Internet of Things and Intelligent Transportation System

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Abstract. As the core of the new monitoring system, the Internet of Things realizes the integration of wireless sensor networks and traditional communication networks, and provides a platform for remote management and monitoring of the underlying equipment. The intelligent transportation system framework built on this basis combines intelligent transportation technology and the organic combination of vehicle management technologies is conducive to the safety, speed and reliability of vehicle transportation, and plays an important role in further reducing transportation costs. Based on this, this article launched the research on the Internet of Things and intelligent transportation systems. This article first summarizes the concepts of the Internet of Things, intelligent transportation and wireless sensor network technology and the current research status at home and abroad. By analyzing and comparing the performance and characteristics of various communication methods, embedded core microprocessors and embedded operating systems, this paper proposes an overall design scheme of the Internet of Things transportation system based on embedded technology. This paper analyzes the path planning problems in the application of the transportation system, combining the shortest path algorithm simulation results and the actual characteristics of the transportation network, and proposes a simulation data fitting method based on two network parameters and Bellman-Ford, Dijkstra, and Floyd algorithms. The route optimization scheme, and the above-mentioned design scheme was implemented in the transportation system, and the scheme verification was carried out. Finally, this article describes in detail the overall debugging process and operating results of the transportation system, thereby fully verifying the feasibility and correctness of the design and implementation methods of the intelligent transportation system based on the Internet of Things. The research results show that when the INF-PROPORTION is small, the Dijkstra algorithm is better than the Bellman-Ford algorithm. When INF-PROPORTION=0.3, the two algorithms T overlap. Since then, the advantages of the Bellman-Ford algorithm gradually appear, but it is approaching in INF-PROPORTION. At 1 o'clock, the Dijkstra algorithm has a sharp decrease, which is again smaller than the Bellman-Ford algorithm. The second loop condition in the main loop of Dijkstra's algorithm cannot be satisfied, resulting in a decrease in T.

Keywords: Internet of Things, Intelligent Transportation System, Route Planning, Route Optimization
1. Introduction
In today's information world, there are a large number of information interactions between people and things, and things and things, which makes the field of information and communication technology gradually present a new model: the Internet of Things model [1-2]. With the development and deepening of the Internet of Things, its ultimate goal is to connect things in all corners of the world through various nodes formed by sensors, so as to realize the connection between people, people and things, and things anytime and anywhere[3-4]. Our country's vehicle transportation industry should adapt to the trend of the times, walk in the forefront of the times, so as not to be eliminated by the market, and enterprises can obtain greater benefits from it [5-6]. Transportation enterprises should be based on increasing innovation investment, taking innovation as the strategic goal of enterprise development, and rationally applying advanced technology to production practice [7-8].

In the Internet of Things and intelligent transportation systems, many scholars have conducted research on them and achieved good results. For example, Raskar C proposed a plan to develop a ubiquitous network society, which will realize a seamless connection ubiquitous network environment from wired to wireless, from network to terminal, including authentication and data exchange, and finally achieve everyone can benefit from information and communication technology [9]. On the basis of perfecting and expanding the physical layer and data link layer protocols, J Wu formulated new network layer, application support sublayer and high-level application specifications, thus developing a short-distance, low-complexity, and low-power consumption , Low-rate wireless sensor network technology [10].

In order to better carry out the research, this article first gives a brief overview of the development status of the Internet of Things in the transportation industry, and secondly, further analyzes the performance requirements of the intelligent transportation system. We simulate the three algorithms under MATLAB, analyze the actual operating efficiency of various algorithms under different network parameters, and provide a theoretical basis for formulating the optimal path planning scheme of the transportation system. To this end, in order to verify the effectiveness of the measures in this article, we conducted an in-depth analysis of the surveyed data.

