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Intelligent Logistics Tracking System Based on Wireless Sensor Network

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Abstract: *Wireless sensor networks are widely used to collect and monitor data in the physical world and play a vital role. This article mainly studies the intelligent logistics tracking system based on wireless sensor network. In this paper, the compressed sensing theory is used to reconstruct the environment monitoring data in the cabin to verify the validity of the theory. The five types of sensors are placed in the specified position in the carriage for multi-point sampling, and each node performs data collection every 45 seconds. This paper uses the entropy weight fuzzy comprehensive evaluation method to evaluate the platform planning scheme. The wireless network adopts a multi-zone network networking method, which divides the entire coverage area into multiple sub-areas. Each wireless access point is responsible for controlling a sub-area. At the same time, each wireless access point will also become a mobile terminal and the backbone network. In the actual image transmission, there are two data transmission modes of Zigbee module involved, transparent transmission and point-to-point mode. In the transparent transmission mode, only the communication between the gateway device and the edge device can be carried out, and the communication between the edge devices cannot be carried out. In order to test that the wireless sensor node can actively track the logistics status of the logistics object, this paper uses a temperature sensor to test to test whether the wireless sensor node can actively track the logistics object at different temperatures. In order to achieve the goal of performance testing, a test program was written to simulate a large number of users logging into the system at the same time to perform operations to test the performance of the system. Starting from 15m, the communication radius increases by 5m each time to 50m, and the average positioning error is gradually decreasing. The results show that the introduction of Internet technology and mobile communication network positioning technology into the logistics tracking system can greatly improve the utilization of existing resources.*

Keywords: *Wireless Sensor Network, Intelligent Logistics Tracking System, Positioning Algorithm, Vehicle Routing Problem, System Evaluation*

1. Introduction

WSN does not depend on the original communication facilities in the deployment area, and communication connections can be automatically established between devices in the network, and the network topology will be dynamically adjusted as the devices go online and offline to ensure smooth network flow. This paper combines GPS positioning technology, GPRS data communication technology and wireless sensor network technology to design an efficient and comprehensive intelligent logistics tracking system, which overcomes the traditional use of human-computer interaction interface type computer monitoring system to monitor and track items. The more difficult problems meet the needs of the logistics industry and better serve the modern market.

With the rapid development of modern logistics, the demand for logistics information, especially logistics information tracking service, is constantly increasing. Shippers, logistics enterprises and receivers all hope to obtain timely and accurate information about the logistics status and safety of goods in all links of the supply chain, so as to meet the needs of themselves and other supply chain members for logistics information services, and then promote the improvement of the service level of the whole supply chain. The function of the system is designed based on the flow, storage and distribution of goods, covering all aspects of the business. The logistics management platform can make the correct plan for the user's order demand, and complete the order operation with the minimum purchase cost and the optimal transportation cost.

After using wireless sensor technology in the intelligent logistics system, we can make full use of the advantages of wireless sensor technology, such as non-contact, multi-target and high-speed identification, which not only improves the efficiency of logistics work, but also provides a good basis for intelligent decision-making. In the process of logistics tracking, the passive search of information acquisition is transformed into active push, which makes the system achieve real-time logistics tracking without the huge cost of traditional methods. In the construction of the index system, we should follow the principles of scientificity, systematicness, conciseness and operability, and screen according to the relationship between the evaluated factors, and finally determine the evaluation index and its hierarchical structure.

2. Intelligent Logistics Tracking System

2.1 Related Work

The wireless sensor network expands the existing network and builds a bridge between man and nature. Chen believes that one of the main applications of wireless sensor networks is navigation services for emergency evacuation. Its purpose is to help people escape dangerous areas safely and quickly when an emergency occurs. He proposed CANS. Specifically, CANS uses the idea of the level setting method to track the evolution of the exit and boundary of the dangerous area, so that people near the dangerous area can achieve light congestion at the cost of slight detours, while those far away from the dangerous avoid unnecessary detours. CANS also consider emergency situations by combining local status update schemes. He believes that CANS does not require location information, nor does it require any specific communication model. In the case of limited storage space on each node, it can also be distributed and expandable to the network scale. Although his algorithm is more effective, the factors considered are not comprehensive [1].

Hassani A considers a multi-task wireless sensor network, in which some nodes are designed to apply multi-channel Wiener filters to denoise their local sensor signals, while other nodes are designed to implement linearly constrained minimum variance beamformers to extract specific Based on the desired signal signal of the node and eliminate the interference signal, other methods aim to estimate the node-specific direction of arrival of a set of desired sources. For this multi-task WSN, relying on the low-rank approximation of the required signal correlation matrix distributed signal estimation technology, he designed a distributed algorithm, under this algorithm, even if the nodes are solving different signal processing problems, they It can also collaborate tasks with reduced communication resources. Although his algorithm has a certain degree of convergence, it is not very innovative [2].

Naranjo P G V believes that energy efficiency is one of the main issues that will drive the design of fog-supported wireless sensor networks (WSN). In fact, the behavior of this kind of network becomes very unstable in the heterogeneity of nodes and/or the failure of nodes. He proposed an improved stable election protocol to extend the stable time of the sensor network supported by Fog by maintaining a balanced energy consumption. He evaluated the performance of the proposed method by changing various parameters of the network. Although his algorithm network has a long life, it lacks some necessary experimental data [3].

