TELKOMNIKA, Vol.11, No.11, November 2013, pp. 6907~6915
e-ISSN: 2087-278X

Application of Radio Frequency Identification in Construction Intelligent Home Furnishing Network

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Abstract

Intelligent home furnishing network is to build a communication network in a home furnishing, various appliances connected to each other, to realize the remote use and control of intelligent home furnishing all devices on a network and any required information exchange. First of all to establish a communication network in a home furnishing, provide the necessary pathway for family information, in the control of home network operating system, the corresponding hardware and actuator, control and monitoring of home appliances and equipment all family network. The paper puts forward the novel application of radio frequency identification technology in construction intelligent home furnishing network. In view of the advantages of RFID devices in the software and hardware cost, RFID positioning solution has a wide practical potential.

Keywords: *intelligent home furnishing network, radio frequency identification (RFID), intelligent home*

1. Introduction

With the development of science and technology, LAN is also gradually to the wireless network, the development direction, in the network of a rapid development process, the wider use of a variety of wireless technologies, WIFI is one of them. At present, the intelligent home furnishing industry also is like a raging fire is, predictably, the future development of intelligent home furnishing, will no longer control in household appliances, lighting, remote control, embedded intelligent terminal, the wireless WIFI technology, and the wide application of Internet will let home furnishing control becomes more automated, intelligent and humanization, will change the traditional intelligence home furnishing model, intelligent home furnishing push the last rapid development stage.

WiFi is composed of AP (AccessPoint) wireless network and wireless network card, AP, commonly known as the network bridge or access point, is a bridge between the wired local area network and traditional wireless local area networks, so any one equipped with a wireless network card PC can through the AP to share the wired local area network and wide area network resources, its working principle is equivalent to a built-in wireless transmitter HUB or routing, and the wireless network card is responsible for receiving CLIENT terminal equipment signal emitted by AP [1]. Compared to the traditional intelligent home furnishing system using cable network, the application of WIFI technology reduces wiring trouble, has better scalability, mobility. Therefore the use of wireless intelligent control model is the inevitable choice of intelligent home furnishing development.

Radio frequency identification (RFID) is a non-contact automatic identification technology, its basic principle is to use the radio signal and space coupling (magnetic or electromagnetic coupling) or radar reflection transmission characteristics of object recognition, automatic identification. The RFID system at least comprises electronic tag and reader. RFID readers (Reader) wireless communication through the antenna and RFID tag, can achieve a write operation on the tag identification codes and memory read data or. The typical reader contains a high frequency module (transmitter and receiver), the control unit and the reader antenna.

Radio frequency identification tag data is usually a few bytes to several thousand bytes. But, with one exception, this is the 1 bit tag. It has 1 bit of data is enough, so that the reader can make the following two states: “judgment RFID tags" or "in the electromagnetic field without RF

Received May 20, 2013; Revised July 27, 2013; Accepted August 8, 2013

tag in the electromagnetic field". This requirement is enough for realization of sending signal monitoring or simple function. Because the RF tag 1 bits without the need for electronic chip, so the RFID tags can be made very low cost. For this reason, a 1 bit tag in department stores and shops for commodity anti-theft system. As with no payment of the goods leave the department store when installed, writing device can identify in the export of reading "tag" in the electromagnetic field in the situation, and cause the corresponding reaction. For according to the provisions of payment of the goods, 1 bit tag is removed or deactivated in payment.

Intelligent home furnishing network refers to the establishment of a communication network in a home furnishing, various appliances connected to each other, to realize the remote use and control of intelligent home furnishing all devices on a network and any required information exchange, such as music, doors and windows, power supply, TV or data etc. Architecture of intelligent home furnishing network including data communication between home network system, it is intelligent home furnishing controller and intelligent home furnishing network and external network. Among them, the intelligent home furnishing controller is an important part of the intelligent home network, and plays the role of the core management, control and communication with external network. It is through the family management platform and home furnishing life of various subsystems of the organic combination of a system, but also connect family intelligent internal and external network physical interface, completed between family internal with external communication network data exchange function, is also responsible for the management and control of the set by family. The paper puts forward the novel application of radio frequency identification technology in construction intelligent home furnishing network.

