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*Retraction*

# Retracted: Construction of Landscape Ecological Planning Evaluation Model Based on Sensor Network

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

## References

[1] Y. Lu, S. Cheng, X. Zhu, and G. S. Yang, "Construction of Landscape Ecological Planning Evaluation Model Based on Sensor Network," *Journal of Sensors*, vol. 2022, Article ID 2989351, 10 pages, 2022.

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*Research Article*

# Construction of Landscape Ecological Planning Evaluation Model Based on Sensor Network

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The application of wireless sensor network (WSN) technology promotes the modernization of forestry. WSN application technology in forest areas is an important research topic for the sustainable development of forestry in China and is also a research hotspot for forestry ecological monitoring at present. The application of wireless sensor networks in forest areas, first of all, solves the problem of limited energy supply and low-latency data transmission in the forest environment. Due to the large area of the forest environment and uneven tree density, dynamic changes in forest height, easy to block the signal, and other characteristics, the forest environment is prone to node energy depletion fast, the network life cycle is short, and data transmission delays large dilemma. Second, the application of wireless sensor networks is usually centered on maximum data acquisition, but the contradiction between high data acquisition rate and limited energy supply is inevitable, so it is necessary to construct a maximum data acquisition rate model with limited energy supply as a constraint to guarantee the optimal acquisition conditions for wireless sensor networks. In this paper, from the application of wireless sensor network technology in forest environment, the research on the application of wireless sensor network in forestry is carried out around the analysis of energy self-collection permanent function of sensor nodes, sensor node transmission routing strategy, data collection, fusion, and fuzzy inference decision-making fire danger warning process, so as to provide a solution to the overall problem of forest fire warning based on rechargeable wireless sensor network. In this paper, we analyze the dynamic replenishment of energy in rechargeable wireless sensor networks and propose an energy-based transmission control protocol that effectively improves data transmission efficiency. In the rechargeable wireless sensor network, the network E2E (end-to-end) average delay time is calculated based on the number of nodes on the data transmission link. The research idea of this paper starts from the application technology of wireless sensor network in the forest environment, and the design of the energy self-collection permanent function of sensor nodes, sensor node transmission routing strategy, data collection, fusion, and fuzzy inference decision fire danger warning process are realized vertically.



## 1. Introduction

Forestry development is changing from traditional forestry to modern forestry, and the continued deepening of forestry reform will be the catalyst to ensure the continuous growth of forestry resources, the increasing income of forestry workers, and the continued prosperity of forestry and related industries [1]. At this stage, the main goal of China's forestry modernization reform is to ensure the full and rational utilization of forestry resources and improve the marginal returns of forestry industry inputs while ensuring the construction of forestry ecological civilization [2]. Wireless sensor networks (WSNs) in the forestry industry is widely popularized, the formation of wireless sensor networks in the forestry industry of practical applications [3]. Wireless sensor networks use a variety of sensors, RFID, visual acquisition terminals, and other sensing equipment instruments, widely used in forestry processing, operation, management, and services, as much as possible to obtain on-site environmental information in the field of forest planting, tree growth, and forest fire danger warning [4]. The use of wireless sensor networks establishes data transmission channels to achieve reliable transmission of forestry information and ultimately achieve unified collection and decision-making [5]. The emergence of wireless sensor networks has not only attracted great interest from industry and researchers but also from the forestry field [6]. A wireless sensor network is a network formed by a collection of one or more wireless sensor nodes (WSN) and one or more aggregation nodes or sink nodes (SN) organized by themselves through wireless networks [7].

Wireless sensor networks do not require the support of fixed network infrastructure, can be rapidly deployed, and have the characteristics of damage resistance, energy supply constraints, and dynamic topology [8]. The nodes can preprocess the collected environmental data through embedded system and send the preprocessed data to the base station through random self-assembled wireless communication network and finally forward to the management node through wired network or 4G/5G network. Wireless sensor networks are a revolution in information sensing and acquisition in the forestry field by being able to replace people working in unapproachable dangerous and harsh scenarios [9]. At present, wireless sensor network technology is a frontier hot research area integrating multidisciplinary intersection, which is highly valued by industry, military, and research institutes [10]. The current wireless sensor network technology is widely used in various fields such as military, transportation, medical, environmental, and postdisaster collection and is one of the key technologies for computing ubiquitous. Considering from some perspectives, many experts and scholars believe that the emergence of wireless sensor network technology is even comparable to the epoch-making significance of the Internet. Business Week named wireless sensor network technology as the most influential world-changing technology in the 21st century, and it is known as one of the three hottest high-tech industries in the world at present along with bionic anthropology and plastic electronics [11]. Along with the development of wireless sensor network technology, many countries and research organizations have devoted great enthusiasm to the technology [12]. The relevant U.S. science and technology departments in 2003 began to gradually develop a number of programs on the development of wireless sensor networks and provided up to $ 34 million in investment to help relevant institutions to conduct research on the main theoretical and practical applications of wireless sensor networks [13]. Many universities in the United States have also carried out research work on wireless sensor network technology, especially Intel Corporation and the University of California, Berkeley, jointly created the Smart Dust Network Laboratory, and the main purpose of the establishment of this laboratory is to the U.S. military to develop intelligent devices that can achieve the collection and sensing of communications on a chip of 1 cubic millimeter size [14].

