Research on Efficiency Optimization of Logistics Vehicle Monitoring Model Based on Wireless Sensor Network

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Abstract

For enhance running effectiveness efficiency of logistics carriage supervisory depended on wireless sensor network (WSN), a novel wireless sensor network optimized by improved bat algorithm is established. Firstly, working theory and system framework of WSN depended on logistics monitoring system are analyzed. Secondly, B-MAC protocol is used in proposed wireless sensor network, and corresponding models are established, and recovery ratio of wireless sensor network is defined, and node deployment optimization of wireless sensor network is constructed. Thirdly, the optimization algorithm of node deployment of WSN is designed based on amended bat algorithm, and analysis procedure of this algorithm is established. Finally, a simulation analysis is carried out, analysis results show that performance of proposed WSN logistics carriage supervisory based on improved bat algorithm is better, which has quicker convergence speed and higher convergence precision, and reliability of proposed WSN logistics carriage supervisory is improved, the energy consumption of sensor node data transmission is reduced, and

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the life of WSN is improved. Proposed WSN based on logistics carriage supervisory based on improved BA has higher coverage ratio and higher efficiency. Therefore proposed wireless sensor network based on logistics carriage supervisory based on improved bat algorithm can obtain better monitoring efficiency, which has prospect application view.

Keywords: Logistics carriage supervisory, improved bat algorithm, wireless sensor network, coverage ratio.

1 Introduction

Electronic commerce has developed quickly, logistics field has also grown quickly, and logistics industry has been important for people life. Development of logistics industry not only involves basic necessities of life, but also is a pillar industry integrating information and intelligent applications. Information based on Internet of things is epoch-making, and intelligent logistics system has developed greatly, which can help logistics enterprise effectively mange inventory goods, vehicle transportation status, and product information, and the maximum effect of cutting edge technology is adequately developed. Internet of things technology is a good selection of logistics enterprise based on its strong function and developing platform. WSN of Internet of things is a system concluding enequal number of sensor nodes in self organizing or multiple hog mode, which can monitor and percept all kings of information of perception object at location of nodes and process these information to transmit to observer in wireless method. WSN is a comprehensive technology of sensor means, data collection technology, and wireless communication tool. WSN is a novel information acquiring and processing technology. Currently WNS has been applied in some aspects of logistics industry, such as device monitoring of producing logistics, warehouse condition monitoring, dangerous goods logistics management, and cold chain logistics management [1, 2].

Based on demand of logistics industry on communication work, the network core needs big covering range and big communication width band. Network edge should has feasible networking architecture for ensuring reliability of data transmission. In addition, wireless local area network should has seamless coverage. Due to loading conditions variety of logistics vehicles and frequency movement of vehicle positions, carriage supervisory is more complex than static storage facility monitoring system. Currently, many logistics carriage supervisory has been applied widely, but most of them are single.

From perspective of monitoring means, navigation and positioning systems and video monitoring systems are mainly applied. Although Internet of things technology has begun to be applied in carriage supervisory, it is still nor universal. WSN has merits of low power consumption, low cost and flexible deployment, and relaxed installation requirement, automatic identification and alarm, it has wide applicability. For these advantages and features, WSN based logistics carriage supervisory has broad application view. Although WSN has positive effect on development of logistics monitoring system, its research, promotion and application in modern logistics industry are very complex system engineering, a series of management problems and technology difficulties should be recovered. Improving running efficiency of logistics carriage supervisory based on WSN is significant for development of modern logistics [3, 4].

2 Basic Theory of Logistics Carriage Supervisory

For traditional logistics enterprises, once vehicle is in the process of transportation, it is difficult to for enterprises to understand real time information and timely release dispatching information to vehicle. In the past among third party logistics company, enterprise manager, cargo owner and vehicle driver can not clearly grasp what status the goods are in during transportation, and can not be informed in time in case of accidents. Therefore the safety of goods and vehicles can not be ensured, the efficiency of logistics will be affected, and enterprise will suffer serious economic reverse. Effective monitoring and management of logistics process can greatly decrease transportation cost of logistics enterprise, decrease logistics productivity and decrease unnecessary economic loss. In this context, logistics carriage supervisory has been quickly popularized and applied [5].

