ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

Situational Perception Information Fusion Technology of Internet of Things for Smart Library

Hui Wang*

University Library, Jilin Agricultural University, No.2888 Xincheng Street, Changchun 130118, Jilin, China
[a]huiwang558@163.com
**Corresponding Author*

Abstract: *With the rapid development of microelectronic technology and communication technology, the traditional computer-based computing model is gradually transformed into a human-centered universal computing model. This led to the idea of the Internet of things, which allows people to access information about their surroundings on demand through different terminals. Library is an indispensable part of human life. How to provide a more comfortable library environment to better meet people's family requirements is a place where the Internet of things plays its role. The purpose of this paper is to solve the difference between the data fusion of library environment and the data fusion of other environments by the method of data fusion oriented to library, objectively reflect the change of library environment, and consider the influence of people in the environment, which also puts forward some new problems for the data fusion. In this paper, the process of data fusion middleware from obtaining data to informing the upper module of the changed family environment after deploying the smart library system in a library includes data collection and processing, how to judge whether events are triggered, how the system reacts, and the acquisition and update of user preferences. In the end, this paper presents a general technical framework of situational awareness for smart library system. This paper presents an effective data fusion model and algorithm for library.*

Keywords: *Smart Library, Internet of Things, Situational Awareness, Information Fusion, Data Fusion*

1. Introduction

With the emergence and development of various new technologies, people also put forward higher demands for improving their quality of life. The library, which occupies the space of people's life, has also entered the list of human beings to transform it [1]. The emergence of a new computing model "pervasive computing" provides a solution to this problem. It emphasizes computing integrated with the environment, and people can obtain and process information at any time, anywhere and in any way [2-3]. When applied to library, such "anytime, anywhere" interaction mode requires that the devices arranged in the library can perceive the changes in the environment of the library, and then make automatic behaviors based on user needs or pre-set according to the changes in the environment. If you want to perceive the change of family environment in the family, it is inseparable from the perception of the network, the sensor networks can be made up of cable equipment, can also be composed of a wireless device, its task is to pass the sense all kinds of physical devices in the network to obtain the data library environment changes, the data through the preliminary processing will be sent to the upper module for use [4-6].

Gaohui Cao aims to define the concept of intelligent library and put forward an overall method of constructing intelligent library by combining the current practice and the latest technology. Based on an extensive review of existing library construction documents and practices, this paper makes a distinction between similar types of intelligent libraries and divides the relevant concepts of intelligent library construction into three dimensions: technology, service and people. Traditional libraries can transform to intelligent libraries through the strategic design and implementation of cloud computing, data mining, artificial intelligence and other advanced technologies, but they also need to consider service construction, user training and librarian training. Aiming at the three dimensions of intelligent library (technology, service and humanities), this study clarified the concept of intelligent library and proposed strategies [7]. Intelligent library is a new type of library model, and its green development requires to provide convenience for readers and protect their privacy at the same time. Wang Jialing analyzed privacy risks brought by digital technology, network technology, data mining technology and RFID technology from two perspectives of network platform and physical library. Then, combined with the existing information security technology and network security technology, the corresponding technology protection strategy is proposed [8]. The extraction of visual information is essential for controlling movement in dangerous situations and maintaining situational awareness. Changing coordination while wearing protective gear can affect the likelihood of injury or death. Jongil Lim examined the effects of load size and distribution on environmental perception, segmental coordination, and head gaze. Twelve soldiers stepped down the steps and were instructed to quickly and accurately identify visual information while establishing marksmanship positions in protective gear. Additional packaging and helmet loads were added to extend the visual information recognition time, with a small increase in helmet loads having the greatest impact. Under lighter loads, the head-guidance and the same phase of the trunk-head coordination is stronger, while under heavier loads, the trunk-head coordination is enhanced and the head-gaze dynamics is more disturbed [9].

The first part of this paper introduces the background significance and related work. The second chapter puts forward the technical framework of the smart family system deployed in a library, which provides some references for the standardized design system. The third chapter, aiming at the special environment of library, puts forward the characteristics of data fusion in this environment and the methods and models to be adopted. The fourth chapter mainly introduces the design and implementation of intelligent library data fusion middleware. The fifth part is the summary and experiment conclusion.

2. Proposed Method

2.1 Basic Structure of Smart Library

When we design a smart library system, we first need to be clear about how the system works and what devices it is deployed on. Therefore, after careful search and research, the possible running environment is given. It shows the intelligent library system in this system has a variety of physical equipment and communication methods, which mainly includes two network parts, one is the Internet of things devices deployed in the library, and the other is through the wan and user dialogue terminal. They can be broadly divided into three parts: the Internet of things part inside the library which is responsible for collecting real-time environmental information of the library; The wisdom box section, which is responsible for judging environmental changes and responding to library members and events; Service centers outside the library and users' personal mobile devices [10-11].

