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Situational Awareness System in the Smart Campus

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ABSTRACT Smart campus is based on the Internet of Things (IoT) technology, and its purpose is to achieve the intelligent management and service on campus. Through the IoT, the mutual blending of teachers and students, learning facilities, and information generated by facilities is realized. This paper introduces and analyzes the current research status of smart campus and the difficulties in integrating various kinds of service data in smart campus. After analyzing various kinds of situational data, this paper analyzes and designs smart campus service discovery algorithm and perceptual data fusion algorithm on the basis of previous research on the situational awareness system framework for smart campus. Compared with the traditional campus platform, smart campus can manage perceptual data more efficiently, which brings convenience to campus service and management.

INDEX TERMS Internet of Things, perceptual data fusion, situational awareness, smart campus.

I. INTRODUCTION

With the rise and rapid development of cloud computing, big data and Internet of Things (IoT), advanced information technology is gradually integrated into the education industry, making the level of university informatization is also constantly improving. However, there are still many problems in the traditional campus management, so the smart campus construction is imperative.

Smart campus is an intellectualized campus work, learning and living integrated environment, which is based on IoT. This integrated environment takes all kinds of application service system as carriers to fully integrate teaching, scientific research, management and campus life [1]. There are mainly three core features: First, providing an intelligent perceptual environment and comprehensive information service platform, developing role-based personalized services; Second, integrating the information service of computer network into various applications and services to realize interconnection and cooperation; Third, through the intelligent perceptual environment and comprehensive information service platform, to provide an interface for school to communicate with the outside world.

The smart campus is an open, innovative, collaborative and intelligent integrated information service platform. With the intensive research and extensive application of IoT technology, it can be used to solve the problem of connection human with thing that not considered in the traditional Internet. The IoT technology is used in the smart campuses construction, which can change the interactive mode between various organizations and individuals on campus, improve the efficiency of information transmission, make the response more flexible, and build an intelligent campus information service system based on this.

At present, the predecessors have conducted in-depth discussions and researched on smart campus. For example, Swiss Federal Institute of Technology has constructed an Every Thing Has Online Content (ETHOC) system, which considers the design from information provider interface and user interface to realize the campus information interaction [2]. Yonsei University in Korea, learners use intelligent devices to access the smart campus, and construct the smart campus by the means of big data, IoT, cloud service, SNS and other information technology [3]. There are also the realization of smart campus by strengthening campus construction, for example, Brescia University in Italy, using the Building Energy Model (BEM), which was developed on the basis of Building Information Model (BIM), to build the smart classroom with low energy consumption and realize

the energy saving and emission reduction on campus [4]. Hiroshima University in Japan uses cloud computation and radio frequency technology to form the attendance system, which can check attendance at anytime and anywhere through intelligent terminals and realize the information sharing [5]. Marist Institute has established a big data analysis platform, analyzing the curriculum development and students' academic performance on the basis of big data to help students complete course assignments [6]. Professor Chen Ping of Beijing Normal University analyzed the definition and connotation of smart campus, put forward the construction of multi-layer framework of intelligent IoT perceptual infrastructure platform for smart campus, and carry out the overall design and hierarchical design of the foundation framework [7]. As a high-level university in China, Zhejiang University proposed to build a ''smart campus'' in 2010, which has realized the main core functions of public communication, discussion and communication, shared data, and provided comprehensive information services [8].

This article is divided into six parts. In the ''Introduction'', introduces the development trend of the smart campus construction. The second part introduces the related concepts of the smart campus and the necessity of the smart campus construction for the modern education, and analyzes a series of problem existing in the smart campus construction. The third part, aiming at the existing problems in the smart campus construction, this paper puts forward the framework for the smart campus construction system based on situational awareness, and introduces the related technologies in the framework construction. The fourth part is also the core part of this paper. Aiming at campus network users how to choose campus services accurately, this paper designs a situational awareness service discovery model; With the help of wireless sensor to perceive the campus services information, and the perceptual data are merge from the information processing hierarchy. The fifth part introduces the construction of smart campus platform based on situational awareness, give an example of intelligent application in smart campus. In the ''Conclusion'', compares the situation-based smart campus platform with the traditional campus platform technically. It concludes that the smart campus system is not only superior to the traditional campus platform, but also can bring convenience to teachers and students, provide better services and facilitate management.

II. SMART CAMPUS

A. RELATED DESCRIPTIONS AND INTRODUCION OF SMART CAMPUS

Colleges and Universities are the most concentrated and authoritative places to train the young people, which takes students as the principal part. Students' learning and life will certainly become the most concerned part of the campus. How to integrate the students' study and living environment with campus work is the pursuit of today's colleges and universities. Smart campus is based on the traditional campus, which integrates the students' campus life with school related management, scientific research and teaching activities. The intelligent integration of smart campus internal system needs to take service and application as the carrier, relying on the IoT to support. Campus life and campus culture under the smart campus system have great attraction for college students. Smart campus must ensure an energy conservation, stable and safe campus environment. The IoT technology [9]–[11] plays an extremely important role in the construction and implementation of smart campus, which connects different objects of the campus network. Smart campus relies on IoT technology to provide a service platform environment for many teachers and students. The environment is a comprehensive intelligent perceptual environment, so it can provide a comprehensive personalized service for the whole school. The core features of smart campus is to optimal fusion the application of each section in school with the help of network information, so as to promote the interconnection and collaboration of various parts [12]. In short, based on the role of situational awareness, we should take student service as the main body and take the useful information from outside and internal needs of schools mutual recognition. The main function of smart campus is to build an effective and mutual cognitive bridge between inside and outside the campus.