2. Research on Internet of Things and Intelligent Transportation System

2.1 The Development Status of the Internet of Things in the Transportation Industry
As a strategic emerging industry, the Internet of Things will bring great vitality to the market and will become a new economic growth point in the next few years. Our country's investment in the Internet of Things related industries has a relatively rapid development trend. Our country's logistics and the Internet of Things vehicle transportation management system based on logistics have developed greatly in recent years. The following is an analysis of the current development of the industry:

1) The degree of informatization of the transportation industry is low: With the development of the market economy, the logistics industry is no longer in the position of my country's terminal industry, and on the contrary, it has become my country's leading industry due to the promotion of the market economy. With the support of communication technology and the modern transportation industry based on the manufacturing industry, the vehicle transportation process will be systematized, informatized and standardized, and it has become the focus of my country's logistics industry. At present, the degree of informatization of my country's vehicle transportation industry is still at a relatively low stage, causing problems such as asymmetry of upstream and downstream information in the transportation industry, and the increase of transported timber due to the complexity of the circulation process. Statistics show that among Chinese enterprises, the degree of informatization has only reached 21%, and even fewer enterprises have fully implemented informatization, which currently only reaches 10%[11].

2) The degree of matching between the transportation industry and economic development is unbalanced: Our country's transportation industry is severely affected by factors such as unbalanced regional development, e-commerce, retail and manufacturing models. It is reported that the
development of China's transportation industry is seriously lagging behind the requirements of economic development. At the same time, it is also affected by the environment of imperfect legal system, imperfect credit system, and enterprise investment cost. These all restrict economic development to a certain extent [12].

(3) Irregular management of the transportation industry: Because the enterprise itself does not have a clear management model and the industry is not standardized, once the enterprise faces difficulties, it is difficult for the enterprise to be acquired and merged, and most foreign acquisitions also end in failure. Therefore, enterprises can only integrate through alliances and alliances.

(4) Trends in the degree of scale and grouping: Related companies in developed countries such as the United States have formed powerful integrated logistics companies through capital expansion and restructuring. Our country's logistics companies lack reasonable management models, advanced management concepts, and have insufficient funds. Therefore, their scale and strength in all aspects are difficult to compete with foreign companies. To change this status quo, we must take the road of cooperation with large domestic logistics companies, reorganization and merger, so that our country's logistics enterprises will develop into comprehensive large-scale multinational enterprises.

2.2 Analysis of Performance Requirements of Intelligent Transportation Systems

Due to the diverse functions of the intelligent transportation system and the complex use environment, many requirements are put forward for the performance of the intelligent transportation system, mainly including accurate data, safe and reliable, low cost, simple operation, and adaptable to various complex industrial environments.

(1) Real-time: As a system that is responsible for data monitoring and alarming, it is a necessary prerequisite to collect accurate data in real time. Therefore, the intelligent transportation system must ensure real-time, that is, no matter the system is parallel to any other business, the data should be guaranteed first Collection and transmission.

(2) Stability: Determined by the function of the intelligent transportation system, its use mode is mostly long-term all-weather operation and unattended, so long-term stable work, low failure rate, and easy maintenance are very necessary for the efficient work of the system. This requires the system's software and hardware design to be reasonable, no hardware failures, and corresponding solutions to problems such as software abnormal deadlocks[13].

(3) Safety: Because the use of this system is mostly in dangerous industrial environments such as electric power and mines or between high-voltage live equipment, such as high-voltage switch cabinets, mobile substations, high-protection switches, and underground high-voltage cable joints, etc. The safety of the entire system is of utmost importance, and it needs to have anti-explosion, flame-retardant, anti-static, low-temperature operation and dustproof properties. On the other hand, the data and user information collected by the system may have high confidentiality, so the system software needs to have a good security mechanism.

(4) Practicality: As an actual product, the intelligent transportation system must be considered not only from the perspective of technical performance, but also from the perspective of practicability. On the one hand, the cost of the entire system is required to be controlled within a certain range, the subsequent operation and maintenance costs are low, and the system platform is easy to build, which is conducive to large-scale use. On the other hand, considering the limited technical level of the actual operators of the system, the entire system should be designed to be easy to operate, easy to maintain, and beneficial to the majority of users [14].

