



Real time data monitoring of water resources environment based on computer remote data collection and image analysis

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Received: 23 September 2023 / Accepted: 22 November 2023 / Published online: 1 February 2024
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Abstract

The traditional monitoring method of water resources environment mainly relies on manual sampling and laboratory analysis, which is limited in time and space and can not realize the comprehensive monitoring of water resources environment. With the continuous development of computer technology and network communication technology, real-time data monitoring method of water resources environment based on computer remote data acquisition and image analysis has gradually become a new solution. This paper aims to propose a real-time data monitoring method of water resources environment based on computer remote data acquisition and image analysis, in order to achieve accurate and efficient monitoring of water resources environment, timely acquisition and analysis of key data of water resources environment, and provide scientific basis for relevant decisions. In this paper, the key parameters of water quality, water quantity and water ecology are collected by using computer remote data acquisition and image analysis. Using computer image analysis technology, the collected image data are processed and analyzed, and the related characteristics and indicators of water resources environment are extracted. The results show that the real-time data monitoring method of water resources environment based on computer remote data acquisition and image analysis can monitor the data changes of water resources environment accurately and efficiently. Through the analysis and processing of the real-time data, the problems in the water resources environment can be found and warned in time, and the corresponding measures can be taken to regulate and manage.

Keywords Remote sensing image recognition · Wireless sensing technology · Water resources · Environmental monitoring

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1 Introduction

This article proposes a boundary merging algorithm based on remote sensing image recognition. The algorithm first retrieves the region identification on the boundary, creates a region adjacency graph on the boundary according to the spatial relationship of the boundary pixels, and then traverses the region adjacency graph, and processes the boundary region according to a certain fusion criterion (Zhang et al. 2020). Finally, we will test the effectiveness of the boundary merging algorithm by experimenting with the boundary merging algorithm. In view of the large amount of remote sensing image data, the neural network training range is too large, and it is difficult to meet the high-precision requirements, this paper uses object-oriented recognition technology to select the superpixels formed by the remote sensing image recognition and segmentation results, extract the spectral and texture features, and combine them into the neural network (Tan et al. 2021). In the experiment, 6 sets of remote sensing image data were selected for vegetation detection, and compared with ENVI maximum likelihood method and Yikang KNN detection algorithm to verify the detection accuracy of the algorithm. With the continuous deepening of industrialization, the problem of environmental pollution has become increasingly serious. In particular, water resources are damaged to varying degrees, which not only affects the sustainable development of human society, but also threatens people's lives (Liu et al. 2019). Therefore, it is necessary to strengthen the protection of water resources and realize the transformation of the social development model of the ecosystem. In order to strengthen the protection of water resources, it is necessary to detect water pollution and take measures as soon as possible. Therefore, it is necessary to monitor the specific conditions of the water environment (Gogoi et al. 2018). However, the conventional methods of water environment monitoring are relatively expensive and have great limitations. Especially in areas with weak economic foundations, traditional automatic communication methods cannot be used for water monitoring. Therefore, modern wireless sensor technology, communication media, and computer technology and related software is designing an automatic online monitoring system for aquatic environment based on wireless sensor technology network (Ullo and Sinha 2020). The power-saving design enables the system to continuously monitor certain water bodies, store and transmit data, and analyze the data received by the remote control terminal in real time. The system hardware includes sensor nodes and convergence nodes; the software includes network, program design for collecting water quality data, high-end computer design and network management system design (Jiang et al. 2020). After the software and hardware design is completed, tests are performed on the calibration of each wireless sensor, wireless communication between nodes, data acquisition and processing, and system joint debugging (Hsiao and Chen 2018). Multiple sensor nodes are distributed in the water area to be measured. The pH value and resolution of the sensor nodes need to be updated and optimized to better protect the water environment, realize the sustainable development of the rural ecological environment, and ensure the water safety of the people (Shamsuzzoha et al. 2018).