2. The Research on Intelligent Home Furnishing Network Theory

To complete the processing of all the family internal data, including a data acquisition and control commands, is the core of intelligent home furnishing control, using Linux embedded system for monitoring system home furnishing center, can automatically run, data processing, through the serial port management, wireless network to control the control terminal, communication and the central controller through GPRS module the realization of family system with mobile phone, users can achieve remote control, home system through text messages at the same time, the controller also adopts 10.3 inch touch screen provides a command input for the user, using Linux Qt to write the man-machine interface, complete the transmission within the family data through ZigBee wireless communication protocol, is convenient for the user to realize local control [2]. Control of each household equipment control system, a number of small control terminal consists of MCU, and through the control bus will these small control system network, connected to the intelligent home furnishing controller, intelligent home furnishing is controlled by the controller.

Linux system integrates a number of network applications, network technology support for standard internet protocol and all almost all, so the design of the application in intelligent home furnishing controller, has small code size, operation consumption less system resources, high reliability advantages, development cycle is short and so on, to meet the requirements of smart home controller for data acquisition the operating system.

Qt as a GUI system based on C++ platform can provide powerful user to construct graphical user interface. This paper use Qt software to design the graphical user interface and strong transplantation, the GUI utility, simplicity, the realization of human-computer interaction, through the keyboard or input panel on the procedures, save, modify and compile, information and temporary information timely output, display, through the GUI to achieve the purpose of the integrated system, as is shown by Equation (1).

$$F(x,y)=\frac{\sum_i w(d(x,y))I_i(x,y)}{\sum_i w(d(x,y))} \quad (1)$$

The main wiring design of the first way is: according to the different application systems respectively with copper wiring frame, coaxial cable and optical fiber distribution frame. The copper wiring rack can be used to connect the vertical lines of weak signal, and through the

lines to control all wiring frame of the weak signal routing, so as to realize the voice signal and other weak current signal centralized management objective. For the computer system can use copper wiring frame or a fiber distribution frame will be the backbone cable together into the main distribution room.

Intelligent control linkage lighting system and security system, when alarm occurs, the independent start alarm mode, the lighting system in all open, let the invaders not know what course to take, at the same time, alarm security device will automatically call. In addition to the family's gate installed fingerprint lock, the user or family unauthorized premise, outsiders will not be able to freely. But if the user is away from home, the guests suddenly visit, then the user can remotely control electronic door by phone, without the need to let the guests in the waiting in front of long time.

Intelligent lighting control system runs through every place in the family, room, aisle lights can be connected through the intelligent switch and the huge Chinese intelligent controller. You can either in the room within a room to control the entire light switch, exempt from trouble back and forth. Can also set the scene memory mode to control the light switch, brightness, arbitrarily control room, dining room, study, aisle lights illuminate the mode [3]. For example: eat, watch TV, read a Book light at different switching. Highlights of intelligent lighting system in the huge China dimming function, a timing function, function and other advantages of the scene, the lights will Ambilight, colorful inside the house, as is shown by Equation (2).

$$\sum_{i=1}^{N} z(kN+i)\phi_{M,i}(t) = \sum_{j=L}^{M-1}\sum_{m=1}^{2^j} d_{s,m}^{j}\psi_{j,m}(t) + \sum_{m=1}^{2^L} c_{s,m}^{L}\phi_{L,m}(t) + \sum_{i=1}^{N} v(kN+i)\phi_{M,i}(t) \quad (2)$$

The control system through intelligent lighting, users can sit on the couch or laying in bed with the lights the entire remote control home, without having to shut the lamp to and fro. Intelligent remote controller is more suitable for lighting and appliances more users, it can control the lighting, socket, curtains, 99 Road, 12 sets of air-conditioning, TV, DVD each one. Enhanced remote controller can control 12 road lighting, curtains, air conditioning, TV, 2 Road, DVD each one, suitable for lighting and electrical fewer users. In addition, computer controller, intelligent weak current switch panel, telephone and mobile phone and other various control modes can be selected according to need.

Intelligent home furnishing network is defined as the use of computer, network and integrated wiring technology, through the family information management platform will be associated with the home furnishing life of various subsystems are combined into a system. Specifically, is the first to establish a communication network in a home furnishing, provide the necessary pathway for family information, in the control of home network operating system, the corresponding hardware and execution mechanism, the realization of home appliances and equipment all on the home network control and monitoring? Secondly, they must be through the network platform, and communication channel outside, outside the world communicate information to achieve and family, meet the remote control, monitoring and the demand for the exchange of information. To satisfy the people to safety, comfort, convenience and green environmental protection requirements [4].

