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Smart Home System with Bluetooth and Wi-Fi as Communication Mode

Wenyi Liu

Beijing No.4 High School International Campus, Beijing, China.

Abstract

Smart home systems are meant to establish a better living situation for humans, they are usually associated with intelligent technology. This paper proposed a smart home system that employs WIFI and Bluetooth in the communication system. And we compared the characteristics of each technique in order to review the pros and cons. By analyzing the differences between WIFI and Bluetooth, we could demonstrate how smart furniture within our smart home system communicates with the control center. In addition, we introduce how we achieve lighting and temperature control in a smart home. To make the sensors work smartly and adjust automatically, we employ a tracking system that can help localize people in the smart room accurately via mobile devices, and this paper also discuss our evaluation on different indoor localization methods. For this purpose, a blueprint for a smart home system is displayed and functions of essential components are illustrated.

Keywords

Smart home System; Bluetooth; Wi-fi.

1. Introduction

To live more conveniently is a realistic problem, and smart homes are expected to take care of residents in an intelligent and automatic way. This helps them to control or adjust furniture and light systems without physically touching the switches. Currently, a predominant technology adopted in the human-computer interaction control process is the voice recognition system, in which humans can operate conditions of the smart home by giving out oral orders. In this case, the elderly and disabled people can easily operate the lighting or temperature system without moving around. However, for people who cannot talk or pronounce clearly, it is difficult for them to use this function. Therefore, in this paper, we propose a tracking system that would automatically localize residents and adjust conditions correspondingly. We also simulate a single living room in a smart home and discuss how the sensors in this room work and cooperate with each other. By exploring and comparing Bluetooth and WIFI methods, we try to find a solution that will fit our system. For Bluetooth, we mainly focus on the communication of related facilities (control center, sensor, and smart furniture) within the living room. From the current development point of view, Bluetooth technology has certain advantages in realizing the communication of home facilities, because the smart home system that realizes communication by Bluetooth technology has the characteristics of low cost and comprehensive functions. Bluetooth is a wireless technology standard that is used for receive and transfer data between devices over short distances using radio waves in 2.402 GHz to 2.48 GHz bands, and it can build piconets. 【Wikipedia, edited on 31 July 2021, at 14:38】 The current status of Bluetooth technology has rapid development and wide application since Bluetooth technology was proposed in 1998. As a new short-range wireless communication technology standard, Bluetooth has been widely concerned by more and more industrial manufacturers and research institutions all over the world. Rarely in the past has an open, globally uniform technical specification received such

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widespread attention and support from the industry. In recent years, some authoritative standardization organizations in the world are paying attention to the formulation and development of Bluetooth technology standards. Next, the second wireless communication system that we proposed in our smart home is WIFI, It can be set up by adding sensors to any furniture located within the smart home, the sensors can sense pieces of information, changes, etc., and transmit the data to control center. In the smart home system, there are different types of sensors such as temperature sensor, light sensor, moisture sensor, and smoke sensor, once they are connected with control center through WIFI, they could gain the ability to communicate with the router, and then the router will send signals to control center for further instructions. WIFI is a wireless communication method that allows multiple devices to connect with the internet simultaneously, and it is also a radio signal that is capable of supporting internet access within hundreds of meters. However, the defect of WIFI is obvious, its high power consumption and strong networking professionalism should be the main focus for us so that we can create a reliable, suitable, and comfortable smart home system.

2. Motivation

Although smart home system can facilitate human life to a great extent, in fact, smart home system is not popularized in people's life. At present, the current smart home system mainly has two problems: first, the cost of smart home system is not affordable for most of people. When users are using the smart home system, the cost includes not only the price cost of the device itself, but also the user's purchase expenses, the consumption of their own time and energy, and the risk of the device itself. This leads consumers to feel that they are serving smart furniture. Therefore, the number of people who buy and use smart home system will be greatly reduced. Second, the smart home system's authority has not been established in the eyes of humans which means many people in the world think that the smart home system is not safe, because there are still many bugs in the smart home system, and there is a great chance that unexpected things will happen.(For example, users' information may be leaked.) In order to solve the above problems related to the smart home system itself, this paper puts forward the concepts of using Bluetooth and piconet in the communication process of smart furniture. The introduction of the concepts of Bluetooth and piconet will largely solve the shortcomings of the smart home system proposed above, but Bluetooth itself also has shortcomings.

3. Review of state-of-the art

3.1 Bluetooth

In the previous smart home system communication, [1] used the Android based user interface to control household appliances, and thus achieved the purpose of human-computer interaction. This communication mode can be connected from the designed application to the intelligent life system through Bluetooth or Internet connection. In addition, the smart home system of [1] also includes a family safety and alarm system. Low cost, user authentication, voice activation, security, monitoring and automatic control make the system unique. In [2], this paper introduces a telemedicine sensor network based on human piconet. This is similar to the smart home system designed by this paper [2], The system includes multiple intelligent sensor nodes, which are organized in the Bluetooth piconet controlled by the master device. The data observed by the nodes are stored in the master device and then transmitted to the network hospital regularly. This communication mode can also be realized in smart home after improvement.

