Hindawi
Journal of Sensors
Volume 2022, Article ID 9002533, 11 pages
https://doi.org/10.1155/2022/9002533

Research Article

Wireless Music Playing Buzzer Sensor-Assisted Music Tone Adaptive Control

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Received 16 November 2021; Revised 8 January 2022; Accepted 15 January 2022; Published 2 February 2022

Academic Editor: Gengxin Sun

Aiming at the problem of adaptive change of auxiliary music tones, this paper proposes a MAC protocol with a common music tone listening/sleeping type based on a wireless music buzzer sensor. First of all, the new MAC protocol adopts network-wide synchronization, and all sensor nodes in the entire network use the same scheduling table, so that the entire network nodes enter the music tone listening period and the sleep period at the same time. Secondly, the node adaptively adjusts the duty cycle of the node according to the number of data packets in the sending queue, increases the node's music tone listening time, reduces the end-to-end delay of data packets, and improves the throughput of the network. Then, the experiment adopts a new backoff strategy to adjust the contention window according to the backoff times and collision times of data packets sent by nodes in the last five working cycles, increase the backoff time of sending data packets under high network load, and reduce the appearance of data packets. We build four simulation experiments on the NS2 simulation platform: unassisted music tone adaptive network, single auxiliary music tone adaptive network, auxiliary music tone adaptive convergence network, and random deployment network, which will be based on the auxiliary music tone adaptive MAC protocol, and IEEE802.11 protocol and SMAC protocol are run in four simulation experiments, respectively, and the performance of the three protocols is analyzed according to the tracking files in the simulation experiment. The analysis results show that the simulation wireless sounding buzzer sensor network is adaptive to different auxiliary music tones and different topologies.

1. Introduction

Since the wireless music buzzer sensor network is an extremely limited energy network, reducing the energy consumption of the sensor network is the research focus of the wireless music buzzer sensor network protocol [1]. Among the various layer protocols of the wireless music buzzer sensor network, the design of the media access control (MAC) layer and the network layer routing protocol plays a decisive role in the energy efficiency of the sensor network. The wireless music buzzer sensor network is composed of a large number of energy-limited sensor nodes through self-organization, and the nodes cooperate to improve its detection rate, and finally combine the two to get the final feature subset [2–5]. However, due to the limitation of node size and cost, sensor nodes are usually greatly affected in terms of computing power, communication ability, and energy. The energy consumption of nodes comes from batteries with limited capacity. How to minimize the energy consumption of the wireless music buzzer sensor network and maximize the network lifetime is the optimization goal of the wireless music buzzer sensor network. Existing research work extends the survival time of wireless music buzzer sensor networks from different directions. This article starts from the MAC protocol in the link layer and studies the method of optimizing the MAC protocol in wireless music buzzer sensor networks to extend the network.

With the continuous development of science and technology, the form of network existence is also constantly changing, from the initial local area network to the wide area network, to today's Internet, and the Internet of Things that is gradually taking shape. As the name suggests, the Internet of Things is the "Internet of Things Connected". That is to say, the core and foundation of the Internet of Things is still the existing Internet, and a network extended and expanded on the basis of the Internet: its user end extends to any object and object to exchange and communicate some information. As an extension technology of the Internet of Things in the Internet, the wireless sensor network (WSN) has become a research hotspot in the academia and industry. The wireless music buzzer sensor network integrates sensor technology, embedded computing technology, network technology, distributed information processing technology, and wireless communication technology [6–8].

The paper proposes a wireless music buzzer sensor network MAC protocol based on low-power music tone listening (LPL) to reduce preamble crosstalk energy consumption and increase data transmission throughput. This protocol is aimed at the wireless music buzzer sensor network MAC protocol in low-power music tone listening (LPL) using too long preamble to wake up the node, resulting in unnecessary "crosstalk" energy consumption for the sensor network. The target node information in the received data packet start message received in the preamble sequence is compared with the node information (DS-MAC), and it is determined whether to continue to receive subsequent messages and data according to the comparison result. At the same time, in LPL, in each transmission cycle, the node receives a fixed data packet, consumes the energy required to send a too long preamble. Extending the time sequence of a single receiving data cycle increases the amount of data received by the receiving node in each cycle. The simulation results show that the protocol not only improves the energy consumption of the sensor network but also increases the network throughput.

2. Related Works

The throughput rate, delay, packet delivery rate, and energy consumption are usually the main performance indicators of the WSN MAC protocol. Since the nodes in WSN are usually powered by batteries, energy consumption has become the primary principle of the MAC protocol design. At the same time, when WSN is used in industrial control, military reconnaissance, medical diagnosis, and other fields, the reliability of its data transmission has also become a key indicator that the MAC protocol has to consider. For the WSN that uses IEEE 802.15.4 CSM ~ CA default parameters for channel access, the increase in the number of network nodes and the data load will make it unable to withstand the fierce channel competition, resulting in serious data transmission reliability and energy consumption decline. For the deterioration problem, relevant researchers work to solve this problem as the research goal, aimed at designing an adaptive optimization strategy, so that each sensor node can adjust channel access parameters according to network load changes, so as to meet the application layer's requirements for packet delivery rate and low power consumption [9–11].

Regarding the MAC protocol using the fixed multiplexing access mode, Aguilera et al. [12] proposed a MAC protocol based on the TDMA mechanism for WSN with a clustered structure. The protocol divides the nodes in the network into multiple clusters. Each cluster has a cluster head. The cluster head allocates sending time slots for the ordinary nodes managed by itself and collects the data sent by the ordinary nodes and merges the data and then sent to the sink node. Although the MAC protocol based on the clustered network reduces the energy consumed by the common node competing channels, the energy consumption of the cluster head is too large, so further research is needed. Distributed energy-aware node activity protocol is also one of the classic protocols that uses time division multiplexing access. The timeframe is divided into a scheduled access phase and a random access phase according to the cycle. The scheduling access phase is divided into multiple time slots. A certain time slot is allocated to a specific node to send data, while the random access phase is only used for the transmission of control frames. However, the DEANA protocol does not consider how to allocate time slots reasonably according to the needs of nodes to send data.