2 Related work

The literature introduces three levels of environmental monitoring, wireless sensor network technology, and local area network protocol for theoretical explanations, which lay a solid theoretical support for this article (Chen and Wang 2020). In the environmental monitoring theory, it is mainly explained that water quality monitoring and analysis, air pollution monitoring and air quality monitoring are the main content, and water quality monitoring and analysis are the parts that need to be interpreted and analyzed; in the overview of wireless sensor network technology, mainly from technical interpretation of network structure, network node, network protocol, and network positioning are carried out to understand the functioning mechanism of wireless sensor network; in the theory of LAN protocol, Zigbee protocol is mainly introduced, and from the technical system, technical structure and topological structure three give specific explanations in each aspect (Rahim et al. 2018). The literature introduces the water environment monitoring demand analysis part, which is analyzed from two aspects: water environment monitoring demand and water environment monitoring system design (Sousa et al. 2018). It specifically includes data collection requirements, operation management requirements, production and application requirements, etc., so as to design and formulate system design principles according to requirements, and develop corresponding functional modules to give full play to the role of wireless sensor network technology in water environment monitoring (Manfreda et al. 2018). The literature introduces the design practice of water environment monitoring system. There are mainly four aspects. The system development is for node architecture, terminal program design, cluster head node, aggregation node, etc. The functional modules involved include communication modules, database analysis and other modules (Ullo and Sinha 2020). The literature introduces the relevant theoretical basis of remote sensing image segmentation and remote sensing image recognition. The first part introduces the definition of remote sensing image segmentation, introduces the common methods of remote sensing image segmentation, and briefly introduces the difficulties and evaluation of remote sensing image segmentation (Kotaridis and Lazaridou 2021). The second part first introduces the definition and principles of remote sensing image recognition, then introduces the general characteristics of remote sensing images based on it, and finally introduces the basic methods of remote sensing image recognition (Cai et al. 2021). The literature introduces an improved scheme for remote sensing image segmentation, and describes the superpixel generation algorithm SLIC. Algorithms such as remote sensing image data segmentation, boundary merging strategy and parallel OpenMP transform of SLIC segmentation are proposed. Finally, the effectiveness of the algorithms is compared and verified through experiments (Yin et al. 2018).

3 Remote sensing image recognition and wireless sensing technology

3.1 Remote sensing image recognition

Remote sensing image recognition is a method of using computer technology to simulate human cognitive ability, automatically identifying or classifying information on the

earth’s surface and its surrounding environment on remote sensing images, and finally extracting intentional features.

In remote sensing images, the difference of different features is reflected in the difference in pixel height or spectral value, which is an important physical basis for distinguishing the features of different remote sensing images. The remote sensing image recognition step first uses a computer to analyze the spatial and spectral information of the various features in the remote sensing image, then extracts the intentional features, and finally recognizes the various features, and divides the recognized features into different regions, namely different pixels corresponding to different objects are divided into different recognition results.

In remote sensing images, features of the same type have the same or similar spectral or spatial information under the same conditions. Similar features can be represented by features or feature vectors of the same type. In the spatial region, the functions with the same features converge in the same space, different features form different spaces. This is the reason for using remote sensing image recognition.

The K value method is the most widely used and simplest clustering algorithm. The K value uses distance as a measure of similarity. The basic idea is to cluster samples into different clusters based on distance. The smaller the distance between two points, the greater the similarity, and the more compact and independent the target clusters.

For a given D-dimensional Euclidean space data set, the goal is to cluster the data set into K clusters. Regardless of the background of the problem, the points closer to the cluster must form clusters from the perspective of pure Euclidean space. The farther ones are clustered into different clusters. The K-value clustering technique is to find K centers and map all the data to the center of the next cluster so that each point has the smallest distance from the center of the corresponding cluster. Therefore, the following loss function can be defined:

$$J = \sum_{n=1}^N \sum_{k=1}^K r_{nk} \| x_n - \mu_k \|^2 \tag{1}$$

x_n are independent of each other, so you only need to divide each n into the nearest cluster, that is:

$$r_{nk} = \begin{cases} 1 & \text{if } k = \arg \min_j \| x_n - \mu_j \|^2 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Since J is the quadratic function of μ_k , the derivative = 0 is obtained:

$$\sum_{n=1}^N r_{nk} (x_n - \mu_k) = 0 \tag{3}$$

Then the value of μ_k is:

$$\mu_k = \frac{\sum_n r_{nk} x_n}{\sum_n r_{nk}} \tag{4}$$

The calculation process of the algorithm is as follows: first select the cluster centers of K superpixels, and then select the 2*2 space on the xy plane of the image as the search area for each cluster center. D_s is the sum of the color feature distance of each

pixel and the spatial location feature distance, and this value is normalized by the super pixel distance S .

$$d_{kb} = \sqrt{(l_k - l_i)^2 + (a_k - a_i)^2 + (b_k - b_i)^2} \tag{5}$$

$$d_{xy} = \sqrt{(x_k - x_i)^2 + (y_k - y_i)^2} \tag{6}$$

$$D_s = \sqrt{d_{lab}^2 + \frac{m}{S} d_{xy}^2} \tag{7}$$

The algorithm cannot guarantee that the label of each pixel can be updated iteratively, but only a few such pixels can meet the requirements. It is not guaranteed that all pixels are connected in the same superpixel. Therefore, some processing is required later, that is to say, the isolated points are merged to obtain the next set of adjacent pixels. The computational complexity of the algorithm is:

$$T \times 4S^2 \times K = 4NT \tag{8}$$

where T is the number of iterations. According to statistics, for most images, T is set to 10, which gives very stable results. Therefore, setting the actual algorithm parameters sets the exit condition to 10 iterations, resulting in an actual complexity of 40N.