Han G believes that localization is one of the key technologies of wireless sensor networks (WSN) because it provides basic support for many location-aware protocols and applications. A promising method for locating unknown nodes is to use mobile anchor nodes, which are equipped with GPS units that move between unknown nodes and broadcast their current location regularly to help nearby unknown nodes locate. In addition, he strives to conduct a comprehensive review of the latest breakthroughs in the field and provide links to the most interesting and successful developments in the field of research. Although his research is relatively reliable, its accuracy is not high [4].

2.2 Wireless Sensor Network

Most of the current sensor nodes are highly integrated, small in size, and usually equipped with batteries with very limited energy. However, the way of battery power supply makes the communication capacity of the nodes greatly restricted and is not easy to maintain. At present, there are many researches on the power supply mode of sensor nodes. Most of them are by analyzing the environment in which the sensor is located and obtaining energy from it. This method is theoretically feasible, but the actual operation is more cumbersome, which undoubtedly increases the complexity of the positioning technology [5]. Assuming that the node has unlimited energy storage capacity, the

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energy collected by the node in the time period $\left[t_0, t_0+\Delta T\right]$ is:

$$E_h(t_0,t_0+\Delta T)=\int_{t_0}^{t_0+\Delta T}\eta_e f_e(t)dt=\eta_e\int_{t_0}^{t_0+\Delta T} f_e(t)dt \tag{1}$$

Where t_0 is the starting point of the energy collection time, and ΔT is the collection time interval.

Assuming that the maximum stored energy of the node is $E_{\max}$, and the remaining energy of the node is E_{left}, then the remaining energy after energy collection is:

$$E_H(t_0,t_0+\Delta T)=\min(E_{left}+E_h(t_0,t_0+\Delta T),E_{\max}) \tag{2}$$

In most cases, the target's motion state will not change much in a short time, so the following approximate constant velocity model can be used to describe the target's motion:

$$X(k+1)=A(\Delta\tau_k)X(k)+w(k) \tag{3}$$

Among them,

$$A(\Delta\tau_k)=\begin{bmatrix}1 & \Delta\tau_k & 0 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & \Delta\tau_k\\ 0 & 0 & 0 & 1\end{bmatrix} \tag{4}$$

$$Q(\Delta\tau_k)=\begin{bmatrix}\frac{\Delta\tau_k{}^3}{3} & \frac{\Delta\tau_k{}^2}{2} & 0 & 0\\ \frac{\Delta\tau_k{}^2}{2} & \Delta\tau_k & 0 & 0\\ 0 & 0 & \frac{\Delta\tau_k{}^3}{3} & \frac{\Delta\tau_k{}^2}{2}\\ 0 & 0 & \frac{\Delta\tau_k{}^2}{2} & \Delta\tau_k\end{bmatrix} \tag{5}$$

The prediction of the target by the extended Kalman filter is:

$$\hat{X}(k+1|k)=A(\Delta\tau_k)\hat{X}(k|k) \tag{6}$$

$$P(k+1|k)=A(\Delta\tau_k)P(k|k)A(\Delta\tau_k)^T+Q(\Delta\tau_k) \tag{7}$$

Before dispatching the sensor at τ_k, the predicted value of the target state at time step $k+j$ is:

$$\hat{X}(k+j|k)=\left[A(\Delta\tau_k)\right]^j\hat{X}(k|k) \tag{8}$$

The predicted value of the corresponding error covariance is:

$$P^-(k+j|k)=A(\Delta\tau_k)P^+(k+j-1|k)A(\Delta\tau_k)^T+Q(\Delta\tau_k) \tag{9}$$

The Kalman gain is:

$$K(k+j|k)=\frac{P^-(k+j|k)H^T(k+j|k)}{\left[H(k+j|k)P^-(k+j|k)H^T(k+j|k)+R(k+j)\right]} \tag{10}$$

Where $H(k+j|k)$ is the Jacobian function of the measurement function $h(X(k))$ at τ_k

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with respect to $\hat{X}(k+j\,|\,k)$.

Given a threshold value T, if the variance value in time window t is greater than the threshold value T, then N new abnormal RSSI values added in this time window are eliminated. The expression of anti-interference measurement value is as follows:

$$\overline{RSSI} = \frac{1}{M-N}\sum_{i=1}^{M-N} r_{l,T}(i) \tag{11}$$

The optimized centroid weight formula is as follows:

$$\begin{cases} x_p = \dfrac{\sum_{i=1}^{3} w_i RSSI_i x_i}{\sum_{i=1}^{3} RSSI_i w_i} \\ x_p = \dfrac{\sum_{i=1}^{3} w_i RSSI_i y_i}{\sum_{i=1}^{3} RSSI_i w_i} \end{cases} \tag{12}$$

Sensor networks need to have certain self-organization ability to configure and manage the nodes in the network. In practice, sensor node failures or failures due to lack of energy often occur, or some nodes are added artificially. As for whether to add or delete nodes, the topology of WSN should also be changed, and this dynamic topology change needs self-organization adaptation [6]. The security and reliability of the network is the focus of any network, and sensors are placed in the harsh environment that human beings should not reach. Nodes may be affected by various environmental factors, such as solar radiation, wind and rain, and cold climate. The test area is usually very wide, which poses a great challenge to the establishment of a reliable network [7-8].

