Hindawi
Wireless Communications and Mobile Computing
Volume 2023, Article ID 9768238, 1 page
https://doi.org/10.1155/2023/9768238

Retraction

Retracted: The Optimal Path of College Art Teaching Based on Embedded Sensor Network

Wireless Communications and Mobile Computing

Received 10 November 2022; Accepted 10 November 2022; Published 24 January 2023

Wireless Communications and Mobile Computing has retracted the article titled "The Optimal Path of College Art Teaching Based on Embedded Sensor Network" [1] due to concerns that the peer review process has been compromised.

Following an investigation conducted by the Hindawi Research Integrity team [2], significant concerns were identified with the peer reviewers assigned to this article; the investigation has concluded that the peer review process was compromised. We therefore can no longer trust the peer review process and the article is being retracted with the agreement of the Chief Editor.

References

[1] Y. Li and J. Zhu, "The Optimal Path of College Art Teaching Based on Embedded Sensor Network," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 1937259, 12 pages, 2022.

[2] L. Ferguson, "Advancing Research Integrity Collaboratively and with Vigour," 2022, https://www.hindawi.com/post/advancing-research-integrity-collaboratively-and-vigour/.

Hindawi
Wireless Communications and Mobile Computing
Volume 2022, Article ID 1937259, 12 pages
https://doi.org/10.1155/2022/1937259

Research Article

The Optimal Path of College Art Teaching Based on Embedded Sensor Network

Yumei Li[1] and Jiang Zhu[2]

[1]*Academy of Fine Arts, Dong-A University, Busan 612022, Republic of Korea*
[2]*International Businesses & Management Institute, Shanghai Sipo Polytechnic, Shanghai 201300, China*

Correspondence should be addressed to Jiang Zhu; jiang.zhu@my.jru.edu

Received 23 December 2021; Revised 10 February 2022; Accepted 16 February 2022; Published 19 March 2022

Academic Editor: Rashid A Saeed

As a new type of intelligent network technology, sensor network has been widely used in recent years. This paper is aimed at studying the optimization path of art teaching in colleges and universities based on embedded sensor network, proposing methods such as ZigBee network, HRPTC, wireless routing protocol, and sensor technology, and carrying out experimental research on the application of embedded sensor network in the optimization path of college art teaching. The experimental results show that the embedded sensor network can promote well the development of the optimization path of art teaching in colleges and universities and promote the reform of art education teaching methods. At the same time, the education and teaching methods optimized based on sensor network technology can better play the role of education and teaching so that students' learning enthusiasm has been improved by at least 10%.

1. Introduction

1.1. Background. The application prospect of wireless sensor network is very wide, and it will bring far-reaching influence to people's lives and society. In recent years, the computing and storage capabilities of embedded systems have been continuously enhanced, and the rapid changes in communication technology have made the transmission of big data no longer a problem. Combined with sensing technology, wireless sensor networks have been widely used in military, industry, agriculture, etc., and wireless sensor networks have become a hot spot in the field of information research and development.

In recent years, the design of sensors has become increasingly detailed. The sensors manufactured are small, low in price, and have improved processing capabilities. The development of WSN has also made great progress. As a new type of intelligent real-time monitoring information network, wireless sensor networks can not only collect the required data information but also process the collected information and finally send the correct data to management customers. At present, WSN technology is used in business, industry, military, medical, and other fields, which have greatly changed people's lives, made life more intelligent and comfortable, and greatly improved social productivity.

With the development of society, science and technology are also constantly improving, and sensor network technology is also developing rapidly. Wireless sensor networks (WSN) have become an important part of various environmental, surveillance, military, traffic control, and healthcare applications. However, wireless sensor networks also face many challenges in practical applications. The Remah survey explored state-of-the-art methods based on SOA and service-oriented middleware (SOM) architectures that provide solutions to WSN challenges [1]. In many WSN applications, flooding is a basic network service used for remote network configuration, diagnosis, or propagation of code updates. Although there is a lot of research on flooding in the literature, the research on flooding tree construction in asynchronous low-duty cycle WSN is very limited. Cheng et al.'s research focuses on flood tree construction that takes into account duty cycle operation and unreliable wireless link minimum delay and energy saving, and Cheng et al.'s research also shows the delay during flooding—the existence of energy balance [2]. Since most sensor nodes are equipped with limited nonrechargeable batteries, energy-saving optimization has become one of the main issues in the design of wireless sensor network (WSN) routing protocols. Therefore, Luo et al.'s research focuses on minimizing energy consumption and maximizing the life of the data relay network in a one-dimensional queue network. During the experiment, Luo et al. used the Opportunistic Routing Energy Saving (ENS_OR) algorithm to ensure the lowest power cost during data relay and protect nodes with relatively low remaining energy. A large number of simulations and real test bench results show that, compared with other existing WSN routing solutions, the solution ENS_OR proposed by Luo et al. can significantly improve network energy saving and wireless connection performance [3]. With the extensive use of wireless sensor networks, wireless sensor networks have also attracted the research interest of a large number of researchers, especially in the context of performing surveillance and surveillance tasks. However, it is challenging to make compelling compromises between various conflicting optimization criteria (for example, energy dissipation, packet loss rate, coverage, and life span of the network). Fei et al.'s research provides the latest research methods using multiobjective optimization (MOO) technology to solve this problem, as well as tutorials and survey schemes for related development work [4]. Positioning technology is also an important part of wireless sensor networks. For indoor positioning based on wireless sensor networks, the transmission of wireless signals may be interfered by obstacles and walls. This condition, called non-line-of-sight (NLOS), reduces positioning accuracy and may cause positioning to fail. Pak et al. proposed a new NLOS recognition algorithm based on distributed filtering to mitigate the effects of NLOS, including positioning failures. The algorithm they proposed does not process all measured values through a single filter, but distributes the measured values among multiple partial filters [5]. Network security has an essential relationship with sensor networks, and the development of sensor networks is closely related to the development of network security technology. In their survey paper, Buczak and Guven described the survey results of network analysis, machine learning (ML), and data mining (DM) methods used to support intrusion detection, discussed the challenges of using ML/DM for network security, and provided some information on recommendations on when to use a given method [6]. As modern cars become increasingly interconnected, they become new targets for cyberattacks. When driving on the road, sharks (i.e., hackers) only need to be within the communication range of the vehicle to attack it. In Eiza and Ni's research, they aim to shed light on the latest vehicle cybersecurity threats, including malware attacks, on-board diagnostics (OBD) vulnerabilities, and automotive mobile application threats. In addition, Eiza and Ni demonstrated the vehicle network architecture and demonstrated the latest defense mechanisms aimed at mitigating such threats [7]. In these studies, most researchers have conducted research on the application and security of wireless sensor networks, but have not done too much research on the development of wireless sensor networks themselves.

