Electromagnetic Spectrum Control Method Considering Information Security of Wireless Sensor Networks

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Abstract: The radio frequency spectrum has three-dimensional characteristics of space, time and frequency, and is not limited by geography, space and time. As a limited resource shared by human beings, its reasonable, fair, effective and economical use has caused countries around the world, especially developed countries extensive attention and research. The wireless sensor electromagnetic control system consists of sensors, digital control panels and transmission systems. The purpose of this paper is to consider the wireless sensor network information security to realize the electromagnetic spectrum control method, support the spectrum management process as a whole, solve the interference problem, and provide scientific basis and technical support for frequency assignment, scientific management of spectrum and radio planning. The outdoor point-to-point connection test was carried out 9 times in total. The surrounding environment of the test was complex, there were people moving in the field, and a small number of vehicles moved outside the field. Due to the limited outdoor test equipment, only 15,000 packets of data were sent. Simulation and actual measurement also proved that the sensor electromagnetic spectrum control network adopts the TCP/IP transmission method based on IEEE802.11g to meet the requirements of daily application control spectrum data.

1. Introduction

The basis and principle of spectrum management is to control the electromagnetic spectrum, strengthen the scientific nature of electromagnetic spectrum management, and use advanced control methods to provide technical support for spectrum management tasks, which is of greater significance for the effective use of the electromagnetic spectrum and ensures the quality of people's daily life. It is of great significance to ensure normal military activities and even national security [1]. As an organic supplement and segment of "next-generation wireless broadband mobile network", wireless sensor network is a new type of distributed information retrieval system based on wireless network self-organization technology in recent years. Its application in electromagnetic spectrum control can not only meet the needs of electromagnetic spectrum management, but also improve the existing precision and precision control [2].

Regarding the research on the electromagnetic spectrum control method considering the information security of wireless sensor network, many scholars at home and abroad have studied it. SubbaB aims to solve these problems by proposing a multi-level intrusion detection framework for WSN based on game theory. The proposed framework uses a combination of normal rules and a light neural network based anomaly detection unit to detect malicious sensor nodes. Furthermore, the framework models the interaction between the IDS and monitored sensor nodes as a non-cooperative two-person Bayesian game. This allows the IDS to adopt a game-based Bayesian Nash equilibrium probabilistic monitoring strategy, thereby reducing the IDS traffic introduced into the sensor network. The framework also proposes two different reputation update and eviction mechanisms to enhance cooperation and deter malicious behavior among monitoring nodes. These mechanisms are based on two different approaches, namely the ShapleyValue and the Vickery-Clark-Grooves (VCG) mechanism [3]. DeyN considers a home-based wireless ECG control system using Zigbee technology.

Such systems could be used to control people's conditions in their homes, as well as for doctors to regularly control access to appropriate healthcare, allowing people to stay at home for longer periods of time. Health control systems can continuously control many physiological signals and provide further analysis and interpretation. The features and shortcomings of these systems may affect the wearer's mobility during the control of vital signs. Real-time control systems record, measure and control cardiac electrical activity while maintaining consumer comfort [4]. MozhaievM uses the method of improving the frequency resolution of the acousto-optic spectrum analyzer to control the process of the quality index of the computer network of the forensic information system. The aim of this work is to improve the possibility of QoS metrics for computer networks by using a super-Rayleigh resolution method in an acousto-optic spectrum analyzer (AOSA) to estimate the potential accuracy of the frequency of two simultaneously arriving radio pulses [5]. The purpose of magnetic spectrum control is to carry out frequency assignment, scientific management of spectrum, and to provide scientific basis and technical support for radio planning, to support the process of spectrum management as a whole, and to solve the problem of interference.

With the advent of the information age, the demand for spectrum is increasing, and all countries in the world are faced with the contradiction between limited spectrum and unlimited demand. In my country, this contradiction has become increasingly prominent in recent years. Since the reform and opening up, my country's radio communication industry has increased at an annual growth rate of 20% to 30%, but at the same time, my country's spectrum resources have become increasingly tight. By controlling the device to achieve the control effect, the frequency can be applied reasonably and effectively. Therefore, the electromagnetic spectrum control method considering the information security of wireless sensor network has become an extremely important issue.

2. Research on Electromagnetic Spectrum Control Method Considering Information Security of Wireless Sensor Network

2.1 Status Quo of Electromagnetic Spectrum Testing

(1) Single-user spectrum sensing

Its main principle is to scan a specific frequency band, use the fast Fourier method to calculate the total energy of the received signal within a period of time, and compare the final total energy value with a certain set limit to determine whether there is a main signal [6-7]. Due to the low complexity of the energy detection algorithm, large blind source detection range, and no need for any prior information of the detection signal, it is widely used in electromagnetic spectrum detection systems.