In this paper, we first analyze the energy conversion rate in a wireless sensor network based on energy replenishment in a forest environment, then study the network delay and data collection rate problems based on the characteristics of the energy conversion rate, and use a network delay model based on transmission energy control to reduce the network data transmission delay and improve the utilization rate of nodes. In terms of improving data collection rate, the relationship between energy conversion rate, network energy consumption, and network data flow is analyzed, a linear programming model based on optimization techniques is established, and the data collection rate problem is investigated under the adoption of data fusion strategy. Finally, a link model with low-latency data transmission and high data collection rate of network nodes is studied, and a forest fire danger early warning monitoring system based on wireless sensor network is established. If the network delay is much larger than the average delay time during the data transmission, it indicates that there is still much room for reducing the network delay, and the transmission control model can be used to reduce the data transmission delay. The research idea of this paper starts from the application technology of wireless sensor network in the forest environment, and the design of the energy self-collection permanent function of sensor nodes, sensor node transmission routing strategy, data collection, fusion, and fuzzy inference decision fire danger warning process are realized vertically, so as to provide a solution to the forest fire warning problem of energy-supplemented wireless sensor network.

## 2. Related Work

Wireless sensor networks can also monitor the disaster situation of landslides in forest areas and achieve efficient early warning [15]. The collection and analysis of forestry environmental resources through wireless sensor network technology is, in essence, all about collecting monitoring data and analyzing them to accomplish certain management functions [16]. First, the main information in the air of the forest area is collected using wireless sensor network technology to obtain specific information on humidity, light intensity, etc.; in addition, soil parameters in the forest area can be dynamically monitored, while wind direction, wind speed, and atmospheric pressure can be dynamically monitored using meteorological collection nodes; second, RFID technology is used to dynamically locate objects in forestry resources, thus enabling monitoring of the transport and origin of the items [17]. Accordingly, it achieves the requirements of source management monitoring and tracking timber logistics and improves the circulation management of timber [18]. Considering the limited and time-varying nature of node energy acquisition, the node working time is divided into a working schedule consisting of multiple time slices and shared to neighboring nodes. The use of the working schedule mechanism reduces the energy consumption of nodes for neighbor discovery and improves the transmission efficiency.

The implementation of the application layer needs to meet not only the important needs of users but also their general needs, to be able to provide them with access to dynamic information and to monitor and provide feedback on the main functions of the system [19]. The connection with the server is realized by the Internet to ensure the overall integration of system information resources and effective exchange of remote information. The monitoring center server can complete intelligent processing through the corresponding data management system, including data conversion and identification, then complete effective analysis, and complete the sharing of data. By creating and improving the GIS support system, the network information can be efficiently managed and supported accordingly [20]. In general, the key function of the application layer is to intelligently monitor and process the corresponding forest environment factors, thus completing dynamic early warning and supervision functions. The application layer realizes effective monitoring of the forest environment and can store and forward the data collected by the sensing layer through the mobile communication network and calculate and interact with the forest environment information at the central server to ensure remote monitoring of the forest environment information [21]. The wireless sensor network nodes in remote areas are powered by batteries. In order to effectively save power in the process of transmitting information, the battery life of the collection nodes needs to be monitored, and the battery power of the collection nodes needs to be effectively controlled, and the frequency and time interval of data collection and transmission of the collection nodes also needs to be monitored. In order to achieve effective energy saving, it is necessary to monitor the data sending time and adjust the node to sleep state immediately after the data is sent. If the system is in the early warning state, at this time, the system mainly realizes real-time monitoring. When there is no fire danger warning, the collecting nodes do not need to transmit dynamic data frequently in order to reduce node energy consumption and thus achieve energy saving.

## 3. Data Transfer Model for Landscape Ecosystem

*3.1. Low-Latency Transmission of Data for Ecological Planning Species.* After the deployment of wireless sensing nodes in forest environment, the frequency of data collection usually maintains a low level. Usually, the requirement of data collection and transmission time limit is not strict, and the data is sent to the remote server after data collection, and the data is analyzed in the remote server, and the timeliness of data demand is not high. However, in some emergency situations, it is crucial to achieve low delay data transmission; for example, in forest fire monitoring, when the node detects the fire danger, it needs to send the data to the remote terminal at the first time to notify the information to the management personnel in time, and the management personnel or forest fire fighters make forest fire fighting arrangements according to the acquired information, so the data transmission time requirement is strict. Data transmission delay problem is the basic problem faced by wireless sensor networks; wireless sensor networks as a computer network or wireless communication networks, in the initial routing protocol research, drawing on wireless networks and computer networks are commonly used by carrier sense multiple access (CSMA) mechanism. CSMA is a distributed medium access control protocol in which each station (node) in the network can independently decide on the transmission and reception of data frames. Before each station sends a data frame, it first listens to the carrier and is allowed to send the frame only when the medium is free. It is obvious that the CSMA mechanism was created to avoid data transmission conflicts, and the method is simple and effective in application and is commonly promoted, the principle of which is shown in Figure 1.