(1) Camera equipment

The device is connected to the smart library server by means of WiFi communication, through which the user can directly obtain the image information at home, facilitating the user to view the situation at home in real time and giving the user a sense of reality. Since it is a separate device with its own IP address, it can be controlled remotely.

(2) Radio frequency identification system (RFID)

A complete RFID system consists of a Reader, a TAG, a transponder and an application software system. After the magnetic field is applied to the tag, it receives the rf signal sent by the reader and sends the information in the internal memory chip by virtue of the energy obtained by the inductive current. Another way is to actively send the signal of a certain frequency. When the reader receives the data, it will send it to the upper module after preliminary processing.

(3) Wireless sensor network (WSN)

It is a wireless device that distributes large amounts of data over the job area to obtain the target data, performs preliminary processing on the resulting data, and then transmits the data to the user. They are widely used in military, environmental monitoring, medical, production monitoring and other exploration environments, providing an essential data base for system decision-making.

(4) Other underlying physical equipment

This part consists of a large number of sensors and other information acquisition equipment, the network system deployed in the user's home. In the smart library network, there are many types of Internet of things nodes, such as infrared detectors, smoke detectors, sensors to monitor the health of the elderly and so on. Other sensor base stations, as the devices for transmitting data between the underlying Internet of things and the upper module, receive the sensor data and conduct preliminary processing.

(5) Wisdom box

This part is the processing center of the whole system, which is responsible for connecting the Internet of things system inside the library with the outside world of the library and users' personal mobile devices. It can be divided into user interface and server, which are composed of Haier set-top box, server and various information receiving equipment. Due to the current treatment and research stage, each part is separate. With the research entering and the improvement of various aspects' support, the final product will be a concrete object.

(6) Smart library service center

It is responsible for connecting the library to various vendors in the outside world, minimizing the time lag between service requests and responses. This section responds to multiple requests for service information from the smart library system, splits and distributes the service request information to various providers.

(7) Internet and communication network

When users cannot reach the library, they need to use the Internet or communication network to learn about the situation at home or to receive some prompt messages from the intelligent library system, etc. On the other hand, the intelligent library system needs some real-time information from the Internet to provide users with the latest weather or road information and so on.

2.2 Intelligent Magic Box System Architecture

In the previous description, it can be seen that the connecting part is the wisdom magic box located in the middle part, so it is further analyzed here. The smart box is responsible for further processing of data from the Internet of things and needs to respond to changes in the library environment. It also serves to separate the underlying hardware device from the upper service module. The intelligent magic box consists of server and man-machine interface. The whole intelligent library system is deployed in the server part of the intelligent magic box. The function structure diagram of wisdom magic box is given, from which we can see that middleware is in the position of the whole magic box and its indispensable role. It is mainly composed of two blocks: the first is the library service network, whose function is to provide services to library members through existing local programs for events caused by changes in the library environment, or to transmit a service request to a remote service center; The other is the Internet of things, which requires the management of hardware devices deployed in the library, including the management of different communication protocols, registration and deletion of different devices [12-14].

The intelligent library system is deployed in the intelligent magic box, which is divided into six layers: Internet of things layer, data layer, event layer, situation layer, pattern layer and service layer. Data is transferred in different semantics between different layers, which covers the device interface, that is, the common interface to physical devices. Data filtering, data transformation, data classification and other data level fusion of the data received by the Internet of things; Event layer, that is, after obtaining accurate, stable, semantic data, according to the rules to combine the data into a specific or some events; In the context layer, the single event or multiple events to be obtained can be converted into one or some situations according to the event-to-situation mapping rules. Pattern layer, in which a large number of specific situation combinations are stored, reflects the specific state of the library in a macro sense. For example, when a guest enters the library, the system can automatically launch the corresponding service. The service layer, also known as the application layer, is the interface that directly interacts with the user, communicates with people in a friendly way, and will directly provide corresponding services to the owner.

