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Research Article

Multicluster Analysis and Design of Hybrid Wireless Sensor Networks Using Solar Energy

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A wireless touch network is a distributed, self-organizing network of multiple sensors and actuators in combination with multiple sensors and a radio channel. Also, the security area of such a network can be several meters to several meters. The main difference between wireless sensor networks from traditional computer and telephone networks is the lack of a fixed infrastructure owned by a specific operator or provider. Each user terminal in a touch network is capable of acting as a terminal device only. Despite the long history of sensor networks, the concept of building a sensor network is not finally imposed and expressed in some software and hardware (platform) solutions. In this paper, the design and analysis of multicluster model of the sensor nodes in wireless sensor network with the help of solar energy. This proposed model provides the required energy to transmit the information between two end nodes in different cluster. The communication between the end to end clusters was increased based on this design. The implementation of sensory networks at the current stage depends largely on the specific needs of the industrial problem. The architecture, software, and hardware implementation technology is at an intensive development stage, attracting the attention of developers looking for a technological niche of future makers.

1. Introduction

One of the first prototypes of a touch network is considered to be a social system designed to detect and identify submarines [1]. Wireless sensor network technology has been developing intensively recently. However, only at the beginning, it was possible to produce a very cheap element base for devices such as the development of microelectronics [2]. Modern wireless networks are mainly based on the ZigBee standard [3]. A significant number of industries and market segments (manufacturing, various types of transportation, security, safety, security, safety, and security) are ready to implement sensor networks, and this volume is continuously increasing [4, 5]. This trend is related to

technological processes, the development of production, expanding the needs of individuals in the security sectors, expanding the needs of resource control, and the use of material-material values [6, 7]. Semiconductor technologies are developing new practical tasks and theoretical problems related to the applications of sensory networks in industrial and ethnic campuses [8]. The use of low-cost wireless sensor control devices opens up new areas to apply telemetry and control systems [9]. A liquid flow battery that is particularly suitable for large-scale long-term energy storage systems is provided with two chemical components dissolved in a liquid separated by a diaphragm. It is exposed in Figure 1.

(i) Directly identify possible failures of the means of execution on the control of such parameters, vibration, temperature, pressure, etc.

(ii) Real-time access control to remote monitoring object systems

(iii) Ensure the protection of museum values

(iv) Ensure accounting views

(v) Automatic censoring of views

(vi) Inspection and inspection of industrial properties

(vii) Management of commercial assets

(viii) Application as components in energy and resource saving technologies

(ix) Control environment environmental parameters

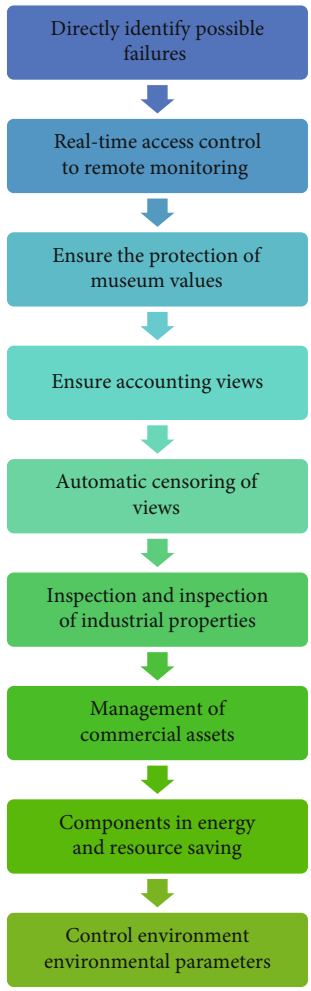

Figure 1: Objectives of low-cost wireless sensor control devices.