The innovation of this article is that the research content of this article is based on the embedded sensor network. This paper studies the application of embedded sensor network in the optimization of art teaching path in colleges and universities, integrating modern technology with traditional education, promoting the application of sensor network in education and teaching, to achieve the purpose of effectively using sensor network technology to innovate the teaching mode of art education in colleges and universities.

2. Sensor Network and Teaching Path Optimization

2.1. Sensor Network. With the continuous development of science and technology, the continuous enhancement of sensor technology, and the continuous maturity of network technology, wireless sensor network technology is also produced with the development of sensors and network technology. It is one of the three pillars (sensor technology, communication technology, and computer technology) of information technology [8]. Wireless sensor network combines computer technology, communication technology, and sensor technology. It is composed of a large number of sensor network nodes covering a specific target area. Most of these nodes are small, low in cost, and have data perception, data processing, and wireless communication capabilities. They jointly monitor various conditions (such as temperature, sound, vibration, pressure, and signals) in different geographic locations. Due to the ability of wireless communication, wireless sensor nodes can share information and cooperate with each other and can also transmit relevant data to other nodes [9].

2.1.1. ZigBee Wireless Communication Technology. The name of the ZigBee protocol comes from the communication method of bees. It is a low data throughput, short distance, low energy consumption, low complexity, and low cost protocol specification for the wireless network interconnection and control of small devices [10].

(1) The Composition of ZigBee Network. The types of ZigBee network equipment include full-function equipment, network coordinator, and streamlined-function equipment [11].

Full-function device: the network coordinator of the full-function ZigBee network can also be a full-function device, which can be connected to other full-functional devices or retrenchment-functional devices; full-function equipment has the function of controlling equipment and can transmit information in both directions [12]. Fully featured devices have all features and functions of network devices specified in IEEE 802.15.4. More computing power and storage space can allow it to serve as a router for the ZigBee network when it is idle, and it can also be used as a terminal device for the ZigBee network.

Simplified function equipment: it can only exchange information with full-function equipment and send and receive information [13].

Network coordinator: the main feature is the largest storage capacity, the strongest computing power, and it includes all information of the network [14].

(2) Application of ZigBee Network. Due to the short distance, low energy consumption, low complexity, and low cost of ZigBee network technology, it is widely used in many aspects of social life [15]. Figure 1 shows the application field distribution diagram of ZigBee wireless communication technology.

In industry, using sensors and ZigBee networks, the automatic collection, analysis, and processing of data will become easy, and the information collected by the sensors can be used as an important part of the decision support system.

In medicine, the use of various sensors and ZigBee networks can accurately and real-time monitor the patient's blood pressure, body temperature, heart rate, and other information, reduce the burden on doctors, and enable doctors to respond quickly.

In agriculture, a large number of wireless sensor network terminal nodes distributed in the monitoring area are responsible for ZigBee data collection of agricultural information such as temperature, humidity, and harmful gas concentration and wirelessly send it to the ZigBee digital transmission module network coordinator. The coordinator transmits the received data to the control center via the Ethernet through the gateway. After the control center stores, analyzes, and processes the data, the expert decision-making system issues feedback instructions.

(3) Topological Structure of ZigBee Network. The ZigBee protocol network is based on independently working network nodes and contains a total of three different network topology structures of communication devices, namely, ClusterTree, mesh, and star. For any ZigBee topological structure, its independent ZigBee network has a unique network identifier, that is, the PAN identifier of the ZigBee protocol network [16]. The PAN identifier corresponding to the 16-bit network address is mainly responsible for the network access and communication of network devices and can be used to activate the communication between ZigBee network devices. Among them, the star (star network) network is more commonly used to form a network topology with a long running time; the mesh (mesh network) network realizes the reliability of multiple data communication channels by establishing the interconnection of all wireless nodes in the network higher ZigBee network topology. Although the structural redundancy of the mesh network is relatively high, when a network device fails when communicating, there are other paths that can support data communication. ClusterTree network is a topological structure that combines mesh and star networks, combining the advantages of the two structures. Each device node in the network can have different functions [17]. Figure 2 shows the three network topologies of the ZigBee protocol.

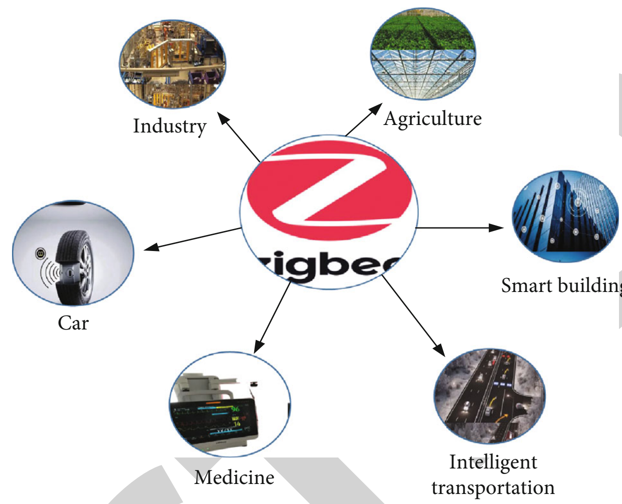

Figure 1: Application areas of ZigBee wireless communication technology.

In a star network, communication between subnodes can only be completed through the coordinator, and direct communication is not possible. However, in a mesh network, full-functional device nodes can communicate directly and they all have routing functions. Retrenchment functional device nodes can only communicate with adjacent full-functional device nodes.

(4) ZigBee Protocol: Physical Layer. IEEE 802.15.4 stipulates that the physical layer is the bottom layer of the ZigBee protocol, which is responsible for direct contact with the outside world. The transmission distance of ZigBee protocol signal is about 50 m (indoor) to 150 m (outdoor). The regulation defines two physical layer standards: the 868/915 MHz physical layer and 2.4 GHz physical layer [18]. Table 1 shows the agreement provisions of the ZigBee physical layer in different regions.

The protocol standard uses 27 channels to allocate three physical layer frequency bands and 16 channels for 2.4 GHz; 10 channels are allocated to 915 MHz; and one channel is allocated to 868 MHz. The composition of the ZigBee protocol channel is shown in Table 2.

2.1.2. HRPTC Wireless Routing Protocol. HRPTC is a mixed-mode clustering routing protocol based on the time components. Like LEACH routing protocol, HRPTC calculates the network working time in "rounds" [19]. On the basis of uniform clustering, a hybrid model combining single-hop and multihop time components in the case of multiple clusters is proposed and improved.