(1) Device interface

It can be known that a large number of different types of equipment and sensors are deployed in the library, but the communication technology of these devices and sensors is different. In order to solve this problem, an interface is needed to eliminate the inconvenience caused by these different communication methods. This layer plays this role, which mainly includes the transformation of wi-fi protocol, ZigBee protocol, RFID technology, bluetooth technology, Haier interface, WSN interface (Cross Bow), and 3G technology. Wi-fi protocol, or IEEE802.11 wireless protocol, defines two different types of devices: a wireless base station and a wireless access point. The base station is responsible for issuing instructions and receiving data, while the access point is responsible for transmitting instructions and data. ZigBee protocol, IEEE802.15.4, is an effective short-range wireless communication technology with a communication range of less than 10m. It is an Adhoc network that does not require network infrastructure such as access points. RFID technology, which combines radio frequency communication technology and automatic identification technology, a new communication technology. It can be divided into low frequency (30khz-300khz), high frequency (3mhz-30mhz), ultra-high frequency (850mhz-910mfz) and microwave (2.45ghz) four different operating frequencies, according to different needs. Bluetooth technology, it is suitable for near field communication, communication distance is less than 2m, there can be no obstacles in the middle, and can only be used between two devices at the same time, there are many obstacles. Haier interface, provided by Haier, is used to receive and send information from Haier equipment. We can call the interface directly. WSN interface (Cross Bow), which is composed of other wireless or wired sensors and devices in the library, most of which adopt ZigBee communication protocol or WiFi communication protocol. 3G technology is a new communication technology produced with the development of mobile phones. It can provide users with rich multimedia information, reaching 144kb/s when the device is moving at high speed, 384kb/s when walking, and 2Mb/s when at rest [15-17].

(2) Data layer

In the data layer, the data value is converted, and the converted data is further processed. Various denoising methods, such as grouping average and moving average, are applied to ensure that the obtained data reflects the changes of the library environment most truly. User preferences are also merged on this layer and updated to prepare for the next event fusion.

(3) Event layer

After data conversion and filtering, the event layer follows event inference rules, and matches the data obtained from the data layer into corresponding events based on user preferences. Here we use the production rule system for reasoning.

(4) Data layer

The data in the database can be divided into two kinds. One is static data, that is, all kinds of data that have been input before the program runs, such as the location information of each sensor in the home, personal data of family members and personal preferences of each person. This data is stored in the local database in the form of a data table. The other is dynamic data, that is, real-time information collected through the underlying Internet of things during the operation of the smart library system. This data is either dynamically queried by Tiny DB from a sensor node or from other types of sensor devices.

(5) Rule base

The rules in the rule library are defined when the system is initialized, but it also adds new rules during system use to meet the needs of the system. Rules are stored in the database when they are defined and passed into the matching function as an input when they are matched. The context, pattern, and service layers are not covered in this article, so I won't elaborate here.

2.3 Research Status of Situational Awareness

With the development of computer technology, people are no longer satisfied with the interconnection between people, but want to be able to connect between objects and between people and objects. Therefore, the concept of Internet of things is proposed, and it has been widely used in manufacturing, military applications, transportation, aerospace and other fields. The Internet of things comes from pervasive computing, which was proposed in 1991. It is generally believed that pervasive computing should be that computers exist anywhere in the physical world, but users do not know that these computers are providing them with various services. Then in 1994, "situational awareness" was defined as a computer system with adaptive responses to the surrounding environment, illustrating the importance of the surrounding environment. Former researchers used examples of situations to define situations. It is defined as follows: according to the user task, the system USES situational information to provide relevant information or services to the user. From this definition, it can be seen that the goal of situational awareness is the same as that of the personalized system. The former provides information and services based on the user's situation, while the latter provides information and services based on the user's personal interests. As a form of computing service, situational awareness

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

computing has the characteristics of adaptability, reactivity, responsiveness, emplacement, situational sensitivity and environmental orientation. At present, the application of situational awareness mainly focuses on smart space, such as collecting the user's location information, automatically transferring the phone for the user, opening the X Window session for the user, reminding the user what to do, assisting the user to interact with nearby objects, recommending media information to the user, and taking care of the elderly [18-20].

In China, in the e-learning environment, students can be intelligently provided with more humanized services by perceiving their knowledge, social situation and technical situation. Emotion-sensing technology also plays a big role in traffic problems. On the Internet outlet facing the road network environment and under the Service framework of Web Service, it provides a platform for the situation publishing of other intelligent cars in this system, and also provides a simple and easy to use situation Service interface for other context-related applications. It can be seen that situational awareness will play an important role in future life and work.

2.4 Middleware Architecture

Smart library has a variety of applications, each of which requires a different type of sensor; The operating mode and communication information format of various devices at the bottom of the system are also very different. When designing smart library applications, if the applications communicate directly with the underlying devices, the reusability of the written applications is very low. When the underlying device changes, the application has to change along with it, or even be rewritten. Moreover, direct communication between the application and the underlying device also results in a greater burden on the application developer to write the program.

In order to solve the above problems, the introduction of a system to the system structure, the underlying equipment and separation between the upper application, the application layer shielding the underlying equipment is different, so that the application developers to concentrate on the application of development and don't care about the underlying equipment, application of reusability have been improved to a certain extent, is the middleware.