Trojan Battery is a lead-acid battery that discharges itself over time, even if it is not connected to a load and is charged to a very low level. This self-discharge rate changes with temperature, with higher temperatures increasing the rate of discharge, while lower temperatures decreasing the rate of discharge. Wireless sensor networks (WSN) are meds with miniature computing devices (temperature, pressure, light, illuminance, vibration levels, location, etc.) and signal transceivers operating in a specific radio scenario [10, 11]. The flexible configuration, cost reduction of installation is available. Intelligent sensors in other wireless and wireless data transfer interfaces allocate wireless networks, especially when it comes to the large number of devices connected to each other; the touch network allows you to connect up to 65,000 devices [12–14]. A constant reduction in the cost of wireless solutions and increasing their operational parameters allow you to gradually reorient through wired solutions in telemetry data collection systems, remote diagnostic information transfer [15]. "Sensor network" today is a well-established term, distributed, self-organizing, stable to the failure of individual components, a nonmaintained network, and does not require special installation of devices [16]. Each sensor network node may contain various sensors to control the external environment, a microcomputer, and a radio receiver [17]. They perform device measurements, perform initial data processing, and communicate with external information systems [18]. As with other lithium-ion batteries, lithium nickel manganese cobalt oxide (NMC) batteries do not require critical maintenance. A battery management system (BMS) monitors the battery's voltage, current, and temperature to ensure safety and service life. Excessive activity will reduce battery life, and the monitoring system will notify the warranty through battery management system (BMS) logs. Battery management system (BMS) shutdowns in any operating conditions where the system is not safe. The battery energy storage system uses lithium nickel manganese cobalt oxide (NMC) batteries manufactured by LGChem. A lithium nickel manganese cobalt oxide (NMC) battery can be used in winter as long as the safety temperature limit is confirmed.

Telecommunication 802.15.4/ZigBee is one of the modern directions for the development of "sensor networks" monitoring and self-regulation of resource management and process fault-tolerant distributed systems [19]. Today, the technology of wireless sensor networks is the only wireless technology through which you can monitor and control problems that are critical to the uptime of sensors [20]. Sensors integrated into a wireless sensor network form a regionally-distributed self-organizing system for collecting, processing, and transmitting information [21]. The main

application area is monitoring and monitoring of measured parameters of physical environments and objects. The adopted IEEE 802.15.4 standard describes wireless channel and access control for low-speed wireless private networks, which are the two lowest levels according to the OSI network model [22].

Usually, BCC is used to collect data from devices equipped with sensors: a temperature sensor, humidity, lighting, and monitoring. For example, miniature sensors could be used in medicine to monitor patients. Devices that the patient brings themselves can control the work of vital organs, in case of certain dangerous situations to inform the doctor [23]. The small dimensions of the devices allow not only "superficial" patient observations but also to examine the internal organs of a person. This is especially true for lead-acid batteries that are added to water, as when distilled water is added to fill the electrolyte level, the acidic liquid is exposed to the outside. We recommend that battery maintenance personnel wear safety glasses and gloves. If the customer requests external, then personnel complete this task in battery maintenance. Therefore, when gastroscopy is carried out in state hospitals, Polygynax uses a special device, a gastroscopic tube, but not all patients can swallow it. It is already available in the market in the form of tablets for conducting such studies [24]. These battery operated devices have a power supply, sufficient to work continuously for 24 hours, and send readings to another device that the patient has at this time. After that, the doctor can analyze the obtained results and make an accurate diagnosis. When using a battery in or near a living space, the basic part of the computer is chosen because the computer is an important guiding principle. The energy storage system uses lithium nickel manganese cobalt oxide (NMC) battery to monitor the battery management system. It is long lasting and very safe. This battery can store more electricity than other types of lithium-ion batteries by adding elements like nickel and manganese to the battery chemistry.

2. Related works

It can be used to automatically change the way a person enters a room to be used to manage any device (in a smart home system). Sometimes you have to follow the movement or destruction of any objects where it is difficult to find the cables. To do this, it is very profitable to apply touch networks again; the sensors are wireless because they provide an autonomous power supply [1]. Also, wireless sensor network technology can be used to transmit audio data—an intercom system and multimedia system with low power consumption. Based on wireless technology and telecommunication networks based on them, it has well-known advantages among flexible configuration and low installation costs [2]. Currently, wireless communication systems can account for the mass and most popular number of systems in the consumer market. Wi-Fi and Bluetooth. Each of them is characterized by range and transmission rate, operating frequency range, function and purpose, as well as other characteristics that determine the structure and structural features of remote telecommunication networks [3]. In the architectural aspect, the main difference between classical telecommunication radio networks and BSS is the use of a large number of supramundane intelligence sensors in the network that transmit small blocks of information over long distances (10-100 m) on average [4]. A zinc bromide liquid flow battery consists of a bromide salt dissolved in an electrolyte. The battery technology is slightly different from traditional bromide liquid flow cells, and its diaphragm is not cleaned or replaced. A liquid flow battery has an infinite charge and discharge cycle without performance degradation.