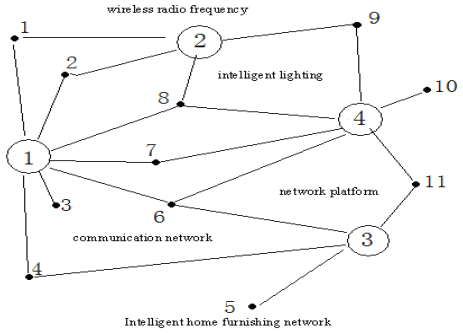

Figure 1. Intelligent Home Furnishing Network Diagram

Some wireless radio frequency technology is widely used in vehicle monitoring, remote control, telemetry, wireless network, industrial data acquisition system, the wireless tag, identification, non-contact RF and other places, manufacturers have introduced into the intelligent home furnishing system, but because of its anti-interference ability is weak, networking inconvenience, reliability, just passable application in intelligent in home furnishing, patchy, eventually abandoned by mainstream manufacturers. Zigbee: Zigbee is based on IEEE 802.15. But the IEEE only with low-level MAC layer and physical layer protocol, so the Zigbee alliance has extended the IEEE, the network layer protocol and API standard.

$$ax(t)+by(t)=\sum_{j=1}^{n}ac_j(t)+ar_n(t)+\sum_{j=1}^{n}bc^{y}{}_j(t)+by_n(t)$$
$$=\sum_{j=1}^{n}(ac_j(t)+bc^{y}{}_j(t))+(ar_n(t)+by_n(t)) \quad (3)$$

Application of ZigBee initially expected to include consumer electronics, energy management, health care, home automation, building automation and industrial automation. With the development of Internet of things, ZigBee has gained new application opportunities [5]. The edge of the network application of the Internet of things is the most sensor or control unit, which is the most basic form of Internet of things the most extensive unit cells, while ZigBee can coordinate with each other between the thousands of tiny sensor drive unit to achieve communication, and these cells need only little energy, a way to relay through radio waves the data from a network node to another node, so its communication efficiency is very high.

The technology of low power consumption, anti-interference, high reliability, easy configuration, easy expansion, easy to use, easy maintenance, convenient and quick deployment of large-scale characteristics conform to the Internet of things development and trend. At present, the application of Internet of things and ZigBee technology in intelligent home furnishing, industrial monitoring and health care and other aspects of the integration of large.

Wireless intelligent dimming switch: this switch can directly replace the wall switch panel in the home, through which not only can be used as normal switch, the more important is that it has and keepers networking home equipment automatically to form a wireless sensor network, through the wireless gateway to issue a switch, dimming instructions. Its significance lies in the fact that there is no need to worry about the home all the lights are forget to turn off the home owner, as long as the owner of the home, all forgot to turn off the lights will automatically shut down. Or when you sleep you need not by room to check the lamp is open, you need to do just by downloading in the bed of the sleep button, all the lights will automatically shut down, and you get up in the night, the lights will automatically adjust to soft, so as to ensure the quality of sleep.

$$F(\phi,\theta;\phi_0,\theta_0)=\sum_{n=0}^{N-1}A_n e^{j\kappa R[\cos(\phi_0-\phi_n)\sin\theta_0-\cos(\phi-\phi_n)\sin\theta]} \quad (4)$$

Wireless infrared anti intrusion detector: This product is mainly used for preventing illegal intrusion, such as when you press the bedside wireless sleep button, close is not only light, it will also start the wireless infrared anti intrusion detector automatically fortification, at once the invasion will send out alarm signal and can set the automatic opening intrusion area lights off the invaders [6]. Or when you left it automatically fortification, once someone broke in, through the wireless gateway automatically to remind you of your mobile phone and accept your mobile phone alarm processing instructions issued.