In recent years, the smart campus has become more and more concerned. Here, searching for ''smart campus'' as keyword in an academic search platform, and getting the number of articles published in recent years as shown in Table 1.

TABLE 1. Published articles on smart campus.

Particular Year	2010	2011	2012	2013	2014	2015	2016	2017
Quantity	19000	22600	26900	28600	30000	30300	29200	28400

B. DEMAND ANALYSIS OF SMART CAMPUS

Today, with the high development of the information society, IoT service is also constantly improving, the traditional campus model has been unable to adapt to the current educational requirements. The construction and research of Smart Campus [13] is more and more strongly supported by the education department. First of all, in the teaching mode, teachers can only teach by blackboard transcription and other forms in the past. This form of teaching cannot mention the interest of students, teachers are not efficient in teaching, the most important thing is that it is impossible to pass on valuable information to students more quickly by effective measures. With the support of IoT, computer software is configured in the classroom, which provides a better environment for teachers to work and students to learn [14]. Completely and effectively changed the traditional teaching methods, under the digital facilities, classroom and library have been got huge construction investment in the multimedia aspects [15]. Campus network service is the most important part of the basic network service and application service system. The structure

of campus network service and various structure services is shown in Figure 1.

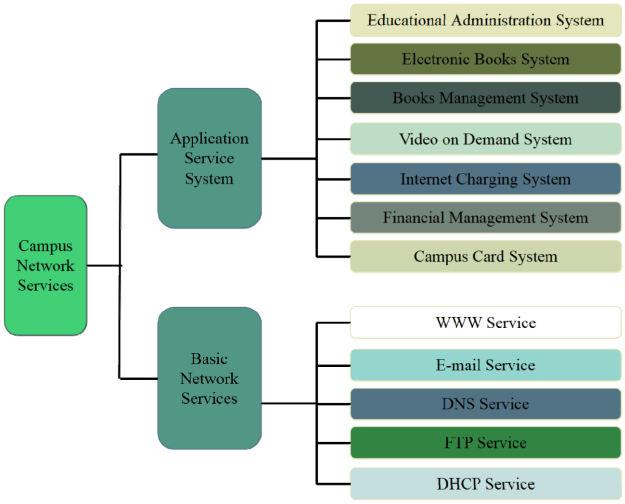

FIGURE 1. Network service structure.

C. PROBLEM IN THE CONSTRUCTION OF SMART CAMPUS

The construction of a smart campus is a process of constant pursuit. Although some colleges and universities are in the forefront of the smart campus construction, there are still many colleges and universities have not been able to build a highly efficient information development process. Because the university is a place with a large number of people, and the service departments are more comprehensive and complex, it is particularly important to build a platform if unified shared resources and data. However, the construction of many information platforms cannot meet the requirement of unified shared data. Under the loss of large amounts of data, some service departments have encountered obstacles.

Interface is the core of the Internet of Things, but at present, it is not possible to connect different service sectors effectively through an interface on many occasions. In the early construction of smart campus, there is no unified planning for the system, and its irregular division [16]. The isolation of information makes the service system tend to granularity, and many data cannot be used as a whole of information processing, making many data become complicated, causing great obstacles to classroom, dormitory and most of the public service space.

The principle of smart campus construction [17] is to build a high-quality campus network with IoT technology, which makes each platform become normalized and standardized. The information under these data can not only meet the needs of the overall service construction, but also build personalized information platform. However, many colleges and universities are facing the following problems: it cannot achieve a comprehensive understanding for the campus overall environment; lack of high-level personnel in information; campus characteristic value-added services are seriously missing; the relevant plans for smart campus cannot be effectively implemented. The problem of traditional campus is shown in Figure 2.

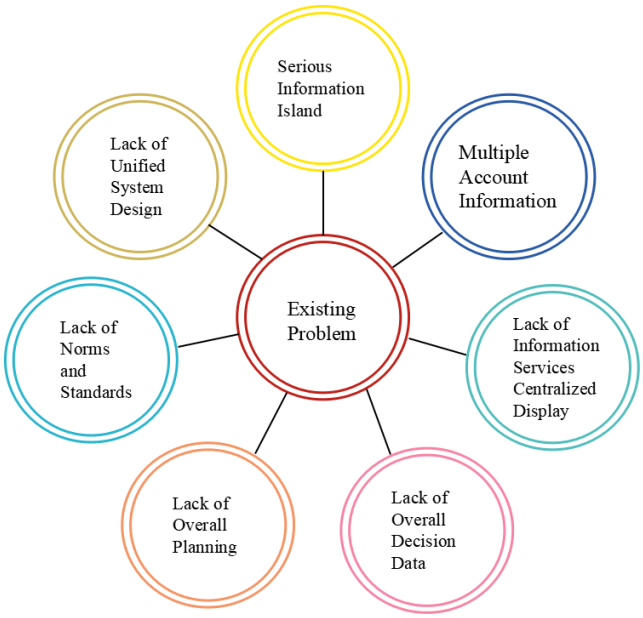

FIGURE 2. Problems existing in traditional campus network.