The covariance matrix of the received signal can be expressed as:

$$R_x = E[X(t)X^H(t)] = AE[SS^H]A^H + AE[SN^H] = E[NS^H]A^H + E[NN^H] \tag{13}$$

Assuming that the signal and noise are independent, and the noise is Gaussian white noise with zero mean and variance of σ^2, that is, $E[NN^H] = \sigma^2 I$, the above formula can be simplified as:

$$R_x = AR_sA^H + \sigma^2 I \tag{14}$$

Where R_s is the covariance matrix of the incident signal.

When the nodes in the wireless sensor network collect information, each node collects information, but it is possible that this information will be redundant or useless, which is caused by its own randomness and dynamics [9]. Data fusion technology can calculate and process these data, reduce the number of node information transmission, save node energy consumption, and obtain efficient and accurate information. After positioning, the ratio of the number of successfully positioned unknown nodes to the number of all unknown nodes in the monitoring area is called positioning coverage [10]. The most ideal location coverage is that the node can cover 100% of the monitored area. In the actual network, due to the uneven distribution of sensor nodes, there will be too many or too few anchor nodes in some areas, resulting in the inability to locate and the performance of the positioning algorithm [11]. Generally speaking, this method will ensure that the unknown node uses the corresponding correction factor for its nearest anchor node. In addition, if the network is large, the TTL field can be set in the packet to allocate the correction factor, so as to reduce the signaling and congestion in the network. This will again ensure that the correction factor calculated by the anchor node is used by unknown nodes in its neighborhood. The TTL field limits the propagation of the correction factor and also complements the use strategy of the received first correction factor. The distance between the anchor node and the unknown node is estimated, and there may be errors with the actual distance, so in the calculation, the error of calculating the unknown node coordinates will increase. For example, for trilateration, if the three anchor nodes around the unknown node are in the same line, then the node position cannot be obtained. When the average hop distance of the three anchor nodes is very different, the calculated node position will also have a big error.

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2.3 Intelligent Logistics Tracking System

Intelligent logistics systems generally contact multiple production companies and users, and their needs, supplies, channels, and prices are constantly changing. Therefore, intelligent logistics systems will be subject to extensive constraints from social production and demand. Therefore, it must have the ability to dynamically adapt to the environment, and make corresponding adjustments when the social environment changes significantly [12]. Flexibility and variability are very important for intelligent logistics systems. Because the Internet has the advantages of high speed and low cost, it is very suitable as the communication channel of logistics network. In order to realize the information sharing between various links and departments in the information system, it is first necessary to clarify the main sources of information in the logistics system, and then make different treatments according to the characteristics of these different sources of information [13].

The use of RFID technology to complete the data collection of the system solves the problems of slow manual entry, high bit error rate, high work intensity, and low work efficiency. The RFID system realizes the rapid and accurate collection and upload of information. In the work of the RFID system, multiple radio frequency tags can be read simultaneously under dynamic transmission, the reading process does not require manual intervention, and the reading is efficient and accurate [14]. In addition, the amount of information stored in the radio frequency tag is larger, and it can be automatically rewritten during the reading process. The label is more safe and difficult to forge. The radio frequency tag is not afraid of oil stains and dust pollution, and can work in a variety of harsh environments [15].

The system framework is shown as in Figure 1. In a relatively large-scale system, in order to ensure the timeliness of information, the collection, transmission, processing and processing of information must be accelerated. The introduction of logistics tracking and emergency decision-making systems is one of the trends in logistics development. The integration of GIS technology into the logistics process meets the immediate and efficient requirements of modern logistics, helps logistics distribution companies to effectively use existing resources, and helps the fourth party logistics to track the logistics process in an all-round way. Whether it is a cargo owner enterprise user or a third-party logistics company can obtain the services provided by the system, understand the various status of the goods in real time during the logistics process, and can complete the query and statistics through the system [16-17].

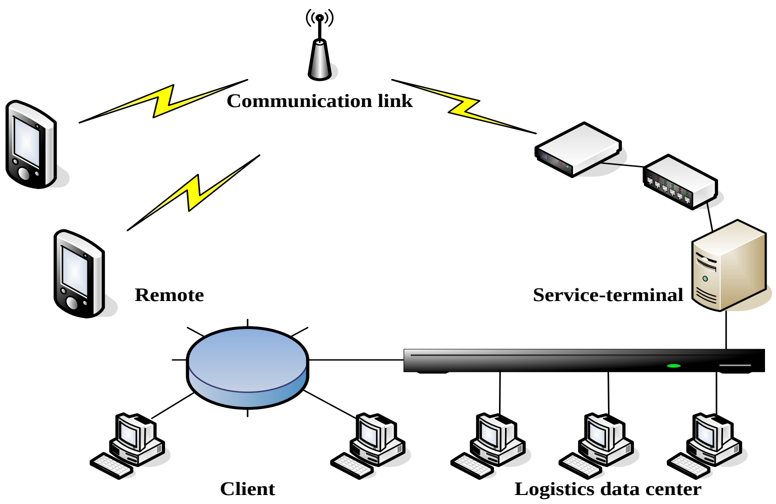

Figure 1: System framework

The internal structure of the sensor node is shown in Figure 2. It can be seen from the figure that the simplest structure is the energy supply module, which is responsible for supplying energy to the other three modules to ensure that other modules can work normally. Therefore, the sensor network needs to have certain self-organization ability to configure and manage the nodes in the network. In actual situations, sensor node failures or failures caused by insufficient energy often occur. Or sometimes add some nodes artificially. Therefore, the sensor network needs to have certain self-organization ability to configure and manage the nodes in the network. In actual situations, sensor node failures or failures caused by insufficient energy often occur. Or sometimes add some nodes artificially.

