Exploration of the Integration and Application of the Modern New Chinese Style Interior Design

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Abstract   Artificial intelligence (AI) is increasingly used in the Internet of Things (IoT), and allows physical devices in the real world to connect with the Internet. Now, with the emergence of resource conservation, energy efficient utilization and social harmony, the rapid realization of the new Internet of Things combined with artificial intelligence technology also puts forward higher requirements for the sustainable design of modern interior environment designers. This paper mainly studies the distributed positioning algorithm based on relative position information in 3D environment, provides the latest algorithm model for the application of new communication and sensor technology in indoor environment design, and proposes sufficient conditions. The algorithm uses Laplace matrix to skillfully transform the position information in local coordinate system, and gives the process of calculating the weight of the directed edge. Then, the algorithm is simulated using Matlab. The simulation starts from whether there is noise, and verifies the robustness of the distributed algorithm by introducing noise interference. Simulation results show that the algorithm can achieve high positioning accuracy, and verify that noise interference has no effect on the effectiveness of the algorithm.

Index Terms   communication technology, sensing technology, indoor environment design, indoor mapping

I. Introduction

But the environmental problems caused by social industrialization are also increasingly prominent [1]. In traditional architecture, the quality of indoor environment design is directly related, which virtually increases the importance of ensuring the quality of indoor environment. Poor indoor environment may also induce some diseases, such as skin diseases such as xerosis and pruritus, respiratory diseases such as asthma and dry cough, itchy eyes, headache, difficulty in concentration and other neurological problems [2], [3].

First of all, various environmental parameters required for intelligent control of the indoor environment design system are mainly obtained through the indoor environment monitoring system, such as indoor temperature, moderation, light intensity, to control other intelligent appliances to adjust the indoor environment; Secondly, both the indoor environment monitoring system and the indoor environment design system are the products of the continuous development of the Internet of things technology, it has important practical significance for accessing more intelligent electrical appliances and providing more comprehensive and comprehensive indoor environment design services in the future; Finally, the deployment of a complete set of indoor environment design system requires high costs. Most ordinary families can hardly afford the economic level, and they need to transform the existing housing to meet the deployment requirements of the indoor environment design system [4], [5]. The indoor environment monitoring system is relatively simple, and does not require too much economic expenditure. In addition, the use of wireless means does not require too much transformation of the house wiring [6].

In addition, in today's increasingly perfect sustainable design in the building field, the indoor environment design is developing in a positive direction due to its influence. However, the sustainable indoor environment design is not as good as the building system specifications, and there are still many problems: improper materials, improper ventilation and lighting, low indoor comfort, air safety problems, noise problems, excessive energy consumption for refrigeration and heating, etc [7], [8]. The sustainable interior environment design theory is based on the internal environment theory of green buildings, but its own characteristics are concentrated and it is an independent research direction. At present, domestic attention and research efforts are insufficient [9]. In particular, due to the large flow of people in the indoor environment, more energy is needed for the comfortable coexistence of indoor personnel, which requires more water, light and electricity resources [10]. How to make sustainable indoor environment design reasonable and evidence-based has become an important responsibility of researchers and designers. Secondly, the regionality and many conditions limit the diversity of indoor environment design practices. Designers should adjust measures to local conditions, utilize local natural resources and existing conditions to maximize the

use of sustainable elements, reduce energy consumption and pollution, and improve the economic, cultural and social value of the indoor environment [11].

If we want to discuss the use of new communication and sensing technologies in indoor environment design, we need to clarify the main features of indoor environment design, namely comprehensiveness and multifunction [12]. More and more indoor environments of commercial buildings show the characteristics of complete functions and comprehensive supporting facilities. Large commercial spaces have the functions of office, shopping, finance, catering, living, leisure, entertainment, and are equipped with complete functional facilities. The distribution of internal spaces combines these functions to create a good indoor environment for internal personnel. Even small commercial spaces are also rich and colorful [13]. Taking the catering space in the commercial space as an example, in addition to the dining area, kitchen, staff office and rest area, the comprehensive restaurant also has exhibition area, performance area, bar, to guide customers to diversify their consumption. In general, the modern indoor environment revolves around commodities, commodity demanders and commodity managers. For commodities, the indoor space has the functions of display, sale and storage; For customers and consumers who have demand for goods, the indoor environment has shopping and leisure functions, and more importantly, it can meet the spiritual and cultural needs of consumers; For commodity managers and commercial administrators, the indoor environment has the functions of office and operation. These combine to form a good atmosphere of diversified and multi-functional indoor environment [14].