The S-MAC mechanism uses periodic listening and sleeping, all nodes in the network synchronously use the same sleep and wake up methods, and all nodes work with the same duty cycle, use synchronous frame sending mechanism to ensure that all nodes wake up and sleep at the same time, and listen only when all nodes are in the wake up state to determine whether to send or receive data. When all nodes are asleep, the RF transceiver is automatically turned off to save energy. The original TinyOS protocol used by UC Berkeley in the MICAz nodes is the S-MAC protocol, and the latest version of TinyOS uses the BOX-MAC protocol. Comparing the S-MAC mechanism with the CSMA mechanism, we can see that in the S-MAC mechanism, the node only needs to be active half of the time, so the S-MAC mechanism is 50% more energy efficient than the CSMA mechanism. However, in S-MAC mechanism, it is obvious that the data transmission delay is more severe than CSMA, because the node has to wait for the neighboring nodes to be in working state before data transmission can take place. Since the S-MAC mechanism was proposed, experts and scholars have proposed a large number of energy saving and data transmission delay reduction algorithms, but in general, energy saving and data transmission delay reduction go to two opposites; if we want to reduce energy consumption as much as possible, we must sacrifice data transmission delay, and if we want to reduce data transmission delay, we must increase energy consumption. A balance needs to be found between energy saving and data transmission delay reduction, and different routing protocols need to be designed according to the actual application needs.

Based on the S-MAC protocol, researchers have proposed B-MAC, T-MAC (Timeout-Media Access Control), Z-MAC, X-MAC, WiseMAC protocols, etc. The low-power communication protocol implemented by B-MAC relies on extended pilot and low-power listening (LPL) technology and uses idle channel evaluation for channel adjudication. A node using B-MAC protocol needs to send a preamble sequence before sending data. To avoid packet null transmission, the length of this lead sequence needs to be greater than the resting time of the receiver. If the receiver node wakes up and listens to the preamble, it remains in the working state until data is received or the channel becomes idle again. The X-MAC protocol reduces the length of the preamble by introducing a handshake mechanism, which further reduces the energy overhead by reducing the length of the preamble, thus avoiding excessive preamble in the transmitting node and excessive listening in the receiving node. These protocols take into account aspects such as energy

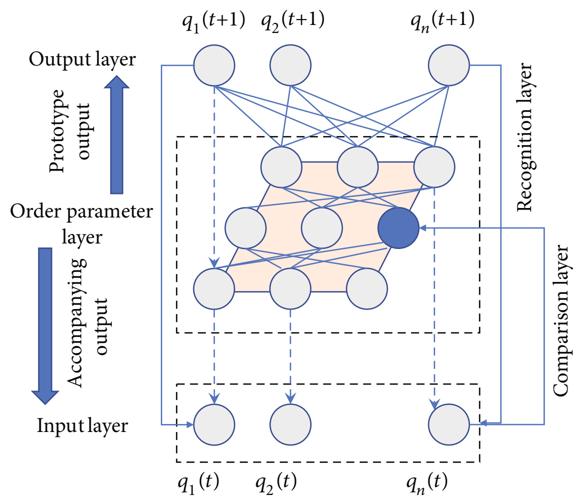


Figure 1: Carrier listening multiple access mechanism.

consumption and coordinated utilization between data transmission delays and are commonly used in the initial routing algorithms of wireless sensor networks.

*3.2. Network Low-Latency Model.* In energy-supply wireless sensor networks, considering the limited and time-varying energy acquisition of nodes, the node working time is divided into a working schedule consisting of multiple time slices, and the node working schedule is shared to neighboring nodes. The time slice of the node is divided into two time slice states, working and dormant, and the node can receive information only in the working state and turn off the receiving transpose in the dormant state in order to reduce the energy consumption of the network, as shown in Figure 2. The advantage of the node using the working schedule mechanism is, on the one hand, to reduce the energy consumption of the node for neighbor discovery, and on the other hand, the node has to passively implement a dynamic working/sleeping adjustment mechanism due to the instability of the energy replenishment of the node.

The simulation of the proposed low-latency energy transmission control algorithm is implemented in NS-2 environment, 300 common nodes and 2-5 base station nodes are randomly generated, all nodes are randomly distributed in a flat area, the area is 500 m × 500 m, the maximum transmission radius of nodes is $D = 80$ m, the transmission power of all nodes can be adjusted, and any two nodes can communicate with each other directly within the transmission distance.

Assuming that the time slice of node $i$ is $t_i = \{t_1, t_2, t_3 \cdots, t_n\}$, then for phase $i$, the time slice is $t_i = \{t_1, t_2, t_3 \cdots, t_n\}$, and then for the neighboring node $i + 1$, the data communication delay between node $i$ and $i + 1$ is

$$d_{i,i+1} = t_{i+1} - t_i, \tag{1}$$

where $t_i$ denotes the moment when node $i$ receives data from its neighbor node in time slice $k$. When node $i$'s neighbor node $i + 1$ is woken up in time slice, node $i$ sends data to it immediately, at which time the data delay is $g_{i,ij}$. The minimum data delay between node $i$ and node $i + 1$ is the time delay incurred by node $i$ to send the data in its cache when node $i + 1$ wakes up for the first time.

$$d_{i,i+1} = \min\,(t_{i+1} - t_i). \tag{2}$$

The data is transmitted through multiple hops in the network and finally reaches the target node. During the transmission, the network E2E delay can be calculated as

$$d_{it} = \sum_{i}^{n} d_{i,i+1}. \tag{3}$$

The transmission control model is based on the node working schedule mechanism to control the transmission radius of node communication to reduce the data transmission delay, and the communication can cross over the nearest neighbor node to convert the single-hop transmission to the transmission between the node directly and another node in the multihop range. Considering the time-varying and uncertainty of node energy acquisition, when the node energy changes, especially when the energy acquired by the node is significantly increased in a certain time period, in order to improve the node energy utilization, this node can adjust the transmission distance of the node according to its energy change at any time without changing the number of working time slices in the working schedule, which ensures the stability of the working schedule.