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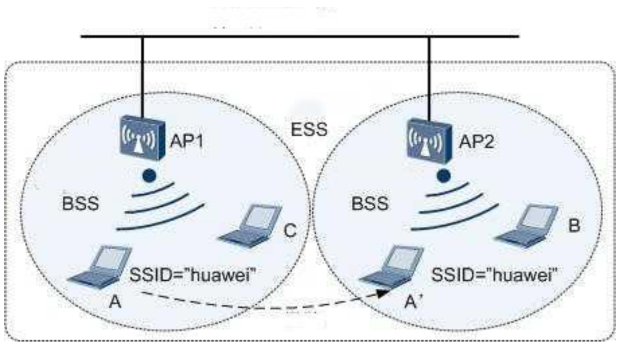

Figure 2: The internal structure of the sensor node (picture from http://alturl.com/egrvh)

3. Simulation Experiment of Intelligent Logistics Tracking System

3.1 Experimental Environment

In this paper, the compressed sensing theory is used to reconstruct the environment monitoring data in the cabin to verify the validity of the theory. The five types of sensors are placed in the specified position in the carriage for multi-point sampling. Each node performs data collection every 45 seconds. The system immediately enters the sleep state after transmitting the data. When the next 45 seconds, the system repeats the above data collection work. The system adopts the B/S architecture, and it can be operated anywhere without installing any special software. It can be used as long as there is a computer with Internet access, and the client does not need to be installed or maintained [18-19].

3.2 Construction of the System Evaluation System

In this paper, entropy weight fuzzy comprehensive evaluation method is used to evaluate the platform planning scheme. In the evaluation index system of this paper, there are differences between the standards of various indicators, so it is necessary to deal with these standards in a unified way, that is, standardization [20]. According to the uncertainty and fuzziness of the influencing factors in the environmental system of the train carriage, the relationship and interaction among the five influencing factors are fully considered to comprehensively and accurately evaluate the environmental quality of the train carriage. The wireless network adopts the networking mode of multi area network, which divides the whole coverage area into several sub areas. Each wireless access point is responsible for controlling a sub area, and at the same time, each wireless access point will also become a bridge device between the mobile terminal and the backbone network [21-22].

3.3 Zigbee Module Debugging

In actual image transmission, there are two Zigbee module data transmission modes involved, transparent transmission and point-to-point mode. In the transparent transmission mode, only the communication between the gateway device and the edge device can be carried out, and the communication between the edge devices cannot be carried out. The data received by the routing node and the end node from the serial port will be sent to the gateway device intact, and the data received by the gateway device's serial port will be transmitted to all routing nodes intact. The transmission method at this time is similar to broadcast, transparent mode, you can configure the module to automatically fill in the short address or MAC address of the transmission initiator, so that the gateway device can confirm the source of the data. The maximum packet length of transparent transmission is 269 bytes [23-24].

3.4 Vehicle Location Information Test

After the wireless sensor node is successfully initialized, it starts the logistics task, collects logistics data periodically, and determines the next transportation task according to the collected partial information, and can respond to the changes in the external environment in a timely manner. After the sensor node starts to work, customers and administrators can grasp the location information of the wireless sensor node in real time through the view provided by the background server. In order to test that wireless sensor nodes can actively track the logistics status of logistics objects, this paper uses

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temperature sensors to test whether wireless sensor nodes can actively track the logistics objects at different temperatures [25].

3.5 System Test

After the implementation of the system interface and the code, this article uses black box testing to conduct multiple rounds of testing on the logistics information tracking system. The test requires that all functions of the system are tested as much as possible, and the system is tested under pressure by using some special values to expose system problems as much as possible. In order to achieve the goal of performance testing, a test program was written to simulate a large number of users logging into the system at the same time to perform operations to test the performance of the system [26].

4. Simulation Results

4.1 Performance Analysis

The logistics tracking system of wireless sensors is shown in Figure 3. The three-dimensional Euclidean positioning algorithm cleverly uses the relationship between the node coordinates and uses geometric methods to calculate the position, which greatly reduces the complexity of the algorithm. At the same time, it uses loop iteration to solve the problem of not unique positioning nodes. However, before starting positioning, the entire network needs to experience two flooding of node coordinate information to obtain the node information within two hops of the node, which greatly increases the communication volume and depends on the topology of the entire WSN. The average positioning error of the algorithm in this paper will change greatly with the change of the communication radius. When the communication radius is relatively small, the average positioning error is much lower than the previous two algorithms, so this algorithm is suitable for scenarios with a small communication radius.