In terms of MAC protocols that use random contention access methods, the sensor MAC protocol based on the IEEE 802. 11 MAC protocol of wireless local area networks is known as one of the most classic WSN MAC protocols. The protocol uses a fixed periodic music tone listening/sleep scheduling mechanism to reduce energy consumption and uses the CSMA/CA access mechanism to compete for channels during the active period. Under the premise of ensuring low power consumption, Shi et al. [13] minimized delay and increase throughput. Aiming at the problem that the relatively fixed scheduling period cannot adapt to the adaptive changes of network-assisted music tones, a MAC protocol that adaptively adjusts the duty cycle is proposed: T-MAC (timeout MAC) protocol, which dynamically adjusts the scheduling. The length of the active time in the cycle changes the duty cycle. However, the T-MAC protocol may have the problem of the destination node going to bed early, so further improvement is needed. Gupta et al. [14] proposed the wiseMAC protocol, which was originally designed for the WiseNET low-power WSN platform. The protocol introduced preamble sampling technology on the CSMA mechanism and improved the protocol to the network communication control node in idle music by minimizing the preamble mechanism. Compared with MAC and T_MAC, it has higher energy efficiency. Nozawa et al. [15] proposed the SiR MAC protocol. The basic idea of the protocol is to use a fixed-size contention window and select an appropriate transmission probability distribution for nodes at different time slots, so that different nodes that detect the same event can be within the contention window to send messages without conflict in each time slot. Cannard et al. [16] found the problem of excessive energy consumption by the boundary nodes of MAC virtual clusters is brought forward by algorithm, which effectively improves the network life of boundary nodes. Researchers are concerned with synchronous periodic music tone listening/sleeping mechanism. If the underreporting rate is high, it will lead to deviations between the evaluation results and the actual ones. The MAC protocol and the x-MAC protocol adopting the asynchronous periodic music tone listening sleep mechanism establishes a Markov queuing model. Through this model, the network throughput, delay, and energy consumption in the synchronous and asynchronous conditions are analyzed, and the theory is provided for the optimization of the WSN protocol [17–20].

3. Wireless Playing Buzzer Sensor-Assisted Music Tone Adaptive Control Model Construction

3.1. The Level of Wireless Music Network Space. When a wireless music buzzer sensor network faces different applications, the hardware components selected by the sensor nodes are also slightly different. The difference lies in the size, cost, and energy consumption of the nodes. The functions of the main four unit modules of a node are as follows: (1) The sensor module is used to sense and obtain the information of the monitoring area and the related physical quantities of some objective objects and pass the analog signal through the analog to digital converter (analog-to-digital (A/D) converter) signal. (2) The processor module is used to process the information data collected by the sensor and the data sent by other sensor nodes and is responsible for coordinating the work of various parts of the node. (3) The wireless communication module converts the digital signal output by the processor into an analog signal through a digital-to-analog converter (D/A) and sends it to the equivalent node through the wireless medium. Usually, the transceiver adopts low-power consumption and short-distance communication. The wireless communication module has four states: sending, receiving, idle, and sleeping. Figure 1 shows the hierarchy of wireless music network space.

The MAC layer is the first layer above the physical layer, so the performance of the MAC protocol is strongly affected by the physical layer. In wireless sensor networks, the MAC protocol determines the use of wireless channels and allocates limited wireless communication resources between sensor nodes to build the underlying infrastructure of the sensor network system. In fact, the medium in a wireless environment is usually a wireless channel, and the essence of wireless channel transmission is broadcasting. In other words, within the communication range, any ongoing transmission may be interfered by other transmissions. Interference means the loss of data packets. In this case, the MAC protocol needs to provide a suitable retransmission mechanism.

$$C(r,t)-\sum\left(C(r,t)/C(s,t)+\frac{C(r,t)-C(s,t)}{C(r,t)\times C(s,t)}\right)\times 100\%=0. \tag{1}$$

The use of scheduling-based MAC protocols will also cause some problems. In a network without infrastructure, huge energy needs to be spent to maintain global clock synchronization, and a highly complex distribution algorithm calculates conflict-free time slots. The conflict-free schedule needs to understand the topology of the two hops around the node and place the topology within the two hops in the node with limited memory, which will consume additional energy to maintain the topology.

$$F(x,t)=\lim_{x\longrightarrow\infty}\sum_{i=1}^{N}a_i-\frac{1}{\prod a_iy_ja_jy_i}\sum_{i=1}^{N}\sum_{j}^{N}a_iy_ja_jy_ik\left(x_i^2,x_j^2\right). \tag{2}$$

It can be seen that most of the energy consumption of sensor nodes is in the wireless communication module. The wireless communication module consumes the most energy in the sending state, followed by idle and receiving states. The wireless communication module always monitors the usage of the channel in the idle state, checks whether there is data sent to it, and turns off the radio transceiver in the sleep state, reducing unnecessary forwarding and receiving, and entering the sleep state as much as possible when there is no communication requirement can make the communication of sensor nodes more efficient.

3.2. Tone Adaptive Analysis of Auxiliary Music Data. Before the auxiliary music data node receives the start symbol (start symb01), the sender's information is received at least twice. The first time is the semaphore information, and the second time is the reception start information. From the perspective of energy consumption, the semaphore information is received earlier than the reception start signal, which is more conducive to preventing nodes from responding to signals from nondestination nodes.