Intelligent home furnishing or intelligent residential, is moving with wireless remote control, multimedia control, high-speed data transmission and other functions of the direction of development, the key technology for the family controller compatibility and meet the needs of home network information transmission. At present, the transmission network with integrated wiring technology, limiting the application system, and the cost is high. Construction of intelligent home furnishing security monitoring system is flexible and convenient using wireless technology becomes a focus of current research, as is shown by Equation (5).

$$\hat{v}_{X,j}^{2} \equiv \frac{1}{M_j} \sum_{k=L_j-1}^{N-1} w_j^2(k) = \frac{1}{M_j} \sum_{k=L_j-1}^{N-1} \overline{w}_j^2(k) \tag{5}$$

This study proposes and designs an intelligent home furnishing security monitoring system based on RFID, respectively, from the introduction of system function, hardware design, software design, experimental data analysis of the application of RFID technology in the system. The application of RFID technology in intelligent home furnishing, realize the wireless network communication rapid rate, low cost, low power consumption. The traditional sensor alarm system and video surveillance system combination formed the intelligent security system model. The user can receive MMS information through the mobile phone or PC machine, according to the needs of remote mobile phone set, so as to realize the family safety monitoring flexible, convenient.

With the technology of radio frequency identification is not perfect and promotion, and by virtue of its light weight, low power consumption and strong ability to identify the unique advantages, being used in various occasions, such as identity, engineering control and tracking etc. The focus of this paper is combining the study of Wi-Fi wireless transmission technology and RFID recognition technology, to achieve the solution of Wi-Fi positioning using RFID tags. According to preliminary retrieval, the work of RFID positioning technology research based on Wi-Fi is rare.

3. The Working Principle of RFID Model

The basic model of RFID is system. Among them, the electronic label also known as radio frequency label, transponder, data carrier; the reader is also known as the readout device, scanner, communicator, reader (depends on whether the electronic tags can be wireless overwrite data). By coupling the RF signal components of the space between tag and reader (no contact) coupling, in the coupling channel, according to temporal relations, the exchange of, data to realize the energy.

There are two types of coupling RF signal between the reader and the tag. (1) Inductively coupled. The transformer model, achieved by coupling high frequency alternating magnetic field, is based on the law of electromagnetic induction, as shown on the right [7]. (2) The electromagnetic backscattering coupling: the principle of radar model, electromagnetic wave emitted, touches the target reflection, also carrying back the information of the target, is based on the spatial propagation of electromagnetic waves.

The programmable radio frequency label, must by the data carrier “internal logic " to control the tag memory write/read operation and write/read authorization request. In the simplest case, is obtained by a state machine to complete. The label according to different types of businesses can store from 512 bytes to 4000000000000 different data. Stored data in the label is the application of the system and the corresponding standard [8]. For example, the label can provide product manufacturing, transportation, storage, it can distinguish between machines, animal and individual identity.

The use of state machine, can complete the process is very complex. However, the state machine's weaknesses are: lack of flexibility to modify the programming function, which means to design the new chip, because of these changes need to modify the circuit of silicon chip, the design change to achieve great expense to. The use of microcontroller significantly improves the situation. In chips, will be used for operating system management application data, through the mask were integrated into the microprocessor, this modification would not cost much. In addition, the software can be adjusted to fit a variety of specialized applications, as is shown by Equation (6).

$$F = \int_A E(k) \circ h(k) = \sup_{\sigma \in [0,1]} \min\left[\sigma, h(A \cap E_\sigma)\right] = \max_{\sigma \in [0,1]} [\min(\sigma, h(A \cap E_\sigma))] \tag{6}$$

The working frequency of high frequency RFID tag is generally 3MHz~30MHz. Typical operating frequency: 13.56MHz. Radio frequency label the spectrum, from radio frequency identification application point of view, because of its working principle and the low frequency tags are exactly the same, namely using inductively coupled mode, so it should be classified as

low-frequency label class [9]. On the other hand, according to the general classification of the radio frequency, the frequency is also known as the high frequency, as shown in Table 2.2, so it is often called the high-frequency tags. In view of RFID tag the band may be an RFID tag most practical application, so we as long as the high, low understanding is a relative concept, which is not in this cause confusion.