(1) Single-Hop Routing Model. The network is equally divided into M clusters, so the area of each circular cluster is $\pi r_m^2/M$, the radius r of the cluster is $r_m/\sqrt{M}$, and the node tree contained in each cluster is $b = B/M$.

Assuming that the energy consumed by the transmission circuit of the cluster head and the ordinary node is

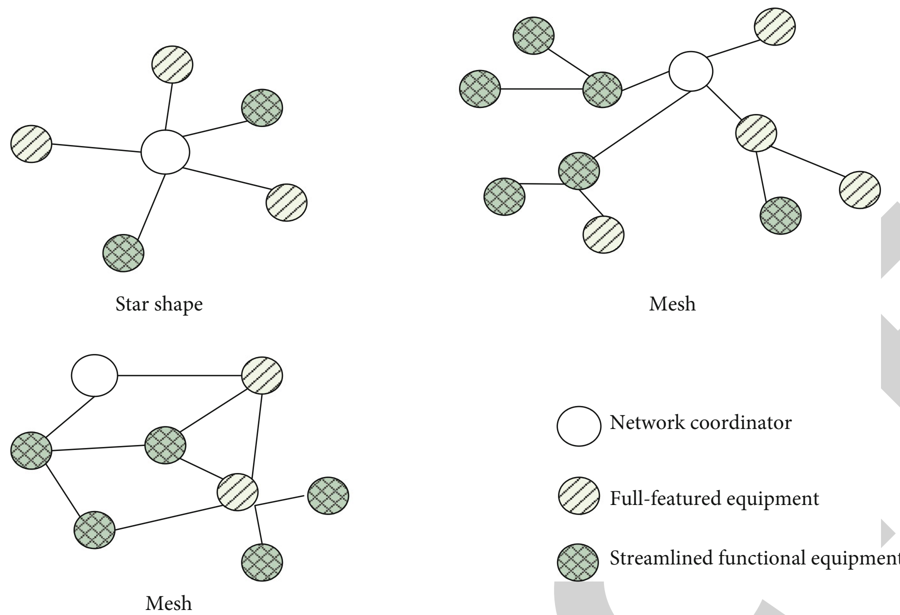

Figure 2: Three network topologies of the ZigBee protocol.

Table 1: Protocols of different ZigBee physical layers.

Operating frequency range	Countries and regions	Modulation	Bit rate
2400-2483.50	Worldwide	O-QPSK	250
902-928	North America	BPSK	40
868-868.60	Europe	BPSK	20

the same, the energy consumption expression of the ordinary node is

$$N_{\text{nonch}} = N_i + \alpha a_{\text{toch}}^{t}. \tag{1}$$

In formula (1), N_i is the energy consumption of its transmission circuit; a_{toch} is the distance from the common node in the cluster to the cluster head, and the expectation of its square is defined as

$$N\left[a_{\text{toch}}^2\right] = \iint \left(x^2 + y^2\right)\theta(x, y) axay = \frac{r_m^2}{2M}, \tag{2}$$

$$\theta(x, y) = \left(\frac{\pi r_m^2}{M}\right)^{-1}. \tag{3}$$

(X, y) in formulas (2) and (3) are rectangular coordinates. Figure 3 shows the heads-up routing structure diagram.

The expressions of energy consumption 1 of the cluster head and energy consumption 2 of each cluster are

$$N_{\text{ch}} = N_{\text{LP}} + N_a + N_{LQ} \approx \frac{B}{M}(N_i + N_a) + N_i + \alpha' a_{\text{tobs}}^{t'}, \tag{4}$$

$$N_{\text{cluster}} = N_{\text{ch}} + \left(\frac{B}{M} - 1\right) N_{\text{nonch}} \approx N_{ch} + \frac{B}{M} N_{\text{nonch}}. \tag{5}$$

In the formula, α' is the power amplifier parameter of the cluster head; t' is the attenuation coefficient of the channel from the cluster head to the base station; a_{tobs} is the distance from the cluster head to the base station; N_{LP} is the energy consumed by the cluster head to receive data. In the case of single-hop routing, the node farther away from the base station consumes more energy. When the initial energy of each sensor is equal, the node farther away from the base station determines the life of the network.

Letting the battery energy of the node be N_d and the distance from the node farthest from the base station to the base station is the network radius r_m, then the average energy of each node is

$$\begin{aligned} N_d &= L\left(N_{\text{cluster}} \frac{M}{b}\right) \\ &= L\left(N_i + \alpha\left(\frac{r_m^2}{2M}\right)^{p/2} + N_i + N_t + \frac{M}{B}\left(N_i + \alpha' r_m^{p'}\right)\right). \end{aligned} \tag{6}$$

Derivation of formula (5) can find the optimal number of clusters in a single-hop network:

$$m_d = \left(\frac{B\alpha p r_m^p}{2^{(2+p)/2}\left(N_i + \alpha' r_n^{p'}\right)}\right)^{2/(p+2)}. \tag{7}$$

If the second derivative of N_d is a positive number, then when $M = m_d$, N_d can get the minimum value.

(2) Multihop Routing Model. Multihop routing simply means that different network devices are all wirelessly connected to each other, and then, each other can forward data

Table 2: The composition of the ZigBee protocol channel.

Channel number	Center frequency	Channel spacing	Upper frequency limit	Frequency lower limit
$X = 0$	868.30	0	868.60	868.00
$X = 1, 2, \cdots, 10$	$906 + 2(X - 1)$	2	928.00	902.00
$X = 11, 12, \cdots, 26$	$2401 + 5(X - 1)$	5	2483.50	2400.00

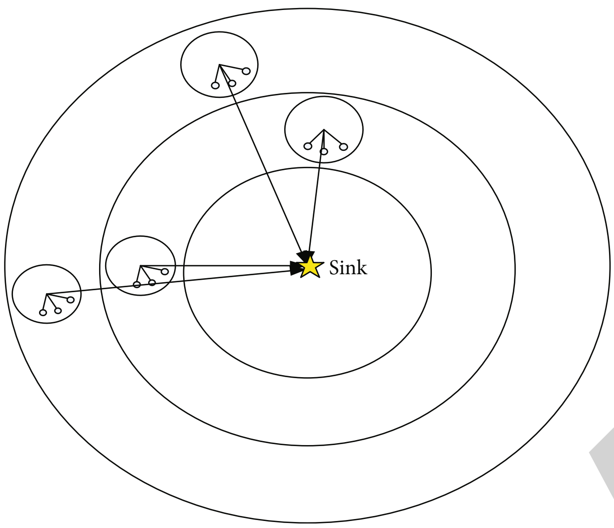

Figure 3: Heads-up routing structure diagram.