III. RESEARCH AND DESIGN OF SMART CAMPUS UNDER SITUATIONAL AWARENESS

In most researches of general calculation, situational awareness technology has been applied [18]. In short, situational awareness is mainly through sensors to enable the IoT devices to intelligently perceive the current situation. According to the situational awareness of real needs for teachers and students in the campus, considering the needs of teachers and students, we can use mobile Internet technology or simple sensor technology combined with the needs of teachers and students to build a complete system of smart campus facilities in different perceptual environments [19]. Under the context aware system, user situation library is the basis of smart campus design. In the design process, the original user situation library is constantly changing. In the process of research and design of smart campus based on situational awareness, it mainly includes application service layer middleware, core service layer middleware, basic service middleware, user layer and resource layer [18]. The design of the whole situational awareness focuses on the intelligent connection between each layer and the basic user context database rely on the IoT technology. The specific introduction of situational awareness is shown in Figure 3.

A. DEFINITION AND RESEARCH OF SITUATIOANAL AWARENESS

The definition of situational awareness was first proposed by Schilit and Theimer [20] in 1994. It is an integrated software service system, according to the position of the

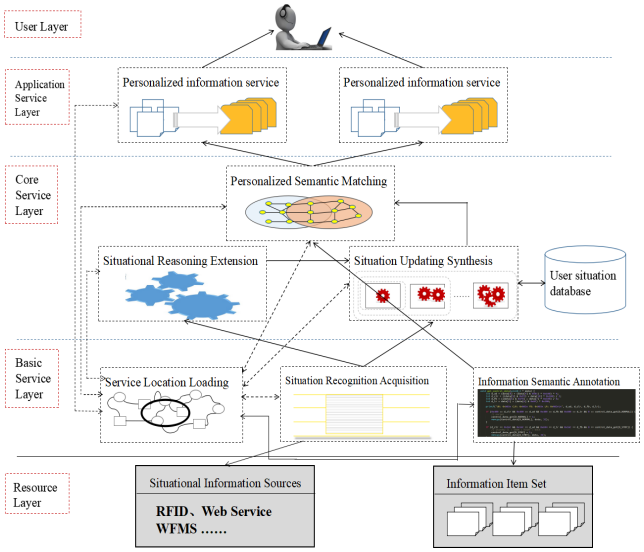

FIGURE 3. **The structure of situational awareness.**

software application and the collection of objects around it, it can be adjusted adaptively according to the need.. However, people are emotional animals, their cognitive needs for the surrounding environment are constantly changing. Therefore, the design and research of smart campus system based on situational awareness is also constantly deepening and comprehensive. To some extent, there are some other similar statements about situational awareness. Later, some scholars believe that situational awareness is to intelligently judge the situation of the current environment, intelligently use the IoT technology and related services within the system to adjust and optimize the current inappropriate location. Then later, some scholars put forward that both active situational awareness and passive situational awareness are the core content of situational awareness. Up to now, situational awareness has been regarded as a system that intelligently judges user behavior and its purpose is to actively provide relevant information or services for the user, humanized adjustment the mutual exchange way and content between human and situation by reasonable application situational information. Situational awareness is mainly based on the actual situation of users, on the one hand, automatically adapt to the environment, on the other hand, it can provide users with more appropriate and accurate service signals [21].

B. PERCEPTUAL NETWORK TECHNOLOGY

The core technology of perceptual network technology is the IoT [22], which can perceive before problems occur, so as to adjust the system internal parameters adaptively. Especially under the construction of many service systems in universities, this kind of perceptual network technology has shown great advantages. In the smart campus research system based on situational awareness, the key technology is to ensure that the whole perceptual service system can run efficiently and continuously in daily life. Therefore, building a systematic perceptual network architecture is the main part of the smart campus construction, in which the interface layer is to combine high-level user goals with the perceptual process of smart campus. Most of the service organizations are decentralized in the traditional campus, there is no unified planning and integration links, the corresponding IoT information is also single. Perceptual network technology is to make the traditional single-layer network through the user's perceptual level, making it more integrated and extensive [23].

C. INTERNET OF THINGS INFORMATION SERVICE

Colleges and universities mainly rely on their informationization in the process of construction. With the continuous improvement of information technology, the combination of smart campus construction and IoT technology has become the focus of informationization construction in Colleges and universities. The construction of smart campus is closely related to the IoT. The classroom, dormitory, library and other parts of the campus need the IoT technology. Technically, each object is connected intelligently to realize omnidirectional intelligent service. Notify the user of a variety of perceptual data aggregation, in accordance with the well-designed ideas in advance, the various objects and the Internet of Things interconnected to achieve high-level management, intelligent information exchange, communication. IoT information service is an advanced platform to provide information service of the IoT, and these platforms are information carriers of the IoT application. Smart campus system contains a large number of data and complex systems, with a huge user group and multi-level service system. In view of the characteristics of smart campus which are different from traditional campus, the advantages of IoT information service technology are highlighted. Through the combination of the IoT technology and campus physical objects, using information technology to deal with a large number of useful data enhances the operability of smart campus design.

