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Electromagnetic Wave Position Measurement Sensor Device Based on Electromagnetic Biological Body Interference

Wei Ren[1,a,*]

[1]The 10th Research Institute of China Electronics Technology Group Corporation, Chengdu, Sichuan, 610036, China
[a]303391771@qq.com
[*]Corresponding author

Abstract: *With the change of the times, electromagnetic wave position measurement sensor is used more and more frequently in our life, and position measurement is an important function of it. However, the use of electromagnetic wave position measurement sensor is easy to be affected by some factors, such as distance and magnetic field, which makes it difficult for the electromagnetic wave position sensor device to achieve accurate positioning. The electrical characteristics of biological tissues are the response characteristics of biological tissues to electrical signals. The electrical properties of biological tissues are essentially determined by their structures with electrical properties. In this case, the electric field biological. The electromagnetic wave position measurement sensor device of body interference has been paid attention to. In order to make the electromagnetic biological body play a more important role in the measurement of the position, we collected the relevant data, designed the experiment and obtained the relevant research data by means of relevant investigation, literature review and interview with professionals. The experimental results show that the electromagnetic wave position measurement sensor device with electric field biological body interference is extremely anti-interference Excellent, in the long-distance side position accuracy is 20% higher than the general electromagnetic wave position measuring instrument, its interference to the magnetic field can achieve basic immunity, and the propagation speed is nearly 28% faster than other sensors, which shows that the electromagnetic wave position measurement sensor with electromagnetic biological body interference can play a very important role in the future life.*

Keywords: *Electromagnetic Organism, Electromagnetic Wave, Anti-interference, Disturbing Electromagnetic Wave*

1. Introduction

With the continuous development of science and technology, electronic equipment is increasing, people are exposed to all kinds of electromagnetic fields all the time. Electromagnetic field has become a part of human living environment, and the influence of electromagnetic field on organisms has been found and confirmed. For the sake of human health, it is necessary to carry out the research of electromagnetic biological effect, study the mechanism of electromagnetic field and biological tissue interaction, and finally achieve the purpose of minimizing the harm of electromagnetic pollution and using electromagnetic field to serve human beings.

Study the interaction between electromagnetic field and biological tissue, and explore the law of electromagnetic energy transmission in biological tissue, as well as its distribution and absorption in the organism [1-2]. Its research results have great practical significance in medical diagnosis and treatment, such as detection of early tumor, organ function monitoring, human body composition detection, tissue structure analysis and tumor hyperthermia. On the other hand, in the information battlefield, ultra-high power and ultra wideband electromagnetic pulse not only seriously damage radar, communication system and weapon equipment system, but also have a profound impact on the psychology and physiology of military command and equipment operators. Protecting oneself from electromagnetic damage has become an important factor in fighting for battlefield initiative [3-4].

The research on the impact of electromagnetic field on human body is helpful to formulate appropriate protection strategies, take reasonable protective measures, and develop advanced protective equipment to avoid combat damage. The measurement of electromagnetic properties of biological tissues is based on the basic theories of electromagnetics, biomedical engineering and biology [5], and involves many new technical fields. It is the basic content of Bioelectromagnetics to provide the necessary information of electromagnetic properties of biological tissues for the research of Bioelectromagnetics. Many experts at home and abroad have made relevant research on electromagnetic wave position sensor [6] of electromagnetic biological body interference

Yinqi briefly introduced the position sensors existing in the market at present, mainly analyzed the electromagnetic sensor and the inductive coil sensor, made a detailed introduction from the measurement principle, frequency response and sensitivity, compared their advantages and disadvantages and the reasons for their popularity at present, providing guidance service for the application of side position sensor [7]; Wang Starts from induction logging tool and electromagnetic wave propagation logging tool, Hao introduces two kinds of most common side position sensors in downhole, expounds the important role of current downhole position sensor research and development, and through the design of new algorithm, simplifies the circuit, reduces the loss, reduces the logical resource occupation, and improves the sensor efficiency; Jie is based on the research of car parking, combined with geomagnetic wave position measurement sensor, and integrated into automatic parking technology. Based on line structured light projector and camera, the electromagnetic wave measurement sensor can accurately perceive the vehicle position and obstacles, and the distance between parking lines, making the measurement more intelligent [8-9]. These studies provide a certain reference for the research of position sensor, but because of the small experimental data sample of relevant experts, the research is not thorough enough, which makes the relevant research results difficult to be applied in reality.

This paper studies the propagation characteristics of electromagnetic wave in special environment, analyzes the factors that affect the transmission loss, analyzes the feasibility of the underground positioning method based on the received signal strength, puts forward the positioning model based on the separation of the received signal arrival time, and the distance measurement standard based on the bidirectional arrival time and the symmetric bidirectional arrival time and the error analysis of two ranging standards [10]. Aiming at the location model based on signal arrival time ranging, this paper proposes a ranging implementation scheme based on linear frequency modulation spread spectrum technology, analyzes its technical principle and application advantages, and obtains the bit error rate under different bandwidth and information transmission rate, which provides a basis and reference for the design and implementation of the system. On the basis of theoretical research and simulation, the whole positioning system is designed and implemented, including ranging subsystem and host computer positioning software, which provides reference for future research.