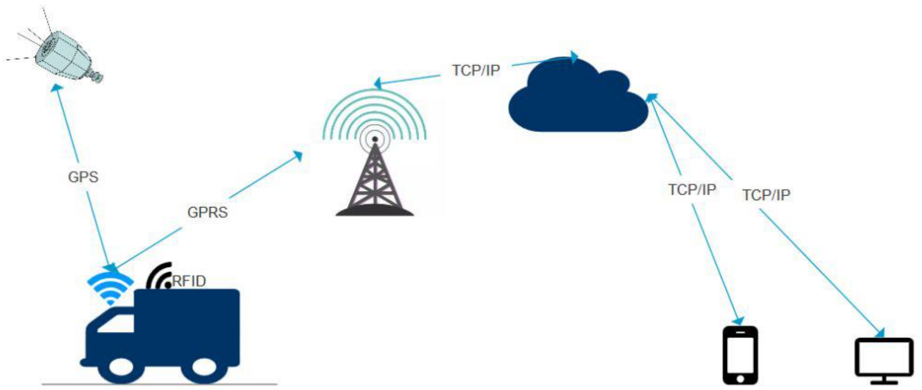

Figure 3: Logistics tracking system of wireless sensors (picture from http://alturl.com/qxtjd)

The influence of the number of nodes on energy consumption is shown in Figure 4. The RATEG mechanism reduces the number of communications between nodes by solving the minimum cost flow. As the network scale increases, the number of nodes increases, and the slope of the energy consumption growth curve gradually decreases and eventually stabilizes, showing its ability to advantages in consumption control. The ranging error is represented by the noise variance, varying from 0% to 50%. As the ranging error increases, the average positioning error presents a basically linear increase. It can be seen that the ranging error has a direct impact on the positioning of the node. When the distance measurement error reaches 50%, the average positioning error of MDS-MAP(P) is more than 15m, while the average positioning error of MDS-ICS algorithm is about 8m, which has better optimization ability.

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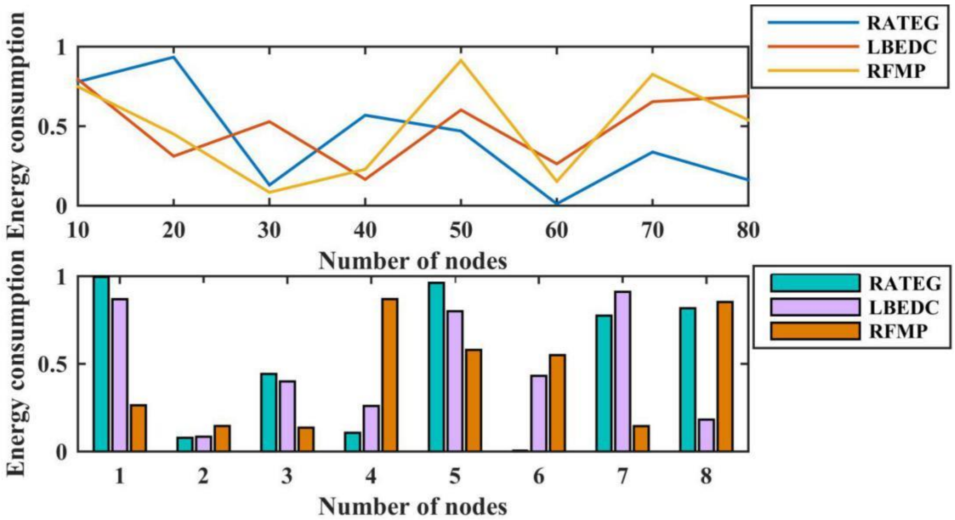

Figure 4: The effect of the number of nodes on energy consumption

The tracking error of the system is shown in Figure 5. When n = 3 and n = 4, the tracking effect is better than the other two schemes. When n increases from 2 to 3, the performance of the algorithm is significantly improved. However, when n = 4, the performance improvement of the algorithm is not large. This is because with the more steps of prediction, the error will increase. On the contrary, the accuracy of prediction may be weakened, which has a negative impact on the global performance. When the target is moving, the convergence center is based on the extended Kalman filter and ADP algorithm, and the weight between the trajectory of the error covariance obtained by the extended Kalman filter and the energy consumption prediction is the utility function, and it is adaptive for each time. Select at most one monitoring target and the corresponding task sensor step by step, and strive to optimize the global performance index over the infinite life cycle.