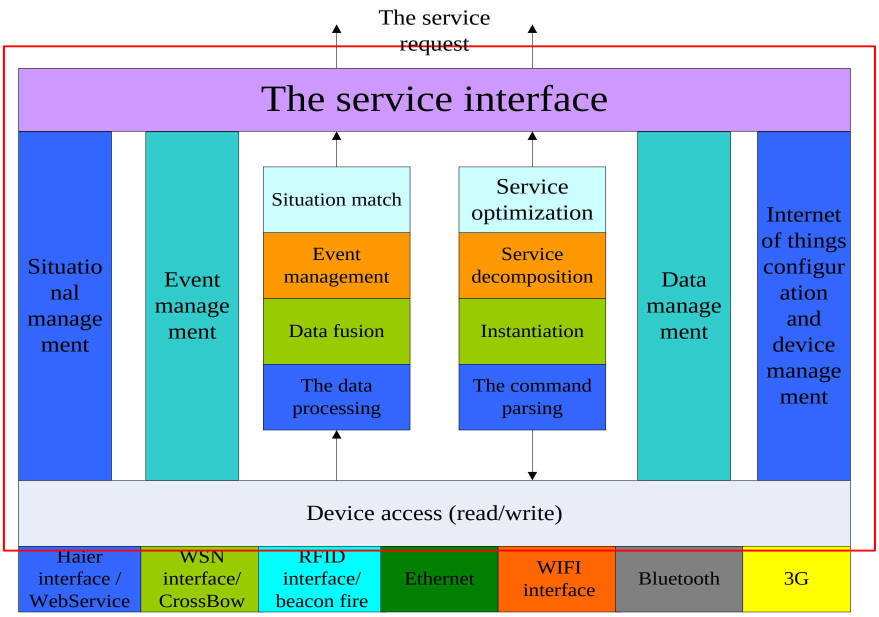

Figure 1: Middleware architecture

The middleware of the intelligent library system is used to process a variety of data collected by the underlying Internet of things and transform them into data form that can be used by the upper module. This middleware provide top event interface directly, after the sensors to perceive a certain trend in the library will immediately send the data to data fusion middleware, after the events of the middleware fusion center, according to the user's personal habits formed after it put some relevant data for processing an event, the event into the event interface, event interface this event will be placed in the upper module. Layer when the situation after receiving the user's instructions, situational layer will put these instructions into the corresponding situation events, these events should be through data

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

integration middleware to find out the corresponding sensors, these events and the middleware is the corresponding information to their corresponding sensor driver module, and then the Internet layer of sensor will perform some operations, to provide users with services you need. The middleware also needs to give these events a unified definition format, such as the main body of the event to describe what the object is, which person, which thing; What is the state of the person or thing, such as its position, where it is moving, what is the temperature, what is the heartbeat; Time, when this data was collected, whether it was urgent data, to indicate its processing priority, and so on. The architecture of the data fusion middleware is shown in figure 1.

It mainly deals with two major data streams: the first is the data transferred from the hardware deployed in the library to reflect the changes of the physical environment in the library in real time. The middleware should conduct preliminary processing and fusion of these data, and then combine relevant data into one or some events that can describe the current situation of the library, and then pass the event to the context layer to match a certain situation. Another data flow is from the upper module's instructions, they mainly according to the current user or system needs to execute a query a state or the hardware setup, let the hardware to complete certain operations, these instructions require service optimization, the decomposition of the final instance into a command for specific hardware devices, to these commands parsing runnin corresponding hardware, the hardware to execute the command.

3. Experiments

Wisdom in a smart library system means that the system can intelligently provide personalized services or prompts based on the idea of ubiquitous computing, depending on the context and the owner. So the key and leading role in this process is to determine what state the library is in, and that's where the sensors play an important role. But due to the nature of sensor hardware itself has led to the it exists many problems, one of the most important is that it is the transfer of data has stability and a certain degree of reliability, so we must to them after get the sensor data processing, to ensure the objective and truly reflect the changes in the environment. After preliminary data processing, data fusion can be used to improve the authenticity of the data. In addition to preliminary processing of data, data fusion can also abstract data to a higher level to formally express the state and change of the real world. This chapter will introduce these processing processes in detail.

From the Internet of things to the real-time information of the library environment to the final response of the system, the whole process requires three steps: first, data collection and processing; Determine whether an event is triggered at this time; 3. The system responds to the event.

3.1 Data Collection

According to the source of information can be divided into the following parts:

(1) RFID devices and infrared sensors: these sensors are mainly responsible for position detection, which are used to detect the target distance, determine the target position, and determine the target state, category and whether there is any human activity in a certain space.

(2) Access control, alarm, glass breakage sensor, monitor: when such sensors are triggered, they will transmit information to the upper layer of middleware and send a sound. The sound can alarm the indoor owner, and its internal information will cooperate with other sensors to determine the source of the alarm.