The heterogeneity calculation method is:

$$Z = w \times h(\text{color}) + (1 - w) \times h(\text{shape}) \tag{9}$$

Z is the weight of adjacent regions, w is the weight of spectral features, $h(\text{color})$ is the equation of spectral heterogeneity, $h(\text{shape})$ is the equation of shape heterogeneity, and total heterogeneity is the weight of the two parts. The calculation is as follows:

$$h(\text{color}) = n_{\text{merge}} \times \sigma_{\text{merge}} - (n_{\text{obj}1} \times \sigma_{\text{obj}1} + n_{\text{obj}2} \times \sigma_{\text{obj}2}) \tag{10}$$

n_{merge} refers to the number of pixels, and σ_{merge} refers to variance.

$$h(\text{shape}) = \omega_{\text{cm\phi ct}} \times h_{\text{cm\phi ct}} - (1 - \omega_{\text{cm\phi ct}}) \times h_{\text{smooth}} \tag{11}$$

Remote sensing images are multi-band images, and the amount of information in each band is different, and the choice of band directly affects its image processing effect. The algorithm first calculates the image entropy of each band, and uses the image entropy as the basis for band selection. The greater the entropy, the greater the amount of information in this band. The three bands with the highest entropy value are selected as the original image bands for subsequent image processing. The formula for calculating the entropy value is as follows.

$$H_E = \sum_{i=0}^{255} p_i \log p_i \tag{12}$$

In order to eliminate the influence of the atmosphere and maintain the attributes of the remote sensing image, we have carried out atmospheric correction on the remote sensing image, especially the correction using the built-in flash module of ENVI.

Convert RGB space to XYZ space:

$$X = 0.620R + 0.718G + 0.204B \quad (13)$$

$$Y = 0.299R + 0.587G + 0.144B \quad (14)$$

$$Z = 0.056G + 0.942B \quad (15)$$

Transform XYZ space to PQ space:

$$P = f(X) - f(Y) \quad (16)$$

$$Q = 0.4 \times [f(Z) - f(Y)] \quad (17)$$

Among them:

$$f(x) = 11.6x^{\frac{1}{3}} - 1.6 \quad (18)$$

PQ space is transformed into ST space:

$$S = (8.880 + 0.966 \times \cos\theta) \times P \quad (19)$$

$$T = (8.025 + 2.558 \times \sin\theta) \times Q \quad (20)$$

Among them:

$$\theta = \tan^{-1} \frac{P}{Q} \quad (21)$$

Transform from ST space to HLC space:

$$H = \tan^{-1} \frac{S}{T} \quad (22)$$

$$L = f(Y) \quad (23)$$

$$C = \sqrt{S^2 + T^2} \quad (24)$$

According to the remote sensing image data block theory, the parallel model data preparation is realized, and the data distribution task is transferred to the intelligent blocker for processing. The intelligent blocker allocates each piece of image data to a thread group.

3.2 Wireless sensing technology

A wireless sensor network is composed of three main components, each with distinct responsibilities crucial to the overall function of the network. The specific structure of a wireless sensor network is illustrated in Fig. 1.

In the wireless sensor network structure, the largest number of components are the sensor nodes. They serve as the basic building block of the network, responsible for sensing and collecting data from the environment. The sink node acts as an intermediary and processor of information, while the task management node serves as the ultimate decision maker and information arbiter. Wireless sensor networks rely on these sensor nodes, which