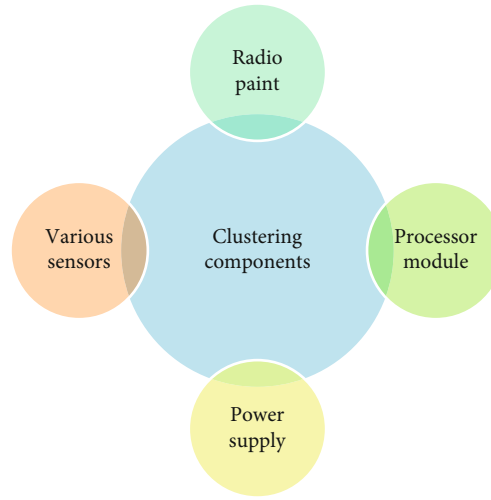

Figure 2: The proposed cluster formation requirements.

IEEE 802.15.4 provides two-way half-duplex data transfer while maintaining AES 128 encryption. The channel access policy is based on carrier sense collision avoidance multiple access (CSMA/CA) with restrictions on carrier and collisions. This is a network protocol, in which the principle of listening to the carrier frequency is used. The transmitting device that transmits data listens for the jam signal (content signal) and the ether [5]. The "someone else's 'jam signal transmitter'sleeps" for a random period, then repeats the frame attempts to initiate transmission. Thus, transmission may come from only one device, which improves network performance. In this case, data is sent in relatively small packages, which contain traffic and monitoring signals in the BSS. An important feature of the standard is the mandatory confirmation of the delivery of messages [6]. A liquid flow battery generally has little maintenance requirements. A liquid flow battery is similar to a fuel-powered lithium battery in that they are only equipped with an electronic device and an electrolytic cell.

A feature of devices connected to the IEEE 802.15.4 standard is low power consumption, which saves the connection in this mode because there is no dynamic data in the "fall" mode. While developing a standard, the main focus was on the speed of the configuration and reconfiguration processes [8]. Specifically, the transmission transition to the active state is about 10-15 ms. And new devices connect to the network in 30 ms. In this case, the duration of reconfiguration and connecting devices depends on the name "listening"

Figure 3: Functions of network coordinator.

by network routers [10]; the flow battery can be used in winter and can be installed in very cold conditions. It is best to monitor all used batteries throughout the day to ensure proper operation and proactively troubleshoot any potential on-site issues. This data can be provided to owners in real-time.

3. Proposed Model

Among the operational rules, the main distinguishing features of BSS are the requirements for stable operation in conditions of dynamic changes in the network topology due to sensors, autonomous power and power consumption, and significant restrictions of microprocessor memory. At the same time, the conditions for BSS operation are provided for the transfer of small amounts of information at low speeds. The "clustered" architecture of a touch network is based on a conventional terminal and the following components. Because the material is heavy, it should be installed in some ventilated area. At this point, their functions and maintenance requirements are well understood, so they are suitable for most solar + energy storage applications and should be stored in a moderately dry location. A lead-acid batteries terminal connection should be checked several times a year to make sure they do not loosen over time. The proposed cluster formation requirements are shown in the following Figure 2.

(i) Radio paint

(ii) Processor module

(iii) Power supply

(iv) Various sensors

The physical layer determines the data transfer method, communication system interface, hardware features, and parameters required to build a network. In practice, the physical state governs the operation of the transceiver, selecting channels, control signals, and transmission power level. The network coordinator (FFD: fully functional device) is shown in Figure 3. A typical node can be represented by three types of devices.