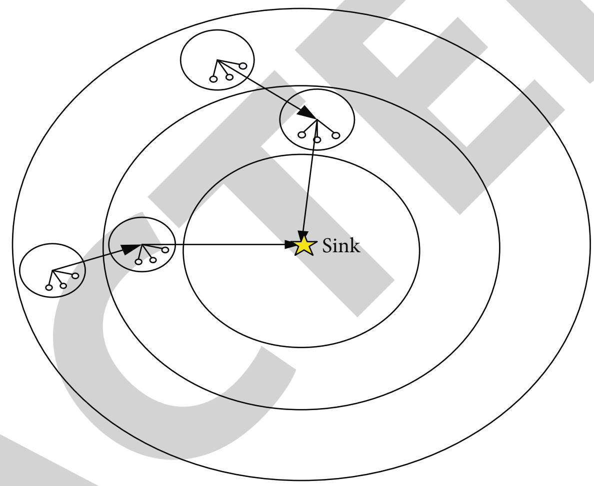

Figure 4: Hop routing structure diagram.

through the network. Data jumps from one node to another until it reaches the destination. Figure 4 shows the structure of the multihop model.

The calculation method of the number of cluster heads and layer width is as follows.

Both multihop routing and single-hop routing use the same network model, that is, the network is equally divided into A cluster, and then, the network is divided into o rings in the radial direction, the width of each layer ring is K, and the width K of the layer and the radius r of the cluster are both smaller than the radius of the network r_a; otherwise, single-hop routing is used.

To ensure the relevance of network multihop communication, the layer width K is required to be greater than or equal to the communication radius r_z of each cluster in the cluster so that the relevance rate is less than $1 - \varepsilon$ and

$$K \geq r_z = r_a \sqrt{\ln \frac{(A/\varepsilon)}{A}}. \tag{8}$$

The following is the average number of data packets forwarded by the m-th layer node S_m:

$$S_m = \frac{r_a^2 - (mK)^2}{K^2(2B - 1)}. \tag{9}$$

The cluster head under multihop routing is not only responsible for receiving and sending data in the cluster but also forwarding other data packets [20]. The expressions of the energy consumption of the cluster head and the maximum average energy consumption of the node are

$$\begin{aligned} N_{\text{ch}} &= N_{\text{LP}} + N_a + N_{\text{LQ}} + S_m N_{ax} \\ &= \frac{B}{M}(N_i + N_a) + N_i + \alpha' a^{t'}_{\text{tobs}} + S_m\left(2N_a + \alpha' a^{t'}_{\text{tobs}}\right), \end{aligned}$$

$$N_m(mK) = \left(N_{\text{ch}} + \frac{B}{A} N_{\text{nonch}}\right) * \frac{A}{B}. \tag{10}$$

In the case of multipath routing, the cluster head node successively transmits the data to the next layer of cluster head node until it is sent to the base station, so the traffic radius of each layer of cluster head is K. To ensure the life cycle Z of the network, it is necessary to find the maximum energy consumption value. The node closer to the base station forwards more data and consumes more energy. Therefore, the average energy consumption of nodes in the first layer determines the life of the network. Letting $m = 1$, we can find N_m:

$$N_m(K) = V + \frac{G}{A_2^{t/2}} + g(K)A, \tag{11}$$

$$V = 2(N_1 + N_a)Z, \tag{12}$$

$$G = \frac{\alpha r_m^t Z}{2^{t/2}}. \tag{13}$$

In formula (11), $g(K)$ is a function related to the layer width. To find the optimal value of $N_m(K)$, the KKT theorem can be used, assuming

$$y = \hat{g}(K, A). \tag{14}$$

Then, the optimization problem can be expressed as

$$\begin{cases} \min : N_m(y), \\ \text{n.m.} \begin{cases} f_1(y) = r_m - K \le 0, \\ f_2(y) = K - r_n/\sqrt{A} \le 0, \\ f_3(y) = K - r_n \le 0. \end{cases} \end{cases} \tag{15}$$

When $f_2(y) = 0$, K is equal to the radius of each cluster, and all clusters are evenly distributed in the area, so the communication between the cluster head and the base station adopts single-hop and multihop to have the same effect. Formula (14) can write the gradient of objective function $\nabla N(y)$ and constraint function $\nabla f(y)$.

The generalized Lagrangian multipliers α_1, α_2, and α_3 are introduced to the three constraint conditions, respectively, and the expression of the KKT condition is as follows:

$$\nabla N(y) + \alpha_1 \nabla f_1(y) + \alpha_2 \nabla f_2(y) + \alpha_3 \nabla f_3(y) = 0, \tag{16}$$

$$\alpha_1 f_1(y) + \alpha_2 f_2(y) + \alpha_3 f_3(y) = 0, \tag{17}$$

$$\begin{aligned} \alpha_1 &\ge 0, \\ \alpha_2 &\ge 0, \\ \alpha_3 &\ge 0. \end{aligned} \tag{18}$$

In formula (18), α_1, α_2, and α_3 are constants. To preferentially adopt multihop routing, let

$$\alpha_2 = \alpha_3 = 0. \tag{19}$$

Then, we can get $\nabla N(y)$=0.

When α_1 is not zero and $f_1(y)$ is zero, there are

$$r_a = r_m. \tag{20}$$

When α_1 is zero and $f_1(y)$ is not zero, there are

$$g'(K)a = 0. \tag{21}$$

Thus,

$$K = \hat{K} = \left(\frac{4N_i}{\alpha\left(t' - 2\right)}\right)\frac{1}{t'}. \tag{22}$$

Substituting formula (22) into formula (11) and deriving it, the expression for the optimal number of cluster heads can be obtained as

$$\hat{a}_m(K) = \left(\frac{Lk\alpha r_m^{tk}}{2^{(t+2)/2}\left(\left(\left(r_m^2/K^2\right)\left(2N_i + \alpha K^{t'}\right) - N_i\right)\right)}\right)^{2/(t+2)}. \tag{23}$$

Substituting formula (22) into the above formula,

$$\hat{a}_m(r) = \left(\frac{Lk\alpha r_m^{tk}}{2^{(t+2)/2}\left(\left(\left(r_m^2/K^2\right)\left(2N_i + \alpha K^{t'}\right) - N_i\right)\right)}\right)^{2/(t+2)}. \tag{24}$$

2.2. Sensor Technology. In the 21st century, information has become the first element of production and an important technological and material basis for the information society. Human social activities mainly depend on the development, acquisition, transmission, and processing of information resources. It is based on this status quo that sensor technology has now penetrated into production, life, scientific research, and other major fields and has been included in the three pillars of the information age [21].

2.2.1. Definition of Sensor. The sensor can perceive the measured information and can convert the sensed information into an electrical signal or a specific form of information, a test device used to meet the requirements of information transmission, processing, storage, display, recording and control [22].