3.2 WIFI

[3] Cultice et al. proposed an auto encoder based approach to anomaly detection in smart grid systems. Sometimes, data collecting sensors within smart home systems might be temporarily disabled or been damaged, such as malicious attacks and physical malfunctions. So If we can apply machine learning to smart home, the sensors could automatically detect any anomalies that might jeopardize the data collected by sensor and sensor-based system functionality. With the application of the method proposed by Cultice's team, early detection of data corruption can prevent many problems that risk

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the security and safety of the smart home system. Another smart home system that is designed base on Zigbee and WIFI is presented in [4], this smart home system is comprised by a terminal node, a gateway node and a remote control terminal. The Zigbee technology is used throughout the terminal node and the gateway node to form an internal network within our home, and the remote control terminal uses WIFI to access and control the network. This design solves the problems of high cost, complicated system by transmitting information through Zigbee wireless communication module and builds a star connection structure. Meanwhile, the WIFI ensures the stability of the system.

3.3 Control System

L. Deng-feng Aiming at the disadvantage of poor lighting effect in field control, an intelligent lighting control system based on CIE color gamut standard and dual-CPU embedded system architecture is designed. An intelligent lighting control system with graphical user interface and touch control technology is designed and implemented by using multi-color LED dimming, color control of assembly lights and scene setting. The system is easy to operate, flexible and reliable control, widely used in hotels, clubs, office buildings, urban landscape and other entertainment places. Tracking System.

J. Zhuang, X. Chen and Y. Chen control Indoor thermal condition system requires dynamic modeling of indoor air temperature in buildings. Indoor air temperature is affected by four factors: outdoor weather conditions, occupants; Plug load of air conditioning area; And the heat and cold energy consumed by the air-conditioning system.

4. Proposed system and algorithms

4.1 Bluetooth

Smart home collaboration is mainly based on a control center to receive information from related sensors (for example, when the sensor senses changes in external environmental factors, such as changes in temperature, humidity, and changes in light), then the control center will send the collected information to other smart furniture for processing. Among them, the cooperation of smart furniture, sensor and control center can be realized through Bluetooth. Among the wireless communication methods of smart homes, Bluetooth has the characteristics of low power consumption, low cost, safety, no damage to human health, and stability.

Bluetooth technology essentially works by connecting two devices together using short- range wireless communication technology, which means that the use of Bluetooth technology is very suitable for the cooperation of different devices in our "living room" space. With the help of Bluetooth technology, after the control center receives the information sensed by the sensors, the control center will transmit the data to different smart furniture. All this process will be completed without cables and wires.

In our design, the use of Bluetooth technology will be managed through "star topology", which contains one control center and several sensors and smart furniture. Before using Bluetooth, all devices must be paired. This will let the device trust each other and being able to transfer and receive data in a safe way. The responsibility of the control center is to provide synchronization to all the sensors and the smart furniture. This is known as a piconet. A piconet is a network of devices connected using Bluetooth technology. The piconet will start with two connected devices, such as a control center and the sensor, and may grow to eight connected devices.

When establishing a piconet, the control center will act as a master and the other sensors and smart furniture known as slaves for the duration of the piconet connection. Each piconet has a different channel. However, in Piconet, not every device has the ability and function to process information independently.

All sensors and smart furniture will hop radio frequencies in unison to make sure all the devices can be connect with each other and reduce or avoid interference with other Bluetooth piconets.

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After successfully performing the connection process, the devices in the piconet will establish a physical connection. In our design, this means that all control centers, sensors, and smart furniture will be connected to a channel. When in connected mode, additional logical links can be created and released, and the mode of physical and logical links can be changed while maintaining the connection with the physical channel of the piconet. The device can also perform inquiry, paging, or scanning processes.