2. Electromagnetic Wave Position Measurement Sensor Based on Electromagnetic Biological Body Interference

2.1 Electromagnetic Organism

The electrical characteristics of biological tissues are the response characteristics of biological tissues to electrical signals. The electrical properties of biological tissues are essentially determined by their structures with electrical properties [11]. Firstly, all kinds of molecules in organism are constructed by covalent bonds generated by overlapping electron clouds around atoms; secondly, the interaction force between molecules is actually the force generated when the electronic shells of two molecules overlap each other; in addition, there are also interactions between ions, hydrogen bonds and other particles generated by electromagnetic interaction [12].

In the past hundred years, the interaction between electromagnetic field and organism has been fully studied, and a relatively complete branch of Bioelectromagnetics has been formed. The research work has experienced the development stage from thermal effect to non thermal effect, from living animal to cell and biomacromolecule, from biological effect to clinical application. Bioelectromagnetics has also made great progress in the field of Biomedical Engineering, and its application in medicine can be divided into two aspects: treatment and diagnosis [13].

In terms of treatment, radiofrequency ablation is widely used in the treatment of arrhythmia, microwave hyperthermia apparatus for tumor treatment, electromagnetic wave physiotherapy and so on. In diagnosis, magnetic resonance imaging is one of the most widely used imaging technologies. In addition, medical imaging technology based on microwave measurement is also receiving more and

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more attention [14]. Microwave measurement can obtain the important characteristics of some biological tissues, such as temperature distribution, blood content, blood oxygen content, etc., and then these information can be graphically visualized, which is convenient for doctors to diagnose diseases. Microwave confocal imaging is a backscattering method [15]. This method uses the antenna to send an electromagnetic excitation signal to the region of interest, and the signal propagates in the biological tissue until it meets the scatterers (the scattering signal mainly comes from the part with significant difference in dielectric constant), then the electromagnetic wave will scatter on its interface, and receive the scattering signal through the antenna array, and extract the position and size of the scattering object through the algorithm. Antenna array detection is used to obtain enough spatial resolution. This method does not quantitatively analyze the dielectric constant of scatterers, and the calculation is relatively small, and the results can be obtained quickly. It is an ideal microwave measurement method for biological tissue [16].

The dielectric constant of biological tissue reflects a kind of macroscopic characteristic, which is the expression of a certain volume about the macroscopic physical and biochemical process. Generally speaking, the dielectric constant of biological tissue is related to the molecular dipole moment per unit volume, while the conductivity is related to the free path length and velocity of electrons. Therefore, the dielectric constant and conductivity of biological tissue reflect the micro environment of cells and molecules in the tissue [17]. When biological tissue changes in physiology due to internal or external changes, such as temperature change, pathological changes, external stimulation, etc., the original state of biological tissue will be changed, and the dielectric constant and conduction of biological tissue will be affected. The relationship between complex dielectric constant and frequency can be expressed by equation

$$\delta_n = \delta_\infty + \frac{\delta_0 - \delta_\infty}{1 + n\gamma\kappa} \tag{1}$$

Where, is the static dielectric constant, is the dielectric constant at infinite frequency, is the relaxation time, is the angular frequency.

According to the dispersion characteristics of biological tissues, a calculation model describing the electrical properties of biological tissues is given

$$\lambda_i = \gamma_\infty + \sum_{n=1}^{4} \frac{\Delta\lambda_n}{1 + \left(ny\kappa\right)^{(1-a_n)}} + \frac{\upsilon_j}{ny\kappa} \tag{2}$$

The communication distance of electromagnetic wave increases with the increase of frequency, and the attenuation of electromagnetic wave propagation decreases gradually. This monotonous inverse change is due to the tunnel diameter is far greater than the wavelength, electromagnetic wave in the roadway has obtained relatively large free propagation space, which makes the tunnel gradually act as a waveguide for electromagnetic wave, so the propagation conditions are gradually improved, and the communication distance is increased [18].

When the signal passes through the lossy tissue, the signal strength will decrease, and the signal amplitude will decrease with the increase of propagation distance.

$$\sin\alpha_i / \sin\alpha_j = n_i / n_j \tag{3}$$

According to the characteristics of the medium, the propagation velocity of the signal in the medium can be obtained

$$v = 1/\sqrt{(\gamma v/2)\left[\sqrt{1+\gamma/\upsilon\beta^2}\right]+1} \tag{4}$$

Paramagnetism produced by the directional migration or movement of conducting carriers. In protein molecules and water molecules, proton currents are generated by the directional movement of protons along hydrogen bonds or rings; sodium currents and potassium currents are generated when nerves are excited; and certain currents are generated when electrons migrate along mitochondria and DNA chains. According to Biot Savart's law, these currents must produce magnetic fields around them [19]. In fact, the distribution of current intensity and direction in organism is very complex, so the magnitude and direction of magnetic field also change with time. Magnetic elements and compounds in biological tissues. There are 13 kinds of metal elements in organism, among which 8 are 3D or 4D

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transition metal ions, which have paramagnetism. At the same time, some biological tissues (such as liver and spleen) can produce induced magnetic field under the action of external field, thus showing magnetism. The highest content of water in organism will also produce paramagnetism under the action of external field. Most biological tissues are diamagnetic and can interact with the external magnetic field.