IV. ANALYSIS AND DESIGN THE KEY ALGORITHM IN SMART CAMPUS

The key algorithm of smart campus is an important point to embody the intelligence of campus. Only a good hardware system can support the application of various software.

A. SMART CAMPUS SERVICE DISCOVERY ALGORITHM

As a universal computing environment, all kinds of campus services in smart campus are deployed in different environments. The key to reflect its "intelligence" of smart campus is to study how campus users can efficiently obtain the appropriate and available campus services. The research of service discovery technology in smart campus can help campus users quickly find the required smart services in the network, detect the changes in service availability, and finally provide users with intelligent services.

1) RESEARCH AND DESIGN OF SMART CAMPUS SERVICE DISCOVERY ALGORITHM FRAMEWORK

Services on smart campus include entities that can be used by people, programs, or other services [24], [25]. Its services may be a calculator, a storage device, a pipeline to communicate with other users, hardware devices, software filters, and so on.

Campus personnel access all kinds of services through campus ubiquitous network, and normally use common computing devices. In the smart campus, we can refer to the existing mature service discovery model to construct a service model which conforms to the characteristics of smart campus services. There are a service index database and an interface gateway in the smart campus, which can accept the registration request from the smart campus service. The gateway also provides the campus staff with the service information it has. Smart campuses can be divided into the following roles: campus services, campus personnel, campus service agents, campus service index database. The smart campus service discovery framework is shown in the Figure 4.

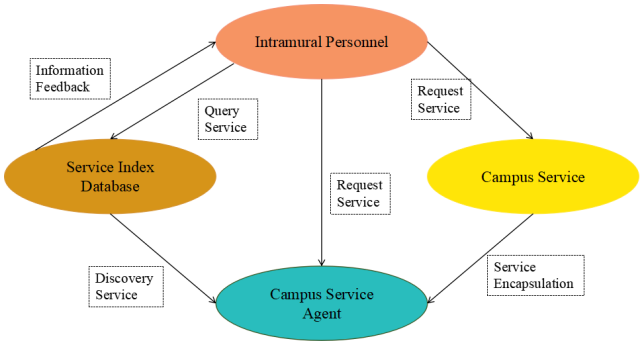

FIGURE 4. The relationship in service discovery of smart campus.

In addition to maintaining the service information provided by the smart campus service provider, the service indexer also provides the school staff with index information for requesting services so that they can enjoy the service. The services provided by smart campus should be configurable. The operation flow of the service registration discovery model is as follows:

(1) In the smart campus system, the deployment of service index database is to manage and maintain the information of index database through indexer. Service agents need to know the gateway location of the service indexer in advance, and register the information they own into the service index database through the gateway of the indexer.

(2) Personnel s gets the location of the index server and then gets the service list L_s through various smart campus service applications on intelligent terminals, but L_s is not necessarily the service L_t in the index database. It may be a list of service classes in the area Z and environment E where the school staff are located or a list of services computed by the keyword A and the fuzzy matching algorithm F. Therefore, the final list of services received by campus users is:

$$L_s = f(L_t, A, E, Z)$$

(3) The user selects the appropriate service s from the service list through intelligent terminal devices. After entering the service parameter $p_1, p_2, \ldots, p_n$, the service user will access the service provided by the service provider. And the calculation result R is abstracted as

$$R = s(p_1, p_2, \ldots, p_n)$$

After the end of service, whether the service execution is successful or not, the user's intelligent terminal equipment and services make final confirmation.

2) SERVICE DISCOVERY MODEL BASED ON SITUATIONAL AWARENESS

In the smart campus system, the design process of service index database needs to consider the situational factors and precisely classify the services according to the situation types. However, this classification is intersecting, that is, a service can be divided into class A, also can be divided into class B. The process of service discovery is as follows:

(1) The service providers on campus classify the newly published services and try to register them in the service index database through the service index gateway.

(2) When the service index gateway receives the registration request, it will obtain all kinds of necessary parameters of the source of the request to help the index database to accurately determine under when and what circumstances the service is provided to the user while saving the service information.

(3) Indexing service requests on smart campuses should be controlled by privileges or by access policies to ensure service security.

(4) When a user requests a service, firstly, the service index database determines the user's request permission according to the access policy, then infers the service he needs according to the source and the situation of the user's request, and pushes the appropriate list of services to the user's device.

By constructing a situational awareness smart campus service discovery model and service discovery algorithm, the smart campus services can be provided to authorized campus users in a more effective and secure way.

B. RESEARCH ON PERCEPTUAL DATA FUSION ALGORITHM

The situational awareness technology of smart campus is based on complex Wireless Sensor Networks (WSN) to cooperative work.

1) PERCEPTUAL DATA PROCESSING ALGORITHM

The basic function of WSN in smart campus is to sense personnel, equipment and environment and return all kinds of perceptual information obtained by various sensor nodes. Because wireless sensor network nodes, such as surveillance cameras, card switchers and so on, battery endurance, the ability of network access and central processing have greater hardware constraints, a single sensor node on the

monitoring range and its reliability is limited, to achieve real-time monitoring of the entire campus is bound to have certain difficulties. Therefore, when deploying campus sensor networks, smart campus need to make sensor devices in a certain unit to achieve a certain density to enhance the robustness and the accuracy of monitoring information of the entire smart campus network, such a simple increase in sensor nodes is easy to cause information redundancy and so on.