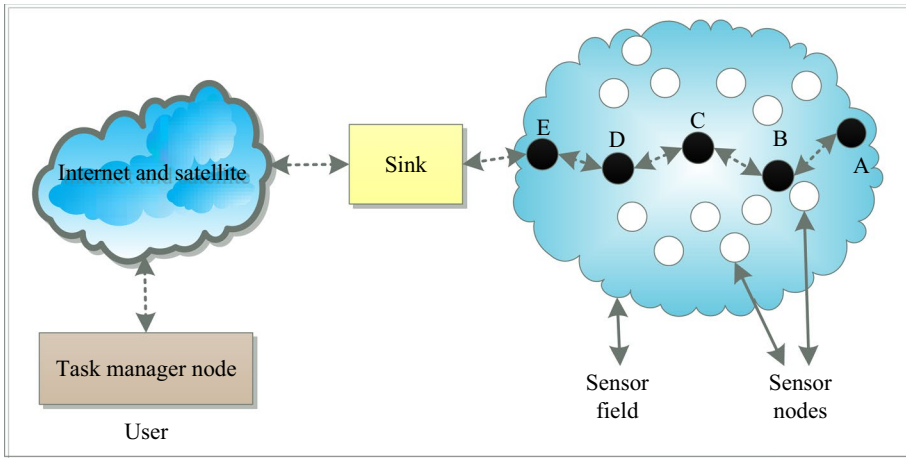


Fig. 1 Structure diagram of wireless sensor network

are placed in various locations within the network coverage area. They collect relevant information from the surrounding environment and use other nodes to transmit and share this information.

The success of a wireless sensor network depends on the proper design and implementation of its components. Among these components, the sensor node is particularly critical, as its hardware and software design directly impacts the performance and overall functionality of the network. The sink node, on the other hand, must have strong data processing, statistics, and transmission capabilities to ensure the effective transmission of monitoring information. Lastly, the task management nodes must possess advanced analysis, calculation, and operation functions that are stable, reliable, and efficient. Only by meeting these requirements can the wireless sensor network maintain stability and effectively achieve real-time monitoring of the water environment. Therefore, in the design of a wireless sensor network, it is essential to focus on the hardware and software design of the sensor nodes, aggregation nodes, and task management nodes. It is also important to select equipment and materials that are durable and stable, while considering economic factors.

3.3 Algorithm simulation

This paper designs the following experimental plan to test the effectiveness of the merge algorithm. The specific experimental data is shown in Table 1:

Table 1 The experimental data parameter list of the boundary merging algorithm

Sequence	Classification	Image size (width*height)	Number of segments	Resolution (m)
1	Landsat8	3000*3000	7	30
2	SPOT5	3000*3000	4	10
3	SPOT6	3000*3000	4	1.5

Table 2 Comparison of segmentation accuracy experimental data parameter list

Sequence	Classification	Image size (width*height)	Number of seg- ments	Resolution (m)
1	Landsat8	2000*2000	7	30
2	SPOT5	2000*2000	4	10
3	SPOT6	2000*2000	4	1.5
4	GFI	2000*2000	4	2

Table 3 Comparison table of serial and parallel time

Sequence	Image size (width*height)	Serial time (s)	Parallel time (s)	Speedup ratio
1	1000*1000	3	2	1.5
2	1000*2000	5	3	1.7
3	2000*2000	11	5	2.2
4	2000*3000	24	13	1.8
5	3000*3000	37	20	1.9
6	3000*4000	50	23	2.2
7	4000*4000	48	25	1.9
8	4000*5000	88	48	1.8
9	5000*5000	110	53	2.1
10	5000*6000	137	62	2.2
11	6000*6000	169	85	2
12	6000*7000	190	101	1.9
13	7000*7000	223	115	1.9
14	7541*7701	270	150	1.8

This paper designs the following experimental program to test the effectiveness of its segmentation algorithm. The specific experimental data is shown in Table 2:

Take the Landsat8 satellite image as the original image, crop the original image, and make 14 images of different sizes. See Table 3 for more information.

It can be seen from Fig. 2 that for the segmentation algorithm, the serial execution time and parallel execution time are approximately linearly related to the size of the remote sensing image.

Due to the time required to read and save data during program execution and the large number of loop instructions in the SLIC algorithm, OpenMP cannot be changed in parallel, so the speed is shown in Fig. 3, maintaining the speedup ratio of 1.9 in Fig. 3.

