Research Article

Optimization of the Intelligent Sensing Model for Environmental Information in Aquaculture Waters Based on the 5G Smart Sensor Network

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Received 29 June 2022; Revised 27 July 2022; Accepted 30 July 2022; Published 1 September 2022

1. Introduction

With the development of science and technology and the advent of the information and networking era, aquaculture production has developed in the direction of digitalization, informatization, and intelligence. In the background of the current information era, the development of the Internet of things and big data has unprecedented opportunities. The Internet of things technology is a new generation of information technology; it is to perceive transmission, information processing, predictive control, and other technologies to achieve intelligent activities [1]. In the field of aquaculture, the development of the Internet of things technology is the use of perception technology and intelligent equipment to make the farming production, management process, “people and people,” “people and things” through the network transmission interconnection, computing processing, and knowledge mining and ultimately achieve immediate...
water quality data sensing, intelligent monitoring of equipment, and accurate management and for scientific decision-making purposes. The value of the Internet of things is data; big data technology can use advanced machine learning models to mine and analyze the data monitored in the farming process, to find out the potential laws, to produce effective results for the reference of farming users, and to further solve the problem of accurate prediction and optimal control and finally the role of the Internet of things to the maximum [2]. For example, the scale of marine environment pollution and water eutrophication caused by the seriousness of the aquaculture water area is shrinking; aquatic products are caused by the increase in the variety of diseases, and it is difficult to prevent the convergence of aquatic products; fishers to learn the speed of intelligent aquaculture fisheries cannot keep up with the rapid update of intelligent equipment [3]. The development of the aquaculture industry economy is one of the effective ways for fishers to get out of poverty and improve their living needs; a fisherman’s income is affected by the scale and quality of aquaculture benefits. The current low density and low yield of traditional aquaculture methods to bring the quality and yield of aquatic products have been unable to meet the needs of the development of Zhejiang’s marine economy, with the rapid development of industrialization and urbanization in China, the growth of the land area for aquaculture fishery is strictly limited, the intensive fishery cannot be expanded on a large scale, and the sustainable development of aquaculture has been greatly affected.

The sensor’s sensing module senses the surrounding environmental information and converts it into electrical signals, which are subsequently passed to the data processing module for data processing and storage. When the distance between the sender and receiver meets the communication requirements, the sender converts the information in the memory into acoustic signals to the receiver through the communication module and the battery supplies power to all modules [4]. When the sensors send and receive information, due to the limited communication distance of the sensor nodes, some of the sensors cannot transmit the information directly to the convergence node and these sensors need to relay through other sensors to transmit the information to the convergence node. The aquaculture IoT integrates professional technologies such as intelligent water quality sensors, wireless sensor networks, wireless communication, intelligent management systems, and video monitoring systems and conducts comprehensive monitoring and management of the aquatic environment, water quality, and fish growth conditions to save electricity and increase production.

This paper is dedicated to the application of IoT technology in smart aquaculture fisheries, including the aquaculture process of aquatic products and the quality traceability of the aquaculture industry. The purpose is to explore how the modern aquaculture fishery can effectively improve the management level and efficiency of the farm with the help of the new generation of network information technology, to promote safe, high-quality, and highly nutritious aquatic products from the farm to the market more quickly and efficiently, to make the whole industry chain of aquaculture fishery more smoothly connected, more intelligent, informative, and networked, and then to improve the overall technical level of the aquaculture fishery industry and promote the integrated development of the industry chain. The technology level promotes the integrated development of the industry chain and ultimately realizes the wisdom of aquaculture fisheries.