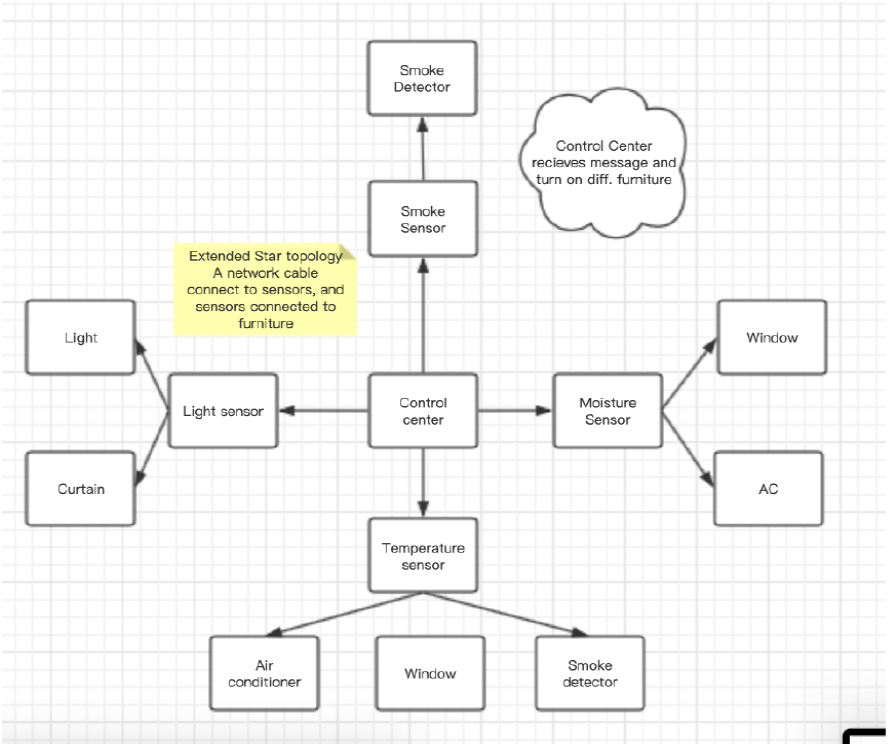

Figure 1. The process diagram of indoor smart home

4.2 WIFI

In reality, there are three steps for the mobile phone to connect with the internet. This includes scanning, authentication, and association. Based on WIFI network access principle [12], we aimed to design a system that can make the communication between sensors and control center be more efficient and more reliable. By this way, the smart furniture can communicate with control center through WIFI and therefore cooperate together to establish better lives for us.

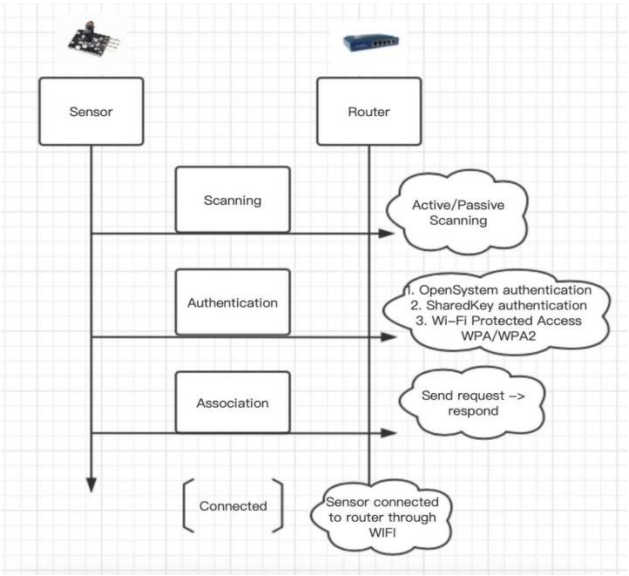

Figure 2. Working process of sensor through WIFI

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There are two types of scanning, which are active scanning and passive scanning. For active scanning, the Work station (Sensor) would send a Probe request frame on each channel and wait for a response from a specific wireless network. In this case, active scanning is actively searching the network, instead of waiting for network to declare its existence. Workstations using active scanning will scan every listed channel through the following procedures:

(1) Skip to a channel and wait for the indication of an incoming frame or wait until the Probe Delay timer times out. If a frame is received in this channel, it is proved that the channel is used by users, so the sensors can be detected. The Probe `Delay timer can prevent the work station waste all its time on an idle channel for entire process because it will declare no users are using the channel once the timer times out.

(2) During the basic DCF access process, obtain media access rights, and then send a probe request frame.

(3) At least wait for the shortest channel time (minimum channel time). If the media is not busy, it means that the network does not exist, then the user could skip to the colocated channel. Otherwise, If the media is very busy during channel time, the workstation will continue to wait for a period of time until the longest channel time (maximum channel time) ran out, and then process any probe response frame.

Next, let's move to passive scanning, which is also what we used in our system. The passive scanning is more practical due to its ability to conserve energy, no signals are needed to be transmit during the period of scanning. In the passive scanning, the control center will constantly switch between the channels of each sensors and wait for the arrival of beacon frame, which is designed to let the work station know the parameters required to join a basic service set (BSS) for communication, once the work station joins the BSS, that will indicates the existence of a sensor and thus that sensor can be detected. After the scanning has been completed, the process of authentication is required before the sensors request to communicate with the router because the most crucial defect of wireless network is security, identifying is necessary, and the authenticated connection must be encrypted to prevent unauthorized users from accessing. Once the process of authentication finished, the sensors are allowed to send an association request to the router to gain full access to the network so they do not need to repeat the process of scanning and authentication whenever the sensors wanted to communicate with the control center.

4.3 Indoor light and temperature control

4.3.1 Light control

The ILACS control algorithm of an intelligent LED indoor lighting system proposed in this paper is an indoor lighting automatic monitoring algorithm; Because a variety of indoor lighting systems can be controlled individually or in groups using multi-transmission and ZigBee solutions, system stability for all configured devices can be ensured by using distributed control capabilities. The distribution of lighting at specific locations within the interior provides an accurate prediction, which is achieved by controlling the natural light of the interior lighting. This can be used to maintain the recommended light intensity for indoor environments.