Assuming that there are $n$ nodes distributed in a straight line, there are $n - 1$ edges from the source node to the target base station node, where $d_{ij}(i, j, m)$ represents the transmission delay of sending data from node $i$ to node $j$ at a distance of $m$ hops. Assume that one time slice of node $i$ and node $j$ is tik = tuk, respectively. When node $i$ and node $i + 3$ communicate directly, the transmission delay is $d(1{,}3{,}3) = 2$.

The working time slice mechanism only sets the time requirement for the node to receive data; i.e., it can receive information from neighboring nodes only when it is working, but the node can send data at any time, which requires the node to have the basic energy storage requirement to realize that the node can finish sending data at least once while waiting for the node to reach the position of the time slice divided for data reception.

Assuming that $t$ is the length of the cycle period of the node time slice, according to the analysis, the transmission delay of data from node $i$ to node $i + 2$ without the transmission control model is

$$d_{i,i+2}(t_i, t_{i+2}) = d_{i,i+1}(t_i, t_{i+1}) + d_{i+1,i+2}(t_{i+1}, t_{i+2}). \tag{4}$$

If the relationship between the nodes of the node sequence $\{i, i + 1, i + 2\}$ satisfies $q(i, i + 1, i + 2)$, the transmission delay of data from node $i$ to node $i + 2$ when the transmission control model is used is

$$d_{i,i+2}(t_i, t_{i+2}, 2) = d_{i,i+1}(t_i, t_{i+1}) - \tau. \tag{5}$$

When the sequence of 4 nodes in sequence satisfies the $q$

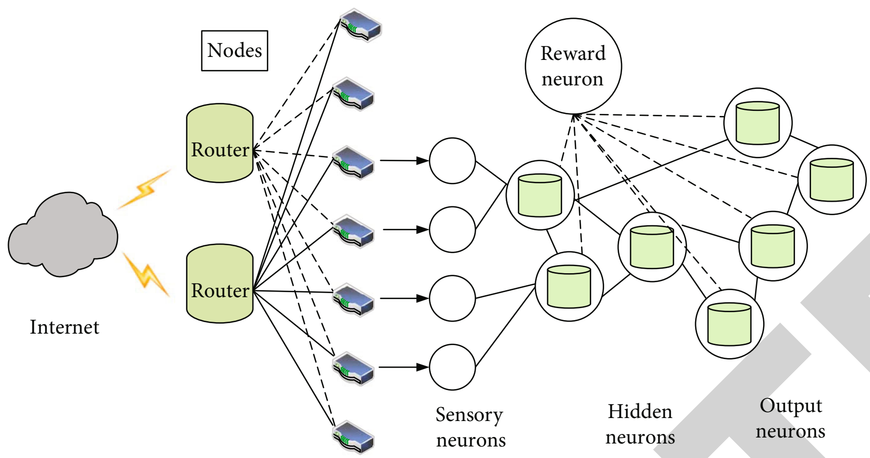


Figure 2: Node work time slice.

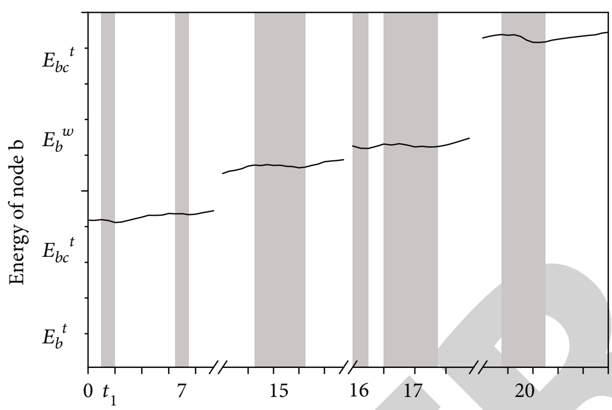


Figure 3: Real-time variation of energy of node *a*.

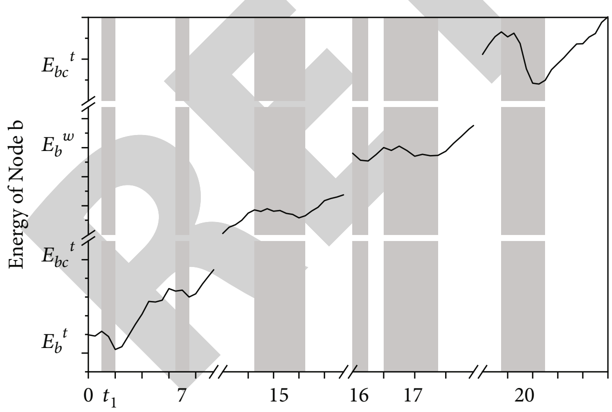


Figure 4: Real-time variation of energy of node *b*.