2. Related Work

Low-power WAN can meet the communication requirements of low power as well as long distance for IoT and has the characteristics of wide coverage, low service cost, and simple deployment, which can meet the connection requirements of the low frequency of data exchange, low connection cost, convenient roaming network switching, and applicability to the complex environment in a wide range of IoT social environment. Therefore, introducing low-power WAN technology into outdoor wide-range monitoring environments and combining existing wireless sensor technology to build long-range information collection and transmission systems is a research hotspot in the direction of the network in recent years [5]. The literature provides a comparative analysis of the existing low-power WAN technologies and a comprehensive overview of many standardization efforts led by several standardization organizations. Since most of the standards focus on the physical and MAC layers of low-power WAN protocols, the work for the application of low-power WAN technologies in the field of IoT lies more in the implementation of crosslayer protocols, such as the application layer, transport layer, and network layer. In literature [6], all LPWAN nodes are directly connected to the gateway by using the star topology network structure, and then connected to the web server for integration. If the terminal node needs to communicate with other terminal nodes, it must transmit through the gateway. If an end node needs to communicate with other end nodes, it must transmit through the gateway. Although the end node location is fixed, the flexible gateway node location allows the gateway to be selected through a nearby wired network or a powered location, thus reducing the power consumption of the gateway and increasing the actual endpoint endurance by shifting some of the more power-consuming computing services from the end node to the gateway [7].

Fitbit monitors the water environment in real time and can control the device when needed [8]. It mainly consists of three parts: the main control module, APP module, and device plug, which can monitor the temperature, dissolved oxygen, salinity, pH, and other parameters of the water body in real time and send them to the user for viewing [9]. Aquaculture can integrate cultural service functions into the aquaculture system and develop industries such as ecotourism, popular science education, and sport fishing, so as to increase income and increase employment. A flat one is mainly a kind of aquarium light control device, which provides the identification mechanism of freshwater fish and marine fish in addition to the precise control of aquarium light, providing certain species identification and strategy
control for ornamental fish breeding, but there are no other functions and low versatility [10]. Three random deployment strategies are proposed in the literature, namely, three-dimensional random deployment, bottom random deployment, and bottom grid deployment. Three-dimensional random deployment is the simplest deployment strategy and does not require any kind of coordination from the ground base station [11]. The sensor nodes are first randomly deployed at the bottom of the submerged 3D target area and then at a randomly selected depth by adjusting the length of the wire between them and the anchor node [12].

Most of the theoretical research is based on the expansion and extension of the review research results; although there have been some independent research results, many technical equipment and systems are still in the theoretical research and pilot application stage [13]. The cost of hardware and software equipment required for theoretical research is high, but few scholars have combined IoT technology with smart aquaculture fisheries with the actual environment, and some research results are not very popular and practical for realistic aquaculture work, which needs further exploration by relevant experts and scholars. The research content related to the coverage control of UWSNs is investigated, and on this basis, the research status of coverage deployment, coverage maintenance, and resource allocation is analyzed and summarized, and the representative research results are analyzed in depth, and the more typical coverage deployment algorithms, coverage maintenance protocols, and resource allocation strategies are compared and summarized. By deeply analyzing and summarizing the problems related to coverage control of UWSNs and pointing out the shortcomings in the current research, we point out the direction for the next work.

3. Analysis of the Design of the Intelligent Sensing Model for Environmental Information of the Farming Sea by a 5G Smart Sensor Network

3.1. The 5G Smart Sensor Network Can Sense the Model Design. The IoT can be divided into three layers: application layer, network layer, and perception layer. At the technical level, the current IoT applications mainly involve technologies that can be divided into four types, which are application technology, network technology, perception technology, and public technology, among which application technology is divided into terminal design technology, application design technology, and application support technology [14]. In aquaculture IoT, the information perception layer is composed of many sensor nodes, and through various sensor technologies, several refined process management data of aquaculture-related equipment are obtained in the IoT, such as water quality information, individual capacity, and behavior information of aquaculture animals. The information transmission layer is further divided into the data layer, network layer, and access layer. The sensor is transmitted from the rotating primary coil to the stationary secondary coil through the signal toroidal transformer and then filtered and shaped by the signal processing circuit on the housing to obtain a frequency signal proportional to the torque received by the elastic bearing, which can be provided to the dedicated secondary coil. The display of the meter or frequency meter can also be directly sent to the computer for processing. The sensors of aquaculture equipment acquire and convert all kinds of data needed in aquaculture by wired or wireless means and release them to local area networks and wide area networks with various communication protocols; the information application layer is to integrate the relevant information acquired and makes scientific management decisions for this and process control and management of the work of aquaculture and the circulation of aquatic products.