(3) Light intensity sensor, water sensor, temperature sensor, pressure sensor, smoke sensor, Co and CH_4 gas sensor: this kind of sensor is used to sense physical phenomena in the library, according to the acquired information, the system will do the corresponding operation to adjust people surrounding environment, in order to make people's lives more comfortable.

(4) Intelligent switch, leakage protector, standby power supply: this kind of equipment is controlled by the upper instructions, and is responsible for the control of power supply in the library and the treatment of power failure.

(5) Intelligent bookshelf, intelligent air conditioner, intelligent desk, intelligent stereo, intelligent security check, intelligent meter and intelligent exhaust fan: this kind of information provides the information of various household appliances to the intelligent library system and is controlled by the upper instructions. Equipment includes all smart appliances in the library.

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

(6) Communication network and the Internet: is wisdom library system one of the important source of information in the information fusion system, intelligent library system through the Internet and communicate information to the master and communication network system, and through it to get information from outside the library or the master's instructions, but also can get some real time information from the Internet to provide service for the family.

(7) System time: As important reference information, time actually determines whether many events should be triggered, such as most events related to turning on lights.

3.2 Data Processing

After the analysis in the previous section, we know that there are two data processing methods in the system. The processing of the second kind of data is divided into four steps:

(1) Convert the obtained data into data types

(2) Integrate the data of a single sensor

(3) Processing of sensors in a specific area (accuracy can be increased by grouping geographical features)

(4) Analyze the trend reflected by the sensor data in this specific area

Figure 2 illustrates the hierarchy of steps 2 through 4.

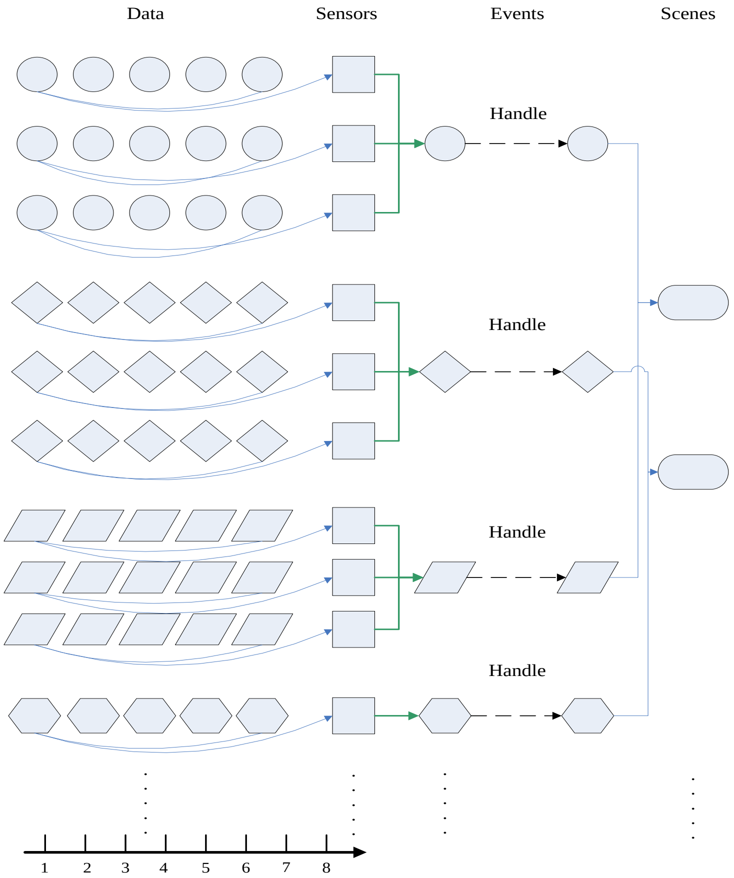

Figure 2: Three-level diagram of fusion

3.3 Data Value Conversion

When the system gets the data, these data are just a series of Numbers, such as 228, 779, 1199, which can not be recognized by people, let alone facilitate people to understand the physical meaning they represent. Therefore, according to the physical characteristics of the equipment and some indicators, this paper lists several data value conversion formulas. Using this formula, the system converts the data it collects into data that can be identified and have physical semantics, including

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

temperature, light intensity and voltage. The formula is as follows:

(1) Temperature conversion formula

$$T = \frac{1.0}{a + b * In(rthr) + c * (In(rthr))^5} - 273 \tag{1}$$

Where a, b and c are constant coefficients, a=0.001307050, b=0.000214384, c=0.000000093, x is the real-time temperature data collected by the system. $rthr = \frac{(10000 * (1023 - x))}{x}$.