requirement, the data transmission delay can be reduced by 2 times the time slice cycle period when the node can communicate directly with a node 3 hops away. Therefore, if the node and the subsequent nodes form a sequence in sequence to satisfy the requirement, the new data transmission delay when the node has enough energy to communicate directly with a node $m$ hops away will become

$$d_{i,i+m}(t_i, t_{i+2}, m) = d_{i,i+m}(t_i, t_{i+m}) - (m-1)\tau. \quad (6)$$

Therefore, according to the above analysis, if the data delay bound of the network system is $B$, and when the node is allowed to communicate directly with the $m$-hop distance node, the calculation formula for the number of transmission control h values to be taken is

$$h = \left\lceil \frac{d_{ij}(i, s) - B}{(m-1)\tau} \right\rceil. \quad (7)$$

In this process, the energy consumption and the transmission radius are not linear, and the energy consumption of the node is the 24th power of the radius, so when the transmission radius is doubled, the energy consumption of the node will increase to at least 4 times, and the energy consumption increases significantly, which is serious for the wireless sensor network with limited energy storage. Therefore, when using the energy transmission control model, priority is given to the proximity transmission, and when the proximity transmission cannot meet the delay bound requirements, the transmission radius is gradually increased to improve the energy supply. Therefore, when using the energy transfer control model, careful measures must be taken to prevent the energy from being consumed too quickly.

To better understand the energy usage during transmission, four nodes $a$, $b$, $c$, and $d$ are deployed in a straight line as shown in Figure 3. Assume that the working schedule of nodes $a$, $b$, $c$, and $d$ is distributed as follows: $t_a = \{2\}, t_b = \{7\}$. Now $t = 2$, the energy of node $a$ is $E_a + E_b$. According to the working schedule of node $a$, node $a$ is in the working wakeup state and node $a$ receives data, but node $a$ cannot transmit data to neighboring node $b$ immediately because the working schedule of node $b$ is 7; that is, node $a$ needs to wait until the moment $t = 7$ when node $b$ wakes up before transmitting data. When $t = 7$, the energy of node $a$ is $w$, while the energy of node $b$ is $E$. The real-time energy state

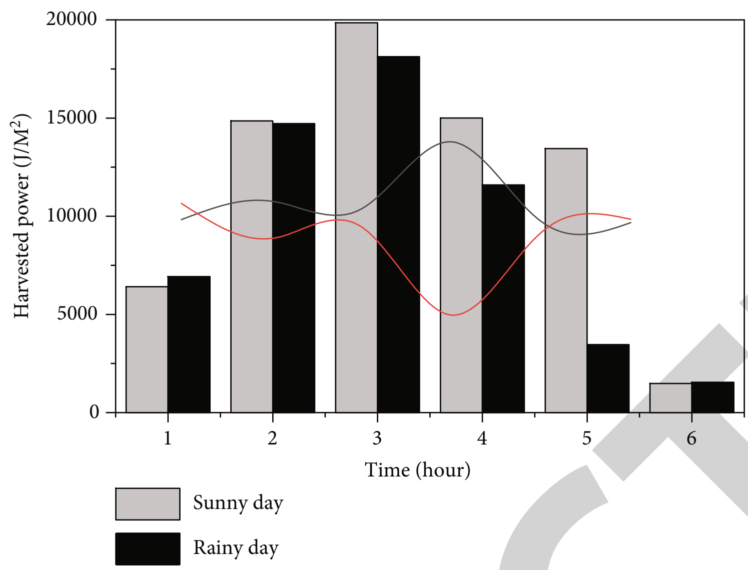


Figure 5: Energy harvesting in a 24-hour period for solar-sourced nodes.

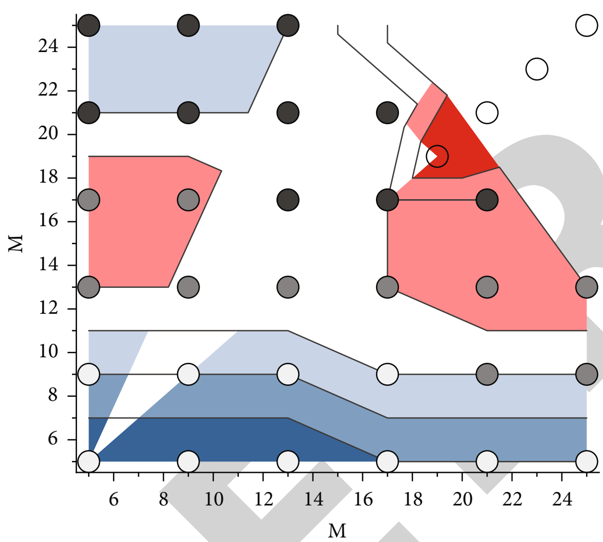


Figure 6: Network routing path based on maximum data collection rate.

of node $b$ remains unchanged. So, now $t = 7$, node $a$ has the energy to transmit data to node $b$, and node $b$ can receive data, and data is transmitted from node $a$ to node $b$.

When the data is sent to node $b$, the remaining energy of node $a$ becomes Ea = Eb + Ec, and there is a sharp drop in node energy, as shown now in the curve change $t = 7$ in Figure 4. The vertical coordinate indicates the change of external energy acquired by the node with time. Now $t = 2$, the energy of the node reaches Ea, and there is an obvious energy drop process, which is because the node wakes up and consumes some energy at that time. Starting from time $t = 7$, the energy of nodes $a$ and $b$ continues to be replenished, and when the time reaches 2t, the energy of node $a$ is Eb + Ec, where $7 < t_2 < 12$. So, in the next time slice cycle, at $t = 12$, if node $a$ receives data that needs to be forwarded, the node can wait for its 2-hop neighbor node $c$ to wake up, such as at $t = 16$, node $a$ directly transmits the data to node $c$ directly instead of waiting until moment $t = 17$ to transmit to node $b$. This can effectively reduce the data transmission delay.