In the MAC protocol mechanism, multiple nodes will compete for the same destination node, that is, the destination node will receive multiple semaphore information. At this time, the amount of information will be interfered, and the semaphore will be adjusted through related methods (used in an analog environment). If it is judged whether it is the destination node in the received semaphore information, at this time, multiple nodes are competing for the same channel time sequence, so when the received semaphore information is selected to determine the sender may affect the channel competition, and when the reception start information is received, at this time, the competition ends and the radiofrequency signal has stabilized, which is conducive to the stability of the sensor network information transmission, so the reception start information is used as the basis for selecting the destination node. Figure 2 shows the distribution of auxiliary music data.

In the process of designing energy-efficient network protocols, it is often not related to a certain layer of the protocol stack, but to achieve the best energy efficiency through the integration of multiple layers of functions and data, which is the crosslayer design mentioned above layer design, because it is difficult to apply multiple energy efficiency strategies together at a certain layer. In a whole receiving cycle, different timing intervals or time slots apply different methods to control energy consumption, so there may be conflicts in the same layer. For example, the method of applying asynchronous purpose LPL in the synchronization protocol TMAC protocol cannot be implemented at the same time at the MAC layer. All data units in the data packet

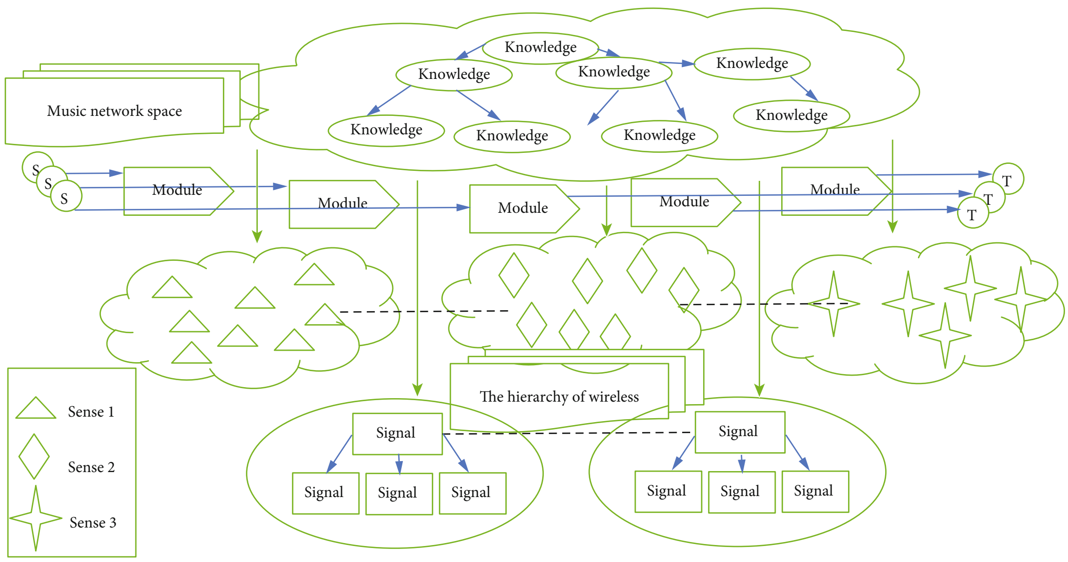

Figure 1: The hierarchy of wireless music network space.

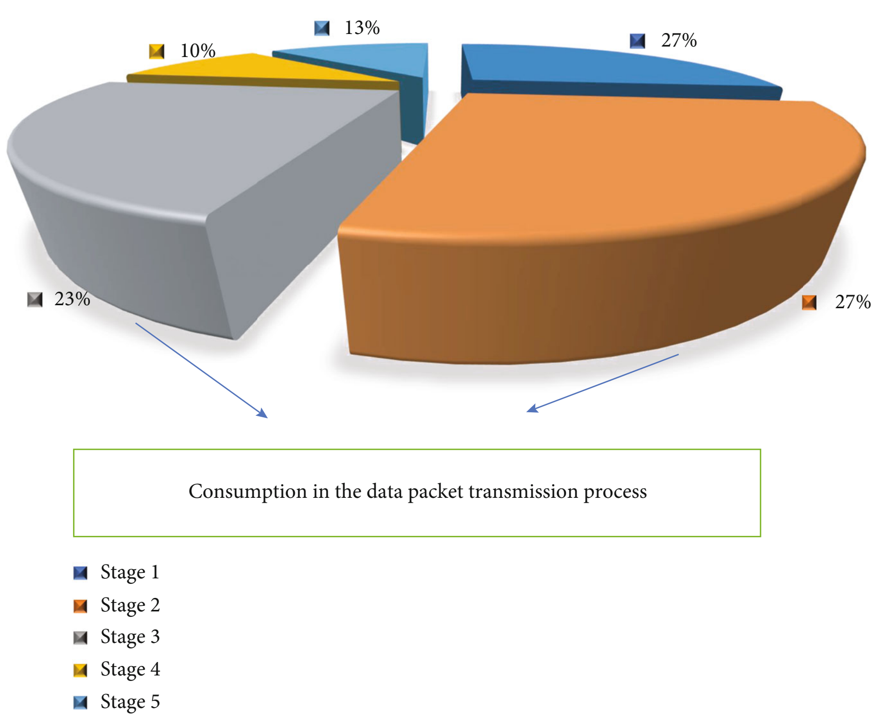

Figure 2: Distribution of auxiliary music data.

transmission process can only be analyzed at the physical layer, so that the proposed new protocol can transmit data.

The mechanism in which sending nodes compete to send wake-up signals in SCP mode is much less expensive than the mechanism of continuous preamble transmission in LPL. However, if the length of the data packet to be sent is too short, the ratio of the energy cost of the wake-up signal to the energy consumption of data transmission is still relatively small. In order to further reduce overhead and improve protocol performance, the improved SCP working mode of MA-MAC adds a short data burst function, that is, when multiple data to the same destination node plus an ACK frame (if ACK needs to be sent), the total transmission time is less.