In the ILACS system, experimental conditions are applied to group and dimming controls, individual controls, permanent lighting controls, scheduled lighting controls, and occupancy sensors. When the ILACS algorithm is applied, the control method is selected based on a schedule of dates, which is determined based on the current time zone for a particular region. Ut measures indoor illuminance through calculation of daylight and ambient light sensors to determine current lighting levels. The algorithm controls lighting devices and divides them into different groups by determined light levels. If the schedule is checked and the system ensures that it is necessary to turn on the lights, lighting control will be terminated. Lighting is controlled by the current lighting intensity in the room and the time of day of the week on the schedule.

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A PIR (Passive Infrared) sensor detects infrared light that is emitted from objects within its field of view. In this ILCAS process, PIR sensor are used to detect whether the person is present in certain areas. Thus, if PIR sensor was occupied, it means that the person is in detected area If the occupancy is not detected, the lighting control is terminated. If occupancy is detected, the lighting level is determined by measuring the indoor illuminance through daylight and ambient light sensor calculations. And the lighting device controls the lighting in the set-group using the light pattern according to the determined lighting level. Otherwise, the control ends. Finally, the algorithm confirms the shut-down status of the system, and the lighting control is repeated by selecting the control method or ending the ILACS.

The process of ILCAS is shown in the diagram below. [6]

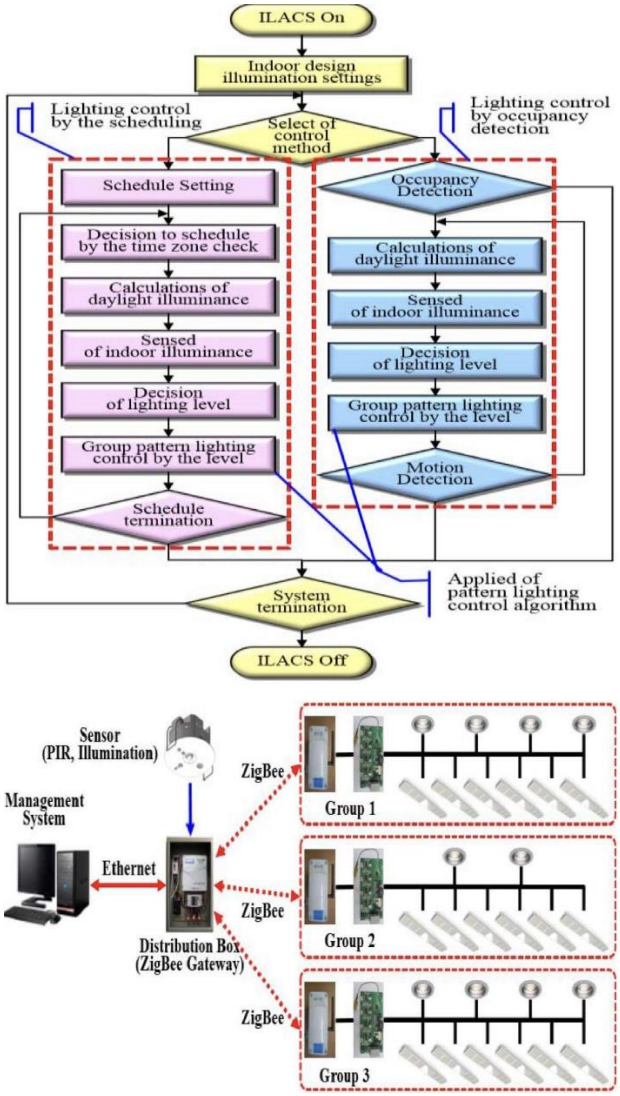

Figure 3. The process of ILCAS

4.3.2 Indoor temperature system

In order to control the indoor temperature in a comfortable range for people, we introduce a improved way of Markov Chain Algorithm to predict the temperature in the room in a time interval.

The comparison diagram between the experimental prediction of temperature and the actual value is shown in the figure. The actual value, the improved algorithm and the traditional algorithm are all labeled in the image, and it can be seen that the prediction curve of the improved algorithm is more close to the actual value than the traditional Markov chain algorithm. [7]

ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0056

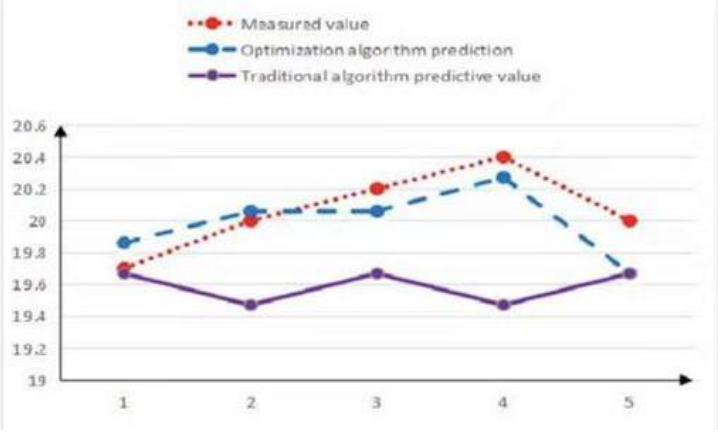

Figure 4. Improved algorithm execution

III. Improved Algorithm

The experimental measurement in spring, venue for the Xi'an Beilin District building. Between March 29th and April 15th, the temperature sequence time interval was 15 minutes. The temperature sequence denoted by $\{t_i\}$, a cumulative sequence denoted by$\{t_i^{(1)}\}$, inside $t_i^{(1)} = \sum_{i=1}^{i} t_i$ .It is found that the indoor temperature in the daytime overall volatility volume is not large, with a certain stability. And because the temperature is affected by many factors, the volatility is random, this randomness does not depend on the past [11], can be used to describe the process of Markov. And linear regression and Markov chain can reflect the regularity and randomness, so will be the combination of the two can reflect the change of the temperature process. In order to more clearly introduced, combined with the data in March 30th to explain. Algorithm is as follows:

Step 1: select the $\{t_i\}$ before the point to calculate the $\{t_i^{(1)}\}$ of the previous point;

Step 2: the establishment of the model $t_i^{(1)} = a*t+b$, the linear regression, if the n=10, by the least square method to estimate the $\hat{a}=19.7515$, $\hat{b}=-0.3050$.;

Step 3: using $T_i = \hat{a}*t+\hat{b}$ calculate the T_i value of $t_i^{(1)}$ forecast;

Step 4: using the formula $\hat{t}_i = T_i - T_{i-1}$, inverse t_i regression value T_i, get the regression sequence $\{\hat{t}_i\}$.

Step 5: the calculation of the relative value of the regression sequence of $\{\varepsilon_i\}$, the calculation method for the $\varepsilon_i = \frac{t_i - \hat{t}_i}{t_i}$, the residual sequence of $\{\varepsilon_i\}$;

Step 6: according to the regression residuals, it is divided into several states. According to the actual situation of this experiment according to the interval $(-\infty,-1)$, $(-1,0)$, $(0,1)$, $(1,2)$, $(2,+\infty)$ is divided into 5 states, respectively, recorded as state 1, 2, 3, 4, 5, and find out the status of each moment s_i , as shown in table 1.

TABLE I
THE MEASURED VALUES AND STATUS DIVISION

NO.	Measured Value	Regression Residual(%)	State
1	19.20	-1.28	1
2	19.60	-0.77	2
3	19.50	-1.29	1
4	19.80	0.25	3
5	20.00	1.24	4
6	20.00	1.24	4
7	19.90	0.75	3
8	20.10	1.73	4
9	20.30	2.70	5
10	19.70	-0.26	2

Step 7: calculation step state transition matrix $P = \{p_{ij}\}$, said state i after one step transition to j probability [12], in the first 10 data in state 1, there were a total of 2 times and after one step transition corresponding state 2 and state 3 each time, the frequency instead of probability, to one by one to calculate the probability transfer matrix of all the elements.So $p_{12} = p_{13} = 0.5$. Therefore :

$$P = \begin{pmatrix} 0 & 0.5 & 0.5 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1/3 & 1/3 & 1/3 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$

Step 8: the most critical step of the improved algorithm. The state of the next step in the evolution of probability transition matrix. In order that convenience, $S = f_m(z_1, z_2, \cdots, z_n, p_1, p_2, \ldots, p_n)$ are defined, including parameter Z said M state by one-step transfer after all possible state value, in this paper all possible values of $z_1, z_2, \cdots, z_n$ for 1, 2, 3, 4, 5; $p_1, p_2, \ldots, p_n$ said the transfer probability respectively, and the function returns the value of S is described as: with probability p_1 from s_1 with probability p_n from s_n .Specifically: the state of a certain time s_i =1, One step transition state from P knowledge state 1 is likely to be 2 and 3 and the probability is 0.5 ;That is, anyone can not determine the value of the s_{i+1} before the execution of the function, only know that the value is 2 or 3, and the probability is 0.5.Once the function is called, then it is determined. The algorithm proposed in this paper and different is that investigation of the one-step transition probability in the literature [8-9] direct probability maximum value as a predictor in the next step, this approach denied the occurrence of other state, obviously, inconsistent with the facts. But the improved algorithm will not shield the state of those with less probability.

Step 9: the next state where the median value as the regression value of the relative error. According to $\tilde{t}_i = \frac{\hat{t}_i}{1-\lambda}$ calculate the final predicted value $\tilde{t}_i$ .For example, after one step after the transfer state is 2, then take $\lambda = -0.5\%$.

Figure 5. Improved algorithm diagram

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4.4 Indoor tracking system

For indoor localization of mobile objectsca uses Bluetooth devices technology. This system consists of Bluetooth devices that placed through the environment (evenly distributed in different rooms and form a devices networks) and smart devices (smartphone, and other smart furniture such as air conditioner, television, etc.) that receive and process the information from the these multiple Bluetooth devices. In the smart home, the person will hold the device that has the Bluetooth function. When the person is moving the home, the Bluetooth devices in the home will detect person's movement by the detection of the signal intensity difference. If the person enter a different room, the relative signal intensity between the person and the smart furniture in according room will increase. Once the person approaching certain furniture, the furniture will detect it and carry out the functions. The data that smart devices process during the localization process consists from UUID, Major and Minor values and the received signal strength from the Bluetooth devices. These three values used to identify devices from other in the environment. The signal level used to find the nearest device–object with the best signal mentioned to be the closest. Such application was implemented for moving Bluetooth mobile devices that person hold in the room l. The sketch map is shown below.