(2) Light intensity conversion formula

$$L = light * (\frac{a}{voltage}) / b \tag{2}$$

A and b are constants,a=1252352 and b=1023. Light is the real-time data of the light intensity obtained by the system, and voltage is the real-time voltage data obtained by the system.

(3) Voltage conversion formula

$$V = \frac{a}{x} \tag{3}$$

A is a constant, a=1252352, and x is the real-time data value obtained by the system.

3.4 Matching and Execution Process of Experimental Rules

For the rules of complex events, it is used to define a complex event and also to match the rules of complex events, so the generation of complex events is a process of rule matching. How can you detect from this mass of data which rules are being followed, which events are being triggered, and which events are being triggered so that you can react to changes in the environment in a timely manner? The trigger of the event must satisfy two conditions:1. The atomic event that constitutes the complex event has occurred; 2. These atomic events have occurred in time.

When the conditions for defining an event are met, the event is triggered, and the inference method of the production system is adopted here. Each condition is expressed by production knowledge representation. The general form of production is < predecessor >→< predecessor >, where the former is a condition and the latter is the result derived. The antecedents are composed of data expressions and connectors. However, in this system, the former is composed of atomic events, and the latter is the events derived according to the conditions. The production system completes the work process by pattern matching, conflict resolution and rule execution, as shown in figure 3.

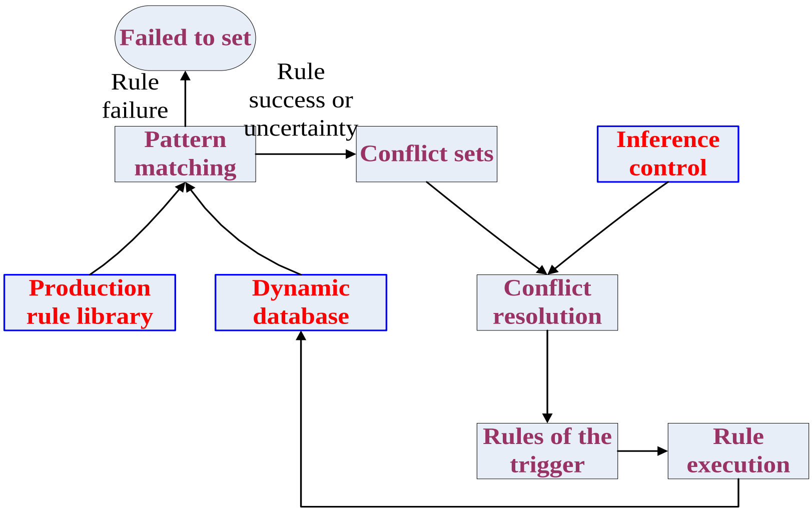

Figure 3: Working process of production system

(1) Pattern matching: Starting from the first rule in the knowledge base, scan all rules in the rule

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

base one by one, compare all elements in the dynamic database with the precursors of each rule, so as to find all rules that meet the conditions. If all conditions in a rule preceding a rule in a rule library match the current fact state in the dynamic database, the rule is added to the conflict set, and the following rules are checked until all rules in the rule library have been matched.

(2) Conflict resolution: Conflict refers to the state in which multiple rules are successfully matched at the same time. At this point, it is necessary to choose which rule should be triggered according to the pre-set evaluation criteria. There are many ways to resolve the conflict, such as choosing according to the order of successful match, that is, choosing the rule that succeeds in the first match; Select according to priority, that is, set the magnitude of each event and the rule with the highest priority option value in the conflict; According to the order of execution, the rule of the last execution is selected first when the conflict occurs; According to the degree of detail selection, that is, in the case of conflict, priority is given to the rule that the premise part includes the maximum number of sub-conditions; According to whether the rule has used the selection, choose the rules that have not been used before; Select by new facts, that is, in the event of a conflict, give preference to rules related to the latest facts added to the dynamic database. In this system, the method selected according to the order of successful matching is adopted, because the sensor network requires the system to make a quick response, while other methods will take up a lot of computer time.

(3) The reasoning of the generative system can be divided into three basic modes: Forward reasoning, backward reasoning and mixed reasoning. Positive reasoning, which starts from a set of conditions representing facts and USES some rules of reasoning to prove whether the objective conclusion is true or not; Backward reasoning, which starts from the conclusion representing the target, USES certain rules to prove the fact condition is true, that is, gives a variety of hypothesis (target) situations, and then verifies whether these hypotheses are true one by one; Mixed reasoning takes the advantage of the first two methods, which proceed from both conditions and objectives, and if the two parties meet somewhere in the middle, the reasoning succeeds.