2.2.2. Classification of Sensors. Up to now, there are many types of sensors, but their classification has not been clearly defined. In daily use, sensors are often roughly divided into physical sensors, chemical sensors, and biological sensors based on their working principles. Figure 5 shows the general classification of sensors.

In physical sensors, according to different measurement quantities, sensors can be divided into pressure sensor, speed sensor, temperature sensor, etc.; chemical sensors can be divided into gas sensors, temperature sensor, etc.; biosensors can be divided into microbial sensors, pulse sensors, etc. according to different measurement quantities. Figure 6 shows the classification of different measurement quantities of three types of sensors.

2.2.3. The Development History of Sensor Technology. With the improvement of our understanding of things and the continuous development of science and technology, sensor technology has generally gone through three stages.

The first generation is a structural sensor, which uses structural parameter changes to sense and transform signals, for example: resistance strain sensor, which uses the change of resistance when the metal material undergoes elastic deformation to transform electrical signals; the second-generation sensor is a solid sensor that was developed in

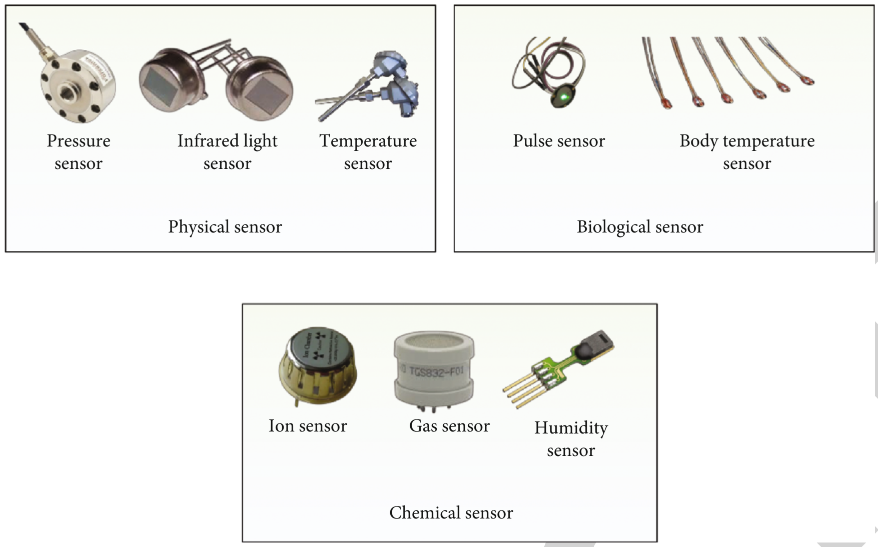

Figure 5: Classification of sensors.

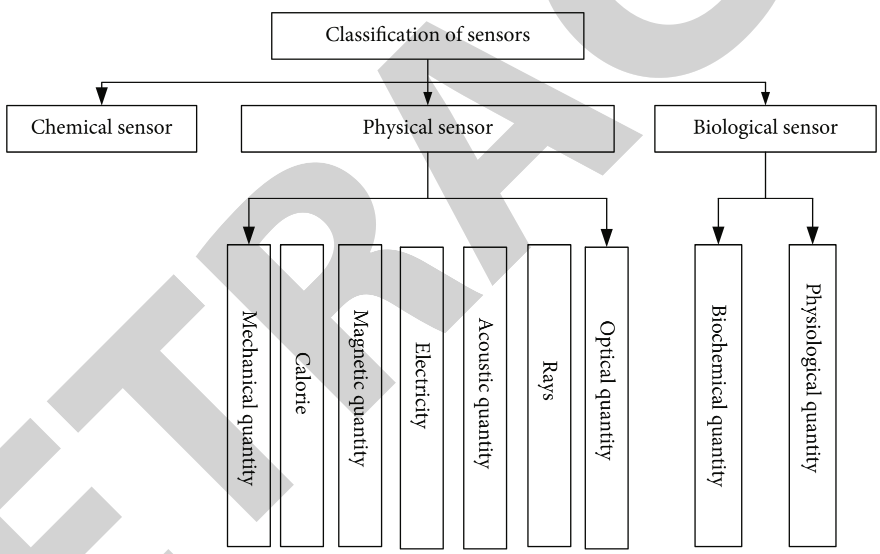

Figure 6: Classification of different measurement quantities of three types of sensors.

the 1970s; this sensor is composed of solid components such as semiconductors, dielectric, and magnetic materials and is made using certain characteristics of materials (such as using thermoelectric effect, Hall effect, and photosensitive effect to make thermocouple sensor, Hall sensor, and photosensitive sensor); the third-generation sensor is a smart sensor, which means that it has certain detection, self-diagnosis, data processing, and self-adaptive capabilities for external information and is a product of the combination of microcomputer technology and detection technology [23].

2.3. Art Teaching and Its Path Optimization. Art education is a special product in the process of human cultural activities. It takes art culture as a carrier and carries knowledge, skills, and aesthetic education in it and uses visual art as a medium to impart and inherit culture between people. Art education in colleges and universities focuses on the ontology and instrumentality of art, which is spreading art knowledge and skills and developing an aesthetic culture of visual modeling.

Divided by the purpose of college art education, art education can be divided into two types: professional art education and general art education. Vocational art education can also be defined as professional art education, which mainly refers to professional art education at the higher education stage (including undergraduate, junior college, and above education); its purpose is to train professional art talents, while the general art education is for improving or strengthening the academic group and the quality of art-related content among non-art-major college students. In the era of information education, art education in colleges and universities needs to get rid of the shackles of traditional art classrooms, innovate teaching models, expand high-quality teaching resources, and cultivate students' autonomy and creativity.

At present, the traditional art teaching activities are still in the state of "you teach me to learn," and most of the students' acquisition of art knowledge is passive rather than active. With the advent of the information age, optimizing the path of art education and teaching activities is the development trend of art teaching in the future. The following points are particularly important in formulating a plan for optimizing teaching paths.

First, strengthen the construction of teaching staff.

Second, expand the construction of teaching and experimental sites.

Third, improve the education and teaching supervision and assessment system.

Fourth, make full use of network resources and select network courses suitable for students of our school for online teaching.

3. Experiments on the Optimization Path of Art Teaching in Colleges and Universities Based on Embedded Sensor Network

As an advanced representative in the field of information technology, sensor network technology hides large application possibilities in the education field. The application of sensor network technology in education can promote the reform of education courses and promote the cultivation of students' questioning and writing skills. The experiment in this paper is based on the embedded sensor network, through the experiment to explore the role of embedded sensor network in the reform of art teaching optimization path.