*3.3. Experimental Analysis of Data Delay.* The energy of the node comes from the configured Tianyang energy plate with a size of 10 cm$^2$ and a light energy conversion efficiency of 15%, and the simulation experiment data is the average value of 50 runs. For the energy rechargeable wireless sensor network system in forest environment, the energy acquired by the nodes depends heavily on the external environment, such as the system with solar energy as the rechargeable energy; when the external environment sends changes, the solar light density changes, and the energy acquired by the nodes will also change. The change of energy acquisition by the node for 24 hours is shown in Figure 5. The node energy conversion is better when there is sufficient light, while at night, there is almost no energy source. On a sunny day, the node acquires energy gradually from 10 am onwards, and the node acquires energy at its peak at 13 pm, and the node acquires energy gradually from 13 pm onwards. In particular, the nodes gain little energy from 20:00 at night until 5:00 am on the second day.

The simulation experiments compare the data low-latency transmission communication protocol LDTL proposed in this study with D-APOLLO, a geolocation-based energy asynchronous type data low-latency transmission routing model, which is still widely used in the construction of wireless sensor networks in forest environments and is the most effective communication protocol for forestry IoT engineering applications. When setting the same delay requirement, the LDTL model uses less control mechanisms than the D-APOLLO model, which means that the LDTL model is more effective in reducing the network delay; for example, when the delay requirement is 150 units, the LDTL model needs to use 45 times of control mechanisms, while

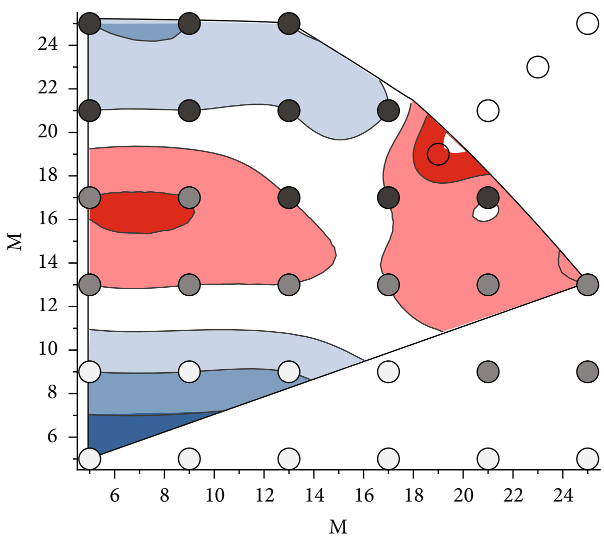


FIGURE 7: 200 sensing nodes and 5 sink nodes linked in the network.

the D-APOLLO model needs to use 55 times of control mechanisms The LDTL model is more efficient than the D-APOLLO model by more than 15%. As the latency demand decreases, the number of control mechanisms employed by LDTL and D-APOLLO models decreases significantly, and the gap between these two communication mechanisms decreases; for example, when the latency demand is 350, LDTL model requires 11 control mechanisms and D-APOLLO model requires 12 control mechanisms, and the advantage of LDTL model is less obvious. This is because when the demand for network latency is not too high, the network is more flexible in routing and forwarding, and the difference between these two routing protocols in terms of their respective communication mechanisms is less, and when the demand for latency is high and the requirements for establishing data transmission links are more stringent, the advantage of the LDTL model is more obvious.

## 4. Scenario Simulation of Sensor Networks

The simulation is implemented in MATLAB environment, 200-400 common sensor nodes and 1-5 base station nodes are randomly generated, the nodes are randomly distributed in a $1000\,\text{m} \times 1000\,\text{m}$ plane area, the maximum transmission distance of the nodes is $R = 100\,\text{m}$, the transmission power of all nodes can be adjusted, any two nodes within the transmission distance can communicate with each other directly, the node energy is obtained through the configured Tianyang energy plate, the size of Tianyang energy plate is $20\,\text{cm}^2$, the efficiency of light energy conversion is 15%, and the automatic energy loss is not considered. The individual node parameters are obtained from the actual operating environment. To improve the operational efficiency of the monitoring system, multiple base station (sink) nodes are deployed in the monitoring area. The multibase station deployment has several advantages; first, it reduces the load pressure of single-base station operation, the data generated by the source node only needs to be forwarded to any of the nearest base station nodes, the path of data from the source node to the target node is greatly shortened, and the data is transmitted to the target node faster, reducing the data transmission delay. Second, it provides system operation stability. In a single-base station network, the common sensing nodes distributed around the base station are responsible for data collection and data forwarding, and the energy of the nodes is easily depleted, causing network fragmentation and network failure, while in a multibase station network, when the nodes around a base station consume energy faster, the data can be diverted to other base stations, thus avoiding network fragmentation. As shown in Figure 6, a total of 15 common wireless sensing nodes and 3 base station nodes are deployed, of which 4 sensing nodes are source nodes that collect data and send it to any of the 3 base station nodes. All nodes are involved in data transmission and a mesh link is formed between the nodes. All the nodes share the pressure of data forwarding and considering that the energy of the nodes can be replenished continuously, the utilization of the nodes is high in this model.