Information sensing technology application and the information sensing layer of the Internet of things are the most basic link, consisting of each node of each sensor, mainly involving sensor technology and GPS technology. The three types of sensors that are currently more widely used in fisheries are physical sensors, biosensors, and microelectromechanical sensors. Aquaculture operations rely on the deployment of many sensors to obtain all information and data about the water quality environment and the growth of farmed organisms in the aquaculture waters. Specifically, they are used to determine the light level, water temperature, dissolved oxygen, pH value, ammonia, nitrogen content, turbidity, and other parameters in the aquaculture environment, all of which have an important impact on the growth and development, reproduction cycle, yield, and quality of the cultured objects, as shown in Figure 1.

The main research direction is modular architecture and open protocol design. The cloud service platform is designed to ensure stable service in the case of architecture and protocol, so the function is relatively simple, and the improvement of the function and architecture of the cloud service platform is also a director of subsequent research. At this stage, the cloud service platform can be divided into the firmware management subplatform, heterogeneous data subplatform, and integrated management subplatform.

The planar network structure is peer to peer between all nodes, so each node can have data collection and routing and forwarding functions at the same time [15]. The hierarchical network structure is a hierarchy of sensing nodes and backbone nodes, in which the backbone nodes are responsible for aggregation and uploading or routing and forwarding, while the sensing nodes generally have only data collection functions and the work of each node is well defined and the tasks are clear.

The low-power wide-area Internet of things (LPWAN) is optimized for M2M communication scenarios in IoT applications, battery powered, is low rate, is ultralow power, is low duty cycle, covered by the star network, and supports long-distance wireless network communication technology of cellular aggregation gateway with a single node covering up to 100 kilometers. The hybrid network structure combines the characteristics of the flat network structure and hierarchical network structure and differs from the above two network structures in that in the hybrid network structure, common sensing nodes can directly establish communication connections with each other without the need for
relaying and forwarding between the two backbone nodes, so the hybrid network can integrate more communication functions but the corresponding hardware cost also rises.

Class A allows bidirectional communication between end devices and network servers, which is one of the features that meet their basic communication needs. In this feature class, downlink transmission (from the network server to the terminal device) can only occur after uplink transmission (from the terminal device to the network server). Class B devices, on the other hand, can support additional downlink transmission at predefined communication times on top of the class A feature. Class C devices allow downlink transmission at any time other than when the terminal device is transmitting. Compared to class A and class B terminal devices, class C terminal devices operate with greater power consumption but the shortest corresponding latency. Both class B and class C are optionally implementable, so most LoRaWAN devices may not support both types. The island monitoring system device designed in this study is based on class A LoRaWAN devices, and class B and C devices are not considered for now.

When the terminal device sends the uplink acknowledgment data message, the device will receive the downlink acknowledgment message in the two subsequent receive windows. If no acknowledgment is received, the end device resends the same message until an acknowledgment is received or until the maximum number of MAC transmissions for the reply message. Each transmission selects a random selection of channels available in the band in which it is operating until the default maximum number of MAC transmissions is reached [16]. If an acknowledgment is not received after 8 attempts, the MAC layer immediately returns the error code to the upper layer and each retransmission is initiated after an acknowledgment timeout cycle, which is selected to start at the start of the second receive window in the last attempted transmission, typically using a random delay value between 1 and 3 seconds by default. Ocean sensors are widely used in the field of ocean monitoring and observation. They can measure and provide raw data of various marine environmental elements, such as temperature, conductivity/salinity and pressure/depth, and other basic physical oceanographic elements, not only for marine science. Research is also an indispensable and important data source for applications in the field of marine resource development. Therefore, it is of far-reaching significance to develop and develop marine sensors.