(2) Multi-user cooperative spectrum sensing

With the rapid development of wireless communication technology and the demand for high-performance spectrum sensing, multi-user cooperative spectrum detection algorithms will become a trend. At present, there are mainly three multi-user cooperative spectrum sensing models. The first is the distributed cooperative sensing model. Distributed cognitive users independently judge the spectrum data detected by themselves, and then send the detection results of each distributed cognitive user to the data. The fusion center makes a decision after judgment and analysis. The cooperative sensing model can reduce the influence of channel multipath fading and improve the detection performance [8-9].

2.2 Wireless Sensor Network Security

Wireless Sensor Networks Have Broad Application Potential As shown in the table, wireless sensor networks have applications in military and anti-terrorism and anti-riot applications, environmental applications, healthcare applications, home applications, space exploration, and other commercial applications. Due to the special uses of wireless sensor networks in the military, such as enemy reconnaissance, troop monitoring and other special purposes, information security research has received extensive attention [10].

At present, the research on WSN security mainly focuses on effective physical-level encryption algorithms, key-level data management, network-level routing security protocols and key

management, and secure application-level multiplexing [11-12].

2.3 Spectrum Control Technology

(1) Narrowband filter

Similarly, measures such as filtering out harmonics and spurious outputs can be taken, and high-power filters are set up in the transmit channel. But filtering is also more difficult, because radars generally have a certain operating frequency range, and the spectrum to be reduced may be exactly within the required operating frequency band, so one or more sharply tuned narrowband filters have to be used, as well as frequency switching. Switches, etc., and high-power filters and switches are required, which will not only have technical problems such as reliability, switch control, and temperature stability of high-power microwave devices, but also require high-power filters and switches due to high losses. Increasing the transmit power greatly increases the cost, weight and volume, and reduces the transmit efficiency, which may be unacceptable for many radars [13-14].

(2) Pulse shaping

To avoid the use of narrowband filters for in-band spectrum control, the transmitter must generate a relatively narrow RF range to meet the requirements. This can be achieved by pulse modulation. To achieve these goals, the shape of the pulses must be different from the usual quadrature pulses. The pulse shape should have the fastest lateral band energy decomposition rate within a given effective pulse width, and this pulse shape can only be a Gaussian pulse [15]. Theoretically, when the pulse waveform is in the form of a Gaussian pulse, within a given effective pulse width, the energy of the transverse band decreases rapidly and the frequency spectrum is the narrowest. But the Gaussian pulse spectrum not only drops fast, but also drops faster and faster [16].

3. Investigation and Research on Electromagnetic Spectrum Control Method Considering Information Security of Wireless Sensor Network

3.1 Construction of Electromagnetic Spectrum Detection Network System

In order to verify the correctness and reliability of the network simulation, we built and tested the outdoor transmission system inside the campus, the single-node shape and internal modules. There are a large number of tall trees and buildings around the campus; a small number of people move in the football field, and there are many 2.4GHz wireless signals. The test adopts the application program based on linux Ubuntu9.10 to realize the multi-point-to-point rate test of wireless transmission under the conditions of TCP and UDP respectively. The network card adopts RT3070 wireless network card Linux version, adopts IEEE802.11b/g hybrid automatic rate, works in 2.46GHz frequency band Infraction mode, and assists 2.4G with omnidirectional 12dbi high-gain antenna.

3.2 Implementation of Electromagnetic Spectrum Control

(1) Parameter setting

The parameters of the physical layer mainly involve the selected channel model and some important parameters such as transmit power. According to the actual industrial standard adopted by the 802.11g network card and external antenna in the project. The channel model adopts the double-path ground reflection (model, in which the linear propagation and the ground reflection path are considered in this model, and the received power is expressed as follows:

$$P_r \frac{P_t G_t G_r h_r^2 h_t^2}{d^4 L} \quad (1)$$

The transmit power of the antenna is selected to be 6.5 times gain according to the actual antenna used. The transmission power is 300mw of the wireless network card, and it works in the 2.4G ISM frequency band.