2.3 Research Algorithm

In the shortest path problem, the network model composed of transportation nodes is represented by a weighted directed graph. The mapping of the function from the edge to the real weight reflects the path weight on the transmission link. The weight of the path refers to the sum of the ownership values of the edges of the transmission link in the network. The algorithm is shown in formula (1):
\[ w(p) = \sum_{i=1}^{k} w(v_{j-1}, v_j) \]  

The weight to define the shortest path from u to v is shown in formula (2):

\[ \delta(u, v) = \{ \min\{w(p): u \rightarrow v\} \} \]

We define a recursive formula for the shortest path estimation algorithm as shown in formula (3):

\[ d_{ij}^{(k)} = \{ \min(d_{ij}^{(k-1)}, w_{ij} + d_{ik}^{(k-1)}) \} \]

3. Experimental Research on Internet of Things and Intelligent Transportation System

3.1 Research Materials and Experimental Design

This article will simulate the three algorithms proposed above in MATLAB, analyze the actual operating efficiency of various algorithms under different network parameters, and provide a theoretical basis for formulating the optimal path planning scheme of the transportation system.

In practical applications, users have different concerns about different networks, such as topology, network scale, etc., and the physical meaning of network path weights in different applications are also different, such as distance, speed, cost, etc. In the process of analyzing our transportation system, due to uncertain user needs, we do not care about the physical meaning of the weight on the transmission path. It can be the transmission speed of the communication link, or the cost and energy consumption of the transmission. Just get the weight of the physical meaning, you can bring it into the algorithm for calculation, and get the corresponding optimal path. As for the network itself, we pay more attention to the network scale, that is, the number of nodes in the network graph, because it will directly affect the operating efficiency in various algorithms.

3.2 Analysis Method and Evaluation Content

Due to the particularity of the transportation system network structure, the actual network topology is often expanded in the network diagram. With this expansion, the proportion of unweighted paths in the diagram will change significantly, that is, the number of edges in the network diagram is The ratio of the number of nodes is not fixed, which will also affect the efficiency of the shortest path algorithm.

Through the above analysis, it can be known that the main simulation parameters finally determined for the shortest path algorithm are the number of network nodes N and the network unweighted path ratio INF-PROPORTION. The three algorithms will be simulated for the changes of these two parameters.

4. Analytical Experiment of Internet of Things And Intelligent Transportation System

4.1 Research and Analysis of Three Algorithms N=5 Running Time Curve

This article selects several groups of representative data to compare the data changes of the three algorithms, and analyzes to find out the rules. When N is constant, T changes with INF-PROPORTION. When N=5 is selected, a graph of the running time T of three algorithms with INF-PROPORTION is drawn. The test data is shown in Table 1:

| Operation hours (ms) | Bellman Ford | Dijkstra | Floyd  |
|----------------------|--------------|----------|--------|
| 0                    | 0.060        | 0.180    | 0.103  |
| 0.1                  | 0.045        | 0.121    | 0.072  |
| 0.2                  | 0.065        | 0.189    | 0.110  |
Table 1. Comparison of the running time of three algorithms with N=5

| INF-PROPORTION | Algorithm | Operation hours (ms) |
|----------------|-----------|----------------------|
| 0.3            | Bellman Ford | 0.042               |
|                | Dijkstra   | 0.115               |
|                | Floyd      | 0.069               |
| 0.4            | Bellman Ford | 0.064               |
|                | Dijkstra   | 0.186               |
|                | Floyd      | 0.112               |
| 0.5            | Bellman Ford | 0.040               |
|                | Dijkstra   | 0.117               |
|                | Floyd      | 0.072               |
| 0.6            | Bellman Ford | 0.060               |
|                | Dijkstra   | 0.168               |
|                | Floyd      | 0.106               |
| 0.7            | Bellman Ford | 0.043               |
|                | Dijkstra   | 0.176               |
|                | Floyd      | 0.079               |
| 0.8            | Bellman Ford | 0.068               |
|                | Dijkstra   | 0.165               |
|                | Floyd      | 0.122               |
| 0.9            | Bellman Ford | 0.042               |
|                | Dijkstra   | 0.106               |
|                | Floyd      | 0.079               |
| 1              | Bellman Ford | 0.061               |
|                | Dijkstra   | 0.158               |
|                | Floyd      | 0.121               |