2.2 Position Measurement Capability

Generalization ability is a very important problem in the support of sensors. The generalization ability of learning model is its generalization ability. In the prediction regression problem, it means that the data not in the training samples can also produce more reasonable prediction results. In the past learning and training, the possible error of training is often minimized, and sometimes the training number is excessively fitted It is possible to minimize the training error, but sometimes, when the trained learning model is used to predict a certain time in the future, the phenomenon of over learning will inevitably occur, thus reducing the generalization ability of the learning model. Therefore, only relying on the minimization of prediction error cannot achieve satisfactory results [20].

In the case of limited samples, the training error and the generalization ability of the model are mutually restricted. Generally speaking, the smaller the training error is, the weaker the generalization ability is. When all the sample data are trained, the training error is zero or too small, resulting in over learning phenomenon [21]. Therefore, in the actual application process, under the condition of sufficient training samples, reasonable selection of prediction model and algorithm can avoid the generation of over learning to a certain extent. It can be obtained that, under the limited number of samples, the minimization of empirical risk does not necessarily meet the minimization of expected risk [22].

Theoretical and experimental studies show that the generalization performance of regional economy greatly relies on the accuracy and diversity of individual regional economy in integration. In order to obtain individual networks with large differences, researchers use different training sets, different network structures, different network types, different initial conditions and different training algorithms to improve the differences between networks [23]. The following aspects are usually taken into consideration:

(1) By changing the initial random weight set, each time the network is trained, the same training data is used, but different random initial weights are used.

(2) Changing the topology before each training, by changing the topology of the network, and then using the same data set to train on the changed network, a group of different networks can be generated.

(3) By changing the network type, different network types can be used to generate members in the ensemble. For example, multi-layer perceptron, radial basis function regional economy and probabilistic regional economy can be used to generate a group of different regional economies.

(4) By changing the algorithm used in the prediction of regional economy, using the same data set but using different learning algorithms for training, a group of networks can be obtained through this method.

(5) The method of changing training data is often used in regional economy, including data sampling, using disjoint training sets, adaptive resampling, different data sources and preprocessing methods. Through these methods, we can get a set of different regional economy.

2.3 Principle of Electromagnetic Wave Position Measurement Sensor

We set up a communication detection space. Since the transmission loss is mainly caused by the refraction loss caused by the electromagnetic wave refraction into the surrounding medium, the ohmic loss caused by the conductivity of the surrounding medium can be ignored in UHF band [24]. Taking the center of the cross-section as the coordinate origin, taking the horizontal direction as the x-axis, the vertical direction as the y-axis, and the roadway direction as the z-axis, a rectangular coordinate system is established

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$$L_x = \sqrt{\left(\frac{i\pi}{a}\right)^2 + \left(\frac{y\pi}{b}\right)^2} \tag{5}$$

The expression of cut-off wavelength is

$$\lambda_x = \frac{2\pi}{L_x} = \frac{2}{\sqrt{\left(\frac{i\pi}{a}\right)^2 + \left(\frac{y\pi}{b}\right)^2}} \tag{6}$$

Electromagnetic wave frequency K

$$k = \frac{v}{\lambda} \tag{7}$$

Where V is the velocity of electromagnetic wave propagation in the medium, the electric field intensity components of each mode can be obtained. Finally, the actual field strength of the simulation point can be obtained by using the superposition principle of the electric field components of each mode.

$$T = \left| \sum_{n=1}^{n} \sum_{m=1}^{m} \sqrt{T_a^2 + T_b^2 + T_c^2} \right| \tag{8}$$

Considering the resources with the same service function, the attributes of the resources are set according to the user preferences, and have certain scalability. The calculation formula is as follows:

$$U_a = p * b \frac{j}{i} * c \tag{9}$$

In order to ensure the objectivity of the results, we use entropy weight method to determine the entropy value and entropy weight of each resource attribute.

$$t = \frac{1}{\ln x} \sum_{n=1}^{1} f_{nm} * \ln f_{nm} \tag{10}$$

$$r = \frac{1-t}{y - \sum_{m=1}^{m} t} \tag{11}$$

Among

$$f_{mn} = \frac{z_{nm}}{\sum_{n=1}^{x} z_{nm}} \tag{12}$$

$$\sum_{m=1}^{x} w_m = 1 \tag{13}$$

2.4 Sensor Device

The field intensity distribution is also complex under static conditions, and there is a fast fading phenomenon, which is caused by the multi-path effect of underground roadway. Even in the half wavelength range, the field intensity amplitude will change from 20 to 30 dB, and this change is random, which is a big obstacle to the use of field strength positioning algorithm. In addition to the fast fading phenomenon, there are also slow fading phenomena in the field intensity distribution in the roadway. When the electromagnetic wave encounters the terrain undulation or obstacles in the process of propagation, the shadow of electromagnetic field will be generated behind these obstacles.