(2) Simulation results and analysis of electromagnetic spectrum control

Before starting the simulation, simply analyze and calculate the expected results of the simulation. Assuming that the application layer uses TCP as the transport layer communication protocol, let m

represent the size of the transmission from the application layer, in bytes, and generally assume that the ideal average time for random access to the wireless channel is CWmin/2. access is used to transmit m bytes of data The maximum transmission rate that TCP can expect to achieve in unit time, that is, the output can be calculated as follows：

$$\begin{aligned} \mathrm{TH}_{noRTS} &= m/(2*(DIFS+SIFS+TACK+(CW_{\min}/2)SLOT \\ &+TDATA_1+TDATA_2) \end{aligned} \tag{2}$$

Among them, TDATA1 represents the time required to send a MAC packet containing TCP data, TDATA2 represents the time required to send a TCPACK MAC packet, and TACK represents the time required to send a MAC-level ACK packet.

4. Analysis and Research of Electromagnetic Spectrum Control Method Considering Information Security of Wireless Sensor Network

4.1 Outdoor Point-to-point TCP Connection Test

The outdoor point-to-point connection test was carried out 9 times in total. The surrounding environment of the test was complex, there were people moving in the field, and a small number of vehicles moved outside the field. Due to limited outdoor testing equipment, only 15,000 packets of data were sent. The results of the test are similar to those of the indoor test, but the communication rate is significantly reduced. The main reason is that the distance is long and the transmit power of the antenna is not large, which leads to the decrease of the communication rate. The average rate fluctuates greatly, and it can be seen that the external interference of the wireless signal is very strong. The test results are shown in Table 1.

Table 1. Outdoor point-to-point TCP connection test rate

frequency	number of bytes	send time	total number of packages	total length(kbits)	average speed(kbps)
1	1000	6.25	15000	90000	115423.32
2	1000	6.35	15000	90000	126311.39
3	1000	6.73	15000	90000	11867.98
4	2000	12.36	15000	90000	10035.53
5	2000	12.65	15000	90000	10262.01
6	2000	12.95	15000	90000	12636.32
7	3500	23.33	15000	90000	113796.55
8	3500	23.56	15000	90000	11501.42
9	3500	23.74	15000	90000	7733.91

As shown in Figure 1, it can be seen from the actual test that the receiving rate of the receiving node remains within a rough range. When the number of sending nodes increases, the sending rate of each node will decrease to varying degrees, but under the same conditions, UDP is still faster than TCP.