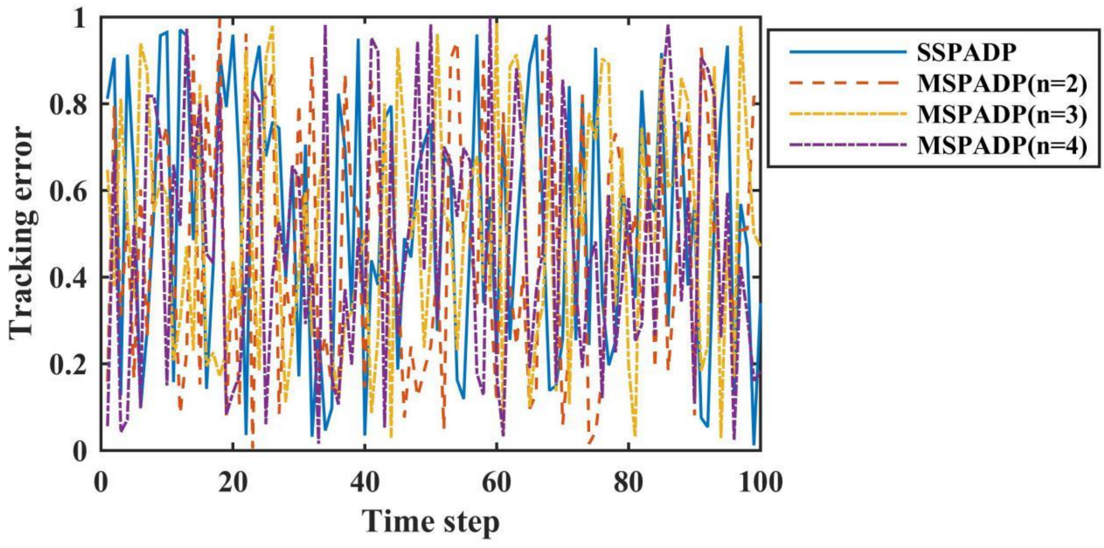

Figure 5: Tracking error of the system

The relationship between label reading rate and label movement speed is shown in Figure 6. When the relative movement speed of the label is small (less than 1m/s), the reading rate of the label is close to 100%, and the reading rate changes little. With the increase of speed, the reading rate of tags has gradually decreased, and the downward trend has accelerated. The faster the tag moves, the more tags pass through the area in the same time, the greater the amount of data read by the RFID system. The label reading rate of the three materials did not change significantly, and the plastic label was low. As the number of tags entering the radiated field of the reader antenna increases at the same time, the recognition rate of the three types of tags gradually decreases. When the number of tags reaches 20, the recognition rate drops to nearly 50%.

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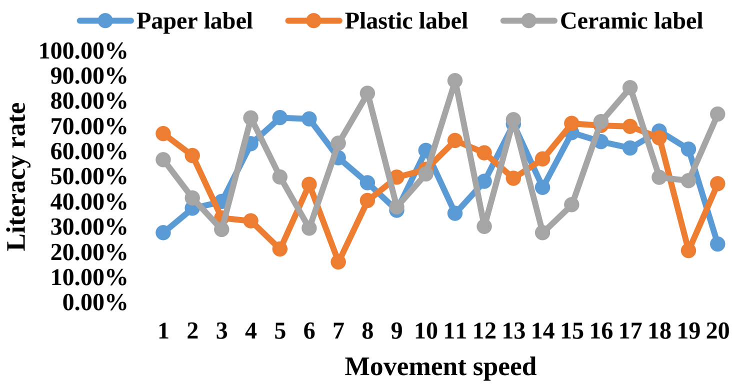

Figure 6: The relationship between label reading rate and label movement speed

The measurement results of the plastic tag reading distance are shown in Table 1. The working frequency of the fixed reader is 915MHz, the transmitting power of the reader is 0.1w, and the distance between the tag and the reader is changed with 0.1m as the step length, and the reading rate of the tag under different distances is tested. Test 200 times in each group to obtain the average reading rate of the label. When the transmitting power is constant, as the distance between the tag and the reader increases, the tag reading rate decreases. When the distance reaches 5m, the tag reading rate drops to 0, that is, the reader cannot read the tag. It can be seen that the distance between the tag and the reader is an important factor affecting the tag reading rate.

Table 1: Plastic tag reading distance measurement results

Reading distance	Literacy rate	Reading distance	Literacy rate
2.7m	91%	4.5m	52%
2.8m	90%	4.6m	55%
2.9m	88%	4.7m	48%
3.0m	86%	4.8m	32%
3.1m	81%	4.9m	19%
3.2m	83%	5m	0

The average positioning error with different communication radius is shown in Figure 7. The number of anchor nodes is 20% of the total nodes, and the total number of anchor nodes is 100. When the communication radius is increased from 15m to 50m, the average positioning error decreases gradually. Because in the simulation adopted in this paper, if the communication radius is smaller, then there are fewer points in the range. In this way, the points in the range are likely to cause three anchor nodes to be collinear, which will bring great error. Compared with the error caused by the increase of communication radius, the error caused by three points to be collinear is greater, so with the increase of communication radius, the average positioning error will decrease.

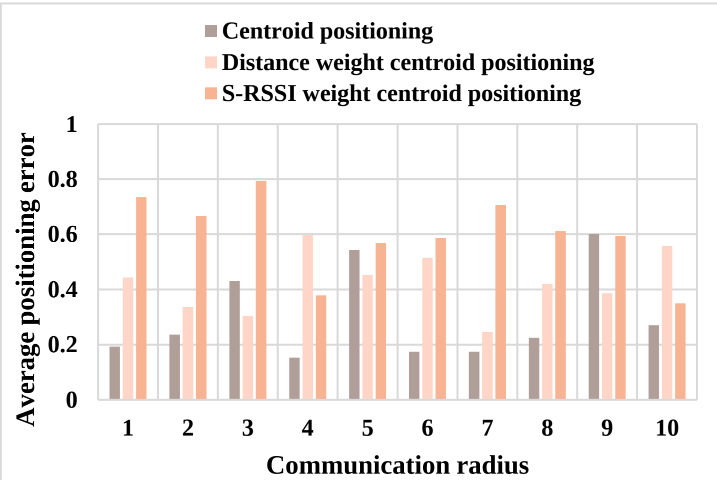

Figure 7: Average positioning error with different communication radius

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4.2 Evaluation Results

The error comparison of 50 unknown nodes before and after the improvement is shown in Figure 8. After comparing the positioning error before and after the improvement, it can be found that the positioning error of the improved unknown node has been significantly improved, which proves the effectiveness of the improved ranging model and ranging distance correction to a certain extent. When the motion noise is smaller, the positioning accuracy improves more obviously. In the CM with motion noise variances of 0.0025 and 0.025, when α is 0.4 and 0.6, the positioning accuracy of CMLKF method compared with MLKF method is improved the most, correspondingly increased by 26.21% and 21.66% respectively.