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When the signal receiver passes through the shadow area of different obstacles, the field strength value of the signal received by the antenna will change, resulting in fading, which becomes slow fading. Compared with fast fading, slow fading is a kind of macro fading, which is measured by a larger spatial scale. Its fading characteristics are lognormal distribution. The amplitude of local field strength of received signal depends on the signal frequency and obstacle condition. High frequency signal is easier to penetrate obstacles than low-frequency signal, and low-frequency signal has stronger diffraction ability than high-frequency signal. One of the key problems in using field strength location is to establish the mathematical model of electromagnetic wave signal strength (power) fading (loss). Many related researchers have carried out in-depth research on electromagnetic wave propagation model, and established many different kinds of electromagnetic wave propagation loss models which are suitable for different environments. However, in practical application, the effect of simply relying on the mathematical model established in advance is often poor.

Firstly, the data base of RSSI is selected to compare with the measured data of indoor environment. If the measurement results are within the allowable error range, the RSSI estimation value of similar environment around the test point is considered to be available;

If there is a big difference between the measurement results and the estimated values, it is considered that the RSSI estimation value of similar environment around the test point is not available, and it is necessary to sample in this area. The sampling method is the same as that of building empirical value database. After sampling, the RSSI value of this area in the database is replaced by the sampling result. Even so, the actual positioning error can sometimes be more than ten meters or even tens of meters, which is still far from the required positioning error of several meters. For the complex environment, the propagation environment of electromagnetic wave is more complex than the indoor environment, the multipath effect is more serious than the indoor environment, and the attenuation law of electromagnetic wave field strength is more difficult to master, which leads to larger positioning error and can not meet the precision required by the design. Therefore, the method based on signal receiving strength is not used for positioning in the course are shown in figure 1.

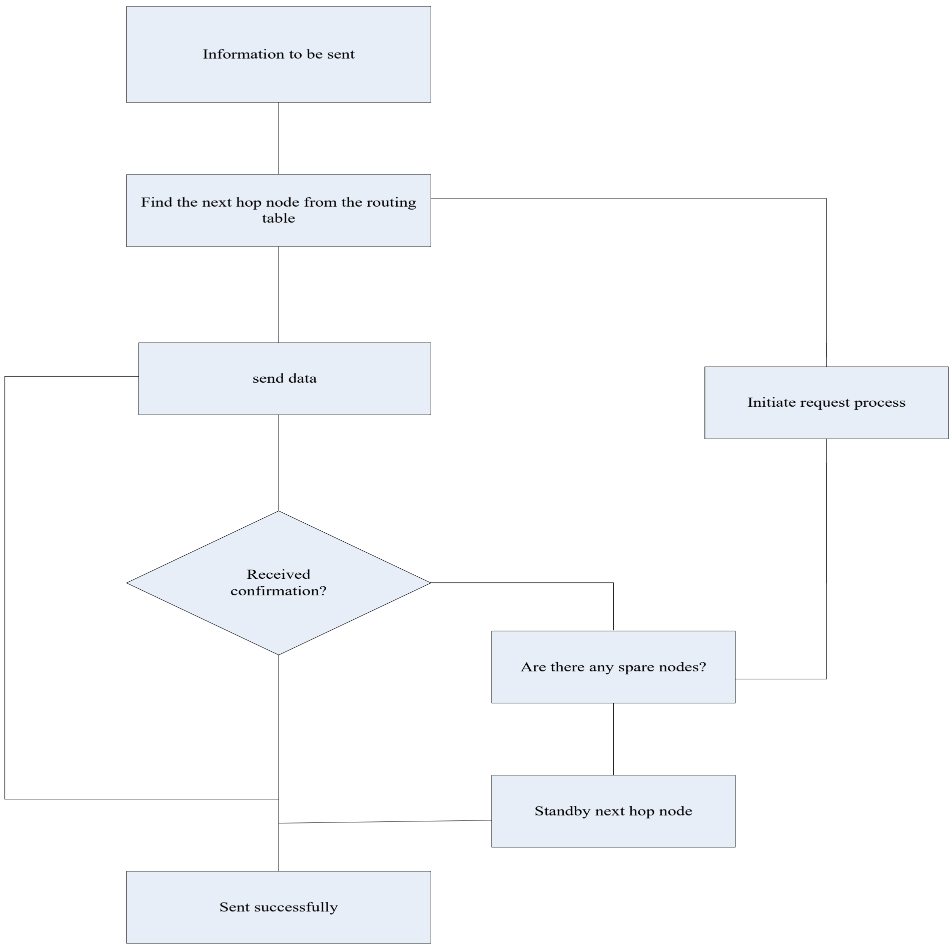

Figure 1: Sensor operation method

In the positioning system, the use of sensors has many advantages, specifically including the following aspects:

1) Sensor is a kind of low-cost, simple structure of sensor equipment, this type of sensor has been widely used in various fields.