A turbidity sensor (SEN0189) is based on the optical principle, by the transmission rate and scattering rate in the solution to be tested, and combined with the qualitative parameters of both, the final determination of the turbidity of the solution to be tested, to achieve the purpose of detecting water turbidity. The sensor is constructed internally by an infrared pair of tubes; when the light emitted penetrates the solution to be measured, the actual amount of light transmission is dependent on the degree of turbidity of the solution. Therefore, the higher the turbidity, the lower the transmittance, and the lower the turbidity, the higher the transmittance. The turbidity sensor is typically used for river effluent testing, as well as in clarifier testing and water quality studies. The turbidity sensor provides both analog and digital signal output modes and is pin compatible, so it can be directly connected to the Arduino expansion board, thus eliminating the trouble of secondary wiring, which is relatively simple and practical.

The sensor terminal node is used as the lower monitoring node of the island IOT, that is, the outermost node, to collect all kinds of island environmental information in the area to be monitored. Since the monitored island environment is characterized by a harsh working environment, scattered breeding areas, and inconvenient manual inspection, it is not possible to provide a stable power supply for a long time, so it is more appropriate to use a mobile power supply for its energy supply, as shown in Figure 2. The sensor terminal node is responsible for collecting the physical and chemical parameters of the island environment and the operating parameters of its node in the area to be monitored and sending them to the convergence gateway node through LoRa communication technology. The Arduino microcontroller is selected as the core control board for the sensor terminal node, and the SX1276 is used as the main RF chip of LoRa with various external sensors.

The data acquisition module consists of six types of sensors: voltage, current, turbidity, pH, water level, and water temperature, each of which works independently and does not affect the other. The sensors acquire information about the surrounding environment, and their principle is
mainly to use sensitive resistance or capacitance for physical sensing [17]. The sensors convert the sensed environmental information into analog voltage or current values through internal conversion and amplification circuits and then convert them into digital signals through analog-to-digital conversion circuits and send them to the control module.

The Arduino UNO used in this study, as a type of microcontrol unit, makes internal resources such as ROM, RAM, and I/O available to the user layer. Arduino is designed with a Harvard architecture, dividing the storage space into program and data areas, which are connected to the CPU through two sets of buses and allow simultaneous CPU access. The communication module uses the existing LoRa module. LoRa is capable of long-distance communication at low transmission rates, and its single-hop distance can reach hundreds or even thousands of meters. Because of its wide coverage, low power consumption of the terminal, and it being not easily affected by the outdoor environment, it is more suitable for use in the island environment.

In the actual deployment of the island IoT, it is found that some terminal nodes need to be placed in the center of the breeding water, which cannot be easily reached by the monitor on the foot, and it is extremely difficult to fix the sensor terminal nodes on the water surface. Therefore, this study designs and implements a remotely controllable unmanned boat carrying all the monitoring sensor terminal nodes for use in the abovementioned complex water environment. The network management and control objects involve various nodes such as high orbit, low orbit, and foundations. Through networking, each node is interconnected to form a “one network.” There are many nodes with different functions. In addition to controlling the status and parameters of network equipment in the world, it is also necessary to realize the management and control of network “soft” resources such as the frequency, power, bandwidth, address, and identification and the management and control information has increased dramatically.

In this study, the third type of FIFO data cache is used; the FIFO data cache is in the RAM storage area of the SX127x, with a total of 256 bytes of storage space. Since the FIFO is only accessible by the user through the LoRa mode, the FIFO data is stored as single-user data, used for receiving and sending payloads, and only accessible by the MCU through the SPI interface. The FIFO will not automatically clear all operation-related data until it is switched to other reception modes.