3.1. The Network Coordinator (FFD: Fully Functional Device)

(i) Enables global integration, configuration, and installation of network parameters

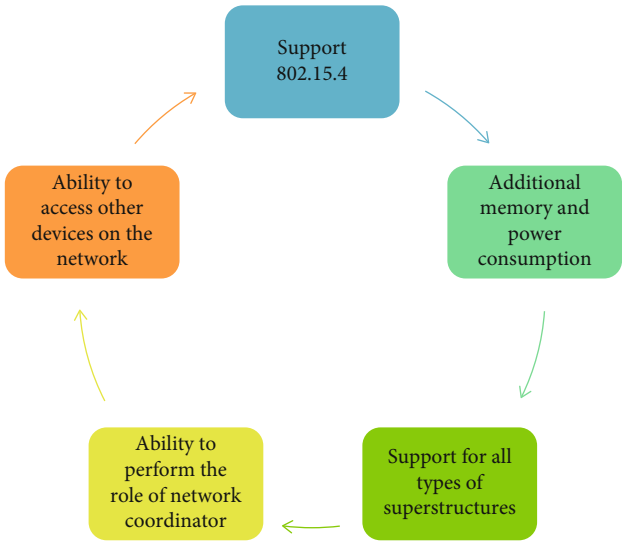

Figure 4: The performance parameters of fully functional device nodes.

(ii) The most demanding of the three types of devices are memory and power supply

Dedicated energy efficiency of network protocols for BSS is required to solve the task, which determines the resource of low power consumption node time during the autonomous power use of network nodes from batteries. A device with a full set of functions (FFD: fully functional device) and a liquid-filled lead-acid battery must be topped up regularly. Glass fiber separator (AGM) battery and gel lead-acid battery are sealed, so do not fill with electrolyte. If a lead-acid battery is not being used temporarily, it must be stored properly. The performance parameters of fully functional device nodes are shown in the following Figure 4.

(i) Support 802.15.4

(ii) Additional memory and power consumption allows the role of network coordinator

(iii) Support for all types of superstructures ("point-point", "star", "tree", and "mesh-free network")

(iv) Ability to perform the role of network coordinator

(v) Ability to access other devices on the network

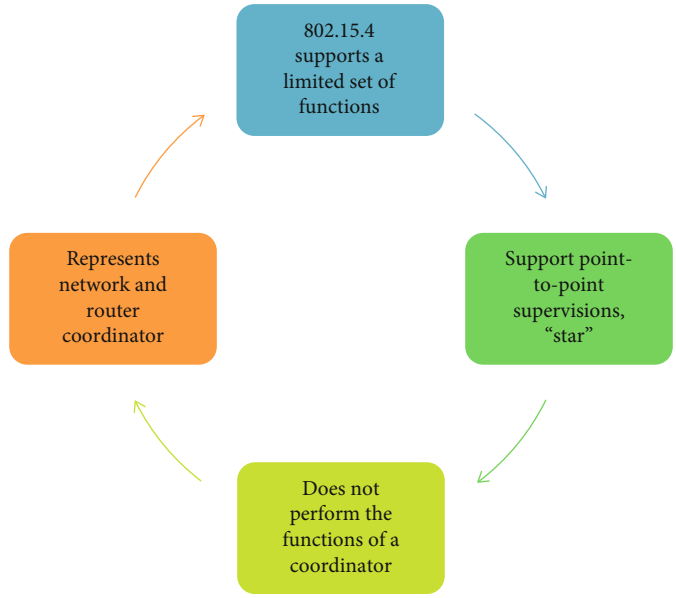

Figure 5: The performance parameters of reduced function device.

The performance parameters of reduced function device were shown in the following Figure 5.

(i) 802.15.4 supports a limited set of functions

(ii) Support point-to-point supervisions, "star"

(iii) Does not perform the functions of a coordinator

(iv) Represents network and router coordinator

The first version of 802.15.4 defined two physical levels with broadband characteristic through direct spectrum expansion DSSS (direct sequence spread spectrum).