Logistics vehicle supervisory system is an information platform that utilizes data gathering, wireless communication, information management and other technical means to conduct real-time monitoring, control and scheduling management of logistics vehicle or goods. Logistics carriage supervisory generally works during vehicle transportation, and supervisory aim of the system is transportation carriages or goods [6].

Logistics carriage supervisory mainly concludes monitoring and management system, data transmission system, base Station and logistics vehicles, which is illustrated in Figure 1.

Main function of the logistics carriage supervisory is to obtain vehicle and cargo information in real time and transmit it to the vehicle monitoring

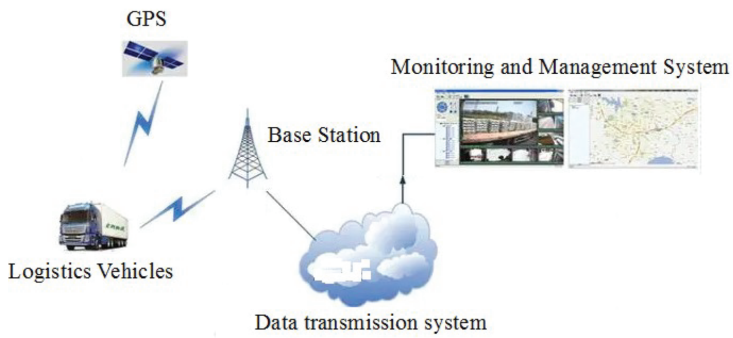

Figure 1 Sketch map of logistics carriage supervisory platform.

center, which controls and dispatches vehicles according to real-time status situation. In this way, the system solves a series of problems such as the lack of transparent management, the inability to locate and track vehicles, and the inability to ensure the safety of goods during the transportation of logistics vehicles, and gets rid of the constraints of mobility on monitoring management, thus realizing effective supervision of logistics vehicles and goods.

GPS is the most widely used satellite positioning system, also known as the global positioning system. Common advantage of many foreign vehicle monitoring and navigation systems around GPS is that they can provide continuous and accurate vehicle positioning, with high stability and reliability. Main tenet of GPS location is described as: first, measure satellite data within the receiving range, calculate the pseudo space between satellite and user receiver, and compute current receiver location according to pseudo distance of multiple satellites [7].

WSN refers to a system composed of abundant sensor panel points in compartment to cover interior of carriage. WSN is an important part of entire carriage supervisory. WSN is composed of many panel points, sink nodes and gateways. Main function of it is gather cargo condition information and advance inspection of anomalous situation. When carriage information is anomalous, inspection results will be transformed to supervisory terminal timely.

Each sensor panel point in carriage is always a minute expletive means with relatively faint buffer volume, handling volume and communication volume, which is supplied by batteries with finite energy. Sensor nodes sample goods at a certain sampling frequency. The sensor's built-in processor analyzes the collected data. From the perspective of network functions, each

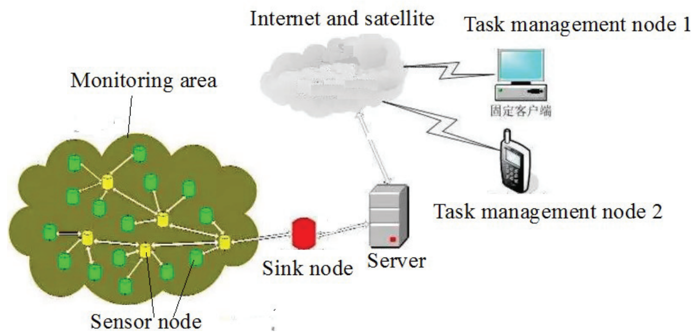

Figure 2 Diagram of wireless sensor monitoring network framework.

sensor panel point requires to gather part information, save and conform information forwarded by other nodes, and coordinate with other panel points to finish specific tasks [8, 9].

