatching Algorithm

4.1 Algorithm design concept

The design of intelligent bus scheduling algorithm should improve the operating efficiency and service quality of buses, and take into account the characteristics of passenger flow changes. The algorithm should be real-time and dynamic, and can adjust the bus operation plan at any time according to passenger information and road conditions. It has to be smart enough to adapt, learn the changing rules of passenger flow by itself, and make the optimal dispatching decision according to different passenger situations. In addition, the algorithm design should also be fair and reasonable to ensure that passengers in different lines and regions can enjoy high-quality bus services.

4.2 Optimization of key elements

4.2.1 Accuracy of passenger flow forecast

Accurate passenger flow forecast is the basis of intelligent bus dispatching. In order to improve the accuracy of passenger flow forecast, we should use a variety of data sources, such as historical passenger flow data, real-time passenger flow data, weather data and holiday information. By establishing an advanced forecasting model, we should analyze and forecast the passenger flow in many aspects, and fully consider the influence of various factors on the passenger flow. At the same time, we should constantly optimize and update the forecasting model, and timely adjust the model parameters according to the actual passenger flow situation, so as to improve the accuracy and reliability of forecasting.

4.2.2 Flexibility of vehicle scheduling

Vehicle scheduling is the core part of intelligent bus scheduling. According to the results of passenger flow forecast and real-time passenger information, we need to reasonably arrange how many cars to invest and their running time. In the period and area with heavy passenger flow, we should invest more vehicles and increase the frequency of departure to meet the travel needs of passengers; In the time period and area with small passenger flow, it is necessary to appropriately reduce the number of vehicles invested, which can reduce operating costs. At the same time, we also need to establish a flexible vehicle allocation mechanism. When the passenger flow of a certain line suddenly increases, vehicles can be dispatched from other lines to support it in time, so as to ensure the stability and reliability of bus operation.

4.2.3 Reasonable arrangement of personnel

Bus operation can not be separated from the support of drivers, dispatcher and other staff. Reasonable personnel arrangement can improve work efficiency and service quality. According to the vehicle operation plan and passenger flow changes, we should

scientifically arrange drivers' working hours and shifts to avoid fatigue driving and ensure driving safety. At the same time, it is also necessary to strengthen the training and management of dispatcher, improve their professional level and emergency handling ability, so that they can accurately judge the changes in passenger flow trends and make reasonable dispatching decisions.

5.Holiday Response Strategies

5.1 Prediction and early warning mechanism

It is very important to establish a comprehensive passenger flow forecast and early warning mechanism for holiday peak passenger flow. Collect and analyze the historical holiday passenger flow data in advance, and accurately predict the scale and spatial distribution of holiday passenger flow in combination with the current holiday characteristics and social activities. According to the prediction results, the corresponding early warning levels and countermeasures are formulated. When the passenger flow reaches a certain early warning threshold, start the emergency plan in time, adjust the bus operation plan, increase the frequency of vehicle delivery and departure, and ensure that the bus operation can meet the travel needs of passengers.

5.2 Resource allocation strategy

During holidays, rational allocation of bus resources is an important means to improve operational efficiency. On the one hand, according to the passenger flow forecast results, reserve enough buses and drivers in advance to ensure sufficient capacity during the peak passenger flow. On the other hand, optimize the vehicle scheduling plan and strengthen the transportation guarantee for popular routes and key areas. The passenger flow pressure on popular routes can be alleviated by opening temporary bus lines and increasing cross-line buses. At the same time, strengthen the connection and coordination with other modes of transportation, such as complementing the subway and taxis to provide passengers with more convenient travel services.

5.3 Service Optimization Measures

On holidays, passengers have higher requirements for the quality of public transport services. Therefore, we need to take a series of service optimization measures to enhance the passenger experience. Strengthen the order maintenance of bus stops, and arrange special personnel to guide passengers to queue up to get on the bus to avoid crowding and confusion. Increase the service facilities of bus stops, such as awnings and seats, to provide passengers with a more comfortable waiting environment. At the same time, through the bus operation APP, electronic bus stop signs, etc., timely release bus operation information and passenger flow warning information, so as to facilitate passengers to make reasonable arrangements for travel. In addition, strengthen the cleanliness and hygiene of public

transport vehicles, improve the cleanliness and hygiene level of vehicles, and create a good riding environment for passengers.

6.Conclusion

The optimization of intelligent bus scheduling algorithms based on passenger flow variation characteristics and the response strategies for holidays are important ways to enhance the operational efficiency and service quality of public transportation. Through in-depth analysis of the daily passenger flow patterns and the characteristics of passenger flows during holidays, the optimization direction of intelligent bus scheduling algorithms is clarified. Starting from key elements such as the accuracy of passenger flow prediction, the flexibility of vehicle scheduling, and the rationality of personnel arrangement, the intelligence and adaptability of the algorithms are improved. At the same time, a complete response strategy for holidays is formulated, a prediction and warning mechanism is established, and public transportation resources are reasonably allocated to optimize public transportation services, which can effectively cope with the peak passenger flow during holidays and meet the travel needs of the public. In the future, with the continuous development and innovation of information technology, intelligent bus scheduling will be continuously improved and upgraded, making greater contributions to the development of urban public transportation.

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