(i) The first-868/915 MHz segment has a transmission rate of 20 and 40 Kbps, respectively

(ii) Second-2450 MHz band at 250 Kbps

Data transfer rates initially allowed on 868/915 MHz increased to 100 and 250 kbps. In addition, four health indicators were identified depending on the modeling method; while maintaining the broadband modulation of DSSS, 868/915 MHz can be used in the range of binary and quadruple phase manipulation (QPSK: quadrature phase shift keying). Since the version of the IEEE 802.15.4A standard, the number of physical dimensions increased to six due to the addition of an ultra-wide radiotechnology level ultra-wide band (UWB) for high-speed data transmission, radio technology with level specifications chirp spread spectrum (CSS), through linear frequency modulation method. In terms of broadening the frequency spectrum, the physical state UWB was defined by dedicated frequencies in three bands: 1 GHz, 3-5 GHz and 6-10 GHz, and five CSS. The spectrum in the 2450 MHz band is unlicensed, and the available frequency bands were expanded in the IEEE 802.15.4C and IEEE 802.15.4D versions. This specification is possible using at the physical level, quadrature phase manipulation or high-order phase manipulation (M-PSK) with a frequency of 780 MHz, and a frequency of 950 MHz-Gaussian frequency manipulation (Gaussian frequency-shift keying (GFSK)) or binary phase manipulation (binary phase-shift keeling (PSK)). The standard IEEE 802.15.4.4 specification defines mechanisms for coordinating network components at the physical level to ensure the generation of data fragments (frames), check and correct errors, and transmit frames at the network level. At the same time, the MAC sublayer (media access control) adjusts multiple accesses to a physical environment with a channel-level one-way separation, manages printing connections, and provides security.

4. Results and Discussion

The proposed multicluster analysis and design model (MCADM) was evaluated with the existing improved metaheuristics-based clustering (IMBC), multiobjective optimization with Mayfly algorithm (MOMA), artificial intelligence–based energy-efficient clustering (AIEEC), and the role of integrated structured cabling system (ISCS).

Network node management: the standard defines two types of network nodes: full-featured device FFD (fully functional device), which implements a function of integration and sets network parameters and operates in standard node mode as in Table 1 and Table 2. A device with a limited set of functions RFD (reduced function device) is only capable of communicating with fully featured devices. Any network must have at least one fully featured device.

It enables the coordinator function. Each device has a 64-bit identifier, but in some cases, the link may be used for a limited area of 16-bit connections. PAN (personal area network). The standard also supports the structured topology "star", in which the coordinator (fully functional device) network must be the central node of the created private

Table 1: Management of fully functional device nodes.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	59.23	40.68	43.00	81.48	96.17
200	59.12	40.70	42.83	81.21	95.67
300	59.10	41.58	43.56	81.51	95.79
400	59.02	41.89	43.69	81.43	95.50
500	58.96	42.34	43.97	81.45	95.31
600	58.89	42.79	44.25	81.46	95.12
700	58.83	43.24	44.53	81.48	94.93

Table 2: Management of reduced function device nodes.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	59.02	41.89	43.69	81.43	95.50
200	58.95	42.34	43.97	81.44	95.31
300	58.88	42.79	44.25	81.45	95.12
400	58.81	43.24	44.53	81.46	94.93
500	58.74	43.69	44.81	81.47	94.74
600	58.67	44.14	45.09	81.48	94.55
700	58.60	44.59	45.37	81.49	94.36

Table 3: Management of network topology.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	58.89	42.79	44.25	81.46	95.12
200	58.82	43.24	44.53	81.47	94.93
300	58.75	43.69	44.81	81.48	94.74
400	58.68	44.14	45.09	81.49	94.55
500	58.61	44.59	45.37	81.50	94.36
600	58.54	45.04	45.65	81.51	94.17
700	58.47	45.49	45.93	81.52	93.98

Table 4: Management of autotuning clusters.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	62.20	44.41	46.90	85.02	89.02
200	63.40	45.73	47.63	86.34	89.40
300	64.01	46.56	48.52	86.88	89.97
400	65.01	47.72	49.30	87.94	90.41
500	65.92	48.79	50.11	88.87	90.89
600	66.82	49.87	50.92	89.80	91.36
700	67.73	50.94	51.73	90.73	91.84

network with a unique identifier. After that, other devices can join the network, which is completely independent of other networks with similar locations.

Usually the network is of "cluster wood" type, and different types of devices (FFD and RFD.) are used in the network design phase. At the same time, most nodes have terminal devices, and as a result, within the radius of each of them, there must be at least one node router. It improves location of various classes of devices.