Hardware system of sensor node generally concludes four models: sensing modular, communication modular, information analysis modular and power supply modular. Sensing modular is applied to percept and acquire external data, transform gathered information into digitalization signals, and then transmit them to information analysis modular. Information analysis modular can deal with and save original information acquired by perception modular, and harmonizing and dominating operating modes of other modules. The communication module is used to realize communication with other sensor nodes or sink nodes. The communication module has four states: sending, receiving, idle and sleeping. The energy consumption in the sending state is the largest, while that in the sleeping state is the smallest. When the cargo behavior is abnormal, the wireless sensor node uses the wireless communication module to transmit the cargo monitoring data to the sink node. The power supply module is responsible for providing the energy for normal operation of each module in the sensor node. The energy supply module provides energy for the operation of the sensor, which is generally powered by batteries. Wireless sensor monitoring network is shown in Figure 2 [10].

Network coordinator is composed of local module, energy supply module, processor module and early warning module. For receiving satellite signals normally, the network coordinator antenna needs to be led out and installed outside the vehicle, and the current position of the vehicle needs to be measured regularly. The collected information communicates with the monitoring center through the 3G module on the network coordinator, and sends the collected information to the monitoring center. In addition, the network coordinator can also perform the gateway function of WSN, which is generally deployed on the top of the car [11].

GPS node of logistics vehicles generally refers to the GPS receiver. The machine is an instrument that receives GPS satellite signals and determines the ground space position. It can receive, track, transform and measure GPS signals. This hardware is not necessary for the logistics carriage supervisory studied in this paper. When the logistics vehicle conducts navigation and positioning, its built-in antenna will receive the data information transmitted from the satellite, and determine the accurate position of the vehicle in combination with the electronic map in the vehicle navigator.

3 Design of WSN in Logistics Carriage Supervisory

WSN based logistics carriage supervisory can realize the real-time and automatic monitoring of goods in the logistics process. At the same time, data transmission in the logistics process is more correct and timely, which is convenient for interaction. Main application environment of system is in the transportation process of logistics vehicle. System can give full play to the advantages of WSN technology, supervise vehicles and goods on the way, realize the whole process monitoring and real-time alarm, improve the coverage of information collection and the stability of information transmission, ensure the security of goods and vehicles, and improve the efficiency and level of logistics management. B-MAC protocol is applied in WSN in this research [12, 13].

B-MAC protocol is a periodic listening protocol, which does not require time synchronization. WSN nodes using this protocol periodically listen to channel and sleep. Compared with other synchronous MAC protocols, it has a short listening time and a long sleep time, which is very suitable for wireless sensor networks with less data throughput. When a node wants to send data, it will first listen to the channel. If the channel is idle, it will send a preamble sequence that is not less than the listening interval of the receiving node, reliably wake up the receiving node, and then send address information and data. Receiving node periodically listens and sleeps repeatedly until it wakes up immediately after listening to the preamble sequence, enters the receiving state, and returns to the sleeping state after receiving all the data. The node wakes up only when it is in the sending, receiving, and listening states, and remains dormant for the rest of the time.

In B-MAC protocol, the node must first send a preamble sequence before sending data, and duration is defined by t_p, and then send address, the corresponding duration is t_{dr}, and then send data, the duration is t_d. Transmission power is defined by *P*, sending energy consumption E_t is calculated by [14]

$$E_t = (t_p + t_{dr} + t_d)P_t \tag{1}$$

Before the node receives data, it periodically listens and sleeps. Listening duration is defined by t_1, sleeping time is defined by t_s. Sleeping period is defined by t_c, which is calculated by

$$t_c = t_1 + t_s \tag{2}$$

When the sending node does not send or receive messages, it also periodically listens repeatedly and sleeps. When a node receives data, it can be divided into two situations:

(1) When the receiving node listens to the channel, the sending node is listening to the channel. Probability of this situation is calculated by [15]

$$p = \frac{t_1}{t_1 + t_s} \tag{3}$$

At this time, the receiving node receives entire preamble sequence with a duration of t_p.

(2) When the receiving node listens to the channel, the sending node has finished listening, probability of this situation is $1 - p$. At this time, receiving node receives 1/2 of the preamble sequence on average, the duration is $t_p/2$, the receiving power is P_r, and the receiving energy consumption E_r is calculated by [16]

$$E_r = [pt_p + 0.5(1 - p)t_p + t_{dr} + t_d]P_r \tag{4}$$

Listening power is defined by P_1, monitoring energy consumption E_1 is calculated by

$$E_1 = t_1 P_1 \tag{5}$$

Sleep power is P_s, sleep energy consumption E_s is calculated by [17]

$$E_s = t_s P_s \tag{6}$$

For the 2D point coverage problem in WSN, suppose that there are n monitoring target points to be covered in the deployment area of the two-dimensional plane, and the deployed sensor nodes use homogeneous sensors, that is, the sensing radius of the sensors is the same. Perceptual radius is defined by r_s, the communication radius is defined by r_c, the unit of it is *m*, and $2r_s \leq r_c$.