If each wireless sensor network node collects sensor information and transmits data to the campus central gateway separately, then processes the data, it will not only consume excessive energy, shorten the life cycle of the whole network, but also easily cause the gateway to collapse, thus affecting the real-time response of smart campus services. Smart campus information network should be dedicated to building a whole, each sensor is the basis of data fusion, multi-source information is the processing object of data fusion, coordinated optimization [26] and comprehensive processing is the core of data fusion.

Considering the data fusion mechanism in smart campus is to local area processing the redundant data perceived by each region. Under the premise of meeting application requirements, minimize the amount of data that needs to be transferred to the upper level server. Processing perceived data on a node consumes much less energy than data transmission. Therefore, the fusion processing partial area sensor data in wireless sensor networks, which reduces data transmission and effectively save energy.

Smart campus network data fusion technology can be implemented in multiple protocols of wireless sensor network protocol stack. The application-oriented data fusion interface is developed in the intelligent application layer, and the data fusion technology combining with routing is developed in the network layer. In addition to the existing protocol layer, the application-independent data fusion technology is proposed to form a data fusion layer between the network layer and the data link layer.

In the construction of smart campus, the solution is as follows: As the basic storage unit of smart campus network, the independent sensor computing group has independent data description form, such as tuple. Its externally published data definition can be merged with other sensor data storage. Each sensor network computing group in the smart campus has the ability to fuse data in the network area, that is, the information perceived by all sensor devices in the area will eventually be processed into a form of data. Similarly, the information processing of the entire campus network can be regarded as a computing group composed of various sensor computing groups, and through continuous regional data fusion to achieve the unified processing of smart campus data.

2) PERCEPTUAL DATA FUSION PROCESSING ALGORITHM

Smart campus wireless sensor network is mainly to perceive all kinds of data of school staff learning and life, its essence is a process of perceptual information processing.

Smart Campus Services provide real-time services, that is, when the user service is requested by the campus users, the service discovery control node begins to transmit data upward in the network, and the relevant sensor computing group receives the command, then it can fuse the area nodes under its control, the sensory data collected by these are basically consistent in form and the sensing targets are basically the same. Therefore, the fusion algorithm is needed to fuse these data to provide less information, but it is the most realistic perceptual data. Such data as the data in this area, when unified transmitted to the upper level of network nodes for processing, only one data of node need to be transmitted, rather than all similar data nodes are transmitted to the upper level, which reduces the network transmission broadband and the load capacity of the central node and achieves real-time service.

Let a local perceptual computing group in a smart campus network contain n sensor nodes and a central control node N, and the data variances collected by each node are respectively $\sigma_1, \sigma_2, \cdots, \sigma_n$. The measured values of the sensors are $x_1, x_2, x_3, \cdots, x_n$. Assuming that they have no effect during the measurement, and X is unbiased estimation, the data validity weights of the n sensors are respectively $W_1, W_2, W_3, \cdots, W_n$. In fact, although the data perceived by n sensor nodes are consistent, In fact, although n sensor nodes perceive the same data, the location of sensing devices and the environment in which they live will inevitably lead to some differences, which have been ignored in previous data fusion methods. Actually, the difference of these locations or environments has certain influence on the actual same acquisition equipment. W reflects the weight among the acquisition nodes themselves. Let e_i^2 be the difference variance of the environment (including temperature, location, etc) in which the acquisition equipment is located, and the formula for calculating the comprehensive variance of each node is shown as formula (1):

$$E = (\sigma_i + e_i)^2 \quad (0 \le i \le n) \tag{1}$$

Then, when all data are aggregated to the central control node, the global perceptual value formula of the computing group is as follows:

$$X = \sum_{p=1}^{n} W_p X_p (0 \le p \le n) \tag{2}$$

$$\sum_{p=1}^{n} W_p = 1 (0 \le p \le n) \tag{3}$$

$$X_p = X_p + E_p = \bar{x}_p + \sigma_p + e_p (0 \le p \le n) \tag{4}$$

The data perceived by nodes are finally aggregated at the central node N, after the data fusion of the central computing node N is completed, the fused data is sent to the unified upper level central gateway of the smart campus. The gateway also feeds back to users based on perceptual data fusion algorithm, so as to complete the service. The use of perceptual data fusion algorithm can greatly reduce the amount of data

transmitted in the network, reduce the occupancy of broadband, reduce the energy consumption of network nodes, and enhance the smart campus services efficiency.

It is important to study the key algorithm of smart campus for designing the smart campus system of colleges and universities. Only on the basis of researching and designing the key technologies can the problems be solved fundamentally.

V. SMART CAMPUS SERVICE PLATFORM BASED ON SITUATIONAL AWARENESS

The framework of smart campus based on situational awareness, when it is constructed, it can be divided into five aspects: perceptual content, perceptual space, perceptual means, perceptual data and perceptual application. According to the hierarchy, it can be divided into perceptual layer, service layer and event layer. The perceptual layer includes perceptual content and perceptual space, the service layer includes perceptual means and perceptual data, and the event layer includes perceptual application. The collection of perceptual content in the perceptual layer is the foundation and premise of other aspects. Its structure is shown in Figure 5.