Security elements are the input part of the network security assessment system, and its classification accuracy affects the results of the assessment. When the protocol supports the maximum length of data packet transmission time, multiple short data packets can be continuously transmitted in bursts. If there are multiple short data packets to be sent continuously, the node sets the BURST_XMIT_BIT flag in the packet header when sending the previous data packet, and the receiving node does not enter sleep after receiving the data packet with this flag set but continues to wait.

3.3. Buzzer Sensor Network Parameter Setting. The protocol stack of a buzzer sensor node usually includes five layers: application layer, transport layer, network layer, data link layer, physical layer, and three management planes, namely, energy management plane, mobility management plane, and task management plane. The result can be obtained according to

$$\begin{cases} V_{(i,f)} - \dfrac{\sum J_i^f + J_i^{f-1}}{\sin\left[w(x,t)\right]} = 0, \\ V_i = \left(V_{(i,i)}, \cdots, V_{(i,f)}\right). \end{cases} \quad (3)$$

The role of the sensor's network protocol stack is roughly the same as that of the Internet protocol stack, coordinating the transmission of data packets in the network. The main role of the three management planes is to enable sensor nodes to work together in an energy-efficient manner, coordinate the forwarding of data packets between mobile nodes in the network, and support multitasking and resource sharing. The functions of the protocols and management planes of each layer are as follows: (1) The main function of the physical layer is to determine the modulation mode and transceiver architecture so that it has simple, low-cost characteristics and can provide the required sufficiently robust services. (2) The main function of the data link layer is to ensure the correctness of transmission, adjust the data transmission rate, and media access control of the MAC layer (the MAC layer is usually considered a part of the data link layer, but in the MAC layer and the rest is a clear boundary between the data link layer). (3) The network layer is responsible for forwarding data packets from the source node to the destination node through the network. The main function is to find the optimal path and forward it correctly along the optimal path. Table 1 shows the applicability of auxiliary music data.

At the end of the backoff time, the wireless channel is always in an idle state, and then, the node will send the RTS packet. The RTS control packet includes the time NAV required for this data transmission. After the transmission is completed, the channel will listen to the music tone and wait for the destination node of the data packet. As the sent CTS control packet, when the clock of the CTS waits for a timeout, the node performs timeout processing and enters the dormant state.

The LEACH protocol clusters the network by first selecting the cluster head and then dividing the cluster area. When receiving the CTS packet sent by the destination node, the sending node immediately sends the data packet to the destination node and waits for the ACK control packet. When the sending node waits for the ACK to time out, the node will also perform timeout processing and retransmit. When the number of retransmissions exceeds 3 times, the node enters the dormant state. When the sending node receives the ACK control packet from the destination node, the sending node checks to see if there is still data to be sent. If not, it enters the dormant state. If there is still data to be sent in the buffer queue, the node needs to reapply for the channel and enter again in idle music tone listening state, after successful channel competition, repeat the above steps to send data packets.

Table 1: Description of the applicability of auxiliary music data.

Index number	First level indicator	Second level weight	Third level weight
1	Auxiliary function rate	0.12	0.34
		0.24	0.25
		0.09	0.26
2	Optimal network layer	0.13	0.25
		0.05	0.41
		0.14	0.52
3	Network auxiliary capabilities	0.22	0.17
		0.31	0.09

3.4. Tone Adaptive Clustering Control. Since the tone adaptive communication module consumes most of the energy of the node, and the MAC protocol determines the state of the radio, the quality of the MAC protocol will affect the lifetime of the entire network. In addition, different nodes sometimes use different power supply modes, such as the use of non-rechargeable batteries, the use of regularly charged equipment (sunlight, etc.), and the use of irregular charging equipment (the ion in the soil, etc.).

In short, under the limited energy and hardware of the node, the MAC protocol design of the wireless music buzzer sensor network should try to ensure the life of the node. Secondly, the MAC protocol is concerned with the quality of service. The service attributes of the wireless music buzzer sensor network are basically determined by the specific application. Therefore, the MAC protocol in the wireless music buzzer sensor network focuses on the lifetime, reliability, fairness, scalability, and delay of the network, and throughput is rarely regarded as the main factor in the design of the MAC protocol. Figure 3 shows the distribution of pitch adaptive clustering data.

To support the mobility of network nodes, the node information management module should include a mobile information management submodule and a neighbor table management submodule, while providing corresponding management and data access interfaces to each layer of the protocol stack. The main function of the mobile information management submodule is to manage the status information of the node itself and nearby mobile nodes. The mobile information is stored in the mobile information database, and the mobile information management routine is responsible for changing and querying it. The function that the mobile information management routine should have is to estimate the node's mobile state based on the information provided by the MAC layer and the application layer. In

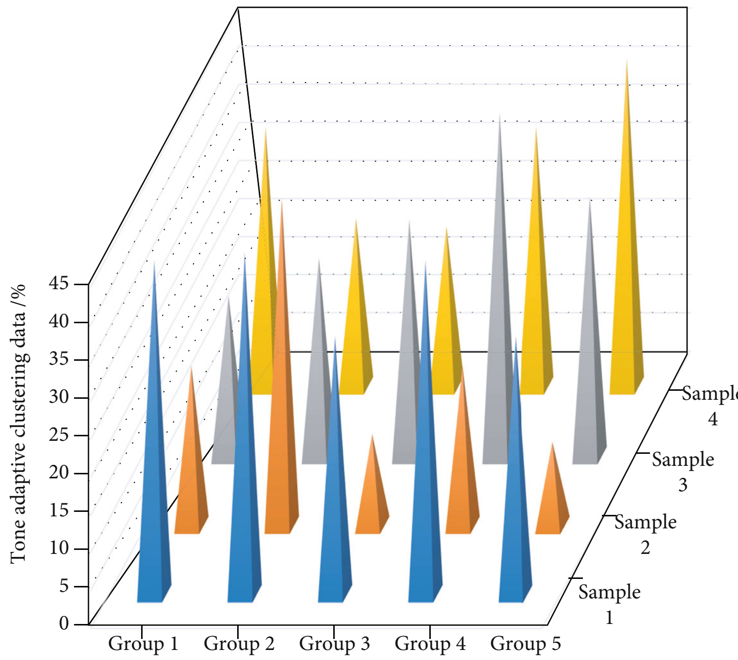

Figure 3: Data distribution of pitch adaptive clustering.