2) The sensor will not use the public network in the process of data transmission and data analysis, which can reduce the use of relevant resources.

3) In the process of data transmission, the sensor mainly adopts radio wave transmission technology, so that it will not be limited by external factors in the process of data transmission, which is suitable for application in modern urban positioning system.

4) The characteristics of sensor distribution and self-organization can be applied in public transport system, and can form self-organization and open system, which is of great significance to improve the accuracy and accuracy of bus positioning system.

5) Using ISM frequency band can reduce the operation cost of the system to a great extent.

3. Experiment of Electromagnetic Wave Position Measurement Sensor

3.1 Purpose of the Experiment

In this paper, based on the theoretical results of electromagnetic wave position measurement sensor for testing electromagnetic biological body interference, using the research results of big data integration theory at home and abroad, using the methods of literature, comparative research, mathematical statistics, logical analysis, etc., to conduct deep-seated analysis, study the difference between the influence of electromagnetic wave interference on position measurement sensor, and experiment electromagnetic biology The release of the body under interference can accurately measure whether the position is universal.

3.2 Experimental Evaluation Criteria

Comprehensive quantitative and qualitative analysis methods, quantitative analysis is to analyze the data of the problem, using the intuitive and clear essence of mathematics to reflect the existence of the problem; qualitative is the collection, reading and sorting of the relevant domestic and foreign research literature, systematically summarizing the relevant theoretical results. The performance evaluation standards of green supply chain are complex and diverse, including not only financial standards but also other non-financial standards. Some standards cannot be directly analyzed by quantitative methods, but can only be evaluated by qualitative analysis methods. The performance evaluation standard system of green supply system is constructed by combining quantitative and qualitative analysis methods. At the same time, the calculation formula and evaluation standard of relevant standards are given.

Entropy method is a relatively objective evaluation index weight assignment method, which can effectively avoid the subjectivity of artificial scoring, and has high accuracy. But at the same time, this study also realized that the entropy method cannot directly reflect the knowledge, opinions and experience judgment of experts and scholars, and the weight results may be contrary to the actual situation. Therefore, this paper uses comprehensive quantitative and qualitative analysis and entropy method to determine the weight coefficient of each evaluation index.

3.3 Determination of Evaluation Weight

Indicates the importance of index and index function. In the index system of evaluation scheme, the weight of each index is different. Even if the index level is the same, the weight is not the same. Index weight is also called weight, which is usually represented by A. It is a number greater than zero but less than 1, and the sum of the weights of all primary indicators must be equal to 1, that is to say, the conditions $0 < a < 1$ and Σ A-1 are satisfied.

3.4 Comprehensive Evaluation Model

At present, there are two main evaluation models: one is the main factor prominent model, the other is the weighted average model. If the weight of a single factor is significant and there are dominant

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factors in the evaluation factors, the prominent main factor model can be selected; if the weight of the evaluation factors is relatively average, the weighted average model can be selected. The two models have their own characteristics. In the specific implementation process, the two methods can be implemented separately. Finally, the results of the two models are compared.

4. Experimental Analysis on Electromagnetic Wave Position Measurement

4.1 Distance Factor Interference

In this paper, three groups of experiments are set up, which are divided into general electromagnetic wave position sensor (experimental group), electromagnetic body electromagnetic wave measuring position (control group), and other position sensors represented by radio wave (control group). The specific experimental data are shown in Table 1, figure 2 and figure 3

Table 1: Distance interference location

	500m	1000m	1500m	2000m	2500m
General electromagnetic wave	5.2	6.1	6.7	7.1	7.4
Electromagnetic body	2.4	2.9	3.5	3.8	4.1
Radio waves	5.7	6.2	6.6	7.3	7.8