3.1. Art Teaching Network Course Setting Based on Embedded Sensor Network. Traditional art teaching is only limited to classroom learning and a small part of the extracurricular sketching environment, and art teachers cannot take into account the learning effects of all students. Network courses can be set up by borrowing network resources, using the teaching videos of our school or other universities and professional painters for students to watch and learn. Through independent learning, they can improve their knowledge and at the same time strengthen students' learning of weak knowledge points. The embedded sensor network can supervise students' performance during online course learning by monitoring the length of online learning, the number of video clicks, and certain permissions, to help students better conduct independent learning. In this experiment, statistics and satisfaction surveys were carried out on the situation of students in a certain university who independently conduct art learning online. Table 3 shows the changes in the number of online classes in different universities in recent years.

With the gradual development of online classrooms, the number of students studying online courses is also constantly changing. Table 4 shows the statistics of the number of students studying art online courses in various colleges and universities in recent years.

3.2. Student Online Learning Supervision Based on Embedded Sensor Network. Through embedded networks and embedded sensors, in learning supervision, administrators can supervise students who are doing online learning under certain conditions. Through smart sensor, action recognition, emotion recognition, etc., it can help supervisory administrators to quickly determine the online status of each student, thereby improving students' learning status and helping students improve their learning efficiency. Table 5 shows a statistical table of students' learning status and learning results in two different classroom environments, online and offline.

Table 3: Changes in the number of online art classes in different universities.

	2014	2015	2016	2017	2018
Fine arts colleges	26	39	64	86	91
Normal colleges	12	20	39	52	66
Comprehensive universities	6	14	22	30	48

Table 4: Average number of times of online learning of art courses.

	2014	2015	2016	2017	2018
Fine arts colleges	68	79	88	96	104
Normal colleges	35	48	61	78	90
Comprehensive universities	28	39	55	64	79

Table 5: Statistics of learning status and learning achievement.

	Offline learning	Online learning	Rank
Attendance rate	88%	98%	1
Positivity	76%	90%	2
Pass rate	70%	81%	3
Late arrival rate	10%	3%	4

3.3. Experiment of Teacher Teaching Supervision System Based on Embedded Sensor Network. The supervision of teachers' teaching is also an important measure in the reform of art education path. Only by perfecting the teaching supervision and teaching evaluation system for teachers can teaching be carried out better. In the art teaching room and other areas where art teaching is conducted, wireless sensor equipment is installed, and the teacher's words and behaviors in the classroom are supervised through the sensor equipment. In this experiment, the teacher's attendance rate, lesson preparation, classroom discipline, teaching methods, etc. are mainly supervised, through sensor equipment and sensor network to identify and record the teaching situation of each teacher.

4. Experimental Analysis of Optimized Path of Art Teaching in Colleges and Universities Based on Embedded Sensor Network

4.1. Survey and Analysis of the Number of Online Courses. Online education is a major measure for the optimization and reform of education and teaching paths. With the development of computer networks and wireless sensor network technologies, the process of online education in universities

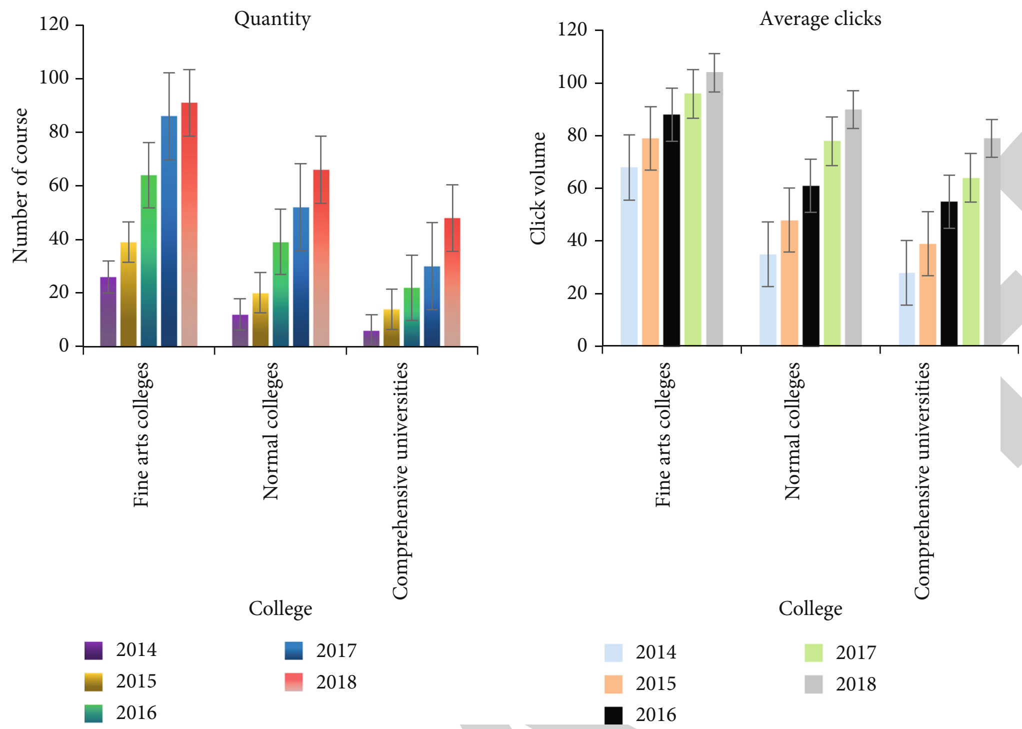

Figure 7: The growth and clicks of art online courses.

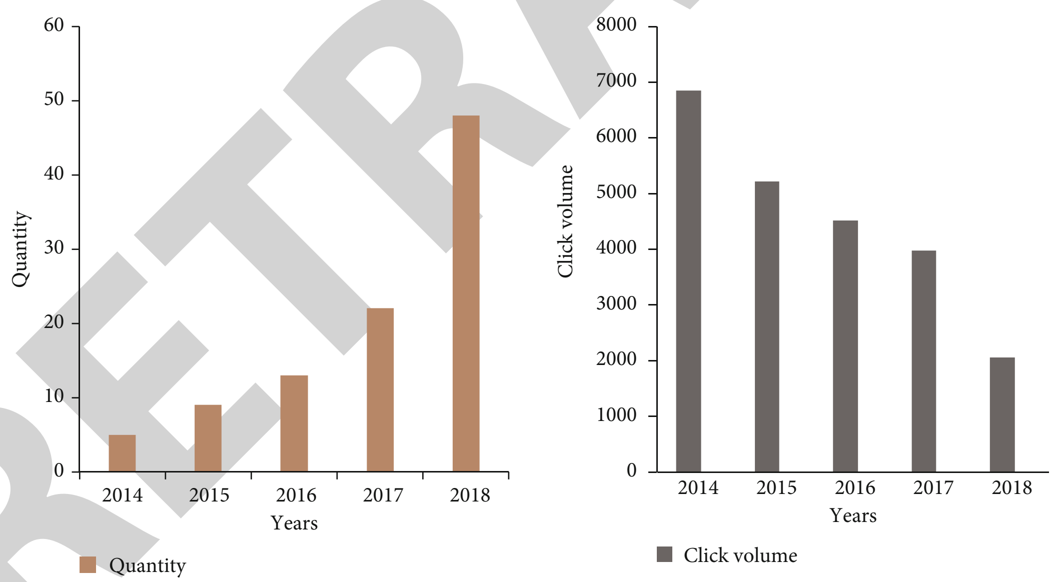

Figure 8: The number and clicks of online art courses on social platforms.

has gradually accelerated. According to the data in Tables 3 and 4, a graph of the growth and click volume of online art courses can be obtained, as shown in Figure 7.