To further demonstrate the application of the routing model based on the maximum data collection algorithm in a large-scale network, 200 sensing nodes and 5 base station nodes are randomly generated in the simulation environment, distributed in a $1000\,\text{m} * 1000\,\text{m}$ network environment, and the network connections are shown in Figure 7. From the figure, it can be seen that all nodes are involved in data transmission, and the data generated by the source nodes may go through a rather long link before reaching the base station nodes. Considering that the energy of the nodes can be continuously replenished, the utilization of the nodes is greatly improved in this routing model, and the amount of data collected by the source node is increased more compared to the traditional network aiming at minimum energy consumption. In wireless sensor networks based on energy replenishment, nodes are powered by external energy sources such as solar energy, and access to energy is unstable and scarce, so nodes usually maintain a low duty cycle and relatively little data transmission interference, so in this paper, only the ideal state data collection rate situation without data transmission interference is considered, and in the actual operating environment, data transmission inevitably exists.

To further compare the performance of the maximizing data collection rate- (MDCR-) based algorithm proposed in this paper in an operational environment, two data collection rate algorithms are provided for comparison in this section: distributed lexicographic rate deployment- (DLEX-) based assignment (DLEX) algorithm and the high-throughput simple scheme (SIM). In DLEX, the authors propose a routing structure and node data volume distribution model using distributed computing to dynamically update the data volume distribution in nodes and links by the optimal distributed data collection rate deployment algorithm. In this model, each node first calculates its own maximum data collection rate by employing a distributed algorithm, and subsequently, the node sends the calculated maximum data collection rate to its neighboring nodes by sending

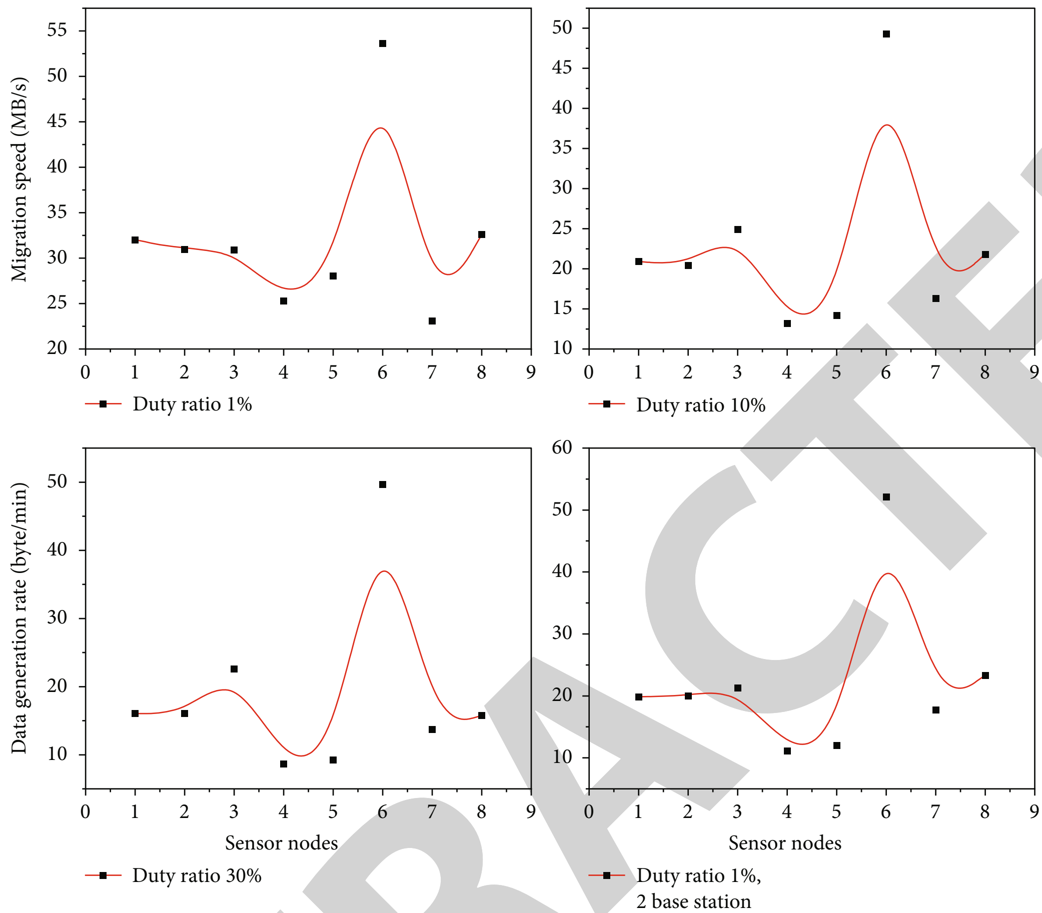


Figure 8: Comparison of data acquisition rates with different duty cycles and different number of base stations.