Future in the RFID tag, reader and the middle parts of mature process, each manufacturer to put forward the innovative application solutions in different fields, such as Manhattan Associates proposed "RFID in a Box", the enterprise does not need again for the front-end RFID and back-end application system hardware connection and trouble, the company and Alien Technology Corp cooperation in RFID hardware development platform, Microsoft.Net middleware based on the company, 900 of the existing supply chain customer group development of Supply Chain Execution (SCE) Solution Manhattan Associates SCE Solution, originally used the enterprise only through the "RFID in a Box", can be in the original application system using RFID to enhance rapid supply chain management transparency is given by Equation (7).

$$\frac{R^{nk}u^{(0)}}{\lambda_1^{nk}} = \sum_{i=1}^{N} \alpha_i \frac{\lambda_i^{nk}}{\lambda_1^{nk}} + \sum_{i=N+1}^{M} \alpha_i \frac{\lambda_i^{nk}}{\lambda_1^{nk}} e_i \tag{7}$$

RFID intermediate between RFID tags and application play the intermediary role, from the application end use intermediate member provides a set of general application program interface (API), which can be connected to a RFID reader, read RFID tag data [10]. In this way, even if the storage RFID tag information database software or back-end application increased or changed by the other software to replace, or read and write RFID reader types increase occurs, the application end without modification can also handle, save the many-to-many connection maintenance complexity problem.

Independent of Architecture (Insulation Infrastructure) RFID middleware independent and between RFID reader and the back-end application, and can with multiple RFID reader and a plurality of back-end application connection, in order to reduce the complexity of structure and maintenance. Data flow (Data Flow) the main purpose of RFID is to the entity object into a virtual object information environment, so the data processing is the most important function of RFID [11]. RFID intermediate with data collection, filtering, integration and transmission characteristics, so that the correct object information to the enterprise the back-end application system.

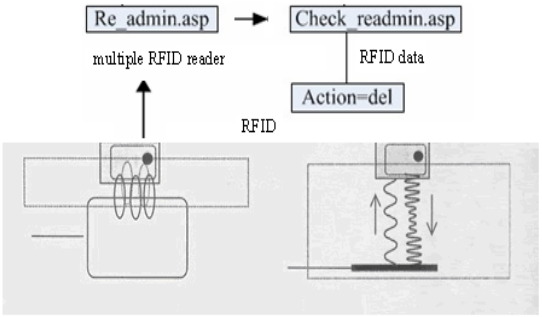

Figure 2. RFID Intermediate between RFID Tags and Application Diagram

RFID data is very vulnerable to attacks, mainly RFID chip, and chip in to read or write data are very likely to be used by hackers [12]. In the United States of America Las Vegas at the Black Conference on Hat 2004, Lukas Grunwald unveiled a tool called RFDump, it can use the RFID system vulnerabilities to attack. Any one person, just plug the last reader in his notebook computer, you can use the RFDump software to obtain the passive RFID chip within 3 feet of the data.

Gain of RFID antenna and the tag chip is the use of active will affect the system using a distance. Think positively, in accordance with the relevant standards of UK in the radiation

intensity of electromagnetic field, the passive situation of 2.45GHz, full wave rectifier, the driving voltage is not more than 3 volts, RFID antenna impedance environment optimization (impedance of 200 or 300 ohms), the use of distance is about 1 meters [13]. Use if you use the WHO limit is more suitable for the worldwide, but their range declined by half. The electromagnetic power of these limits the reader to tag. Effect of distance decreases is with frequency increasing. If you use the active chip distance can reach 5 to 10 meters.

Tag and reader exchange data, due to the adoption of the non-contact mode communication, there is a space of wireless channel. Therefore, tag and reader data exchange between the constitutions is a wireless data communication system. In a data communication system model of this, RFID tag is a data communication of one party, the reader is the communication of the other party. Data communication aims to achieve safe, reliable, effective, both sides must abide by the protocol of data communication mutually agreed upon [14]. There is no basis for such a communication both sides recognized, both data communication will hear each other do not know what the other said, the pace is not coordinated, resulting in data communication cannot be it.

4. Application of radio Frequency Identification Technology in Construction Intelligent Home Furnishing Network

This paper mainly discusses the solution of RFID system based on Wi-Fi program, mainly on the positioning scheme based on signal strength and distance and direction angle based localization scheme, the relevant test results show that: the positioning error of the two algorithms can achieve accuracy of 1 meters, can meet the precision requirements of indoor positioning, and given the advantages of RFID devices in the software and hardware cost, RFID positioning solution has a wide practical potential [15].