To sum up, indoor environment design based on new communication and sensing technology has become an integral part of urban construction. Its forms are ever-changing, the space is full of vitality, and it has positive social benefits. It is an important place for people to carry out public activities and create a comfortable working, entertainment and leisure environment for people.

II. Related works
In the process of interior design, interior architectural drawing belongs to the field of map construction, and is proposed with map construction. The interior architectural drawing was proposed in the mid-1980s and has been developed for more than 30 years, more and more scholars at home and abroad use radio frequency and acoustic measurements for indoor mapping. In reference [15], the author discussed node location tracking and indoor mapping in the absence of infrastructure in combination with IEEE802.15.4a wireless ultra wideband (IR-UWB) link. This paper provides a multi hypothesis tracking filter for TOA measurement with errors to locate nodes and determine room size. Literature [16] proposed a rectangular room and the relative position of wireless communication equipment in the room. Both this document and document [17] use pulse radio ultra wideband link technology and single reflection mode of indoor reflective wall. Considering the secondary reflection of the reflection wall, a self positioning and indoor mapping technology suitable for pulse radio operation is introduced [18]. Literature [19] introduces the application of ultra wideband communication positioning system in building three-dimensional maps, systematically analyzes the problem structure, and proves the feasibility of the mapping system in the paper. Literature [20] uses Multipath Detection Radar (MER) to build indoor maps, which requires a lot of measurements to create scatter maps. Reference [21] uses sound delay measurement to carry out indoor construction drawings, and these documents distribute the received echo to the reflective wall through detailed search.

To sum up, as new communication and sensing technology has been a new topic in the past 20 to 30 years, and the breadth of research fields, involving the material quality and spiritual enjoyment of interior space design, involving many fields such as economy, politics, culture, and ecological environment, determines that the academic community is still lacking in in-depth research on sustainability, which is also the significance of this study.

III. Indoor Environment Design Model of Communication and Sensing Technology
The position of free nodes is unknown, that is, it needs to be determined by positioning algorithm. Generally, free nodes are randomly arranged. As shown in Figure 1, the free node is connected with the anchor node through direct connection or multi hop, so that the position information of the anchor node can be obtained directly or indirectly. At the same time, the distance, angle, topology and other data can be obtained through ranging, angle measurement and other measurement methods.

This model is based on the location algorithm of new communication and sensor technology, and its main purpose is to determine the location of nodes. The closer the estimated position is to the actual position, the algorithm used is considered successful and effective, which is also called positioning accuracy. The number of nodes should also be considered for positioning accuracy. The average value of positioning error is calculated as follows:

$$E = \frac{1}{N} \sum_{i=1}^{N} \sqrt{(x_i - x_i') + (y_i - y_i')^2} \tag{1}$$

However, in the actual environment of indoor design, there will be a lot of noise in data measurement and data transmission, so the location algorithm should have strong robustness, that is, it should be feasible in the case of noise. Some measures can even be taken to ensure the positioning accuracy of the algorithm. At the same time, when the whole network changes the
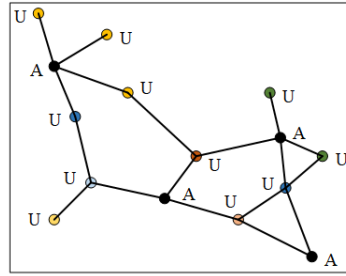
Figure 1: Anchor node and free node in WSNs

number of nodes or changes the location of nodes, the feasibility of the algorithm will not be affected. The following equation is usually used to measure the energy consumption required in the positioning process:

$$Average\,Energy\,Setup = \frac{1}{N}\sum_{i=1}^{N}\left(initial\,Energy_i - after\,Energy_i\right) \tag{2}$$