Network topology management: the channel-level and the IEEE 802.15.4 standard provide the general recommendations for network topology construction. As in Table 3, networks can be peer P2P (peer-to-peer, point-to-point); one has a "star" topology. Structurally P2P compounds are arbitrary structures that can only be defined by bounded ranges between pairs of nodes. Take this into account, there are different options for the topical structure of the BSS, especially the "wood" cluster "tree" RFD, the single connected "tree leaves" FFD, and most of the nodes in the network are FFD. Cellular network topology of each cluster has a local coordinator with a local coordinator. The cluster is formed "based on trees" with the coordinator.

Autotuning of clusters: many network clusters for building BCs use private technical solutions and their own layers of network protocols, which reduce power consumption by including solutions at component sizes. In addition to the technical characteristics of transceivers, microcontrollers and wireless modules for power consumption indicate the operational mode of network use and the intensity of data transmission. An allocation of modes of operations with an intensive work cycle and small transfer intensity are performed well as shown in Table 4.

Intensive operating cycle: in applications with an intensive operating cycle, the main share of power consumption is available on the radio interface-reception/transmission of packets, synchronization, and frequency autotuning. At the same time, in the case of propagation in the transport of long packets, the consumption of the transceiver dominates, and in the case of priority transmission of short packets, the consumption frequency autocalibration schemes by the consumption of radio frequency initialization schemes. In applications with a low intensity of transmission, low power methods of sensors, microcontrollers, and microcrystallization of transceivers play the role of indicators of presence and performance as in Table 5.

Table 5: Management of intensive operating cycle.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	64.42	46.96	48.60	87.18	95.67
200	65.32	48.03	49.41	88.11	96.14
300	66.22	49.10	50.22	89.04	96.61
400	67.12	50.17	51.03	89.97	97.08
500	68.02	51.24	51.84	90.90	97.55
600	68.92	52.31	52.65	91.83	98.02
700	69.82	53.38	53.46	92.76	98.49

Perception subsystem management: as a rule, consists of an account, some statistics and analog-to-digital converter relief. The data processing subsystem consists of a central processor and memory, which is not only the data generated by the sensor but also service information that is essential for the proper and complete functioning of the communication subsystem. The monitoring subsystem allows the sensor to collect environmental data such as humidity, temperature, pressure, magnetic field, and chemical flight analysis. The

Table 6: Management of perception subsystem.

No of nodes	IMBC	MOMA	AIEEC	ISCS	MCADM
100	66.05	48.88	50.01	88.81	96.40
200	66.78	49.73	50.61	89.51	96.65
300	67.51	50.58	51.21	90.21	96.90
400	68.24	51.43	51.81	90.91	97.15
500	68.97	52.28	52.41	91.61	97.40
600	69.70	53.13	53.01	92.31	97.65
700	70.43	53.98	53.61	93.01	97.90

sensor can also be supplemented with a geoscope, an accelerometer, which can form a positioning system as in Table 6.

In the cut-off tip, the proposed model managed 95.50% of fully functional device nodes, 94.93% of reduced function device nodes, 94.55% of network topology, 90.41% of autotuning clusters, 97.08% of intensive operating cycle, and 97.15% of perception subsystem. This is because the proposed energy model directly searches the energy aware clusters, and then the available devices are earlier predicted by the proposed model. So the back-up devices are available to enhance the communication between the sensor nodes. Hence, the communication GAT was eliminated, and the lifetime of the network was increased.

5. Conclusion

Currently developing wireless sensor network technology. Wireless sensor networks are distributed self-regulating networks that are resistant to the failure of individual elements exchanging wireless communication information. Each network element has an autonomous power supply, a microcomputer, and a receiver/transmitter. The network coverage area can be from several meters to several meters, depending on the module and antenna type, as well as due to the ability to relay messages from one element to another. The proposed multicluster analysis and design model (MCADM) was evaluated with the existing improved metaheuristics-based clustering (IMBC), multiobjective optimization with Mayfly algorithm (MOMA), artificial intelligence–based energy-efficient clustering (AIEEC), and the role of integrated structured cabling system (ISCS). If the proposed model range of these devices does not allow their mutual detection, the data transfer between two end devices can be carried out by suspension. Therefore, devices with a small radius can communicate with each other using a system of repeaters.

Data Availability

The data used to support the findings of this study are included within the article. Further data or information is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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