Intelligent home furnishing controller to provide communication interface for the family internal wiring, collect family equipment information, and processing, automatic control and regulation; on the other hand, intelligent home furnishing controller as the home gateway, also provides the network interface for external, connected home internal network and external network, so that users can access the home network through the GPRS network so, monitoring and control [16].

The intelligent home furnishing system for data transmission and monitoring using wireless network, wireless network technology as the communication platform, the family door security system, system, lighting system and household energy metering system, these discrete subsystem integration become integrated intelligent home furnishing network system in a real sense. Can use the intelligent mobile phone or terminal to realize local centralized control, also can realize remote monitoring by using remote access Internet network intelligent mobile phone or computer. Intelligent home furnishing network system is composed of distributed intelligent terminal layer and the upper control layer.

Modular design is adopted in this system. The embedded system board as the core, through the CMOS camera monitoring of key parts, transmission security information and images by mobile phone MMS, and remote control of household appliances, household appliances, wireless networking system board and smoke, temperature, gas sensor using the RFID module, as is shown by Equation (8).

$$X = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} A \\ A\Phi \end{bmatrix} S + N = \overline{A} S + N \tag{8}$$

Intelligent terminal layer with AT89C51 as the core processor, signal acquisition using multiple I/O port for sensor array, including infrared human body detection signal, fire detection signal, toxic gas detection signal, doors and windows open closed signal detection signal; the use of infrared emission chip IR6721C for household electrical appliance control signal transmission, can complete family internal control and GPRS remote control; the use of communication serial port 1 connected wireless data transmission chip XL02-232AP1, the XL02-232AP1 UART interface is half duplex wireless transmission module [17]. This paper used strengthen ZigBee wireless technology, wireless data communication equipment with application of industrial standard, can realize the transparent data transmission between

devices; network communication by RFID; wireless powerful; have the relay route and terminal equipment.

The design of the whole system and make full use of the function of the hardware and the processing speed of ARM11S3C6410, successful transplantation of Linux embedded system based on S3C6410 as hardware core, and complete the development of Linux control program based on Qt, to solve a number of technical difficulties, including the construction based on the wireless network, the RFID communication protocol based on AT89C51 unified appliance control protocol based on the S3C6410 GPRS, remote communication, home appliance control direct decoding and encoding.

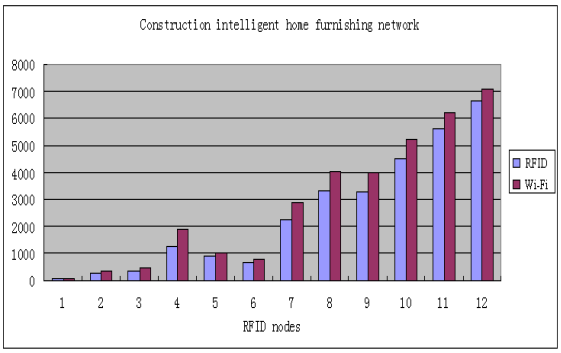

Figure 3. Compare Construction Intelligent Home Furnishing Network by RFID with Wi-Fi Diagram

Intelligent control system for intelligent operation platform can be used for linkage appliances, lighting equipment, environmental control equipment and safety equipment for a variety of ways to control. In the intelligent control operating platform, it only needs a simple setup, can realize remote control, scene control, remote control, home furnishing security control function. And specifically for the user design the control system of intelligent home furnishing the following three: intelligent control system for household appliances, intelligent lighting control system and the security alarm system, to create a safe and comfortable space to live and work for the user to go. The paper puts forward the novel application of radio frequency identification technology in construction intelligent home furnishing network.

5. Conclusion

Lighting design of the intelligent lighting control system can also with other intelligent home furnishing system linkage, will be more human function show in front of you, when your home open a party, as long as you press the ball mode button, your sound will be open, play your favorite song, the lights will change dark, flickering, air conditioning will automatically set to a suitable temperature, to create a warm, comfortable environment for entertainment. This system has realized the remote control of household appliances, intelligent home furnishing remote monitoring. Focusing on the performance test system hardware, software design and system, realized the wireless networking a plurality of monitoring device. The experimental results show that the intelligent home furnishing, remote monitoring system designed to achieve safe, convenient, and has high availability and reliability.

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