Then, a sensor network composed of 8 nodes is given, of which 4 are anchor nodes (labeled 1,2,3,4) and 4 are free nodes (randomly arranged). The whole environment consists of 7 walls, marked a to g, where the equation of the wall is:

$$W = \begin{cases} a : y - 3 = 0 \\ b : 19x - 5y - 574 = 0 \\ c : 15x + 23y - 1046 = 0 \\ d : 7x - 4y + 57 = 0 \\ e : 13x + 9y - 157 = 0 \\ f : z - 6 = 0 \\ g : 38x - 10y - 127z + 3932 = 0 \end{cases} \tag{3}$$

At present, many indoor mapping applications based on new communication systems and sensors use single node to detect indoor environmental information, which has the disadvantages of slow speed and incomplete environmental information. However, multi node indoor mapping is fast and accurate, so how to use multiple nodes to coordinate with each other for indoor mapping, how to formulate corresponding coordination schemes, and how to select corresponding communication methods. The structure diagram of the multi node coordination building environment is shown in Figure 2.
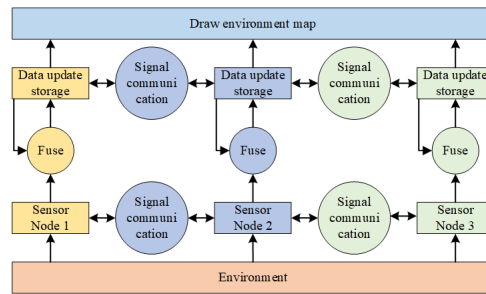

Figure 2: Interior design model based on new communication and sensing technology

In some real scenes of indoor environment design, the algorithm designed needs to rely on angle information to achieve, and angle information is generally obtained using AOA measurement method. The measurement principle of AOA is to use the node with ultrasonic receiver or antenna matrix to sense the direction of arrival of the transmitted signal, so as to calculate the relative angle between the transmitting node and the receiving node. With this measurement method, distance information and angle information can be obtained simultaneously. As shown in Figure 3, Node 1 and Node 2 are receiving nodes, equipped with ultrasonic receivers, and U is transmitting node. Node 1 and Node 2 sense the angle of transmitted signal through the receiver α and β.

The indoor environment design monitoring terminal node is located at the front end of the system and connected with sensors. Each terminal node is equivalent to a sensor node, which is distributed in the room where data collection is required to collect environmental data. Its circuit consists of ZigBee module, data acquisition module and external power supply. The function of the data acquisition module is to collect the environmental data of different indoor areas, and then package the data and send it

Figure 3: Schematic diagram of indoor sensor design measurement

to the coordinator through the ZigBee wireless network. The external power supply mainly provides the ZigBee module with appropriate voltage. The hardware structure of the terminal node is shown in Figure 4.
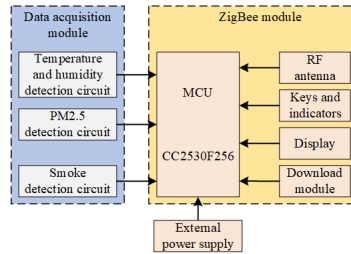

Figure 4: Hardware structure of indoor design terminal node based on new communication and sensing technology

In addition, the design of ZigBee module mainly includes the core board design and the bottom board design of the module. The main control chip of ZigBee core plate is CC2530 from TI Company, and the main peripheral circuit is composed of RF circuit, crystal oscillator circuit and power decoupling circuit. The design of ZigBee backplane module mainly includes the design of power module, key module, indicator light and download module, as shown in Figure 5.
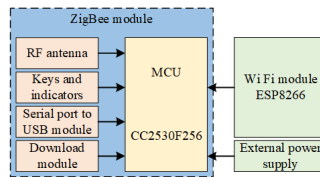

Figure 5: Pin diagram of core panel of interior design based on new communication and sensing technology

The function description of the pin is shown in Table 1.