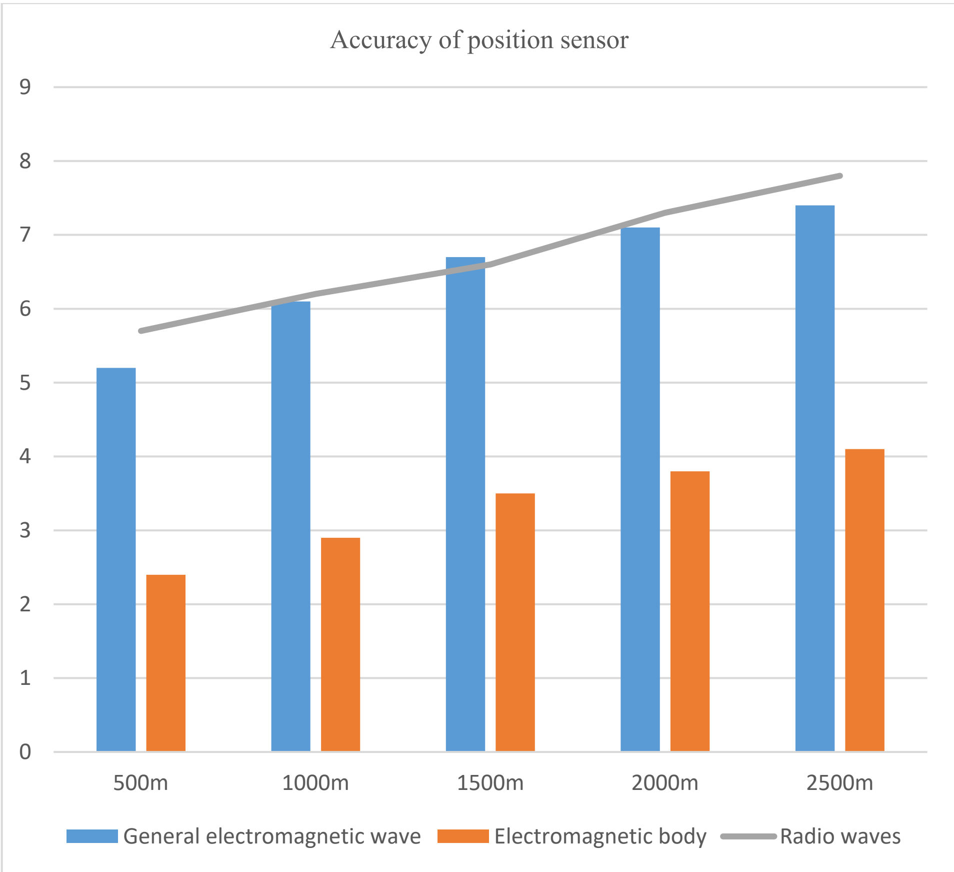

Figure 2: Accuracy of position sensor

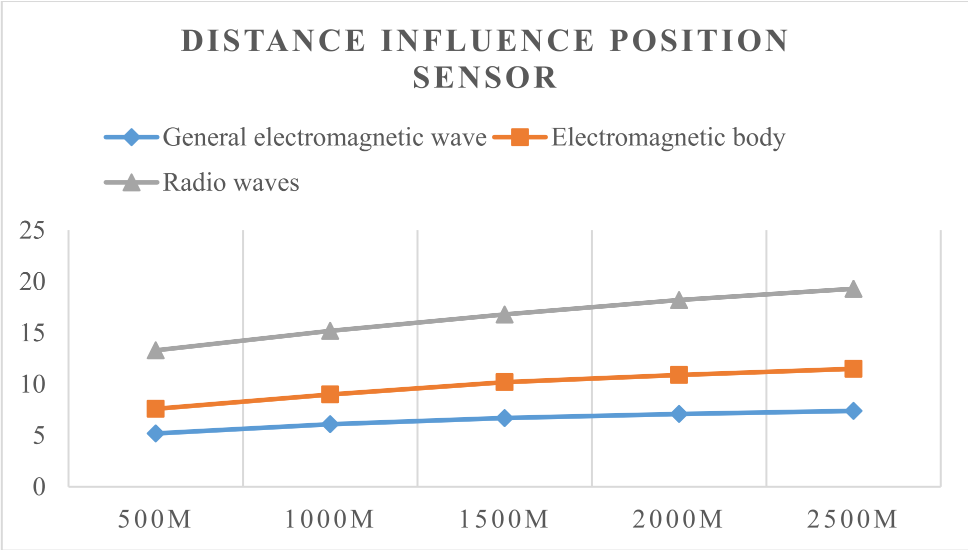

Figure 3: Distance influence of position sensor

From the experimental results, the electromagnetic sensor made of electromagnetic biological body has the least interference factor among the distance factors. From 500 meters to 2500 meters, the position accuracy is far higher than the other two groups, and from the experimental results, the value is more than 20%. The general electromagnetic wave position sensor is higher than the radio wave sensor in short-range and long-distance. There is no difference between the two.

4.2 Influence of Magnetic Field on Position Accuracy

The magnetic field has an impact on the general electromagnetic sensors, resulting in a gap between the measured position and the actual position, or even a complete deviation. We have made 100 experiments for three groups of sensors. The specific experimental data are shown in Table 2, figure 4 and figure 5

Table 2: Magnetic interference factors

	Totally inaccurate	Large deviation	The deviation is general	The deviation is small	No deviation
General electromagnetic wave	3	17	33	34	13
Electromagnetic body	1	8	21	45	25
Radio waves	7	21	42	23	7