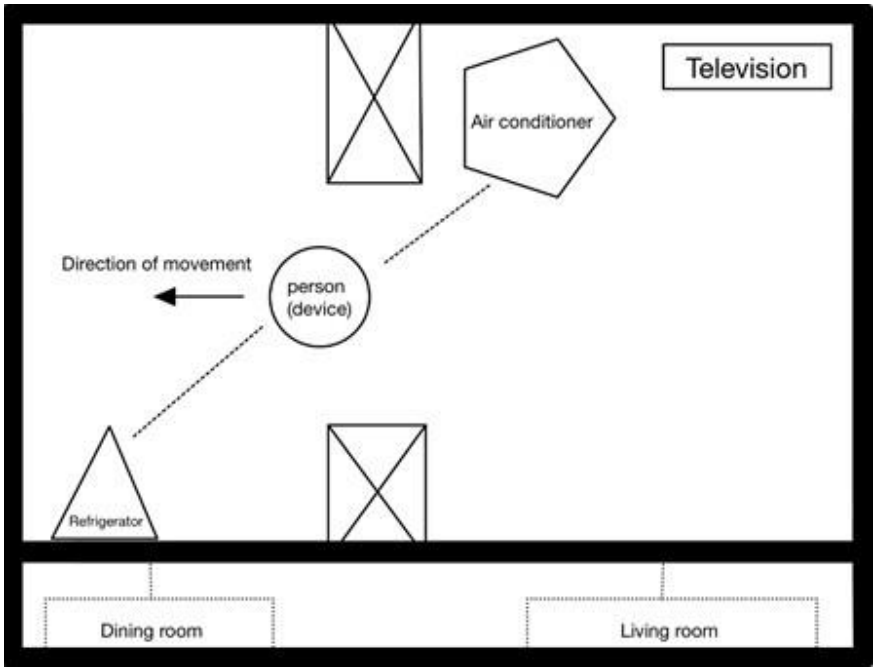

Figure 6. The sketch map

In this process, all the Bluetooth furniture will record the immediate position of the person in the room due to the Bluetooth detection. After the detection, the multiple devices will report the information to the control center (server) and update the person's current position through WIFI [8]. After collecting the information, the control center will locate the exact position in the room and send the functional order to the smart furniture to determine the status of the furniture. If the person is the near the furniture, the server will send message to let the furniture works. If the person is far from the furniture, the server will send message to remain the close status of furniture. In this way the system of localization and tracking of mobile objects will consist of four parts: Bluetooth devices that advertise their data in the environment, the object with smart device that will receive and process this data and then define the current position of the object and send this data on the server, a server itself, and another one object that will track the current position of the object and send the order to control the furniture that is near to the person. (moving objects)

With the function of this bluetooth localization, and the addition of PIR sensor mentioned in light control part, people's location can be further ensured.

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5. Analysis and comparison

5.1 Data rate & Nominal range

In fact, there are various differences between the smart home system based on Bluetooth and the smart home system based on WIFI. First of all, WIFI provides a relatively higher data rate compared to Bluetooth, according to studies [5], within an IEEE standard, the maximum data rate of WIFI is 54 Mb/s while the maximum data rate for Bluetooth at same condition is 1Mb/s. Next, the nominal range for Bluetooth and WIFI are 10m and 100m, respectively, this indicates that the smart furniture using Bluetooth needs to be located close to the control center but that of WIFI does not.

Table 1. Typical system Parameters of the Wireless Protocols

Standard	Bluetooth	UWB	ZigBee	Wi-Fi
IEEE Spec.	802.15.1	802.15.3	802.15.4	802.11a/b/g
Max data rate (Mbit/s)	0.72	110*	0.25	54
Bit time (μ s)	1.39	0.009	4	0.0185
Max data payload (bytes)	339 (DH5)	2044	102	2312
Max overhead (bytes)	158/8	42	31	58
Coding efficiency+ (%)	94.41	97.94	76.52	97.18
* Unapproved 802.15.3a.	+ Where the data is 10K bytes.			

5.2 Size

The network size for Bluetooth and WIFI are also comparative, for the Bluetooth, the maximum capacity of devices connecting to the network's building cell is 8, but that of WIFI is about 2000 and both protocols have provided for more complex network structures built from the respective basic cells: the scatter-net for Bluetooth and the ESS for WIFI.

5.3 Security

In general, both Bluetooth and WIFI use the 2.4 GHz band, thus the coexistence issue needs to be solved. It has been previously discussed in IEEE 802.15.2 standard, which Bluetooth avoid channel collision by employing adaptive frequency hopping and WIFI uses dynamic frequency selection and transmission power control. Also, both Bluetooth and WIFI implemented the encryption and authentication mechanisms in their system to deal with security issue. Bluetooth uses the E0 stream cipher and shared secret with 16- bit cyclic redundancy check (CRC), WIFI uses the AES block cipher and CCM in its system.