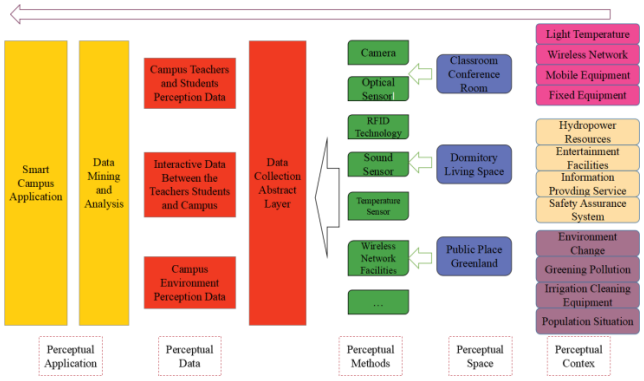

FIGURE 5. Perceptual data framework.

Different perceptual content is produced in different perceptual spaces. Intelligent perception for the different perceptual space based on the situational, the resulting data is storage to the data center. All campus intelligent applications build queries on the basis of smart campus, and ultimately serve the teachers and students.

A. SUMMARY OF SPATIAL DATA IN SMART CAMPUS

Smart campus is an integral structure in space. However, in a certain way of design, there will be differences and connections among smart classroom, smart dormitory and smart public space. Therefore, in the design process of smart campus, it is necessary to aggregate different data perceived by different smart spaces. In the process of building smart campus, the key problem to be considered is how to establish a unified smart campus central database. In the design process of smart campus based on situational awareness, the data types perceived by different intelligent spaces are different, and these complex data types cannot be directly aggregated. In the design process of smart campus, we need to unified filtering and analysis the uniformly sent data by different service spaces, and finally construct a perceptual data that can be used. Let campus as a whole can be accepted and used by the designed model. In the process of traditional campus construction, because of the fewer data type, smart campus needs to constantly change the data type through real-time access at any time. To a large extent, the relevance technology cannot be changed and applied which impends the utilization of data.

Based on the feedback of this problem, this paper uses the data federation mode to realize the application mode of data integration in the design of smart campus. The core of this intelligent model is deep mining for big data [27] and algorithm design to make a mining, sorting, reasoning model. The adapting interface of the central database in the smart campus can be roughly divided into three levels, the first level is the preliminary processing of the original data, the second level is the highly effective collocation of the data and the design of the smart campus space, the last level is to apply intelligence to the advanced data adapters based on the second level. The structural model is shown in Figure 6.

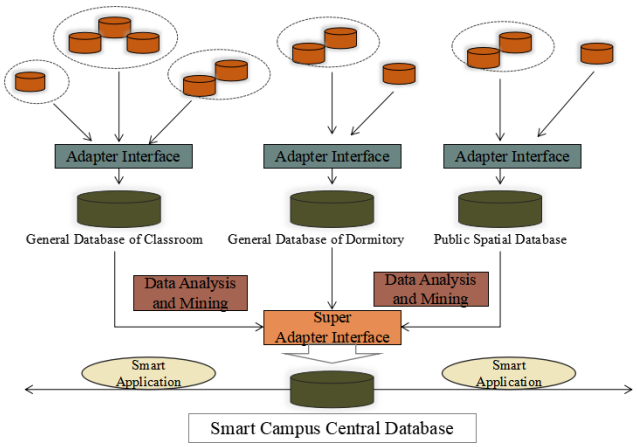

FIGURE 6. Smart campus central database summary mode.

In Figure 6, the data in different subspaces is provided to the super data adapter of the smart campus through the master adapter of each intelligent space. This super-adapter interface secondary adapts all kinds of data from different intelligent spaces, and the data generated can be identified by the campus central database. Then through the three-level data adapter, it provides specific access data interface for campus intelligent applications based on perceptual data, so as to serve different campus areas according to the interface.

B. SUMMARY OF SITIUATIONAL AWARENESS OF SMART CAMPUS USERS

In the process of smart campus construction, we need to monitor all kinds of space in the campus. But the most important part is the perception of people, and then provide an intelligent service architecture for them. Human perception

is mainly divided into two parts, one part is physiological perception, the other is psychological perception. The combination of these two can better reflect the ubiquitous and omniscient smart campus. In the process of situational awareness, campus personnel often use their mobile phones, electronic watches or other mobile devices to perceive the Internet. In addition, there will be cameras monitoring and other electronic equipment in each location of the campus. Through these two ways, we can get the interlaced data between personnel and campus environment. After obtaining this data, we can classify and analyze it. Figure 7 is a scenario diagram for campus staff.

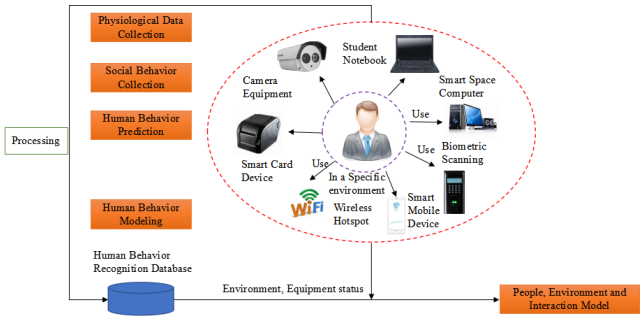

FIGURE 7. Sketch map of human situational awareness.