Pin Name	Pin	Pin type	Describe
AVDD1	28	Power supply (analog)	M=1
AVDD2	27	Power supply (analog)	M=1
AVDD3	24	Power supply (analog)	M=1
AVDD4	29	Power supply (analog)	M=0
AVDD5	21	Power supply (analog)	M=0
AVDD6	31	Power supply (analog)	M=0
DCOPL	40	Power supply (digital)	Decoupling of 18V digital power supply without external circuit supply
DVDD1	39	Power supply (digital)	M=0
DVDD2	10	Power supply (digital)	M=0

Table 1: Overview of pin functions of core panel of interior design based on new communication and sensing technology

The ADC mainly consists of three configurable independent channels, one reference voltage generator and one analog multiplexer. ADC conversion results can be written into DMA direct memory access or directly read from ADC registration access. Table 2 shows the technical parameters of CC2530F256.

IV. Methods

A. Interactive experience and interface analysis of indoor environment design

Taking common shopping plazas as an example, according to the form of top interface, it can be generally divided into transparent top interface and closed top interface. In the specific design process, in addition to introducing the technical means of interactive experience in a large area, we should also comprehensively consider the influence factors such as structure, materials, light color, and pay attention to its overall effect. Transparent roof interfaces are common in private indoor atriums in shopping. While introducing natural light to reduce energy consumption, they meet consumers' experience needs of returning to nature through landscape gardening. Moreover, with the development of glass technology, in the near future, roof interfaces full

Name	Minimum value	Typical value	Maximum	Company
Supply voltage	2.0	3.1	3.8	V
Emission current	28	27.8	45	mA
Receiving current	26	28	30	mA
Working frequency	2.407	-	2.487	GHz
Transmitting power	3.6	4.1	4.3	mW
Wireless transmission rate	-	-	250	kbps
Series Rate	2400	9600	115200	kps
Working temperature	-40	-	80	°C
Size	-	2.5*2.6	-	cm

Table 2: Technical Parameters of the Pin Structure

of large size display glass will become a featured environmental art design field with highly visual impact effects of shopping space self-expression and multi-functional interaction with consumers, as Figure 6.

Figure 6: Classic Cases of Interior Environment Design

In fact, in the interior environment design, different space forms can be formed according to different sensors and various styles of enclosure, which also forms different space atmosphere. The main composition of space refers to the relationship between people, objects and the environment. In addition, space form is the basis of the entire theater space environment and the display of space image. The handling methods of various functional spaces in the theater are different. It is necessary to analyze the characteristics of different spaces, as well as the requirements of environmental atmosphere, the appropriate materials, light environment and color style, and the handling of space interfaces by facilities, equipment, construction technology, which will attach certain characteristics to the space and enhance the integrity of the space. The functional area combination mode of the model is shown in Figure 7.

B. Experimental data and simulation analysis

In this section, numerical simulation experiments will be designed based on relative position information in the 3D model of indoor environment design. There are two groups of simulations designed here. In Simulation 1, assume that the entire application environment is noise free, so as to observe whether the final convergence position of the algorithm is consistent with
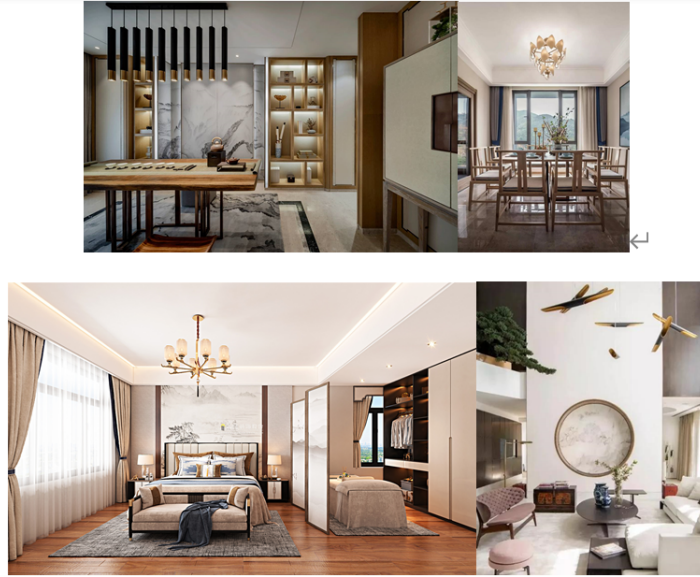
Figure 7: Sensor based indoor space combination mode