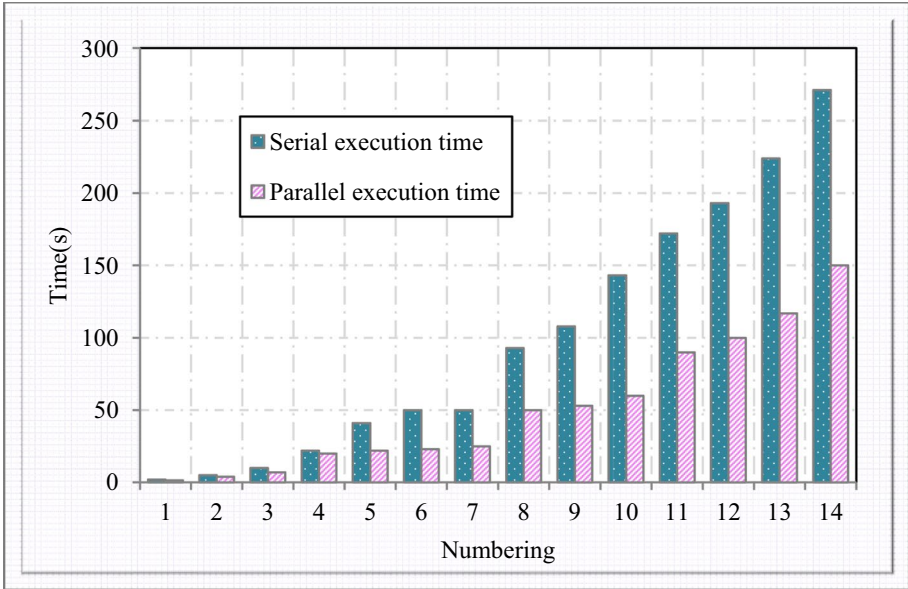


Fig. 2 Comparison of serial and parallel time

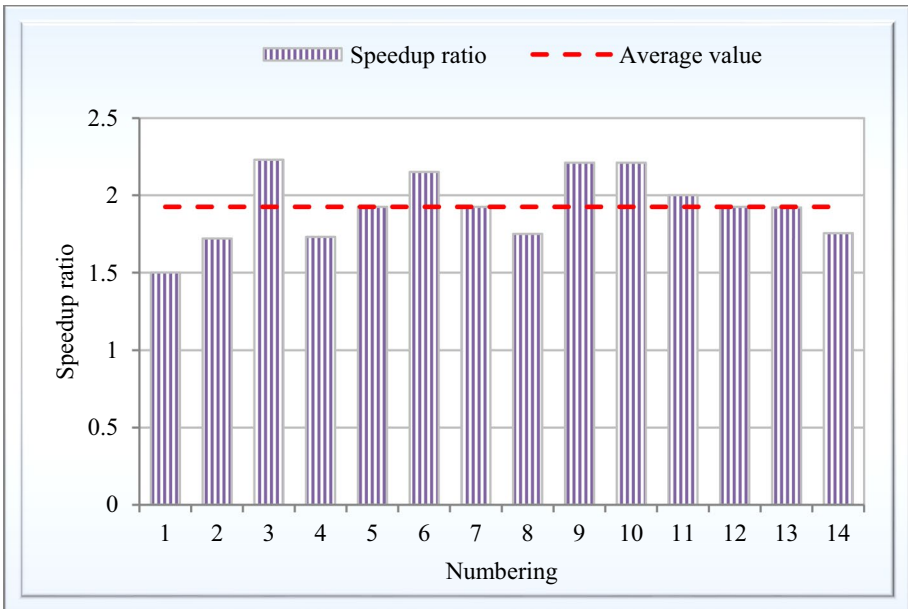


Fig. 3 Comparison of speedup ratio and its average value

4 Research on the design and application of water resources environment monitoring system based on related technologies

4.1 System requirement analysis

In the water environment monitoring system, the data collection system mainly covers two parts: data collection and data transmission. The data collection subsystem mainly completes data collection through sensors in the wireless sensor network, including water temperature, water flow, water volume and other corresponding water quality parameters. Based on this, the sensors and network nodes in the data collection subsystem should have the following three aspects: First, the data collection and analysis function, which can perceive specific water quality information, and combine the information in the existing database. These data are analyzed to obtain the judgment result of water quality; the second is the data transmission and sending function, and after the collected information is processed, the analyzed information can be transmitted and transported through adjacent nodes or convergent nodes to achieve the purpose of remote management and control; the third is the waterproof function, which is required based on the objective working environment of the data acquisition equipment, and is the basic hardware requirement of the data acquisition subsystem.

In water quality monitoring, the quality and wastewater are mainly tested. Water environment monitoring mainly includes surface water temperature, flow rate, flow rate, microbial concentration, and groundwater pressure, height, and infiltration conditions. At this stage, most of the commonly used water quality detection methods are managed by using network automatic communication technology. Although it is out of the scope of manual operation, the cost is high and does not meet the rural economic environment. The water environment monitoring system based on wireless sensor network technology is low in cost, efficient and convenient, economically in line with the rural development environment, and in content, it can also meet the various needs of water environment monitoring, and have a clearer understanding of the current situation of the water environment.