Personnel data need to be collected in smart campus based on the situational awareness. These data types can be roughly divided into three categories: first, the collection of physiological data, when collecting such data, it will encounter more difficult problems, and each person's physiological characteristics will have great differences. Some of these problems involve a lot of privacy issues, so we need to develop some ingenious methods, such as processing them into a large number of representative forms with dimensionless data based on personal preferences and personalities. The second is the collection of human behavior data. Most experiments show that human behavior data is more important than psychological data in the construction and improvement of smart campus. This kind of data represents people's behavior ability and their perception ability. We can intelligently design a reasonable service structure model by analysis and research this kind of data. Providing more humane services and promoting the construction of harmonious and smart campus. Third, the collection of social behavior data, social behavior is the most important behavior characteristics of a person to perceive society, the communication ability of campus personnel, finally through the analysis of these data, to provide a smart campus construction program.

C. THE CONSTRUCTION LEVEL OF INTELLIGENT APPLICATION IN SMART CAMPUS

In smart campus, the intelligent application is the direct interaction level between smart campus and campus personnel. It is built on the basis of perceptual data of smart campus central database. The structure of its application is shown in Figure 8.

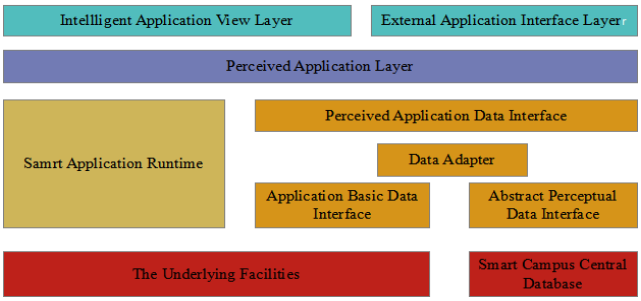

FIGURE 8. Intelligent application building level.

As shown in Figure 8, the Smart Campus application is built in the Smart Campus Center database. Its ultimate goal is to provide services for teachers and students through a powerful perceptual database. Because of the abstract data model stored in the Smart Campus Center database, intelligent applications indirectly use the Smart Campus Center database through middleware. Generally, intelligent campus applications need to build a data application layer on the database when accessing a certain part of the data. The core perceptual data module is closely related by the huge perceptual data and application, which can be used for the intelligent applications. In this paper, the intelligent campus application based on central database only uses part of its data, which effectively reduces the waste of resources and improves the utilization of resources.

In the process of building smart campus based on situational awareness, data security is one of the key issues to be considered in smart campus service platform. It involves three levels of research: the perceptual layer, the network layer and the application layer.

1) PERCEPTUAL LAYER SECURITY

Smart campus, based on the situational awareness, uses the modern sensing technologies, such as: the usage information of campus card, wireless network, cameras, etc, to perceive the campus scene. However, to ensure the security of the perceptual layer is to ensure the rationality of the perceptual data. Therefore, we need to evaluate the security of sensing data to ensure the security and reliability of sensors.

2) NETWORK LAYER SECURITY

Generally, the network of modern smart campus is cover the whole school. How to ensure the security and accuracy of information and data of network users is crucial. Therefore, in the design of network layer security, it is necessary to maintain the security and stability of smart campus network layer by fully using gateway and troubleshooting system.

3) APPLICATION LAYER SECURITY

The application layer construction is on the basis of situational awareness data, which is an interface that interacts