3.2 Optimization Analysis of Intelligent Sensing of Environmental Information in Breeding Waters. The first step is for the data storage module to request the version number of other modules in the architecture, wait for the other modules to reply, and then send the replied version number package to the cloud through the data transmission module. In the second step, according to the received firmware, the data storage module notifies the module to be upgraded via the CAN bus that the firmware is ready to be upgraded, and after the upgrade request is received by the firmware module, it restarts into the bootloader program and then transfers the latest firmware into another user program space in batches via the CAN bus, and after the firmware transfer is completed, the firmware is verified [18]. After the firmware transfer is completed, the firmware is verified, and when the verification is passed, the version profile is modified to identify the upgraded firmware and return the success code, and if the verification fails, the original firmware continues to be used and return the failure code.

The PSSD algorithm and the DSFSOA algorithm are used to implement the deployment of sensor nodes, and the evolutionary comparison plots of the total distance moved by the nodes and the event coverage during the operation of the two algorithms in the three sets of experiments are given in Figure 3. It should be noted that the average of 30 experiments is taken here as the result for each group.
of experiments, considering the possible effects of experimental randomness.

This strategy can effectively avoid the influence of too much pheromone increase or volatilization on the nonoptimal paths on the optimal paths and improve the search efficiency by weakly updating the pheromone of the taken paths and enhancing the pheromone update speed of the unopened paths.

For the search on local paths, the strategy of adaptive adjustment of the step size is used. For the region with better solutions, to obtain better convergence, the next search should be made in a smaller region for a finer search and the strategy of the reducing step size is adopted to obtain better solutions. For the region with fewer or no better solutions, the next search should be made in a larger region and the strategy of expanding the step length to speed up the search should be adopted to obtain effective solutions.

\[
p(i, \text{best}) = \left[ \frac{\tau_{\text{best}} + \tau_i}{\tau_{\text{best}}} \right].
\]

(1)

If the ant does not get a better solution after this search, the next search is directed to move with the probability defined by equation (2).

\[
x_i = \begin{cases} 
    x_{i,x} - \alpha(\tau_{\text{best}} + \tau_{i,x}), & p(i, \text{best}) \leq p_0, \\
    x_{\text{best,x}}, & \text{others}.
\end{cases}
\]

(2)

Experimental comparison and analysis were performed to verify the validity of the model. The model EEMD decomposition, SE sample entropy reconstruction, then LSSVM prediction, and finally BP God network reconstruction are referred to as the EEMD-LSSVM model. It is compared with the traditional single prediction model, different decomposition algorithms, different LSSVM parameter optimization methods, and different result superposition model algorithms, while using the handheld HYDRO Lab multiparameter water quality monitor produced by the United States Hash as the reference value, referred to as the true value, to compare the superiority of the models.

Prediction accuracy refers to the prediction error distribution of dense or discrete degrees. The prediction error is the deviation between the actual value and the corresponding predicted value. Its magnitude reflects the degree of accuracy of the prediction [19]. A small prediction error indicates a high prediction accuracy; conversely, it indicates a low prediction accuracy. Dissolved oxygen prediction also has an error, and the size and degree of the error are an indispensable part of the prediction work.

\[
RMSE = \sqrt{\frac{1}{M} \sum_{i=1}^{M} (y_i - e^i)^2}.
\]

(3)

For the mean absolute error (MAE), which is the average of the absolute value of the deviation of all individual prediction values from the arithmetic mean, the formula is as follows:

\[
MAE = \frac{1}{M} \sum_{i=1}^{M} |y_i - e^i|.
\]

(4)