Suppose there are *n* monitoring target points in the area to be covered. Location coordinate of *i*th target point to be measured is defined by (x_i, y_i), the location of *j*th sensor node is defined by (x_j, y_j), Euclidean distance of target points to be monitored that can be covered by sensor nodes is calculated by

$$d(i, j) = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \tag{7}$$

Probability of target point *i* to be monitored being covered by sensor node *j* $p(i, j)$ is calculated by

$$p(i, j) = \begin{cases} 0, & d(i, j) > r_s \\ 1, & d(i, j) \leq r_s \end{cases} \tag{8}$$

Divide the 2D plane area to be deployed along *x* and *y* axes in steps of *q*, then length of each segment is $l = q$, and intersection point of the grid of the deployment area is q^2. Covering ratio of node is calculated by [18]

$$R_{cov} = \frac{\sum_{i=1}^{J} p(i, j)}{q^2} \tag{9}$$

where number of sensors in node collection *Q* is *J*.

Suppose the deployment area is square and the side length is *L*. Theoretically, the number of deployment nodes in the set deployment area can be calculated. The schematic diagram of full coverage deployment of nodes is shown in Figure 3.

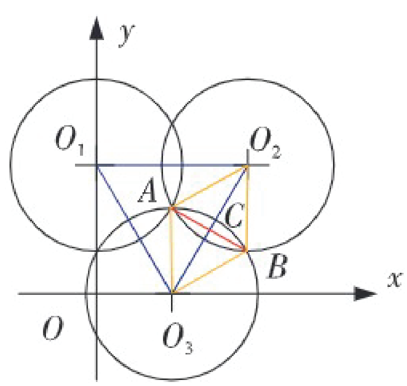

Figure 3 Diagram of full coverage deployment of nodes.

Number of nodes in deployment area in theory is calculated by

$$N = \left(\frac{2L}{\sqrt{3}r_s + r_s} + 1 \right)^2 \tag{10}$$

Node deployment problem can be simplified as a constrained engineering optimization problem, which is expressed by [19]

$$\text{Objective function: } Max\ f(x) = R_{cov} \tag{11}$$

$$\text{Constraint conditions: } s.t. \begin{cases} g_1 = \sum_{i=1}^{J} p(i,j) \geq 0 \\ g_2 = \sum_{i=1}^{J} p(i,j) - q^2 \geq 0 \\ g_3 = d(i,j) - r_s \geq 0 \\ g_4 = J - N \geq 0 \end{cases} \tag{12}$$

4 Design of Optimization Algorithm for Node Deployment of WSN

In this research, bat algorithm (BA) is used to optimize node deployment model. BA imitates behavior of natural bat in catching prey. Main idea of BA is to use echo location to find prey. BA is suitable for iterative worry seeking. At the same time, it has the advantages of simple model, fast convergence and good robustness. Compared with other mainstream swarm intelligent algorithms, BA has better optimization ability. Main idea of BA is to use bats to continuously update relevant parameters, including sound intensity, pulse frequency and pulse emission frequency, which are combined to achieve the optimization ability of searching for targets. Flight speed of bat is determined by the pulse frequency, and probability of bat receiving a new position is determined by the sound intensity in the parameters and the pulse transmission frequency. Main optimization theory of BA is listed as follows:

(1) Update formulas of velocity v_i and position x_i of ith bat individual at time t in the *D* dimension search space is defined by [20]

$$f_i = f_{\min} + (f_{\max} + f_{\min}) \cdot \eta \tag{13}$$

$$v_i(t) = v_i(t-1) + [x_i(t-1) + x^*(t)] \cdot f_i \tag{14}$$

$$x_i(t) = x_i(t-1) + v_i(t) \tag{15}$$

where f_i denotes searching pulse frequency of *i*th bat, $f_{\min} \leq f_i \leq f_{\max}$; η represents random number uniformly distributed in interval [0,1]. $v_i(t)$ and $v_i(t-1)$ represent flight speed of *i*th bat at moments t and $t-1$. $x^*(t)$ represents global optimal location of current bat population.