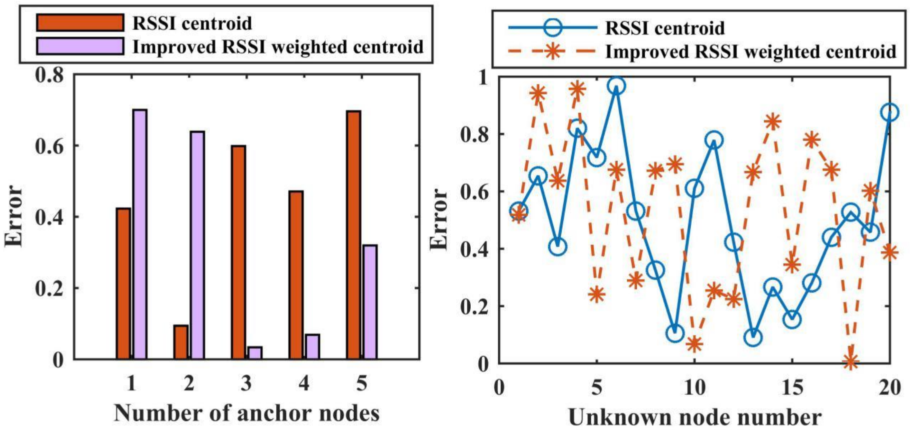

Figure 8: Error comparison of 50 unknown nodes before and after improvement

The influence of communication radius on positioning accuracy is shown in Table 2. From the data in the table, it can be seen that compared to the increase in node density and anchor node density, the increase in communication radius has a greater impact on the average positioning error, especially when the communication radius is between 5m and 20m, the average positioning error decreases very quickly. The main reason is that increasing the communication radius can increase the connectivity of the network, that is, the number of nodes within the communication range of the node increases. When the communication radius is 25m, the average positioning error of the improved algorithm is 0.2365, while the average positioning errors of the other two algorithms, the traditional DV-Hop and the weighted DVHop algorithm, are 0.3568 and 0.3277 respectively.

Table 2: The influence of communication radius on positioning accuracy

	DV-Hop	Weighted DV-Hop	Improve DEDV-Hop
Communication radius	5	15	25
Average positioning error	0.3568	0.3277	0.2365

The stability of different algorithms is shown in Table 3. Compared with traditional DV-Hop algorithm, MDV-Hop, and positioning algorithm, the improved algorithm has higher positioning accuracy and better stability. And because the improved algorithm is self-adaptive, can balance the global optimization and convergence speed, has very superior performance, and the algorithm has higher search efficiency and better stability. When the number of nodes gradually increases, the increase in the amount of data will increase the overall cost of the network. It can be seen from the comparison of the three algorithms that the LBEDC data transmission mechanism does not show its advantages in the whole process of increasing the number of nodes from less to more. The network energy consumption has always been the highest among the three transmission mechanisms. The RATEG mechanism reduces the number of communications between nodes by solving the minimum cost flow. As the network scale increases, the number of nodes increases, and the slope of the energy consumption growth curve gradually decreases and eventually stabilizes, showing its ability to advantages in consumption control.

Table 3: Stability of different algorithms

Algorithm	Average value	Standard deviation
DV-Hop algorithm	0.3431	0.0275
MDV-Hop algorithm	0.2953	0.0213
Location algorithm	0.2435	0.0171
Improve algorithm	0.2133	0.1280

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The relationship between error and cluster head ratio is shown in Table 4. When the number of nodes in the network increases to a certain scale (the number of sensor nodes exceeds 500), that is, when the density of sensor nodes increases to a certain extent, the number of cluster head nodes remains at a stable level, and the node density maintaining the stable level of clustering becomes the critical node density of stable clustering, which is related to the average number of nodes covered by the communication radius of sensor nodes. When the algorithm adopts the energy balance index, in order to achieve the purpose of more uniform distribution of residual energy of sensor nodes, the best sensor nodes may be far away from the target, which makes some sensor nodes with greater information utility will not be repeatedly selected, so the curve fluctuates most.

Table 4: The relationship between error and cluster head ratio

Cluster head ratio	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
Intra-cluster mean	5.22	3.63	2.61	5.05	1.47	5.32	5.07	3.59	3.58	5.11
EG data fusion algorithm	1.10	1.83	1.06	1.60	1.62	1.68	1.28	0.60	1.29	0.82

4.3 Influence of Communication Radius on Positioning Accuracy

Under different signal-to-noise ratios, the PPFA value changes corresponding to different target numbers are shown in Table 5. When the number of targets k=3, the range of PPFA values under different signal-to-noise ratios is between 4.36% and 6.84%, which means that after the MLCP algorithm is processed, the area of the possible landing area only accounts for 5.5% of the original global area area. The dimensionality N of the optimization problem is also reduced by about 94.5%, which greatly reduces the search range of the swarm intelligence optimization algorithm. Similarly, when k=5, the range of PPFA value is stable between 9.78%~13.56%; when k=7, the range of PPFA value is stable between 17.05%~18.75%; when k=9, PPFA The range of values is stable between 23.53% and 23.75%.