Centralized fusion means that there is one fusion node within the network that fuses all the data, and generally, the messenger host plays the role of the fusion node. In a centralized fusion scheme, the sensing node transmits the data to the sender and the fusion is performed by the sender [20]. This node increases the workload of the letter host and does not fully utilize the data fusion without taking advantage of the reduction of data redundancy. The wireless data transmission terminal is the terminal module used to realize wireless data transmission, and is usually connected with the lower computer to realize the purpose of wireless data transmission. Because its transmission principle is basically the same as the data transmission of the mobile phone that we usually use, the more typical equipment includes wireless data transmission, wireless router, wireless...
modem, and other equipment. The following describes the relevant parameters of the most widely used DTU as a reference. The distributed fusion scheme, on the other hand, solves the shortcomings of the centralized fusion scheme. By multiple fusion nodes, these fusion nodes are distributed within the network. These fusion nodes first fuse the data in the subregion and then transmit the fused data to the control center.

The distributed fusion scheme can effectively reduce redundancy. There is a similarity in the data within the subregions [21]. The hybrid fusion scheme, on the other hand, uses a combination of being centralized and distributed. Data fusion can be implemented both at the routing layer and the application layer. During data fusion, the semantics of the application layer data itself can either be considered or not, as shown in Figure 4.

The method uses the signals emitted by these events to construct more distance constraints, thus enabling the localization of these nodes [22]. There are many different events in the sensor field, such as animal growls, bomb explosions in combat, train, and car whistles. But only a few events can be used to assist in localization. But there are only a few events that can be used to assist in the localization of the network. The signals emitted by the events should be detectable and recognized by the sensors [23]. In general, the type of detectable signal depends on the actual setup of the wireless sensor network application. In this study, acoustic events are used as a representative of passive events, since many current wireless sensors have integrated acoustic chips.

The conditions for a locatable connectivity graph remain too stringent for sensor networks generated by random deployments. Sensor refers to a type of element that can sense physical quantities such as force, temperature, light, sound, and chemical composition and can convert them into another physical quantity (usually voltage, current, etc.) that is convenient for transmission and processing according to certain laws. First, external factors within the deployment domain, such as terrain and weather, prevent the sensors from achieving uniform distribution. In addition, the topological structure control mechanism limits the density of sensors. Therefore, this study further considers how to locate nodes that are not included in the connected part in the subgraph.

4. Analysis of Results
4.1. Performance of the Intelligent Sensing Model for 5G Smart Sensor Networks. To verify the correctness of the mathematical model, we first test whether Gurobi can find a network deployment scheme that achieves the lowest energy consumption for network communication while satisfying network connectivity, reliability, network element node communication constraints, and capacity constraints through a series of small-scale networks. If Gurobi can achieve a small-scale network deployment, it validates the correctness of our mathematical model and optimization scheme.

Here, a small-scale network scenario (named scenario 1) with a candidate sensor covering a water area of 1000 × 1000 m is taken as an example. The predeployment diagram before network deployment planning is shown in Figure 5. The points shown in the predeployment diagram are 17 TP points, 17 SN candidate nodes, 4 MS candidate resident nodes, two BN nodes, one HAP node, and one BS node.

Next, we will use the Gurobi Optimizer to optimize the deployment of the network and find the network deployment solution that satisfies the constraints and achieves the optimization objective. The optimization solution process is carried out in the following two steps. In the node fault detection module, the internal chip voltage of the gateway node is sampled and calculated by the ADC module, while the received signal strength is converted from the current received signal power strength of the RF chip. When the user generates a node fault detection request via the Web Information Query module, the internal voltage value and the received signal strength are forwarded to the Web Information Query module via the routing transmission module in the LoWPAN node.

In the ZigBee network deployment, since the monitoring site is far away from the land and basically cannot receive cellular signals, this study chooses to extend and expand the routing relay nodes, so that the sensor terminal node data can be forwarded to the aggregation gateway node through multihop routing to form a WSN with cluster tree topology by increasing the number of hops of routing nodes.

According to the above model, the overall energy consumption of the network is calculated by measuring the current values of various node states in the network, as shown in Figure 6.