During local search, the new position of each bat individual is current optimal position generated by the random perturbation of $x_n(t)$. Formulation of updating the position is as follows [21]:

$$x_n(t) = x^*(t) + \mu\bar{B}(t) \tag{16}$$

where μ represents probability value between -1 and 1, $\bar{B}(t)$ represents average sound strength value of bat individual at moment t.

At the beginning stage of hunting, bat has a large pulse sound intensity B_i and a relatively low pulse emission frequency γ_i, so they can search in a large range. When they find food, they will gradually increase the pulse emission frequency and gradually reduce the pulse sound intensity. B_i and γ_i are updated as follows [22, 23]:

$$B_i(t) = \beta B_i(t-1) \tag{17}$$

$$\gamma_i(t) = \gamma_i(0)[1 - e^{-\kappa t}] \tag{18}$$

where $B_i(t)$ and $B_i(t-1)$ represent pulse sound strength, $\gamma_i(0)$ is maximum pulse emission frequency, $\gamma_i(t)$ represents pulse emission frequency at moment t. β represents ramping factor of pulse sound strength, κ represents reinforcement factor of pulse frequency. $\beta \subset (0,1)$, $\kappa \subset (0,+\infty)$.

Standard BA adjusts the movement of bat individual by searching the number of pulses, so that the global and regional search functions can be controlled. Number of repetitions increases. When the location and information of the bat are updated according to Equations (13) to (15), the speed of bat individual is getting smaller and smaller, and the bat population is concentrated in the local extreme. Effective mutation mechanism of this algorithm is insufficient, influence of population diversity is reduced, and the convergence precision is improved.

This research optimizes position update equation of bat individual, designs a new global search formula, and introduces a dynamic adaptive inertial weighting value to control the change degree of the flying position of the bat. New location update method is as follows [24, 25]:

$$x_i(t) = \nu(t-1)x_i(t-1) + v_i(t) \tag{19}$$

$$\nu(t-1) = e^{-\frac{\varepsilon(t-1)}{\varepsilon(t-2)}} \tag{20}$$

$$\varepsilon(t-1) = \frac{1}{n\sum_{i=1}^{n}[H(x_i(t-1)) - H(x^*(t-1))]^2} \tag{21}$$

where $\nu(t-1)$ represents inertia weight value at the first iteration of $t-1$th iteration, $H(x_i(t-1))$ represents objective function value corresponding to *i*th bat at time $t-1$ during repeated iteration. $H(x^*(t-1))$ represents the best objective function for bat to update at the time $t-1$. As the objective function value is updated, $\varepsilon(t-1)$ will change, so inertia weight will change with the objective function value. The faster $\varepsilon(t-1)$ decreases, the larger $\nu(t-1)$ will be, with greater global search capability. Every time $\nu(t-1)$ changes slowly, the smaller its value is, the greater the chance of global search will be, and the search ability will be strong. At the same time, this method can effectively prevent repeated vibration at or near the limit point, greatly improve the global search capability, and balance the global and local search capabilities of the algorithm.

5 Case Study

In order to verify the effectiveness of proposed method, the following performance indicators of wireless sensor monitoring system inside the vehicle are used to carry out evaluation:

(1) Number of active WSN nodes: this indicator provides statistics on the number of WSN nodes that are active.
(2) Coverage ratio: this indicator describes the percentage of target area covered by WSN node.
(3) Connection percent: this indicator measures connectivity between active WSN nodes.

Simulation parameters are listed as follows: network size is 300–700 nodes, volume dimension is 12*6*10m, percept radius is 0.6 m–1.6 m, communication radius is 0.8–3.2 m, initial energy is 0.7 J, message size is 30 Bytes, energy consumed by data processing is 55 J/bit, constant parameters of free space diffusion is 15 pJ/bit/m^2, constant parameters of multiple path diffusion is 0.0015 pJ/bit/m^2.