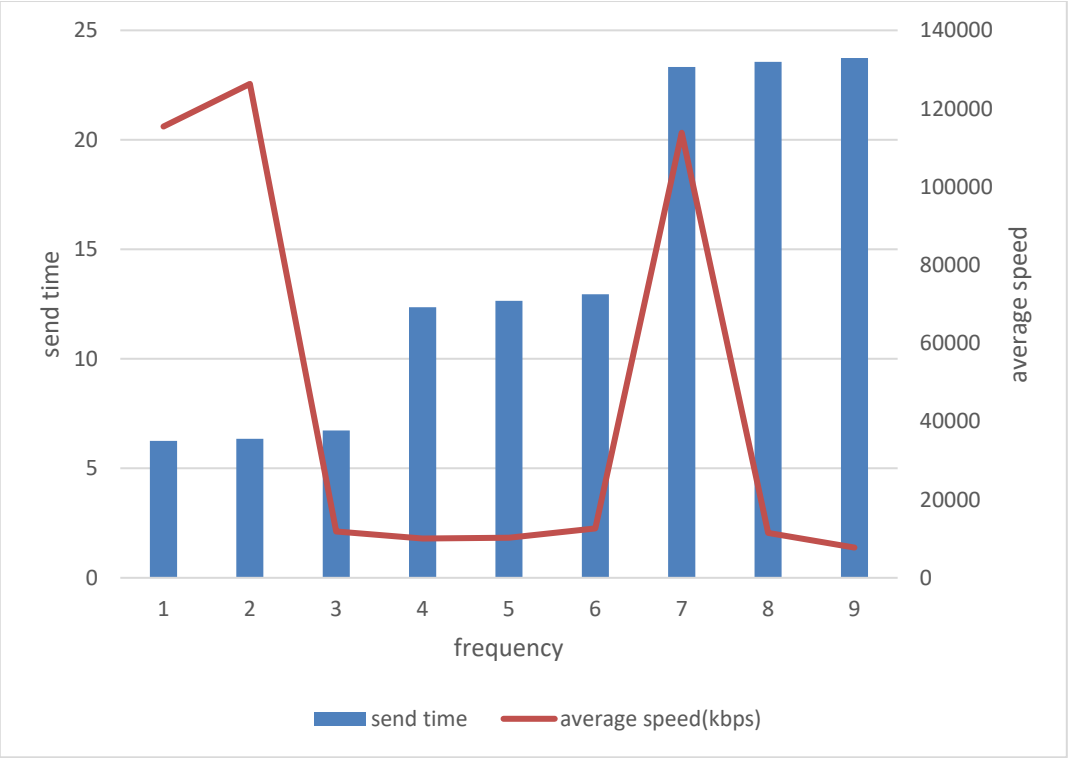

Figure 1. Outdoor point-to-point TCP speed

4.2 Outdoor Point-to-point UDP Connection Test

The outdoor point-to-point connection test was carried out a total of times. The surrounding environment of the test was complex, there was no movement of people in the field, and a small number of vehicles moved outside the field. The number of packets sent is small, and there is no packet loss. Due to limited outdoor test equipment, only packet data was sent. Although the sending rate fluctuates, the average sending rate is significantly faster than the connection under the same conditions, which is in line with the theoretical analysis. The test results are shown in Figure 2.

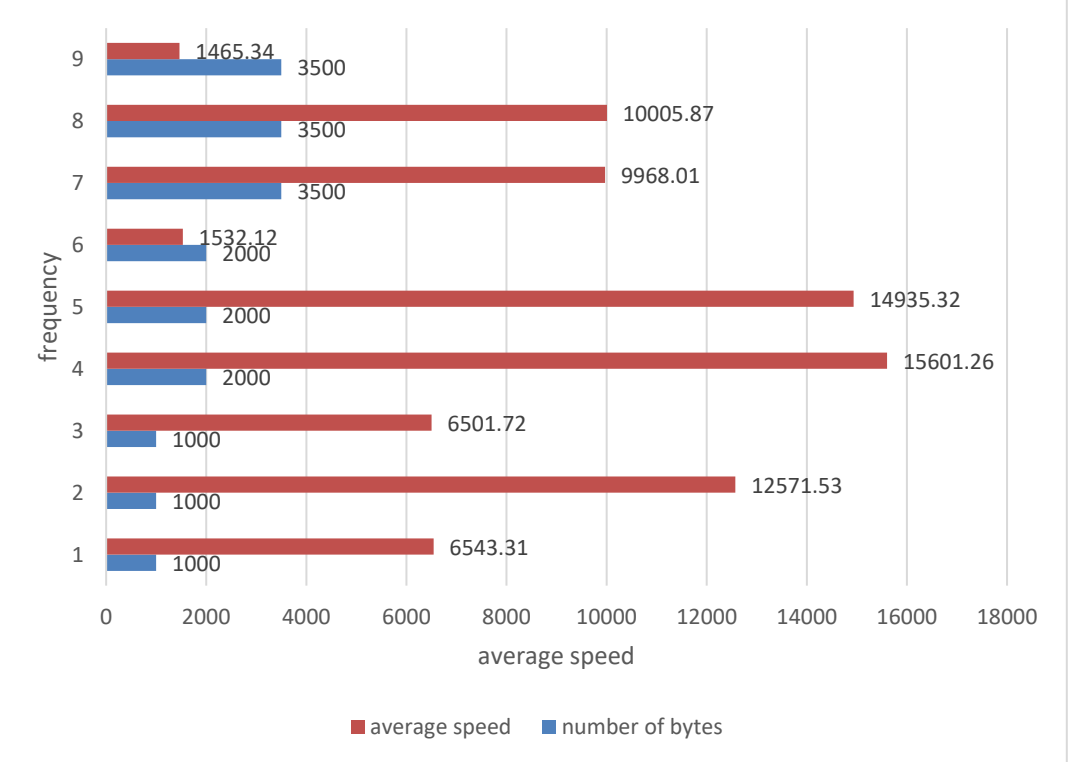

Figure 2. Outdoor point-to-point UDP connection test

Through the field test of the transmission capability of the sensor electromagnetic spectrum control network, the different receiving and sending rates of the network under different conditions are met. The simulation and actual measurement also prove that the sensor electromagnetic spectrum control network adopts the TCP/IP transmission method based on IEEE802.11g to meet the requirements of daily application control spectrum data.

5. Conclusions

In this paper, by analyzing the protocol and wireless transmission mode of electromagnetic spectrum control network based on wireless sensor, theoretical simulation and field test are carried out on the key data of network performance. The simulation results and measured data provide great theoretical support and guidance for the application data transmission of the project. Due to time constraints, there are still many deficiencies in the research on this topic, and there are still many areas for improvement. In the process of studying the electromagnetic spectrum control method, the simulation model is simplified, and only the corresponding two-dimensional model is introduced. In order to conduct a more in-depth study of TR-based wireless sensor network communication technology, it is necessary to create a relatively complex 3D model.

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