Table 5: PPFA value changes corresponding to different target numbers

Number of goals	10dB	20dB	30dB
3	6.84%	4.54%	4.36%
5	13.56%	10.88%	9.78%
7	18.75%	18.19%	17.05%
9	23.75%	23.74%	23.53%

The comparison of reconstruction time under different sparsity K is shown in Figure 9. When the sparsity K is 45, 50, 55 and 60, the reconstruction time is reduced by 22%, 38%, 41% and 45.8% respectively. Therefore, with the increase of K value, the reconstruction time of csvssamp algorithm is shorter. The node death of clustering algorithm based on energy and node density is stepwise, that is, multiple nodes die together. With the increase of the number of rounds, the number of dead nodes increases gradually, and the growth rate is relatively slow. The fact that the nodes die together indicates that the load of these nodes is the same; the slow growth rate of the number of node deaths indicates that the load gap between nodes is small, which can show that the load of nodes in the clustering algorithm based on energy and node density is balanced.

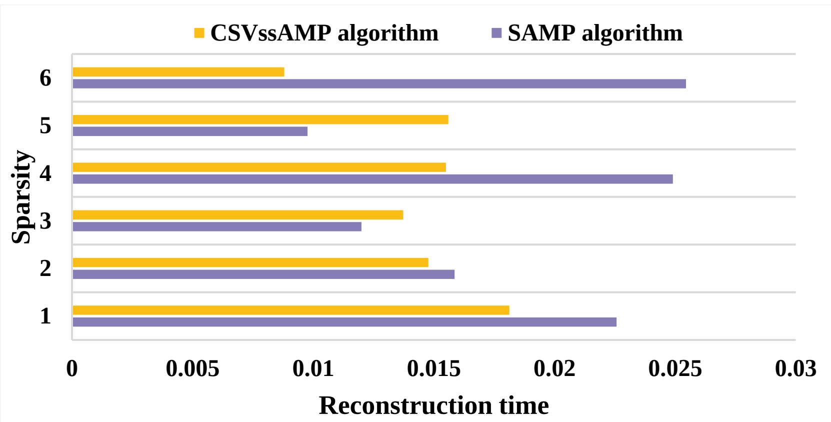

Figure 9: Comparison of reconstruction time under different sparsity K

The task information to be evaluated is shown in Table 6. As the simulation time increases, the number of failed nodes increases due to energy exhaustion, and the values of the three indicators all show a downward trend. In the case of a large load, both the estimated theoretical value and the simulated value have an obvious downward trend, because the network congestion is serious when the load is large. The theoretical value and simulation value of the evaluation of transmission reliability under heavier load drop from 97% to less than 70% in the time range of 0-6000 seconds. Compared with the two, the trend of decreasing reliability at both ends of the source node to the sink node is slower, because each value on the reliability curve at both ends is based on the packet loss rate between all source nodes and sink nodes in the cluster. Calculated from the average value, the impact of network congestion is not obvious.

Table 6: Task information to be evaluated

Task ID	Task interval	Duration	Task failure criterion threshold	Packet size	Packet generation rate
1	10	0.5	0.8	80	50
2	60	1	0.7	200	100
3	300	1	0.9	80	50
4	60	1	0.99	200	100

5. Conclusions

From the formal emergence of the concept of logistics, it has gone through nearly a century of development. The development level of the logistics industry has become a manifestation of the comprehensive strength of a country and region. This paper prototypes and develops the EPC discovery service of the public service layer in the logistics tracking system, designs the architecture and related modules of the EPC discovery service, and implements the data source information registration module and the single product dynamic tracking function of the EPC discovery service, and finally the logistics tracking system is tested and analyzed.

With the advent of the information economy era and the rapid development of science and technology such as information technology and intelligent technology, modern logistics has gradually developed in the direction of intelligence and integration, and will eventually form an intelligent logistics system. The application of logistics tracking system to logistics transportation has important practical significance. It promotes the development of informatization, improves the safety and reliability of transportation, the capacity of road network and the efficiency of automobile transportation. Our country needs to strengthen the application of geographic information system and satellite positioning system in modern logistics in order to optimize resource allocation for logistics enterprises and improve market competitiveness. When the measured residual value of the sensor node is small, its observation data may change the state estimation value of the target node less.

WSN uses the computer network to transform the physical information of the objective world into data that is convenient for observation and analysis, which broadens the communication between man and nature. As a supporting technology for the effective application of WSN, positioning technology has long become a hot research. In each application environment, the positioning performance that the same algorithm can achieve is different, and there is no algorithm that can achieve better positioning requirements in various environments. The purpose of this paper is to research and develop a logistics status tracking system based on wireless sensor network, and provide a new logistics operation support platform for logistics enterprises. It can not only obtain real-time logistics information, but also carry out active and real-time information analysis and decision-making based on the information processing ability and communication ability provided by sensor network. In order to realize the continuous optimization of the logistics process and improve the efficiency of logistics operation, the decision-making and handling of the events occurred in the logistics process with the minimum delay are carried out.

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