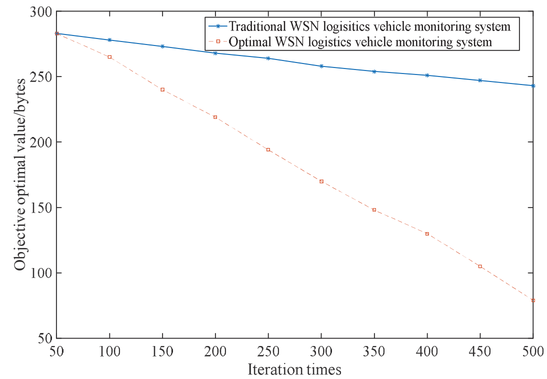

Figure 4 Optimal curves of different methods.

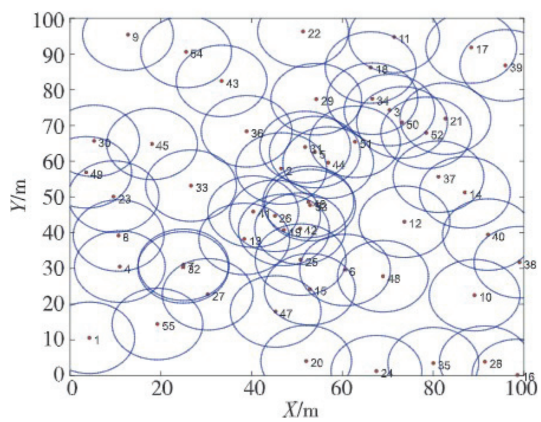

Figure 5 Initial deployment of WSN nodes.

In order to verify the effectiveness of proposed WSN in logistics carriage supervisory, the traditional WSN in logistics carriage supervisory is used in simulation analysis. Optimization curves of two methods are shown in Figure 4.

As seen from Figure 4, performance of proposed WSN logistics carriage supervisory based on improved bat algorithm is better than that of traditional WSN logistics carriage supervisory. Proposed WSN logistics carriage supervisory has quicker convergence speed and higher convergence precision.

Figure 5 shows the initial deployment of WSN nodes in logistics carriage supervisory, and Figure 6 shows optimal deployment of WSN nodes in

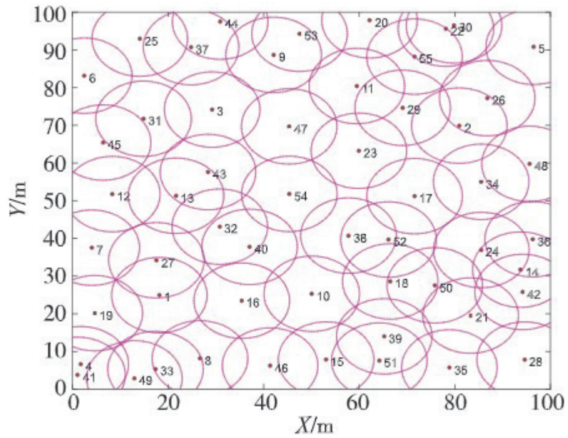

Figure 6 Optimal deployment of WSN nodes based improved BA.

Table 1 Coverage ratio of different WSN logistics carriage supervisory

System	Coverage Ratio	Optimization Deployment Time/s
Traditional WSN logistics carriage supervisory	0.89	25.46
Proposed WSN logistics carriage supervisory based on improved BA	0.96	18.53

logistics carriage supervisory based on improved BA. As seen from Figures 5 and 6, the communication distance between sensor nodes is even, and there are many sink nodes locating near boundary, therefore reliability of WSN logistics carriage supervisory is improved, the energy consumption of sensor node data transmission is reduced, and the life of WSN is improved.

The coverage ratio and optimization deployment time of different WSN logistics carriage supervisory is listed in Table 1. As seen from Table 1, proposed WSN logistics carriage supervisory based on improved BA has higher coverage ratio than that of traditional system, in addition, the optimization deployment time of proposed WSN logistics carriage supervisory is shorter than that of traditional system, therefore the proposed system has higher efficiency than traditional system.