5.4 Transmission Time

In the wireless communication system, the transmission time is based on the data rate, distance between sender/ receiver, and the size of message sent.

Formula:

$$T_{tx} = (N_{data} + (N_{data} / N_{maxPld} \times N_{ovhd})) \times T_{bit} + T_{prop}$$

N_{data}: the data rate

T_{bit}: Bit time

$N_{maxPld:}$ maximum payload size

N_{ovhd}: overhead size

Since the data rate for Bluetooth and WIFI are different, the transmission time will also varies. For example, the transmission time for Bluetooth is longer than that of WIFI because of its low data rate (1MB/s).

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6. Discussion

Discussion of several indoor tracking system

In order to select the most appropriate tracking system, we analyze several ways that can be adopted for indoor localization and assess their feasibility in smart home.

6.1 QR codes

This is an example of passive level of interaction that has two parts: a mobile computer with a camera and tags arranged in places where it is required to determine current location of an object. Obviously, though this method works perfectly while the accuracy is equal to 100%, this requires residents to find a NFC tag and scan it actively to gain location. process which does not match with our “smart” idea. [8]

6.2 WIFI(active interaction level)

Advantage: There is no need for users to make any actions to update current location compared to QR codes.

Disadvantage: the propagation of the signal would change dramatically, and the accuracy is very imprecise: about 10-15 percent. The error is fatal in indoor localization, which would greatly affects the detect of position in a small room. [8]

6.3 Bluetooth

Advantage: Since Bluetooth is also one of the active interaction level methods, it has the same advantage as the WIFI method.

Disadvantage: The time needed to scan the environment is longer. Moreover, the average speed of human walk takes less time to cross the distance between the devices. Decreasing the distance between the devices will cause the decreasing of accuracy. This makes this not our most suitable choice since the distances between sensors and appliances in a smart home are relatively close.

6.4 iBeacon

iBeacon is a new technology created by Apple Company based on current Bluetooth technology, which enables Mobile Apps (can be downloaded in both iOS and Android devices) to receive signals from adjacent beacons react accordingly. Therefore, it allows Mobile Apps to reflect their owners’ current position and deliver hyper-contextual content to users based on location. The underlying communication technology is BLE (Bluetooth Low Energy). [11]

The advantages of using BLE in iBeacons instead of tractional Bluetooth technology are (1) use less power and has low energy requirements as it is called (2) much cheaper.

6.5 Select for our tracking system

Above all three methods, the iBeacon method is most appropriate method to be embedded in a smart home. This is because the localization method via WIFI connection or traditional Bluetooth technology is not accurate enough. With the interaction between different smart furniture (blue tooth devices), the person's location can be located with accuracy.

7. Suggestions for future work

Our proposed smart home is shown in this figure. The smart lock at the door would allow residents to unlock it in three ways: using fingerprint recognition, camera recognition, or voice recognition. Commonly, most smart locks use the first or second way, which requires only a camera to identify the people. However, due to the world pandemic COVID-19, people have to wear masks and sometimes it would be inconvenient for them to take off the mask while opening the door. Also, in some scenarios, like when people go home from shopping, we suggest that people cannot either take off their masks or spare their hands for fingerprint recognition. When the user try to unlock the room, the information sent will be compared with the information that was previously collected and stored. The information

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can then help identify the identity of the person who is opening the door. We hope to design the smart home system in a really "smart" way, which the system can adjust its conditions automatically according to the identity recognized by the lock. For example, when the elderly enters the room, the temperature would be set a higher than when others enter the room. In this system, different residents would benefit from different special treat due to their health condition and favorite environment condition.

In the paper, we only focuses on the cooperation between sensors and sensors and sensors and tracking system. We hope to extend our system to work with the smart locks.

Additionally, since this paper only describes a single living room, we do not consider much other cases that people would encounter at home. In this paper, we discuss about the temperature and lighting system that we would employ in our smart living room, but we do not want to neglect other important rooms in a smart home, such as bedrooms or bathrooms.