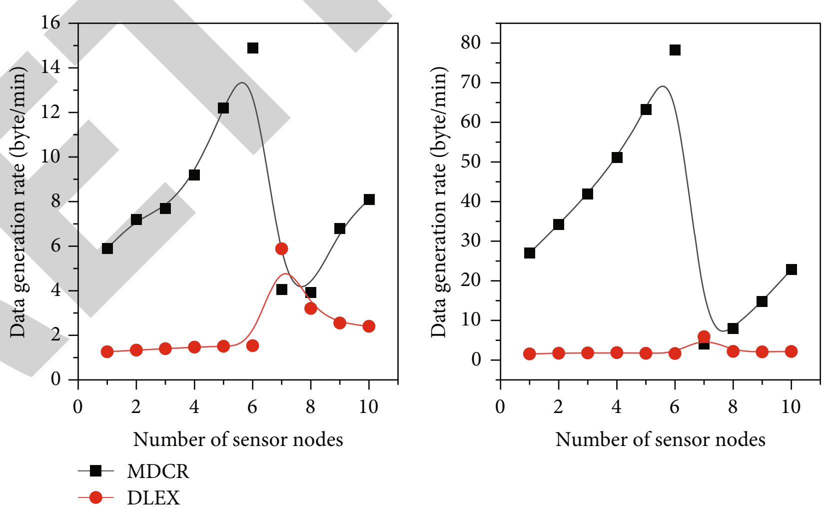


Figure 9: Comparison of network energy consumption when the duty cycle is 1% for different node distributions.

control packets. In the SIM model, the communication radius of a node is kept fixed and the communication energy consumption per unit of data is fixed, and the node decides whether to perform data transmission based on the idle state of the link and the node's own energy condition. When the remaining energy of the node is greater than the energy required for data transmission and the channel is idle, the data will be transmitted to the neighboring nodes. In this section, we first compare the data collection rate of the proposed algorithm (MDCR) with DELX and SIM algorithms for different duty cycle nodes and different number of base stations. Figure 8 shows the data collection rate of MDCR algorithm and DELX and SIM algorithms for 1%, 10%, and 30% of node duty cycle and 1, 2, 3, and 4 number of base stations, respectively. From the figure, it can be seen that the data collection rate of the whole network increases gradually with the increase of the number of nodes under different duty cycles and different numbers of base stations, and the MDCR algorithm proposed in this paper is slightly higher than the other two algorithms in terms of data collection rate.

The MDCR algorithm proposed in this paper is used to calculate the upper limit of the data collection rate of nodes in the network by using a distributed model, which is the maximum data collection rate achieved in the ideal state of network data transmission, instead of actually establishing the actual physical link, so it is better in terms of data collection rate calculation. In the actual operating environment, the network data collection rate is slightly less than the calculated network data collection rate. When the node duty cycle is 1% and the base station nodes are 1, 2, 3, and 4, respectively, the proposed algorithm MDCR is about 4%, 6%, 5%, and 7% higher than the DLEX algorithm and about 7%, 8%, 10%, and 11% higher than the SIM algorithm in terms of data collection rate. As shown in Figure 9, it can be reflected that high node density can effectively improve the network data collection rate and increase the utilization of nodes, so in general, more wireless sensing nodes should be deployed in the monitoring area in order to collect more data in the monitoring area. However, too high node density can easily cause data transmission conflicts, signal overlap, and aggravated interference, making the nodes have to perform more data retransmissions, which in turn reduces the data collection rate. Therefore, in traditional wireless sensor networks, node deployment density is generally taken cautiously according to the monitoring needs considering various elements such as cost.

The data acquisition rate is influenced by the energy acquisition and energy utilization in the network environment, which indicates the energy consumption as the number of nodes deployed in the network increases when the average duty cycle of the network nodes is 1%. From the figure, it can be seen that the energy consumption of the whole network keeps increasing as more nodes are added to the network. Among them, the MDCR algorithm proposed in this paper consumes more energy compared to the other two algorithms, especially when more nodes are added. This is different from the traditional networks aiming at energy saving; instead, in energy-replenishing networks, more energy consumption shows the superiority of the algorithm because the energy of nodes can be continuously replenished. After the energy is consumed, more energy will be transformed from the environment.

## 5. Conclusion

In this paper, we establish a realistic validation model of forest environment based on TelosB sensing nodes. The TelosB sensing node is used as an experimental platform to build a wireless sensing system for collecting temperature, humidity, wind speed, and other data. By implementing the protocol based on the Crossbow TelosB Mote TPR2420 node, the implementation of the low data delay transmission model based on energy control in the forest environment is verified. In addition, this paper studies and proposes a linear programming model with the maximum data collection rate of network nodes as the optimal objective. The maximum collection rate model of wireless sensor network is established, and the network model, energy consumption model, energy replenishment model, and routing model are defined. The upper limit of the maximum data collection rate of the network is solved using optimization techniques, a nonlinear programming model with energy consumption and data flow as constraints is established, a Lagrangian transformation is performed on the model, and a distributed subgradient algorithm is proposed to calculate the maximum data collection rate of the network. In this paper, an approximate inference model based on triangular fuzzy numbers is established to study the forest fire prediction and early warning system. A fuzzy inference system for predicting forest fires based on wireless sensor network technology is proposed. A set of fuzzy coefficients is introduced in the system to assess the fire risk in the study area, and a quantitative potential fire risk rating is established: low, medium, high, higher, and very high. The fuzzy variable values are selected to adjust the forest fire prediction accuracy according to different regional characteristics.

In the future, the research idea of this paper starts from the application technology of wireless sensor network in the forest environment, and the design of the energy self-collection permanent function of sensor nodes, sensor node transmission routing strategy, data collection, fusion, and fuzzy inference decision fire danger warning process are realized vertically, so as to provide a solution to the forest fire warning problem of energy-supplemented wireless sensor network.

## 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.

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