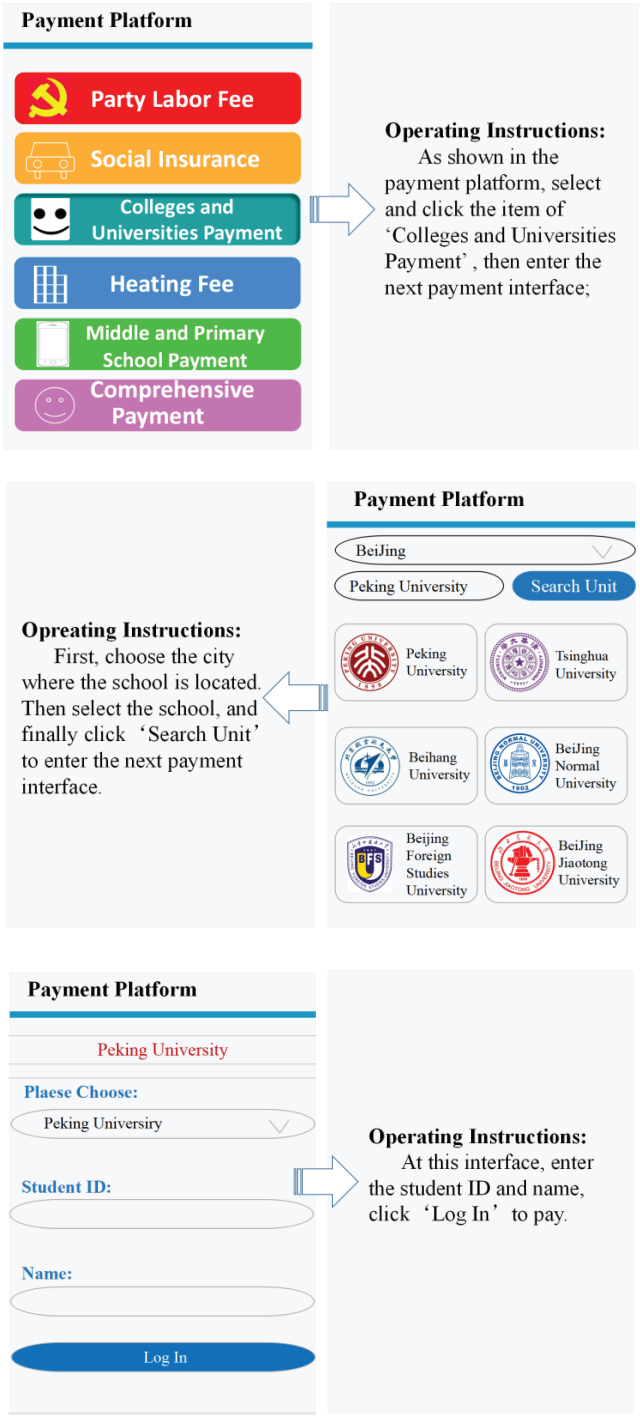

FIGURE 9. Smart campus payment platform.

directly with the school staff. Ensuring the correctness and stability of human-machine interaction from application layer is the problem to be ensured in the construction of smart campus.

D. INTELLIGENT APPLICATION EXAMPLE IN SMART CAMPUS

For a university, the type of students are different: undergraduate, postgraduate, postdoctoral, etc., the number reached tens of thousands. According to the traditional way of tuition payment: cash or credit card, it is time-consuming and laborious, and it is prone to errors, the collection of payment data is complex. However, on the basis of campus information infrastructure, the intelligent payment platform is easy to operate and fast. It only needs a mobile phone to complete the payment under the network environment. Its operation platform interface is shown in Figure 9.

The data generated by the students payment through the intelligent payment platform is uploaded to the campus center database, and the campus administrators access the "student payment data" in the database by the query port, and the payment status is clear at a glance.

VI. CONCLUSION

The smart campus based on situational awareness brings many conveniences to teachers and students. Compared with the traditional campus platform, it has the following advantages:

Firstly, the smart campus network is multi-network convergence. The IoT plays an important role and is conducive to unified management; The traditional campus platform of each application network area is relatively independent, so it is difficult to implement unified system administration. Its technical implementation is compared with Table 2.

TABLE 2. Index comparison between smart campus and traditional campus network.

	Smart Campus Platform	Traditional Campus Platform
Network Composition	Internet, WLAN, Internet of Things and other network infrastructure integration and cross application	The Internet is the main and the local independent wireless LAN is subsidiary
Network Architecture	Using central network and peer to peer network, different network nodes cooperate with each other	The central network is the core and the central gateway strictly controls the nodes
Network Application	All kinds of applications based on network, including LBS based on network	Network is mainly used for data transmission

Secondly, the smart campus perceives the database through application and service based on situational awareness. It realizes unified logic for perceptual data processing, and ultimately achieves the integration of the whole school. In the traditional campus platform, each application platform is independent of each other, and the data storage and processing are independent, which makes it difficult to maintenance the campus data. The corresponding technical indicators are shown in Table 3.

Thirdly, in the smart campus, the user experience of each page should be roughly consistent in the human-computer interaction, the user can access the service at any time and anywhere after a login, and the function list of various services is basically consistent, which reduces the error rate

TABLE 3. Data processing comparison between smart campus and traditional campus platform.

Data	Smart Campus Platform	Traditional Campus Platform
Data Maintenance	Unified Distributed Data	Single database, different application database type is different
Data Sources	Basic business data, various situational awareness data	Most of the different application database are incompatible
Data Processing	Including Unified Data Mining and Analysis	All kinds of system data mining is independent, data mining can not be used by other systems

in the human-computer interaction. The traditional campus platform has different forms of services and different lists. When users switch services, the system needs to change different roles and permission verification, which is inefficient. The main indicators of human-machine interaction are shown in Table 4.

TABLE 4. Human-Machine comparison between smart campus and traditional campus platform.

Human-Computer Interaction	Smart Campus Platform	Traditional Campus Platform
Interactive Page	Unified gateway, unified page layout	Different applications have theirs own gateways
Interactive Place	Platform application can achieve a unified interaction page at the terminal	Many platforms do not take into account the needs of mobile terminal users
Interactive Mode	Basic input and interaction based on perception	Basic platform query, delete, update and other operations

Compared with the traditional campus platform, the smart campus platform based on situational awareness can more conveniently and efficiently fuse perceptual data, and can make corresponding predictions of various behaviors. It is convenient for decision makers to make corresponding decisions, and the campus application is better to serve teachers and students.

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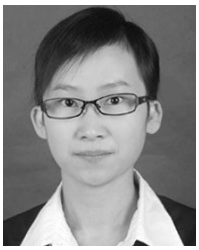

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