In this system, positive reasoning is adopted, because its goal is to find all possible conclusions from a set of given facts, which is in line with the actual situation of the system, deducing possible results from the occurrence of atomic events, and this way is more in line with people's logic.

(4) Rule execution. Running, the reasoning mechanism of repeated cycle to perform the above three stages, it according to the facts and rules of the system in dynamic database in the library knowledge, constantly introduced the unknown by the known facts, and once again to dynamic database, will they into a new premise or facts circular reasoning process, until the final conclusion is deduced.

4. Analysis of Situational Awareness Collaborative Filtering Method

In order to verify the effectiveness of collaborative filtering recommendation based on context perception, we defined a new evaluation indicator from the perspective of Reader experience: Reader Acceptance Ratio (RAR), calculated as follows:

$$RAR = \frac{\sum_{InterestSet}\{I_1, I_2, ...I_m\} \bigcap \{Top - NDocument\}}{\{Top - NDocument\}} \tag{4}$$

Where, {Top-NDocument} represents the literature resources of the TOP -n ranked according to the recommended method, and the Interetrate set {I1,I2 ... Im} represents the literature resources of interest to the target reader. Find the intersection of the two sets, representing the resources of interest to the reader in the list of recommended resources. From the perspective of reader experience, reader acceptance reflects the degree of resource recommendation adoption. The higher the value, the more likely the recommendation method is to recommend appropriate resources to target readers in the current context.

According to the acceptability of readers, the collaborative filtering recommendation method based on context perception is compared with the traditional collaborative filtering recommendation method. We use k-folding cross test to conduct data modeling and testing, and divide the data set into K parts, among which k-1 part is used as training data set and the other 1 part is used as test data set. At the same time, the cross-examination process is repeated many times to make the experimental results more reliable and objective. In the experiment, we applied k-fold cross test (K=10) to repeat the experiment for 20 times, and recommended the literature resources ranked Top 5 to the target readers. The comparison results of the two collaborative filtering recommendation methods on the reader

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

acceptance index are shown in figure 4.

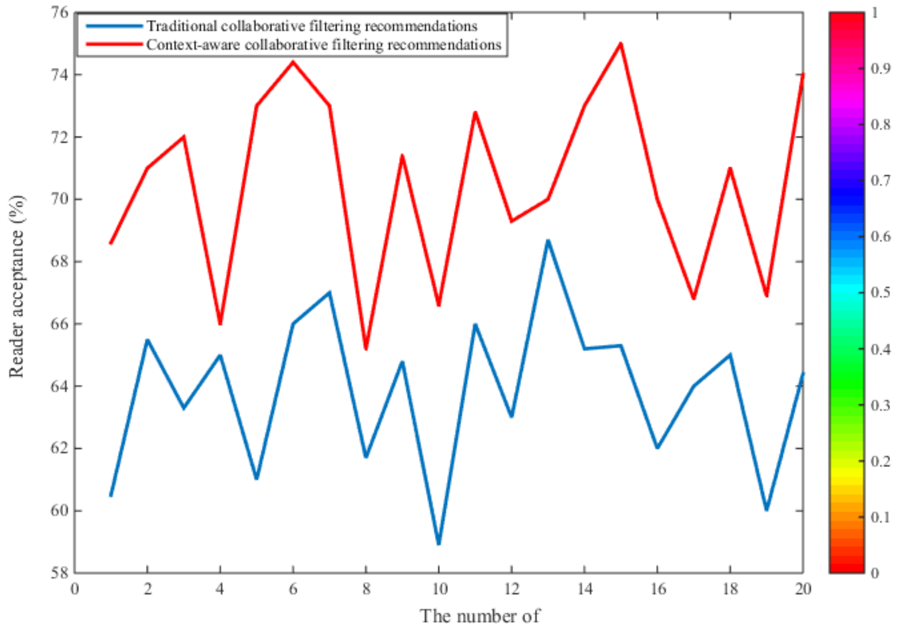

Figure 4: Comparison of two collaborative filtering information recommendation methods

As can be seen from figure 4, the context-aware collaborative filtering recommendation method proposed by us is better than the traditional collaborative filtering recommendation method in performance, and the two collaborative filtering recommendation methods are better than the traditional collaborative filtering recommendation method in terms of reader acceptance. The difference is about 10%. The experimental results show that the collaborative filtering recommendation method based on situation awareness, can well predict the reader perception properties on the situation, and identify the different role in the different situation for information recommendation, which based on the current situation in mobile environment information, accurately provide personalized mobile reading service for readers.