addition, the crosslayer status information of some nodes should also be managed uniformly by the node information management module and provide access and control interfaces for each layer of the protocol stack.

4. Application and Analysis of Wireless Music Playing Buzzer Sensor-Assisted Music Tone Adaptive Control Model

4.1. Buzzer Sensor Network Data Preprocessing. Since in this protocol, all network link constructions and data transmissions are initiated and controlled by the receiving node sending a beacon frame after waking up, the information about the destination address, beacon type, and predicting the next wake-up should be set in the beacon frame. The average load on sensor nodes within 2 hops from the sink node is much higher than the average load on nodes outside 2 hops. Among them, the load of the node within 1 hop from the sink node is the largest, which is about 5 times that of the 3-hop node. For a network with a clustered structure, the network load is mainly concentrated on the cluster head, and the communication bottleneck effect on the cluster head near the sink node is more serious than in a flat structure network. The result can be obtained according to

$$\oint F(x,t)\times L_{(\mathrm{emg},k)}dxdt-\int\left(f_{(\mathrm{emg},n)}+C_{(\mathrm{emg},k)}\right)dkdt=0. \quad (4)$$

From this beacon structure, it can be seen that compared with other asynchronous MAC protocols; this protocol only adds a rand bit to the beacon structure adjustment, which is used to complete the calculation of the next wake-up time and control the beacon's behavior by setting different values of the DST bit type values, and complete the broadcast update operation; this protocol beacon has the feature of low overhead.

Regardless of whether there are new nodes or dead nodes in the later stage of the network, n is used as a normal value for calculation, but the value of n must be greater than or equal to the initial total number of nodes. After the nodes in the network start to work, they need to determine their approximate scheduling cycle through the initial broadcast beacon frame, and the cycle only starts to run after a node successfully broadcasts the beacon frame. In order to avoid the collision of the node's broadcast frame in the initial stage of the network, in the first original period TPrim, the node randomly selects a moment TRand as the time for sending the broadcast beacon frame. Figure 4 shows the data distribution of the buzzer sensor network.

The average energy consumption of each node in the entire network changes with the increase of the CBR interval. The calculation method is the same as that of the single auxiliary music tone adaptive simulation experiment. Due to the change of the topology, the auxiliary music tone adaptive convergence experiment is different. There is a big difference in the energy consumption of a single auxiliary music pitch adaptation experiment. It can be seen from the simulation performance curve that similar to the simulation result of the single auxiliary music tone adaptation experiment, when the CBR interval is different, the average energy consumption of the nodes in the SMAC protocol and the new MAC protocol changes slowly.

The selection of the cluster head is based on the relationship between the self-generated random number and the threshold. All nodes selected as the cluster head broadcast the cluster head message. At the same time, the sending node sends an RTS data transmission request to the target

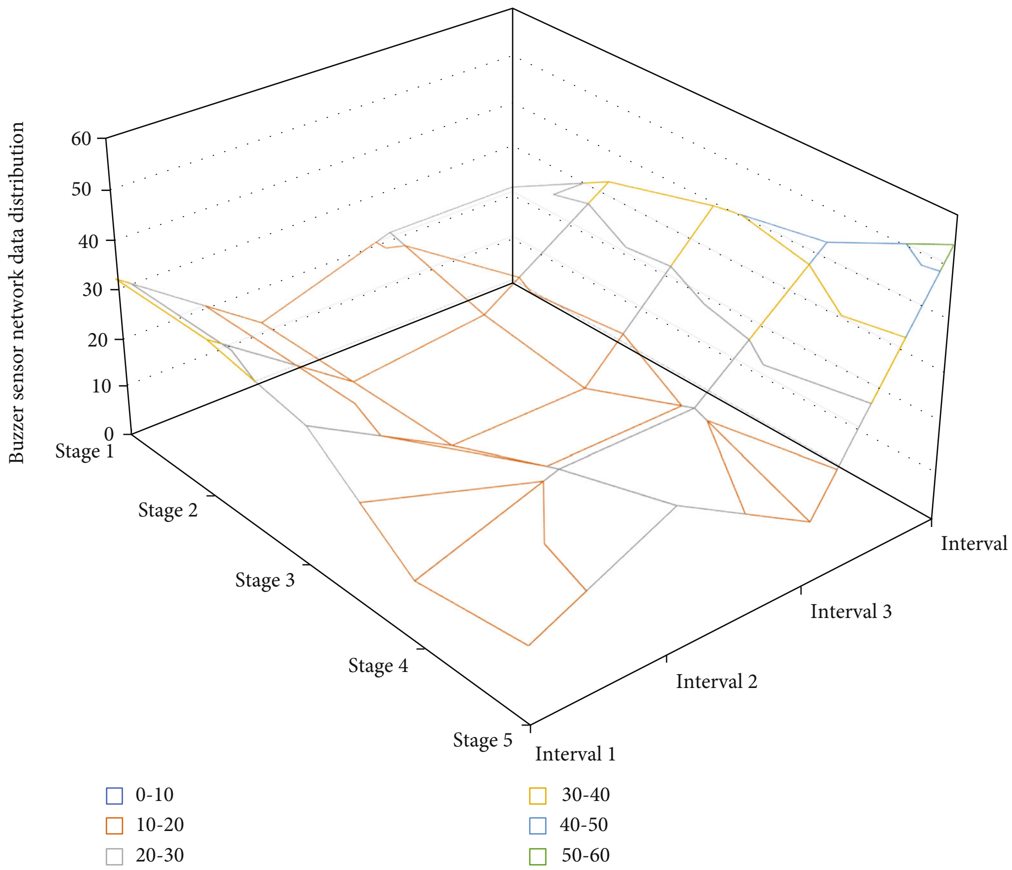

FIGURE 4: Data distribution of buzzer sensor network.