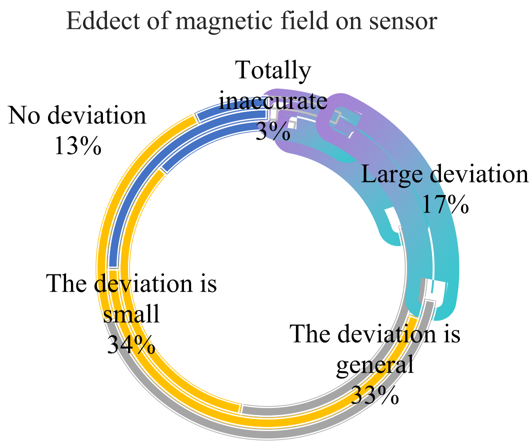

Figure 4: Effect of magnetic field on sensor

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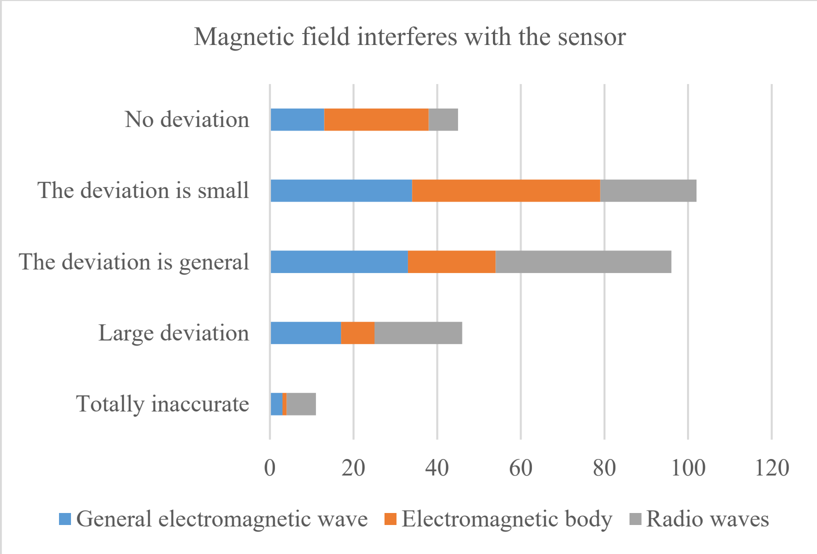

Figure 5: The magnetic field interferes with the sensor

From the chart, we can see that the magnetic field has great interference on the sensor. Under the action of magnetic force, the sensors in the experiment will have deviation basically, but the electromagnetic biological body is the least affected and can basically operate normally. The probability of small magnetic field influence, small position deviation or even no deviation reaches 70%, and the other sensors are only about 40%.

4.3 Sensor Propagation Time

For us, the faster the transmission time of the sensor is, the experimental data are shown in Table 3, Figure 6 and Figure 7

Table 3: Transmission time

	1000m	1500m	2000m	2500m	3000m
General electromagnetic wave	1.2ss	1.7s	2.3s	2.9s	3.7s
Electromagnetic body	0.7s	1.1s	1.4s	1.7s	1.9s
Radio waves	1.5s	1.8s	2.2s	2.9s	3.9s