According to Figure 7, it can be seen that the number of fine arts online courses is increasing, whether it is a professional art college or a normal or comprehensive college. In terms of the number of online art courses, art colleges have the largest number of courses, reaching 91, followed by normal colleges. In terms of students' clicks on art online courses, art colleges also have the highest average clicks on online courses.

In addition to the online art course teaching in colleges and universities, the social platform has also launched online art teaching courses for others to learn. Figure 8 shows the number of art courses in the social platform and the click-through rate.

According to Figure 8, it can be concluded that, in general, the audience and the number of courses offered for art courses on social platforms have been increasing year by year, but the average quality of courses has continued to decrease. In fact, the review of course content and quality by social platforms is usually weaker than that of college

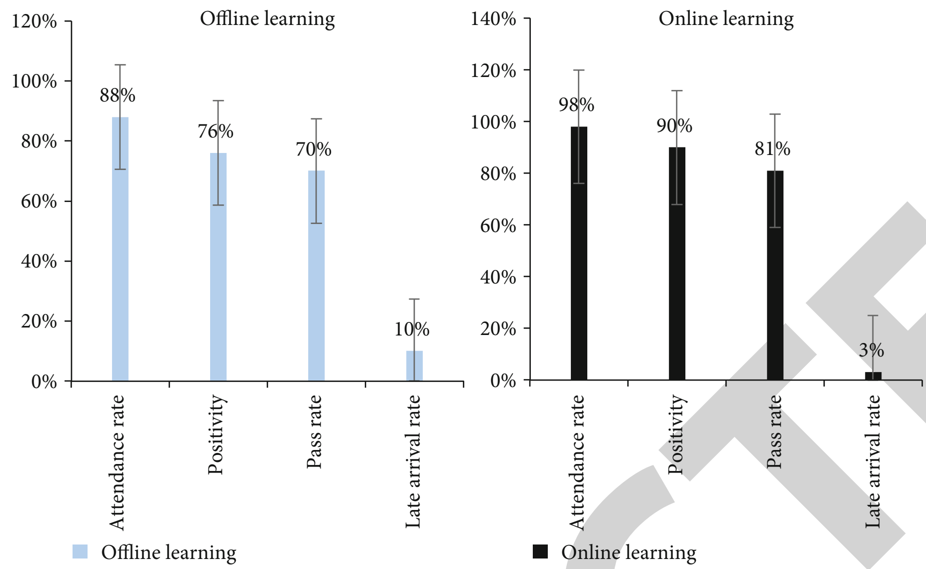

FIGURE 9: Comparison of students' learning status and learning outcomes in different teaching environments.

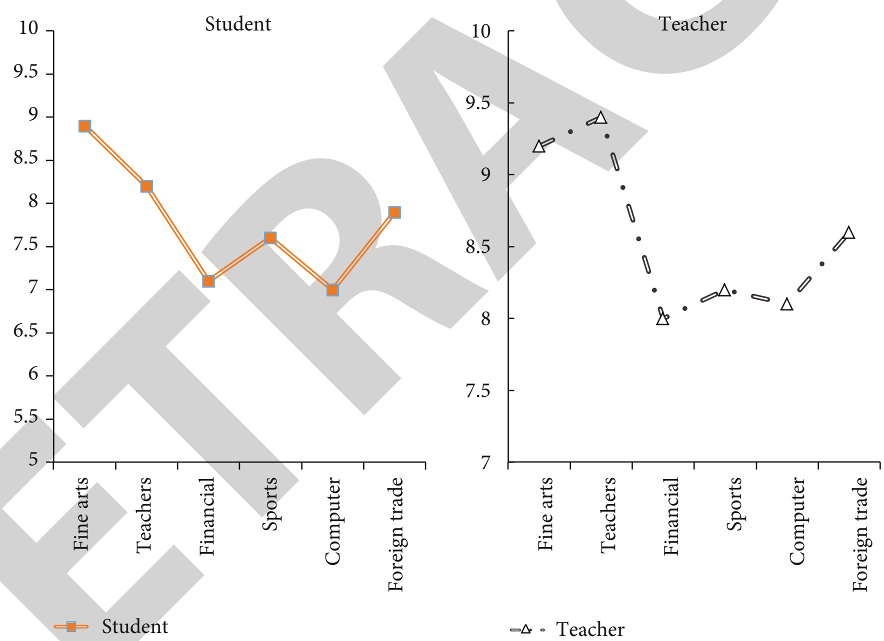

FIGURE 10: Satisfaction survey results.

platforms. From 2014 to 2018, the number of clicks on art courses on social platforms dropped by at least 30%.

4.2. Experimental Analysis of Student Online Learning Supervision Based on Embedded Sensor Network. The sensor network can transmit the student's online learning status in real time through sensor equipment and process the student's learning status accordingly through intelligent recognition. According to the data in Table 5, a comparison chart of students' learning status and learning results in different teaching environments can be drawn, as shown in Figure 9:

According to Figure 9, it can be concluded that art online courses based on sensor networks are more conducive to stimulating students' learning enthusiasm. As can be seen from the figure, students' enthusiasm for online learning has increased by 14%. And online course education based on sensor network can well supervise the learning status of every student, and the student's absenteeism rate and tardiness rate have also been significantly improved.

4.3. Application Satisfaction Analysis of Sensor Network in the Optimization of Art Teaching Path. In this study, the application satisfaction of sensor network in the optimization of art teaching path was also investigated. Figure 10 shows the survey results of this experiment.

According to Figure 10, it can be concluded that the student group's satisfaction with the sensor network in the optimization of the teaching path is lower than the teacher's satisfaction with it, but the average score of the students' satisfaction in the survey is still higher than 7. It shows that the student group is still quite satisfied with it.