node and establishes a reliable communication link and completes data transmission through the RTS/CTS/DATA/ACK mechanism. After receiving the data and sending the confirmation frame ACK, the target node still keeps the music tone listening channel for one TKeep time. If there is a data sending request, it will continue to receive data. If there is no request, it will enter the sleep state. However, it can be clearly seen from the simulation results that the new MAC protocol and the SMAC protocol are not converging. The reason for this is that the fixed duty cycle in the SMAC protocol cannot properly handle the funneling phenomenon.

4.2. Auxiliary Music Pitch Adaptive Model Simulation. This paper carries out simulation experiments on the MAC protocol on the NS2 (Network Simulator Version 2) simulation platform. NS2 is a free software that can run on Windows X. All source codes are open and easy to expand. These features are useful for wireless. The research and expansion of the music buzzer sensor network are very convenient, and the research results obtained by this method are also generally recognized by the academia, so this article uses NS2 as a simulation tool. This method first uses the maximum correlation minimum redundancy method to initially filter irrelevant features to reduce the data dimension. The main purpose of the simulation experiment is to verify the feasibility and performance of the protocol on the establishment of a simulation platform and to compare and analyze with the existing mature MAC protocol. The main aspects of the comparison are energy, delay, throughput, etc. Figure 5 is the architecture of the auxiliary music tone adaptive model.

Unbalanced network load distribution results in unbalanced energy consumption of nodes. Nodes near the sink node consume energy faster than peripheral nodes, and routing holes are easily formed near the sink node, which greatly shortens the lifetime of the entire network. The bottleneck effect caused by the sensor data generated by peripheral nodes cannot be correctly and timely reported to the aggregation node. The use of hierarchical fusion and data compression can reduce the total amount of network data and alleviate the communication bottleneck problem to a certain extent, but this method is only suitable.

In addition, since a small number of cluster heads are responsible for most of the network's auxiliary music tone adaptation, the above two problems are more obvious in clustered networks. There are three transmission links in the simulation scenario and all need to be forwarded by high-rate node 0 to complete the data transmission, and node 4 is the destination node of the three links. Therefore, the simulation of this network scenario can achieve the purpose of verifying the optimization effect of the contention

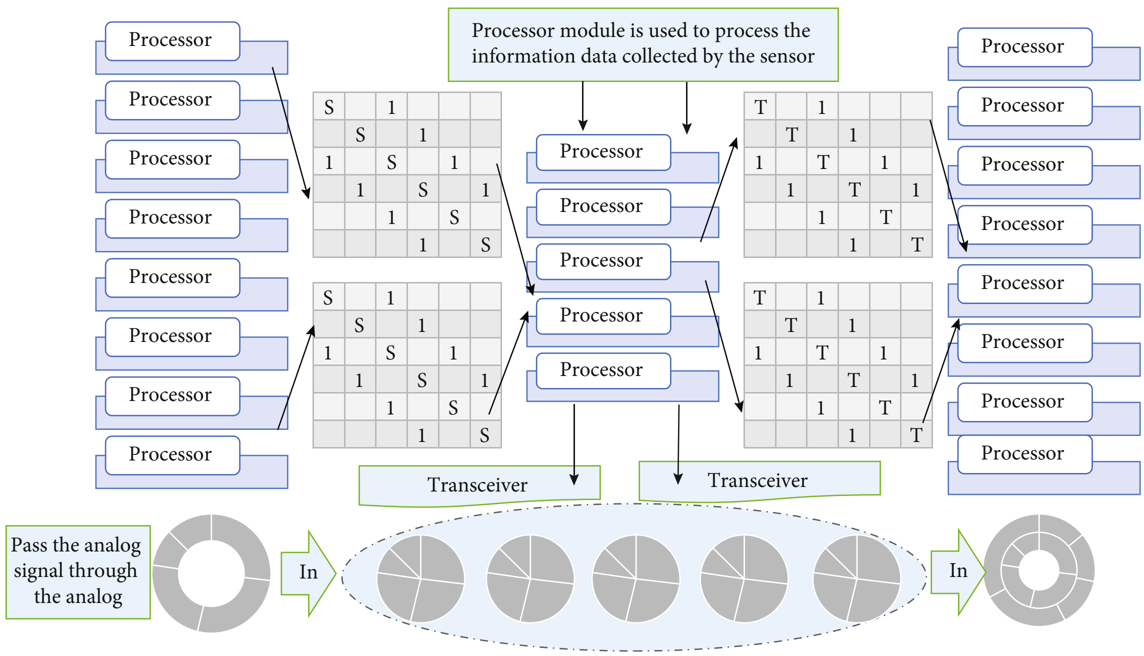

Figure 5: Auxiliary music tone adaptive model architecture.