From the above analysis, the overall energy consumption of LoRaWAN is much lower than that of Zigbee when the upload period of end nodes is set within 5 s. However, as the upload period of end nodes increases, the energy consumption of both networks will become increasingly similar when the upload period exceeds 20 s due to the hibernation wakeup mechanism of the ZigBee protocol.

In the deployment of the island IoT, because the monitoring area is mostly composed of hard reefs, water, offshore mudflats, and other complex environments, it is more difficult to manually deploy nodes, and considering that isolated islands cannot connect to cellular networks, the convergence nodes eventually cannot use cellular IoT, so only relay nodes can be used to extend the coverage of the base station to achieve complete island IoT data transmission. So, in the above comparison experiment, the ZigBee network chooses to deploy 22 routing nodes, resulting in almost 60% increase in procurement cost. Concerning the current market price of LoRa terminal and gateway nodes, although the single terminal and gateway are slightly higher than the terminal and coordinator of ZigBee, the overall construction cost of the LoRaWAN network solution is less than that of the ZigBee network if a large-scale deployment of island aquaculture monitoring network is used.

Under the comprehensive consideration of many constraints such as network communication quality and construction cost, adopting the Zigbee network will lead to a high price of node deployment, manual inspection, and maintenance cost, which is not conducive to the efficient deployment and cost control of the overall network by
system inspectors. While using the LoRaWAN network, the communication distance of a single node is far enough and can easily meet the full coverage of the monitoring area of the island IoT. Moreover, the long-distance communication between sensor terminal nodes and aggregation gateway nodes without any additional routing relay nodes makes the network design simpler and easier to adjust and maintain the system later.

The LoRaWAN network topology shown in Figure 6 is used for the system test, and different frequency bands are set at different sensor terminal nodes to prevent signal interference between nodes. The end nodes only communicate with the aggregation gateway node and send packets with a fixed size of 50 bytes. The aggregation network node must be placed within the signal coverage of the base station to ensure normal access to the wireless network, and there is no obvious building obstruction between the sensor terminal nodes and the aquaculture area. The results were evaluated using the following test scheme to average the performance tests of all end nodes in the network.

Since LoRa long-range communication is derived from the modulation gain of the spread-spectrum signal, the improvement of the communication quality can indeed depend on the increase of the transmitting power but it is also accompanied by the greater energy consumption, which leads to the reduction of the effective survival time of the terminal nodes. Therefore, a reasonable data rate needs to be set to reduce the average PLR and improve the overall communication link quality. In the actual deployment of this system, when the transmit power is higher than 13 dBm, the farthest communication distance between the terminal node and the aggregation gateway can reach 800 m and the
average PLR of the node is less than 3.6%, which ensures that the system has good communication reliability.

4.2. Analysis of Model Optimization Results. The centralized load balancing is an independent load balancing device established between the service consuming end and the service providing end, and the requests are reasonably allocated to each server through this middleware. The process of load balancing is to allocate the load balancing logic at the consumer side and select the appropriate server directly through the registry, thus eliminating the middleware overhead. This system uses Ribbon to design a reasonable load balancing algorithm to reduce the pressure of server requests to a greater extent.

JMeter is used for the stress test of the server on the web server side of the system, and the instantaneous concurrency capacity and the capacity of accepting concurrency within 60 seconds are measured. The test results are shown in Figure 7.

With this typical application example, the module library can accumulate to 68 modules after 37 single-board designs are completed. Among these modules, the average frequency of module usage is 15.53 times and the average reuse rate of modules reaches 0.931. In other words, compared with nonmodular designs, an average of 9.31 modules out of every 10 general-purpose protocol modules can be reused, thus saving about 93% on the development cycle and labor cost. In addition, the module reuse rate is 0.968 in the entire module library, i.e., 96.8% of the design behaviors are reused designs. From the above analysis, it can be learned that in the modular node, if the modular design is used, 93% of the design can be reused, only 7% need a new design, and the resources used will be only about 7% of the nonmodular design.