The logistics vehicle efficiency based on proposed WSN logistics carriage supervisory based on improved BA, particle swarm algorithm (PSA) and wolf algorithm (WA) are obtained, and the results are listed in Table 2. As seen from Table 2, logistics vehicle efficiency based on proposed WSN logistics carriage supervisory based on improved BA can obtain higher efficiency than

Table 2 Logistics vehicle efficiency based on different methods

Method	Logistics Vehicle Efficiency
WSN logistics carriage supervisory based on improved BA	94%
WSN logistics carriage supervisory based on PSA	90%
WSN logistics carriage supervisory based on WA	92%

other two methods. Therefore the effectiveness of proposed method can be validated.

6 Conclusions

The development of modern logistics industry is changing with each passing day and has become one of pillar industries of the national economy. Intelligence are the inevitable trend of development of the logistics industry. Logistics vehicle monitoring has become one of the most promising areas of WSN application. This research focuses on coverage ratio of logistics carriage supervisory, and discusses the feasibility scheme of WSN based logistics carriage supervisory to further improve the monitoring quality and efficiency. The deployment of WSN nodes is optimized based on improved BA algorithm with quicker convergence speed. Simulation results showed that proposed WSN based on logistics carriage supervisory has higher coverage ratio and optimal deployment efficiency, which can reduce system communication time and improve monitoring efficiency of system.

References

[1] Jie Tang, Yifeng Zou, Ruhe Xie, Bo Tu, Guanghai Liu, Compact supervisory system for cold chain logistics, Food Control, 126, 2021, 108025.

[2] Devinder Kumar, Rajesh Kr Singh, Ruchi Mishr, Samuel Fosso Wamb, Applications of the internet of things for optimizing warehousing and logistics operations: A systematic literature review and future research directions, Computers & Industrial Engineering, 171, 2022, 108455.

[3] Qing-Shan Ren, Kui Fang, Xin-Ting Yang, Jia-Wei Han, Ensuring the quality of meat in cold chain logistics: A comprehensive review, Trends in Food Science & Technology, 119, 2022, 133–151.

[4] Giorgia Casella, Barbara Bigliardi, Eleonora Bottani, The evolution of RFID technology in the logistics field: a review, Procedia Computer Science, 200, 2022, 1582–1592.

[5] Romany F. Mansour, Sayed Abdel-Khalek, Shaik Mahaboo, Bashac Manal MKhayyat, Bushra M.E. Elnaim, Vishnu Shankar, Adaptive Parallel Seeker Optimization-based Route Planning for clustered WSN in smart cities, Computers and Electrical Engineering, 102, 2022, 108289.

[6] Pakarat Musikawan, Yanika Kongsorot, Paisarn Muneesawang, Chakchai So-In, An enhanced obstacle-aware deployment scheme with an opposition-based competitive swarm optimizer for mobile WSNs, Expert Systems with Applications, 189, 2022, 116035.

[7] Aparna Ashok, Kamble B.M. Patil, Systematic analysis and review of path optimization techniques in WSN with mobile sink, Computer Science Review, 41, 2021, 100412.

[8] V. Kavitha, Kirupa Ganapathy, Galactic swarm optimized convolute network and cluster head elected energy-efficient routing protocol in WSN, Sustainable Energy Technologies and Assessments, 52, 2022, 102154

[9] Bin Zhao, Hao Chen, Diankui Gao, Lizhi Xu, Risk assessment of refinery unit maintenance based on fuzzy second generation curvelet neural network, Alexandria Engineering Journal, 59(3), 2020, 1823–1831.

[10] Jiahong Chen, Jing Wang, Tongxin Shu, Clarence W. de Silva, WSN optimization for sampling-based signal estimation using semi-binarized variational autoencoder, Information Sciences, 587, 2022, 188–205.

[11] Amir Seyyedabbasi, Farzad Kiani, Tofigh Allahviranloo, Unai Fernandez-Gamiz, Samad Noeiaghdam, Optimal data transmission and pathfinding for WSN and decentralized IoT systems using I-GWO and Ex-GWO algorithms, Alexandria Engineering Journal, 63, 2023, 339–357.

[12] Bin Zhao, Haoyang Song, Fuzzy Shannon wavelet finite element methodology of coupled heat transfer analysis for clearance leakage flow of single screw compressor, Engineering with Computers, 37, 2021, 2493–2503.