the real position. In the second simulation, measurement noise will be added to determine whether the algorithm is convergent in case of disturbance. Consider a wireless sensor network with m=4 anchor nodes and n=10 free nodes. All nodes are randomly arranged in three-dimensional space. Among them, anchor nodes are marked as 1, ..., 4, and free nodes are marked as 5, ..., 14. The measurement topology is shown in Figure 11. A directed edge in the figure represents unidirectional measurement and bidirectional communication between corresponding nodes. At the same time, because the nodes are randomly arranged, the nodes in wireless sensor networks meet the assumptions. Figure 8 is the sensor network meets the two locatable conditions mentioned in the theorem. The next two groups of simulations in this section are based on this wireless network.
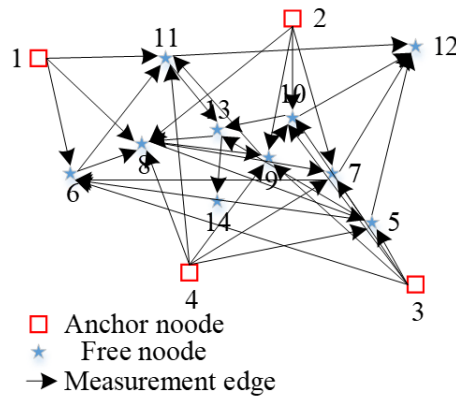

Figure 8: Indoor environment design simulation data source based on communication system and sensor

V. Experiment

In the absence of noise interference, the function curve of error rate eer (t) of indoor environment design coordinate position estimation with iteration steps t is shown in Figure 9, the error rate of position estimation has approached zero. In the subsequent iteration process, the estimated position will remain unchanged and equal to the real position. The corresponding position information of each iteration step is shown in Table 3. From this figure, it can also be seen that the estimated positions of all free nodes are finally equal to the real positions.

According to the working principle of DHT11, VCC chooses to connect 3.3V voltage. DATA is used to connect the pins of CC250F256 chip. The operation results of indoor environment design model circuit experiment are shown in Table 4, Table 5 and Table 6. After the communication process starts, the host will send a start signal to DHT11 through the DATA line. After
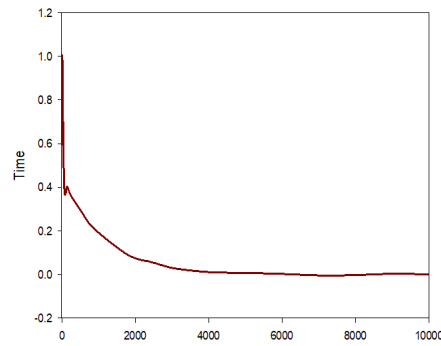
Figure 9: Estimation error rate of indoor environment design model

Parameter	Condition	Min	Type	Max	Company
Resolution (hum)	25°C	-	2	4	%RH
Resolution (hum)	0-50°C	-	6	-	Bit
Repeatability (hum)	0°C	-	±2	-	%RH
Accuracy (hum)	-	-	±4	-	%RH
Accuracy (hum)	-	-	-	±5	%RH
Range (hum)	-	10	-	60	%RH
Range (hum)	25°C	10	-	70	%RH
Range (hum)	50°C	10	-	60	%RH
Range range (tem)	-	0	-	50	°C
Response time (tem)	1/e (63%)	6	-	30	S
Range range (tem)	-	0	-	50	°C
Response time (tem)	1/e (63%)	6	-	30	S

Table 3: Simulated operation parameters of indoor environment design system

receiving the signal, DHT11 will return a response signal. After receiving the response signal, the host will start to receive 40bit temperature and humidity data.