Figure 1. Comparison of the running time of three algorithms with N=5

As shown in Figure 1, it can be clearly seen that Floyd's algorithm is superior to Dijkstra's algorithm in small-scale dense network graphs, which verifies the analysis in the previous section. From the last three sets of data, it can be clearly found that when N is constant, T varies with INF-PROPORTION, that is, the running time of Floyd algorithm is relatively stable, but there is a sudden increase when INF-PROPORTION approaches 1. The overall running time is among the three algorithms Highest. The running time of Bellman-Ford algorithm and Dijkstra algorithm is relatively close. When INF-PROPORTION is small, Dijkstra algorithm is better than Bellman-Ford algorithm. When INF-PROPORTION=0.3, the two algorithms T coincide. Since then, the advantages of Bellman-Ford algorithm gradually appear, But when the INF-PROPORTION approaches 1, the Dijkstra algorithm decreases sharply, which is again smaller than the Bellman-Ford algorithm. This is still due to the previous analysis. In the figure, basically all paths are unweighted. The first in the main loop of Dijkstra algorithm The double loop condition cannot be satisfied, resulting in a decrease in T.

4.2 Verification and Analysis of the Optimal Path Planning Scheme of the Intelligent Transportation System

This paper collects the actual running time of each algorithm in the transportation system through the Web platform, and observes whether the change rule between the two parameters is consistent with the simulation data. Select the data of the INF-PROPORTION=0.2 experimental group for comparison, as shown in Table 2.

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Table 2. Comparison of the actual running time of each algorithm

| Operation hours (ms) | Bellman Ford | Dijkstra | Floyd |
|----------------------|--------------|----------|-------|
| 10                   | 0.08         | 0.14     | 0.15  |
| 30                   | 1.10         | 1.02     | 2.82  |
| 100                  | 32.50        | 32.00    | 96.10 |
| 300                  | 849.00       | 195.00   | 552.01|
| 500                  | 4068         | 3730     | 14063 |

Figure 2. Comparison of the actual running time of each algorithm

It can be seen from Figure 2 that under the same parameter conditions, the JAVA platform realizes the running time T of the three algorithms. The change law curve is basically the same as the MATLAB simulation, but there is a big gap between the two in order of magnitude. The analysis of this reason is mainly due to As an interpreted language, MATLAB's execution efficiency is significantly lower than that of the object-oriented high-level language Java. Therefore, although the two platforms use exactly the same logic to implement algorithms, there is a big difference in the running time of the two under the same parameters, but this does not affect the overall change law of the data is consistent. In addition, because the algorithm module under the Java platform is embedded in the entire Web platform program, Java does not handle the task of the algorithm module separately, and there may be other threads working in parallel in the calculation, which will also run on the algorithm collected by the Java platform. The accuracy of time data has a certain impact.

5. Conclusions
This paper studies the "Intelligent Vehicle Transportation Management System Based on the Internet of Things". The system is divided into two parts: a mobile terminal and a vehicle transportation management system. The mobile terminal includes a collection node and an aggregation node. The collection node mainly uses intelligent sensing technology to obtain environmental parameter values, and uses short-range wireless communication technology to transmit the environmental parameters to the aggregation node. The convergence node applies short-distance wireless communication technology to receive environmental parameters, uses GPS technology to obtain geographic location information of vehicles, and uses GPRS technology to send environmental parameters and geographic location information to the vehicle transportation management system.

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