Therefore, from the perspective of operation and management, the water environment monitoring system needs to meet the following operational and management requirements: First, price requirements. For the rural economic environment, its economic foundation is relatively weak, and it is impossible to invest too much money for water. The design of the environmental monitoring system therefore needs to consider the cost, and the design scheme with a small cost investment should be selected as much as possible; the second is the management requirement. In the monitoring system, in addition to the requirements for the accuracy of the monitoring results, the application of the monitoring results and the management ability of the monitoring system also has certain requirements, so it is necessary to meet the management requirements at the beginning of the system design to improve the efficiency of data utilization; the third is the production and application requirements, which mainly use wireless communication technology to achieve the final data communication, while the agricultural production scale and the area to be detected are relatively large. If wired layout is used, the cost of the entire system will increase greatly, and the maintenance cost in the later period will also be high, which cannot meet the needs of agricultural production. Therefore, it is necessary to introduce automation technology and adopt Zigbee wireless sensing. Technology realizes remote control.

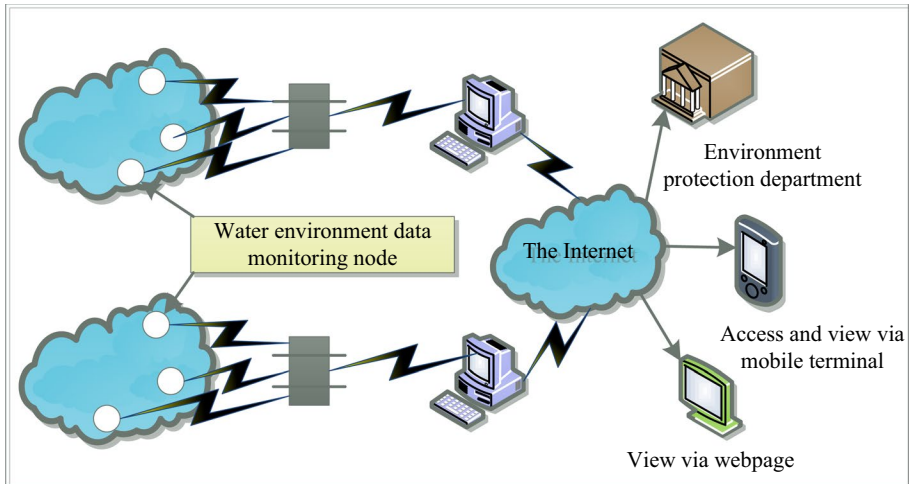


Fig. 4 Framework design of water environment monitoring system

4.2 System frame design

This part of the design consists of two major systems and seven links. The two systems are the data collection system and the remote data collection and analysis system. The seven links are the water environment monitoring link, the information gathering link, the background processing link, the Internet application link, the environmental protection information inquiry link, the access and viewing link, and the background processing. The details are shown in Fig. 4 below.

It can be seen from the figure that in the water resources monitoring system, firstly, the sensor is used to collect data in the water environment area that needs to be monitored. After the information collection is completed, the information is transmitted to the background processing server through the convergence node, and the information statistics are realized with the help of the database. And analysis, get the specific results of water environment monitoring, and finally use the Internet to display the results and send them to the environmental protection department to provide data support for their adoption of water environment management measures. When understanding and viewing the specific results of monitoring, you can view them from the mobile terminal, the web terminal, and the system.

4.3 Design of main functional modules

Sensor nodes play the role of data collection, transportation, analysis, and processing in the entire wireless environment monitoring system, and are the basis for the completion of the water environment monitoring goal. Based on the function of the sensor node, it needs processor, wireless communication equipment, sensor equipment and power supply equipment as support, and finally realize the function of sensor. The specific sensor node architecture is shown in Fig. 5 below.

It can be seen from Fig. 5 that the above parts are the main components of the wireless sensor. Among them, the power module is the prerequisite and basic element for the stable