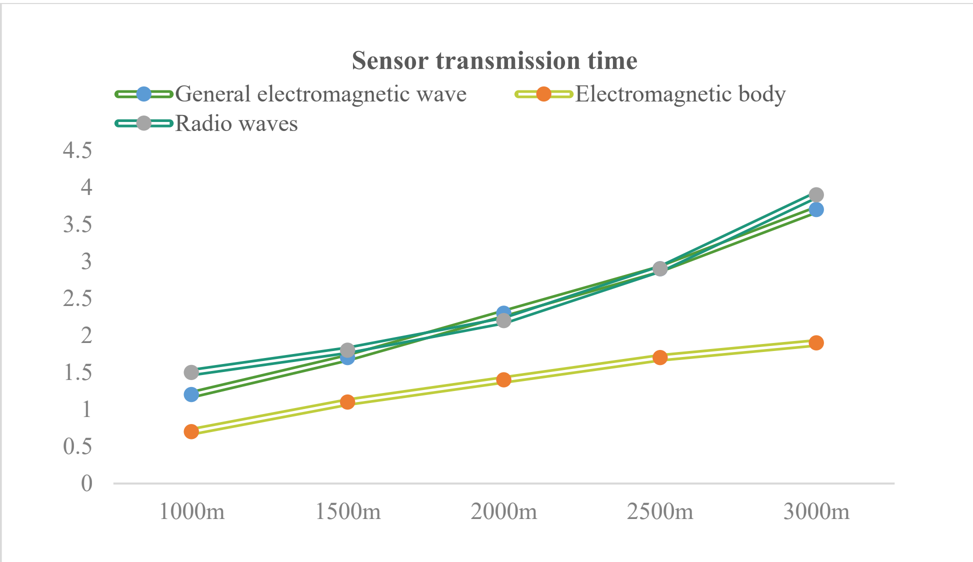

Figure 6: Sensor transmission time

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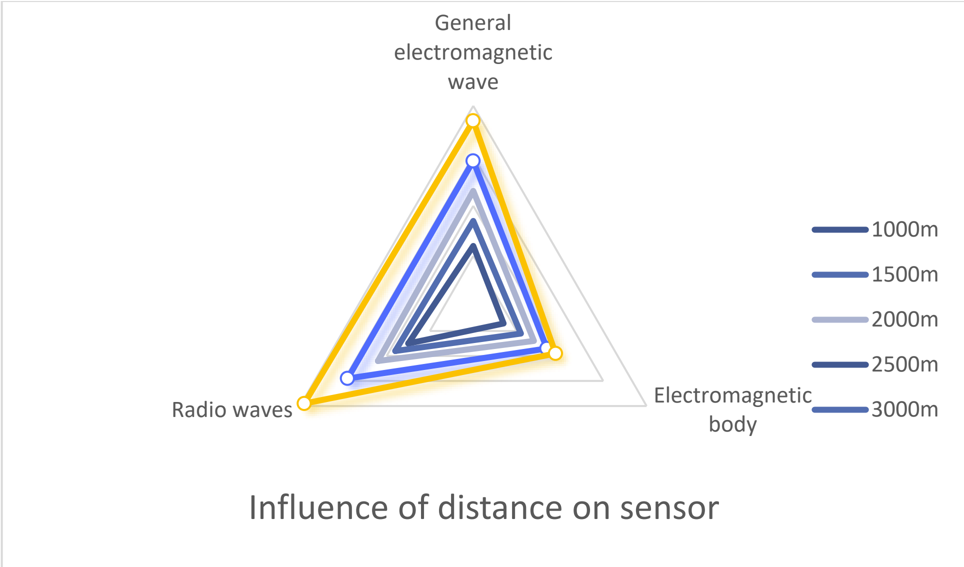

Figure 7: Influence of distance on sensor

We can clearly see that in terms of sensor transmission distance, the biological body electromagnetic sensor position measuring device has a very obvious advantage. In the distance of 1000 m to 3000 m, the biological body can complete a round-trip in less than 2 seconds, and other sensors need about 4 seconds, leading by nearly 50%.

4.4 Energy Consumption

Energy is not very important for the sensor, but it cannot be ignored. When effective energy supplement is not available, the smaller the energy consumption, the better. Therefore, we have also made relevant experiments on the energy consumption of the sensor. The research data are shown in Table 4 and figure 8

Table 4: Transmission time

	Standby time	A small amount of time	General consumption time	A lot of time
General electromagnetic wave	22h	17h	13h	10h
Electromagnetic body	46h	28h	22h	17h
Radio waves	32h	21h	14h	9h

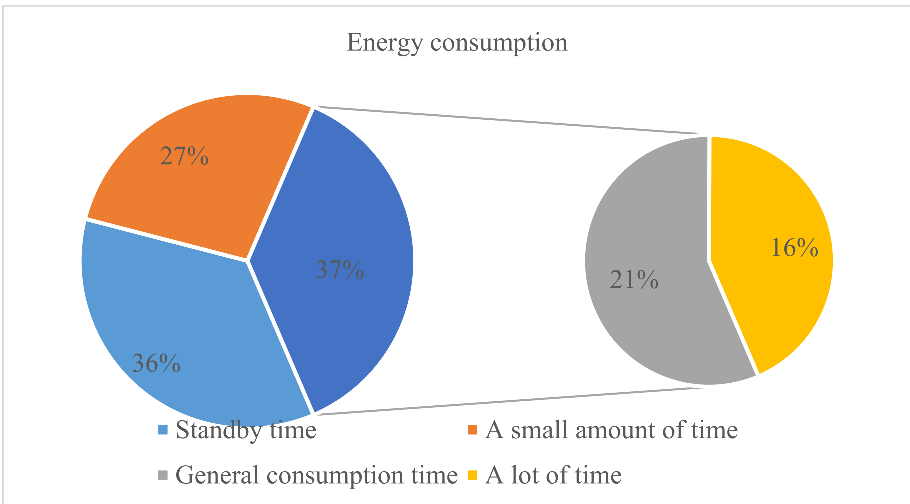

Figure 8: Energy consumption

The experimental results show that in the energy loss, the use of electromagnetic biological body can be limited to avoid energy loss, delay the use of sensor time, in the case of long time or no supplement, the need to locate the best, in terms of electromagnetic biological body electromagnetic wave position measurement sensor is the best choice.

5. Conclusions

The main function of routing protocol in sensor networks is to guide data packets from the source node to the target node. The main functions of the specific incoming routing protocol include the following two aspects: firstly, optimize the path between the source node and the target node; secondly, send the data according to the most optimized path. In the design of wireless sensor network routing protocol, we can learn from the design of wireless ad hoc network routing protocol.

At present, with the rapid development of urbanization, high-rise buildings and various facilities in the city will reduce the positioning accuracy. Under the influence of urban canyon effect, it cannot meet the requirements of positioning system, which will lead to signal interruption. In the process of data transmission, it needs to rely on mobile 4G network. However, the current mobile network does not provide independent bandwidth resources, which leads to the delay problem of data transmission in the peak period of mobile network use, and the data transmission cannot be realized in time.

Based on the electromagnetic biological body interference, the electromagnetic wave position measurement sensor has the advantages of low cost, strong anti-interference performance, low power consumption and simple development mode. In terms of accuracy, it is much higher than other sensors, which can fully meet the business requirements of positioning system. Through the application of various advanced technologies, sensor network nodes can realize online update and automatic error correction, and further improve the stability and practical value of the positioning system based on sensor network. The positioning system of sensor network will continue to develop with the development of software and hardware equipment and related technologies, which will inevitably become the inevitable trend of the development of urban positioning system in China in the future.

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