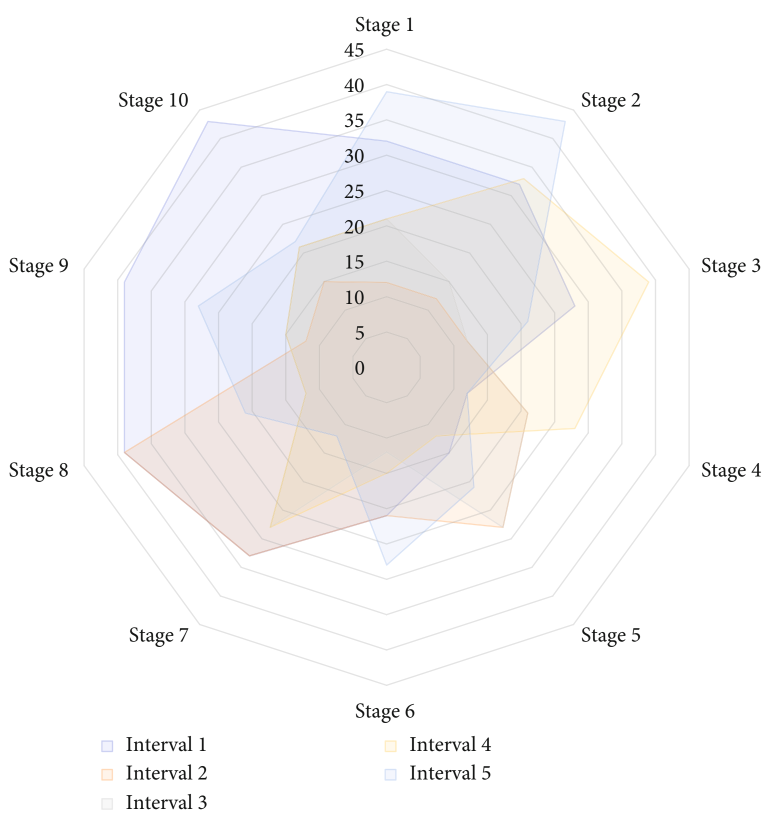

Figure 6: Energy consumption distribution of wireless sensor network nodes.

window white adaptation mechanism of the multirate MAC protocol based on congestion control in this paper. Figure 6 shows the distribution of energy consumption of wireless sensor network nodes.

It can be seen that the performance of this protocol is exactly the same as that of the competition window adaptive protocol. This is because in the hidden terminal scenario, there are only two nodes on the data link, one receiving and one transmitting, and there is no congestion in the network. The protocol in this paper has been using the competition avoidance mode of the competition window adaptive mechanism, so the mechanism is the same.

A common node usually receives information from multiple cluster heads. In the original S-MAC protocol, when the packet sending interval is less than 5 s, the throughput per child is maintained at around 180 bps, and it does not get better until the packet sending interval is 5 s. This shows that under high load conditions, due to the low duty cycle and the overly simple backoff mechanism, the throughput performance of S-MAC cannot be improved when it reaches a limit value. Under high load, the throughput performance of the optimized protocol in this paper is significantly higher than that of the original S-MAC protocol. The result can be obtained according to

$$\cup_{x-t=1} f(x,t) - \text{sign}\left(\sum_{i=1}^{N} a_i \times y_i \times k(x_i, x_j) - b\right) = 0. \quad (5)$$

As the auxiliary music tone adaptation decreases, the performance curves of the two protocols tend to be consistent. When the packet transmission interval is less than 0.006 s, the three performance: packet arrival rate, throughput and delay of the protocol in this paper are better than those of the RBAR protocol. The advantage is weakened, and the performance of the three protocols is not much different. In terms of more important throughput performance indicators, when the packet sending interval is less than 0.006 s, the throughput of the RBAR protocol is basically maintained at 1100 Kbps, while the protocol and contention window adaptation mechanism in this paper are higher than RBAR. The simulation results show that the multirate MAC protocol based on congestion control in this paper solves the problem of abnormal performance of multi-rate networks.

4.3. Example Application and Analysis. Most mobile sensing application scenarios require that a small range of sensor nodes near the mobile node can report sensor data at a high rate and high success rate in a short period of time. Maintaining a high transmission success rate under local heavy load is the goal pursued by a mobile sensor network protocol design. Simulation results show that the combination of the AOCMSN optimization strategy and MA-DC-MAC design can achieve better transmission performance than DC-MAC.

At this time, it determines its own attribution based on the received signal strength. Sending one data in 2 seconds to sending one data every 5 seconds, that is, the average data occurrence rate gradually decreases from 5 packets/s to 0.2 packets/s. In the first ten experiments, each sending interval increased by 0.2 seconds compared to the previous one, and 1 s was increased each time after the sending interval reached 2 s. A total of 13 experiments were carried out. The 5 rounds of experimental data are averaged to get the final result. Figure 7 is the distribution of the communication rate of the buzzer sensor network.

Because the data in DC-MAC is concentrated in a time period for transmission, the collision is very serious when the data transmission rate is high. Because it adopts the data response ACK mechanism, the data packet must be retransmitted continuously after the transmission fails, resulting in a decrease in throughput and an average delay increases. A-DC-MAC only uses the RTS/cTS mechanism near the sink node (data response is not enabled by default). After the node wins the TONE or RTS/CTS competition, it will send multiple data packets continuously in a burst mode to increase the channel utilization. Then, we use the information gain to calculate the feature that has the greatest correlation with the classification result. When the packet transmission interval is less than 0.06 s, the protocol in this paper solves the deficiencies of the competition window adaptive protocol in a network with a relatively complex topology and gives full play to the advantages of the high-rate nodes in the multirate protocol and achieves the highest throughput performance at the same time.

When the packet sending interval is greater than 0.06 s, due to the decrease in network load, the performance of the three protocols is not much different, and the throughput and the packet arrival rate are basically the same. The simulation results prove that the multirate MAC protocol based on control in this paper has realized the optimization of the adaptive mechanism of the contention window. Figure 8 is the load capacity distribution of the buzzer sensor network.