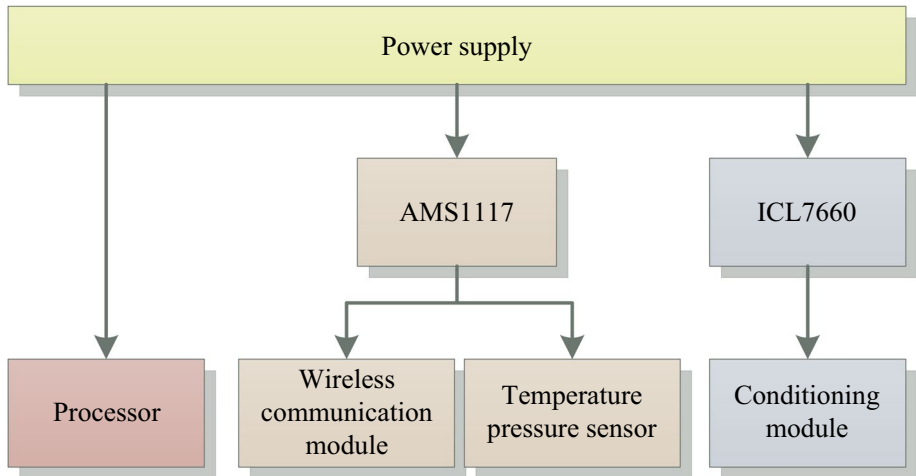


Fig. 5 Wireless sensor node selection

and effective operation of the wireless sensor. Only the power module remains normal, the other modules of the sensor can smoothly realize their functions. In the design of the sensor power supply module this time, since this test does not require high power supply power, a 5 V battery is used for power supply, and the five voltages generated in the circuit are converted into 5 V voltage to ensure that the signal transmission will not be affected. The current is disturbed to ensure the integrity of information transmission.

The ultimate goal of the sensor is to detect the temperature, pressure, and water quality in the water environment. Therefore, the sensor terminal program needs to complete functions such as information collection, data transmission, environmental monitoring, and target positioning. This requires effective connection and integration between different modules. Cooperate to realize the scientific, rational and coordinated terminal program design.

Cluster head node is mainly composed of two parts. The main program is mainly used to start the positioning and record the data to ensure the realization of GPS function; The main work of wireless communication program is to determine the location of data transmission equipment, so as to ensure that the data transmission is correct.

The main program of cluster head node needs to go through four steps. The first step is the initialization of the system, that is, the initialization of the sensor, GPS, serial port, clock module, etc. to prepare for the operation of the system; The second step is to start the GPS function through the at command, that is, start the GPS device through the at command and record the data obtained by the GPS device to realize the positioning function of the sensor, so as to grasp the specific position of the sensor at any time; The third step is to broadcast the cluster head node position coordinate information, that is, the cluster head node position obtained by GPS is sent in the form of broadcast and received by other terminal nodes or cluster head nodes; The fourth step is the final step, that is, entering the routing state. This is because in order to realize the data transmission between different nodes, each node enters the routing state, which is the basic premise. Only in this way can the data transmission and reception function be smoothly realized, and the task of cluster head node be completed. In this water environment monitoring system, CC2530 chip is mainly used as the leading device and zstack protocol is used as the execution mode of sensor information collection and transmission, so

that the broadcast cluster head node can achieve the maximum efficiency of coordinate information dissemination and enhance the function of cluster head node.

When designing the communication module, in order to ensure the integrity of the data, we must consider the compatibility in the transmission process. Based on this, various conditions need to be fully considered to be able to complete the transmission and reception of multiple data types, such as network bytes, abstract bytes, and serial bytes. In addition, in the process of receiving data transmission, in order to avoid interference of different data types, the entire communication system needs to be layered and obtained together after a certain period of time to avoid the problem of not being able to receive complete data at the same time.

After collecting the required data and realizing the data transmission, the data is summarized and analyzed. At this time, it is necessary to design the database, classify and organize the entire data, so that it can be effectively and quickly searched in the complex data to achieve the required data, so as to realize the modernization of the water environment detection system. In the entire database system, the data analysis function needs to be specifically realized through technologies and equipment such as nodes, node units, and sensor fields.

4.4 Water environment monitoring and positioning algorithm

The wireless sensor network involves many fields, is a research hotspot nowadays, and it is also an emerging science and technology with broad prospects. For the wireless sensor network, the network node is the basic component of the realization of its function. The sensor network is built in a self-organizing manner near or inside the area to be monitored, collecting various data needed, and sending these data to the terminal on the equipment, for the observer's reference and analysis.

The principle of receiving signal strength ranging is to convert the signal strength and the distance between nodes to each other. The sensor nodes used today are different. The embedded chip often directly determines the signal strength and directly completes the RSSI storage. This article chooses the newer CC2530 chip, which can realize the information and data needed for RSSI ranging. The calculation formula of the power value $P(\text{dBm})$ in RSSI is as follows:

$$P = (\text{RSSI} - \text{VAL} + \text{RSSI} - \text{OFFSET}) \quad (25)$$

Among them, RSSI-VAL represents the input power, the unit is dB; RSSI-OFFSET represents the reference value, and the general approximate value is -45 dB. In the process of signal transmission, the strength of the signal will often change continuously due to the change of distance. Therefore, the distance can be measured according to the law of signal change. The specific formula is:

$$\text{Pr}(d) = \text{Pr}(d) - 10\text{nl}g() + X \quad (26)$$

Through the trilateral positioning algorithm, the location of most network nodes in this monitoring process can be obtained, but a small part of the network nodes communicate with anchor nodes less than three, and the specific location cannot be obtained through the trilateral positioning algorithm. The genetic algorithm needs to be improved and optimized in conjunction with GPS.