According to Figure 10, it can be concluded that the student group's satisfaction with the sensor network in the optimization of the teaching path is lower than the teacher's satisfaction with it, but the average score of the students' satisfaction in the survey is still higher than 7 (1-10 points, the higher the score, the higher the satisfaction). It shows that the student group is still quite satisfied with it.

5. Conclusions

Through the experimental analysis of this article, the following conclusions can be drawn. The class hours and educational resources of art education in colleges and universities are limited. It is required to consider a series of contradictions in traditional art classroom teaching while ensuring teaching efficiency and effectiveness. It is necessary to use sensor network technology to optimize the reform of teaching paths. Based on the embedded sensor network, teachers and student administrators can well supervise the status of students' online learning and at the same time better promote the utilization of excellent teaching resources. The experimental results of this article show that sensor network technology has played an important role in the optimization of art teaching paths in colleges and universities. The use of sensor network technology in art teaching has greatly improved the learning outcomes of students; in terms of the impact on students' learning enthusiasm, the use of sensor network technology has increased students' learning enthusiasm from 76% to 90%; the effect is very significant.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] A. Remah and E. Khaled, "Performance and challenges of service-oriented architecture for wireless sensor networks," *Sensors*, vol. 17, no. 3, pp. 536–575, 2017.

[2] L. Cheng, J. Niu, C. Luo et al., "Towards minimum-delay and energy-efficient flooding in low-duty-cycle wireless sensor networks," *Computer Networks*, vol. 134, no. 7, pp. 66–77, 2018.

[3] J. Luo, J. Hu, D. Wu, and R. Li, "Opportunistic routing algorithm for relay node selection in wireless sensor networks," *IEEE Transactions on Industrial Informatics*, vol. 11, no. 1, pp. 112–121, 2015.

[4] Z. Fei, B. Li, S. Yang, C. Xing, H. Chen, and L. Hanzo, "A survey of multi-objective optimization in wireless sensor networks: metrics, algorithms, and open problems," *IEEE Communications Surveys & Tutorials*, vol. 19, no. 1, pp. 550–586, 2017.

[5] J. M. Pak, C. K. Ahn, P. Shi, Y. S. Shmaliy, and M. T. Lim, "Distributed hybrid particle/FIR filtering for mitigating NLOS effects in TOA-based localization using wireless sensor networks," *IEEE Transactions on Industrial Electronics*, vol. 64, no. 6, pp. 5182–5191, 2017.

[6] A. Buczak and E. Guven, "A survey of data mining and machine learning methods for cyber security intrusion detection," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 2, pp. 1153–1176, 2016.

[7] M. H. Eiza and Q. Ni, "Driving with sharks: rethinking connected vehicles with vehicle cybersecurity," *IEEE Vehicular Technology Magazine*, vol. 12, no. 2, pp. 45–51, 2017.

[8] K. A. Shim, "A survey of public-key cryptographic primitives in wireless sensor networks," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 1, pp. 577–601, 2016.

[9] H. Zhang, X. Hong, J. Cheng, A. Nallanathan, and V. C. Leung, "Secure resource allocation for OFDMA two-way relay wireless sensor networks without and with cooperative jamming," *IEEE Transactions on Industrial Informatics*, vol. 12, no. 5, pp. 1714–1725, 2016.

[10] M. Dong, K. Ota, and A. Liu, "RMER: reliable and energy-efficient data collection for large-scale wireless sensor networks," *IEEE Internet of Things Journal*, vol. 3, no. 4, pp. 511–519, 2016.

[11] G. Han, J. Jiang, C. Zhang, T. Q. Duong, M. Guizani, and G. K. Karagiannidis, "A survey on mobile anchor node assisted localization in wireless sensor networks," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 3, pp. 2220–2243, 2016.

[12] C. Yang and K. W. Chin, "On nodes placement in energy harvesting wireless sensor networks for coverage and connectivity," *IEEE Transactions on Industrial Informatics*, vol. 13, no. 1, pp. 27–36, 2017.

[13] H. Yang, F. Li, D. Yu, Y. Zou, and J. Yu, "Reliable data storage in heterogeneous wireless sensor networks by jointly optimizing routing and storage node deployment," *Tsinghua Science & Technology*, vol. 26, no. 2, pp. 230–238, 2021.

[14] N. D'Ascenzo, E. Antonecchia, M. Gao et al., "Evaluation of a digital brain positron emission tomography scanner based on the plug& imaging sensor technology," *IEEE Transactions on Radiation and Plasma Medical Sciences*, vol. 4, no. 3, pp. 327–334, 2020.

[15] I. K. Osamh and G. M. Abdulsahib, "Energy efficient routing and reliable data transmission protocol in WSN," *International Journal of Advances in Soft Computing and its Application*, vol. 12, no. 3, pp. 45–53, 2020.

[16] O. I. Khalaf, G. M. Abdulsahib, and B. M. Sabbar, "Optimization of wireless sensor network coverage using the bee algorithm," *Journal of Information Science and Engineering*, vol. 36, no. 2, pp. 377–386, 2020.

[17] G. Beattie, C. Cohan, M. Brooke, S. Kaplanes, and G. P. Victorino, "Automatic acoustic gunshot sensor technology's impact on trauma care," *The American Journal of Emergency Medicine*, vol. 38, no. 7, pp. 1340–1345, 2020.

[18] M. McCarthy, D. P. Bury, B. Byrom, C. Geoghegan, and S. Wong, "Determining minimum wear time for mobile sensor technology," *Therapeutic Innovation & Regulatory*, vol. 55, no. 1, pp. 33–37, 2021.

[19] B. Genge, P. Haller, and I. Kiss, "Cyber-security-aware network design of industrial control systems," *IEEE Systems Journal*, vol. 11, no. 3, pp. 1373–1384, 2017.

[20] A. Guirguis, M. Karmoose, K. Habak, M. el-Nainay, and M. Youssef, "Cooperation-based multi-hop routing protocol for cognitive radio networks," *Journal of Network & Computer Applications*, vol. 110, pp. 27–42, 2018.

[21] D. Chen, P. Wawrzynski, and Z. Lv, "Cyber security in smart cities: a review of deep learning-based applications and case studies," *Sustainable Cities and Society*, vol. 66, no. 3, article 102655, 2021.

[22] S. Sleesongsom and S. Bureerat, "Four-bar linkage path generation through self-adaptive population size teaching-learning based optimization," *Knowledge-Based Systems*, vol. 135, no. 1, pp. 180–191, 2017.

[23] H. Chen, L. Fang, D. L. Fan, W. Huang, and L. Zeng, "Particle swarm optimization algorithm with mutation operator for particle filter noise reduction in mechanical fault diagnosis," *International Journal of Pattern Recognition and Artificial Intelligence*, vol. 34, no. 10, article 2058012, 2020.