[13] Tan Deng, Xiaoyong Tang, Zhiqiang Wu, Xiao Liu, Wei Wei, Zeng Zeng, An improved DECPSOHDV-Hop algorithm for node location of WSN in Cyber–Physical–Social-System, Computer Communications, 191, 2022, 349–359.

[14] Xianfeng Ou, Meng Wu, Yuanyuan Pu, Bing Tu, Guoyun Zhang, Zhi Xu, Cuckoo search algorithm with fuzzy logic and Gauss–Cauchy for minimizing localization error of WSN, Applied Soft Computing, 125, 2022, 109211.

[15] Bin Zhao, Yi Ren, Diankui Gao, Lizhi Xu, Yuanyuan Zhang, Energy utilization efficiency evaluation model of refining unit Based on Contourlet neural network optimized by improved grey optimization algorithm, Energy, 185, 2019, 1032–1044.

[16] Prerna Sharm, Kapil Sharm, Fetal state health monitoring using novel Enhanced Binary Bat Algorithm, Computers and Electrical Engineering, 101, 2022, 108035.

[17] Wei-Chang Yeh, BAT-based algorithm for finding all Pareto solutions of the series-parallel redundancy allocation problem with mixed components, Reliability Engineering & System Safety, 228, 2022, 108795.

[18] Riddhi Chawla Sheh, Mohamed Beram, C Ravindr, Murthyc T. Thiruvenkadam, N.P.G. Bhavani, R. Saravanakumar, P.J. Sathishkumar, Brain tumor recognition using an integrated bat algorithm with a convolutional neural network approach, Measurement: Sensors, 24, 2022, 100426.

[19] Bin Zhao, Yi Ren, Diankui Gao, Lizhi Xu, Performance ratio prediction of photovoltaic pumping system based on grey clustering and second curvelet neural network, Energy, 171, 2019, 360–371.

[20] Nazmiye Eligüzel, Cihan Çetinkay, Türkay Derelic, A novel approach for text categorization by applying hybrid genetic bat algorithm through feature extraction and feature selection methods, Expert Systems with Applications, 202, 2022, 117433.

[21] Wei-Hao Zhou, Yu-Xiang Wu, Yan Zhao, Jian Xu, Research on multi-energy complementary microgrid scheduling strategy based on improved bat algorithm, Energy Reports, 8, Supplement 4, 2022, 1258–1272.

[22] Galiveeti Hemakumar Reddy, Aditya NKoundiny, Sadhan, Gope More Raju, Kshetrimayum Millaner Singh, Optimal Sizing and Allocation of DG and FACTS Device in the Distribution System using Fractional Lévy Flight Bat Algorithm, IFAC-PapersOnLine, 55(1), 2022, 168-173.

[23] S. Eskandari, M. Seifaddini, Online and offline streaming feature selection methods with bat algorithm for redundancy analysis, Pattern Recognition, 133, 2023, 109007.

[24] S Akil, S Allin Christe, A wrapper based binary bat algorithm with greedy crossover for attribute selection, Expert Systems with Applications, 187, 2022, 115828.

[25] Felipe Carvalho Sampaio, Fernando Less, Tofolib Lucas Silveir, Meloc Giovanni Cordeir Barroso, Raimundo Furtado Sampaio, Ruth Pastôr, Saraiva Leão, Adaptive fuzzy directional bat algorithm for the optimal coordination of protection systems based on directional overcurrent relays, Electric Power Systems Research, 211, 2022, 108619.

Biography

Ronghu Zhou, doctor of management, Dean of the school of economic and trade management of Yancheng Polytechnic college, has been teaching logistics management for 13 years and has been engaged in the research of logistics and supply chain management. He presided over 12 projects such as the Jiangsu Provincial Department of education and the provincial education planning office, participated in 2 projects such as the humanities and Social Sciences project of the Ministry of education and the Jiangsu Provincial Social Sciences Fund project, published more than 10 articles on teaching and scientific research, and won 1 second prize of the economic research achievement award of the China Textile Industry Federation, 3 third prizes of the scientific and technological progress award of the China Federation of logistics and purchasing, 1 outstanding achievement award of the topic of the China Logistics Association, and 1 third prize of the outstanding achievement award of the Yancheng Federation of social sciences, Published 3 textbooks and works, and 4 patents and software copyrights.