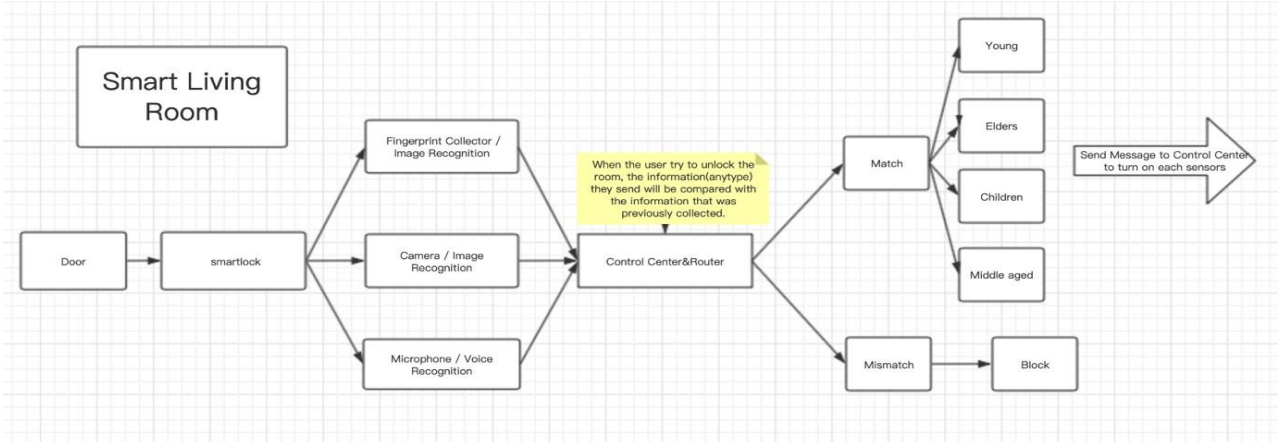

Figure 7. Smart Living room diagram

Bluetooth

Limited transmission distance which means its range is very limited, If the users exceed the scope of use of Bluetooth, Bluetooth technology will lose its role. Therefore, Bluetooth communication mode is not suitable for outdoor use. Therefore, if possible, increasing the range of Bluetooth is something that people need to work hard on in the future. This can greatly increase the application scope of Bluetooth communication mode.

The data rate is 1 MB / s. Slow data rate means that the speed of transfer or receive data will be very slow, so the speed of signal transmission in the smart home system will also be very slow, which may cause the sensor to have sensed a new thing while the control center is still transmitting data to the control center. This may bring people a bad user experience. Therefore, it is very important to improve the data rate of Bluetooth in human future research.

Incompatible protocols between different devices, this actually means that in our design, the sensors can not talk to each other. So as I said before, if one of the sensors fails, the smart furniture connected to it will also lose its function. Therefore, it is also worth studying to make the devices in piconet communicate with each other.

8. Conclusion

In summary, this paper mainly talked about the design of the smart home system in the living room and how they work together by Bluetooth and Wi-Fi. In design part of this paper, it exploring the indoor light, temperature control and Indoor tracking system. For analyze part of this paper, it compares the difference between the Bluetooth technology communication mode and Wi-Fi communication mode and find the advantages and disadvantages of them receptivity.

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References

[1] S. Kumar and S. R. Lee, "Android based smart home system with control via Bluetooth and internet connectivity," The 18th IEEE International Symposium on Consumer Electronics (ISCE 2014), 2014, pp. 1-2, doi: 10.1109/ISCE.2014.6884302.

[2] D. Wang, Y. Lu, H. Zhang, J. Zhang and Y. Han, "Body Piconet for the Telemedicine System Based on Home Networks," 2007 IEEE/ICME International Conference on Complex Medical Engineering, 2007, pp. 1202-1205, doi: 10.1109/ICCME.2007.4381934.

[3] T. Cultice, D. Ionel and H. Thapliyal, "Smart Home Sensor Anomaly Detection Using Convolutional Autoencoder Neural Network," 2020 IEEE International Symposium on Smart Electronic Systems (iSES) (Formerly iNiS), 2020, pp. 67-70, doi:10.1109/iSES50453.2020.00026.

[4] C. Li, K. Dong, F. Jin, J. Song and W. Mo, "Design of Smart Home Monitoring and Control System Based on Zigbee and WIFI," 2019 Chinese Control Conference (CCC), 2019, pp. 6345-6348, doi: 10.23919/ ChiCC. 2019.8865907.

[5] J. Lee, Y. Su and C. Shen, "A Comparative Study of Wireless Protocols: Bluetooth, UWB, ZigBee, and Wi-Fi," IECON 2007 - 33rd Annual Conference of the IEEE Industrial Electronics Society, 2007, pp. 46-51, doi: 10.1109/IECON.2007.4460126.

[6] S. Hong and C. Lin, "An efficient ILACS control algorithm for intelligent LED indoor lighting system," 2017 19th International Conference on Advanced Communication Technology (ICACT), 2017, pp. 29-32, doi: 10.23919/ICACT.2017.7890051.

[7] L. Yang, L. Shang and L. Yang, "Improved Prediction of Markov Chain Algorithm for Indoor Temperature," 2016 International Symposium on Computer, Consumer and Control (IS3C), 2016, pp. 809-812, doi: 10.1109/IS3C.2016.206.

[8] V. Rustinov and A. Sorokin, "Selection of technology for building an indoor localization and tracking system," The Experience of Designing and Application of CAD Systems in Microelectronics, 2015, pp. 178-181, doi: 10.1109/CADSM.2015.7230829.

[9] En.wikipedia.org. 2021. Piconet - Wikipedia. [online] Available at: <https://en.wikipedia.org/wiki/ Piconet> [Accessed 12 August 2021].

[10] En.wikipedia.org. 2021. Bluetooth - Wikipedia. [online] Available at: <https://en.wikipedia.org/wiki/ Bluetooth> [Accessed 12 August 2021].

[11] iBeacon.com Insider. 2021. What is iBeacon? A Guide to iBeacons. [online] Available at: <http://www. ibeacon.com/what-is-ibeacon-a-guide-to-beacons/> [Accessed 13 August 2021].