Indoor air perception	10	1	0.1	0.01
Air quality status	Sick building	Health building	Urban outdoor air	Outdoor air in mountain area

Table 4: Simulation results of indoor environment design model (air perception)

Air supply temperature of air conditioner (°C)	26	28	30
Air conditioning energy consumption (kW · h)	1.47	1.21	1.68

Table 5: Simulation results of indoor environment design model (air conditioning energy consumption)

Even the indoor environment design with communication technology and sensors as the main physical source, its shading, indoor wind speed and air conditioning supply temperature improving the indoor thermal environment and energy conservation. The sun shading prevents most of the direct sunlight from entering the room, and the indoor temperature drops significantly, reducing the load of the air conditioner. At the same time, with appropriate indoor wind speed, it not only further, but also improves the comfortable temperature required by people, increases the temperature setting value of the air conditioner. Not only that, the energy consumption of air conditioners is different when the air supply temperature of different air conditioners reaches the required indoor comfortable temperature of 29 °C. Although 26 °C, 28 °C and 30 °C all meet the comfort requirements, 28 °C is the most energy-saving when the air supply temperature is 28 °C. A comfortable indoor thermal environment does have a significant impact on people's health, comfort and work efficiency. But today, with the increasing shortage of global energy, we should be less blind and more aware of energy conservation in the pursuit of comfort.

In addition, this collaborative positioning and interior mapping problem can be transformed into a simple three-dimensional positioning problem through virtual node transformation. The converted sensor network includes 15 nodes, of which 7 are virtual nodes. The measurement topology is shown in Figure 9. Figure 10 only shows the measurement relationship between nodes and does not represent the true coordinates of nodes. The solid arrows in the figure represent LOS measurement between nodes, and the dotted arrows represent SBR measurement between nodes.

Date	August 1, 2015	August 2, 2015
Comfort (%)	86	95
Energy consumption (kW · h)	19.4	14.4

Table 6: Simulation results of indoor environment design model (comfort survey)
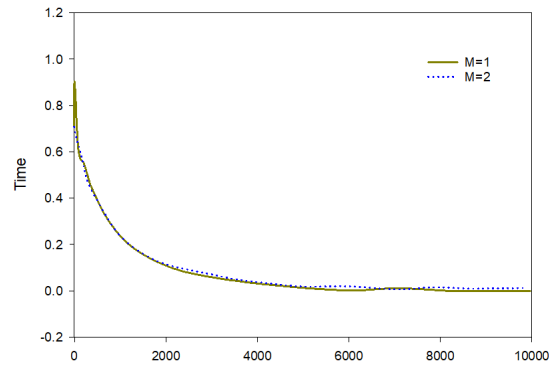

Figure 10: Simulation convergence diagram of algorithm final optimization

VI. Design Effect

Figure 11 case for the new Chinese style, the living room space as a whole without partition design, the maximum degree of preservation of the permeability of the region; the main and secondary bedrooms in the same style, simple and elegant, simple and charming interior decorations; dining, guest kitchen integrated design, to meet the owners of the living life of the flexible space needs; functionality to meet the current living habits, in the design of the Chinese elements decorated with the design of the classical and fashionable perfect conjunction; The overall style pursues a home experience rich in classical flavor, so that the traditional elements in modern home decoration design is appropriately reflected.

Figure 11: New Chinese style

VII. Conclusion

The paper hopes that the introduction of foreign research results and the practical application of design can help designers to better carry out sustainable indoor environment design, the new design can follow the principles of sustainable design and the six design methods proposed by the author, and the old indoor environment will also be transformed into a sustainable commercial space. On the basis of meeting the functional and aesthetic requirements. This paper mainly studies the location and indoor mapping algorithm of distributed wireless sensor networks based on relative location information. Based on the existing literature. At the same time, in terms of convergence, the distributed location algorithm can quickly converge to the true value, and the location success rate is high. In terms of robustness, even if there is noise in the environment, the algorithm will eventually converge. In terms of computation, the algorithm does not involve complex computation, which provides a great possibility for hardware implementation.

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