Table 4 Experimental results

Serial number	Number of iterations (times)	Number of nodes (a)	Path distance (m)	Maximum spacing (m)
1	200	36	1 620	164
2	200	36	1635	127
3	200	34	1 585	127

The initial population in the monitoring area is used to represent the node, and the fitness value of each anchor node is calculated. Assuming that the total number of initial populations $M=100$, the probability of individual j being selected is calculated as follows:

$$P_j = \frac{f(j)}{\sum_{j=1}^M f(j)} \quad (27)$$

4.5 Simulation experiment and system test

The specific effects of the algorithm and system on the water environment monitoring, after deleting some nodes, were tested three times, and the results are shown in Table 4.

It can be seen from the above table that in the case of missing some nodes, good monitoring and information transmission are still formed between the sensors. The verification shows that ensuring that the distance between two neighboring nodes is within the threshold is beneficial to the overall communication quality of the line.

After that, a lot of effective experiments are needed to change the number and position of nodes in the ring WSN line in each experiment, so as to explore the relationship between the distances between nodes in the ring WSN or the relationship between the number of nodes and the chain length increment. Self-define the optimal path calculated in this research and the chain length increment of the shortest path. When the algorithm is iterated 200 times, each node performs 50 experiments, and the average of multiple measurements is taken. It can be seen that as the number of nodes in the ring WSN increases, the relative proportion of chain length increments decreases. Therefore, as the number of network nodes increases, the system can achieve higher communication quality, which helps the algorithm in this article find the best execution chain that satisfies the limited distance limit.

Table 5 Statistics of communication test results

Communication distance (m)	Number of packets sent	Number of packets received	Number of errors	Packet loss rate	Error rate
10	4000	4000	0	0	0
20	4000	4000	0	0	0
30	4000	3950	10	0.80%	0.20%
40	4000	3890	20	1.8%	0.30%
50	4000	3710	40	4.80%	0.70%
60	4000	3230	340	12.80%	6.50%

In order to better understand the impact of distance on the wireless communication water environment monitoring system based on Zigbee technology, the distance between the monitoring node and the receiving node was gradually increased during the test, from 10 to 60 m (increase by 10 each time). Meter distance), each monitoring time is 100 s, which is convenient for observing the continuity, completeness and accuracy of data transmission. At the same time, use the serial debugging assistant to conduct a comprehensive test on the data received by the system. The data in the table shows that depending on the communication distance, packet loss may occur. If it exceeds 50 m, the actual monitoring needs may not be met. Therefore, when monitoring the aquatic environment, the operating distance between nodes should be controlled at 50 m. Within, to fully meet the network requirements and ensure high transmission quality. The specific results obtained after the actual system test are shown in Table 5 below.

Mainly carry out the test work of the wireless communication water environment monitoring system based on Zigbee technology, and analyze the performance of the wireless sensor system, data transmission, and data monitoring functions to understand the applicability of the system. In the process of testing the system, it is found that the distance between the monitoring node and the receiving node has a greater impact on the communication quality, and when the distance between the two exceeds 50 m, the communication quality is greatly reduced, so it is concluded that the monitoring node and the receiving node The conclusion that the distance between the receiving nodes cannot exceed 50 m. In addition, in the process of system testing, the specific operation is simple and convenient, and has high scalability, so it has high feasibility and promotion.

5 Conclusion

With the increasing application of remote sensing images in military reconnaissance and land surveying, the research on remote sensing image segmentation and positioning technology has attracted increasing attention. Although the traditional pixel-based target recognition algorithm can achieve very accurate and efficient recognition, due to the significant increase in the amount of remote sensing image data, pixel-based methods cannot meet the requirements of current remote sensing image processing, so the process needs to be directly changed from pixel-based image processing. Extracted from the recognition, this behavior advances the process of pixel recognition object-oriented recognition; this task can complete the study of the water quality monitoring system according to the system goals, realize the data collection and data display of various parameters of water quality, and realize the remote display of data. This article has completed the design of the system hardware, the design of the node software, the design and development of the network management system, and the design and verification of the five parameter collection schemes.

Author contributions Yang Chen has contributed to the paper's analysis, discussion, writing, and revision.

Funding This paper was supported by Project of Humanities and Social Sciences Research and Planning Fund of the Ministry of Education "Research on personalized Recommendation Mechanism of Libraries based on Dynamic user portraits" (No. 20YJA870004).

Data availability The data will be available upon request.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval Not applicable.

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