In the first set of experiments, 64 target events are considered in this paper and the number of sensor nodes is increased from 100 to 400, 40 at a time, while the sensing radius of the sensor nodes is increased from 10 m to 40 m, 4 m at a time. As shown in Figure 8, the trend of the number of solution sets changes as the number of sensor nodes and the sensing radius change. As the sensing radius and number of sensor nodes increase, the number of solution sets also increases. However, the increase in the sensing radius of sensor nodes brings a more significant impact on the increase in the number of solution sets compared to the increase in the number. Whether an increase in the number of sensor nodes can increase the number of solution sets is highly dependent on the deployment location of the nodes. Since this chapter uses random deployment, the change in the number of solution sets brought about by an increase in the number of nodes is not obvious, while an increase in the sensing radius of the nodes is done at the original deployment location directly increasing the coverage of the network.

A comparison is made between the MPHSA algorithm and the algorithm proposed in this chapter in terms of both solutions running time and number of solution sets when the number of target events is 64 and the number of sensor nodes is 180, as the sensing radius increases from 10 m to 42 m, with each increase of 4 m.

In Figure 8, it is easy to see that the running time of both algorithms decreases with the increase of node perception radius, but in comparison, the proposed algorithm requires a shorter running time for the equal node perception radius, e.g., 8.209 s for the MPHSA algorithm and 0.109 for the proposed algorithm for a perception radius of 10 m. This is mainly because MPHSA is an intelligent optimization algorithm with strict restrictions on the size of the population and the number of iterations, while the proposed algorithm
is more streamlined. In terms of the number of solutions, the number of solutions generated by both algorithms tends to increase as the perceptual radius of the nodes increases, but in comparison, the proposed algorithm generates 1.8–16.1 times more solutions than the MPHSA algorithm, where the multiplication increases with the increase of the perceptual radius. In addition, the stability of the proposed algorithm is good throughout the process, while the MPHSA
5. Conclusion

This paper introduces the concept of the smart aquaculture fishery industry chain and 5G IoT technology, taking maritime aquaculture fishery as an example; firstly, it introduces the current situation of aquaculture fishery and 5G IoT application development, analyzes the importance and necessity of the current IoT technology application for developing smart aquaculture fishery, then introduces the specific application cases existing in each link of the smart aquaculture fishery industry chain, and proposes the positive effect of the IoT application on aquaculture fishery development. The positive effect of the IoT application on the development of aquaculture fishery is presented. At present, the production of aquaculture fishery in most areas is still dominated by the traditional mode and there is still a certain gap from the development goal of the modern fishery and even in the process of development which has caused a series of environmental problems. To obtain more economic benefits, many farmers adopt blindly increasing the breeding density, expand the breeding area, and overuse fish medicine, which causes the continuous deterioration of the water environment and indirectly leads to the deterioration of the quality of aquatic products and causes a certain negative impact on the ecological cycle of the breeding waters and the development of the aquaculture fishery industry chain. A visual dynamic demonstration of the MSMN architecture model was conducted. As the MSMN contains mobile network elements, it is difficult for traditional presentation tools to represent the entire workflow and real-time changes in the network. The visual dynamic presentation is more three-dimensional and real-time than the traditional presentation, which can easily and efficiently express the network structure and operation process, which can help network deployment personnel to quickly adjust the network deployment plan and intuitively understand the network performance and facilitate a more intuitive presentation of the marine Ranch and MSMN network architecture.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by the Research Projects in Key Areas of Artificial Intelligence and Services for Rural Revitalization in General Universities of Guangdong Province in 2019 (2019KZDZX1046) and Research Projects in Key Areas of New Generation of Information Technology in General Universities of Guangdong Province in 2020 (2020ZDZX3008).

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