It can be seen that the optimized protocol in this paper consumes less energy than the original S-MAC protocol when the packet sending interval is less than 5 s. Because under high load conditions, the fixed duty cycle and contention window mechanism of the original S-MAC protocol cannot meet the demand for a large amount of data to be sent in the network. The collision and retransmission phenomenon is serious, and a lot of energy is wasted. The optimization of this article improve the network efficiency of the protocol under high load, thereby saving energy. The result can be obtained according to

$$\begin{bmatrix} g(x) * [0,x,1] & 1 & 1 \\ 1 & g(x) * [0,x,1] & 1 \\ 1 & 1 & g(x) * [] \end{bmatrix} [0,x,1] \times \begin{bmatrix} f(x) \times [x,1,0] & -1 \\ -1 & f(x) \times [x,1,0] \end{bmatrix} = 1. \quad (6)$$

When a gateway node receives a data packet in the virtual grid, it first determines whether any adjacent node in the same virtual grid has received the data packet. This can be done by comparing the node directory and the adjacent node list in the data packet. To finish, if it is not received, the gateway node appends the IDs of these nodes to the node directory in the data packet and forwards the data packet to the neighboring node that has not received the information.

In the first ten experiments, each sending interval increased by 0.2 seconds compared to the previous one, and 1 s was increased each time after the sending interval reached 2 s. A total of 13 experiments were carried out. When a gateway node receives a data packet from other

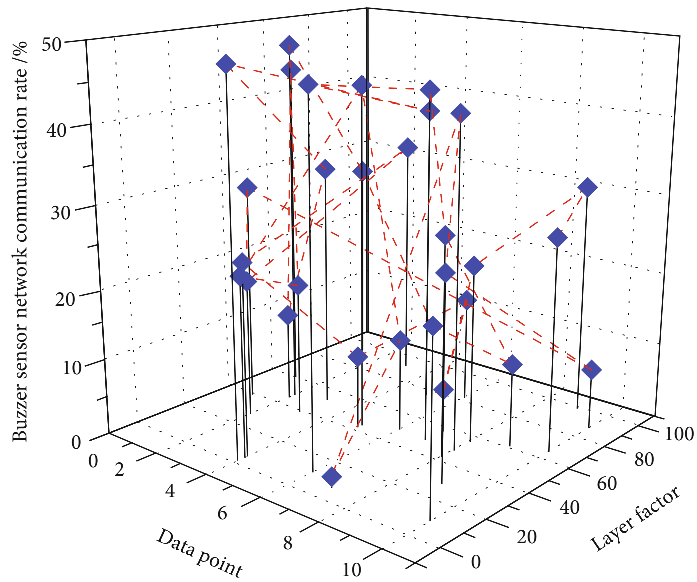

FIGURE 7: Communication rate distribution of buzzer sensor network.

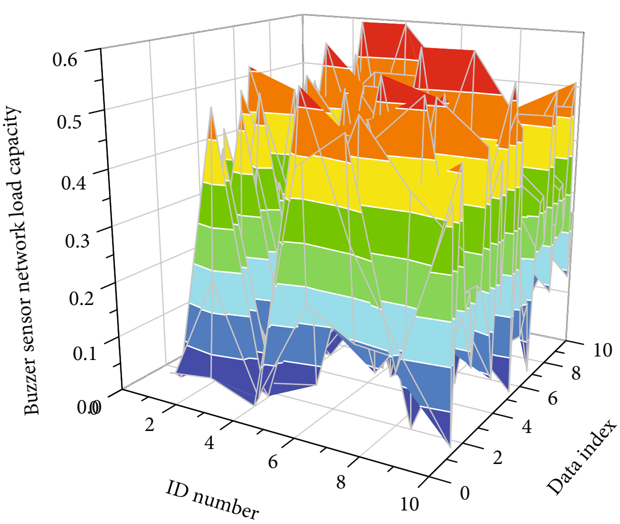

FIGURE 8: Load capacity distribution of buzzer sensor network.

gateway nodes, it first separates the node directory of the data packet, then adds its own ID and the directories of all its adjacent nodes, and forwards the data packet to all adjacent nodes. In this way, when a data packet is transmitted between virtual grids, its information length will become shorter, but when a data packet is transmitted between the same virtual grid, the information length will increase, so the basic idea of location-assisted flooding is fine.

5. Conclusion

This paper proposes a new wireless music buzzer sensor network positioning-assisted flooding algorithm, which uses positioning information to reduce unnecessary data transmission and divides the sensor network into multiple virtual grids. The internal nodes only send data in the virtual grid, and the gateway node is responsible for data forwarding between grids. Aiming at the problem of multidimensional service load balancing in wireless music and buzzing sensor networks, the experiment established a mathematical model of network load balancing based on a swarm particle optimization algorithm and proposed the application of swarm particle optimization algorithm (PSO algorithm) to sensor network load balancing algorithm. In the optimization protocol of this article, the duty cycle mechanism of auxiliary music tone adaptation, with the cooperation of the competition window adjustment algorithm, will effectively improve the performance of the S-MAC protocol under high load. The increase in duty cycle is conducive to meeting the needs of large amounts of data transmission, while the improved backoff mechanism can reduce collisions caused by fierce competition between nodes, and improve network efficiency. Through the proof of the integrity of the data distribution process, the analysis of the energy consumption of different types of networks, and the results of the actual deployment test on the ZigBee platform, it is proved that the auxiliary location flooding routing algorithm has good energy efficiency. At this time, the duty cycle of the optimized protocol is the same as that of the original S-MAC protocol, and the improved backoff mechanism is not effective. The PSOB algorithm balances the network traffic load by adaptively adjusting the service load bundle on the network node according to the network load.

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 Harbin University.

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