4.1 Trend Processing after Regional Sensor Data Fusion

When the real-time attribute value of a specific area is obtained, we need whether this value can truly describe the indoor environment change. The moving average method is adopted here. Moving average method, with a time sequence y1, y2... Yt, ... Then, the average of N Numbers can be calculated one by one according to the order of data, and the moving average can be obtained:

$$M_t^{(1)} = \frac{y_t + y_{t-1} + \ldots + y_{t-M+1}}{N} = M_{t-1}^{(1)} + \frac{y_t - y_{t-N}}{N}, t \geq N \tag{5}$$

Where $M_t^{(1)}$ is the first moving average of the t-period; y_t is the observed value of the t period; N is the number of moving averages, that is, the number of observations used by each moving average.

This formula indicates that when time t moves forward to the next moment, a new data is added, the earliest data is removed, and a new average is finally obtained. Because it continues to "absorb the old and absorb the new" and move forward one time point after another, it is called moving average method. Because the moving average method can smooth the data, eliminate the influence of periodic and irregular changes, and make the long-term trend of the data appear, it can be used for forecasting. Its prediction formula is:

$$\hat{y}_{t+1} = M_t^{(1)} \tag{6}$$

That is, take the first moving average of the t period as the predicted value of the t+1 period.

For example, indoor temperature as shown in figure 5, after moving average method of value was compared with the original values as shown in figure 6, can be seen clearly from the table, after processing the original two peak has become smooth and that they will have much impact on the whole, but also will not mislead the system's response to events, have played an important role in forecasting.

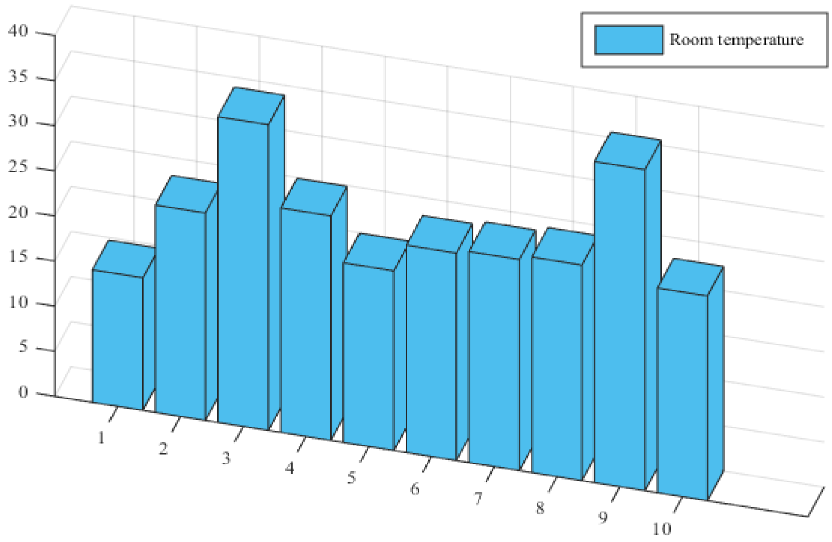

Figure 5: Actual temperature curve of the room

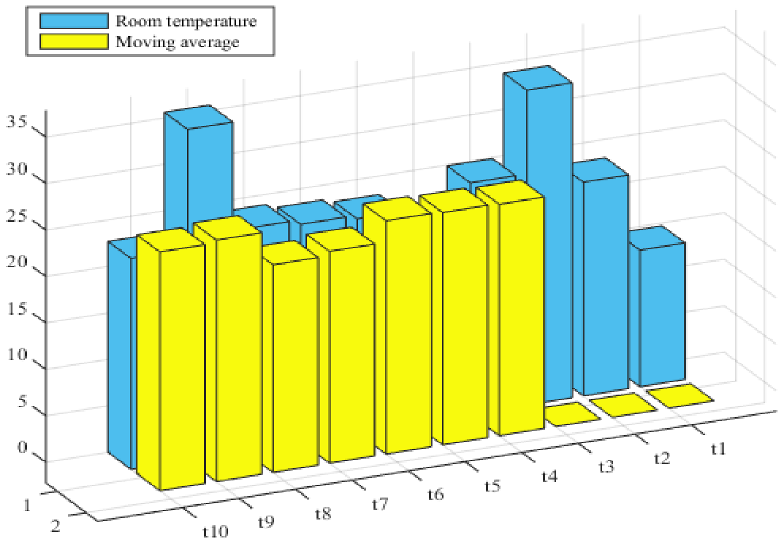

Figure 6: Comparison of renderings

Figure 6 shows the prediction graph given by applying the moving average method to verify the feasibility of the method when the value of sensors in the home keeps rising and the temperature value of room a keeps rising.

4.2 Overall Design of the System

Intelligent library Internet of things data fusion middleware consists of four sub-modules: data receiving and processing module, knowledge reasoning module, user preference acquisition and update module, service decomposition and implementation module.

The global structure diagram of the system is shown in figure 7:

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

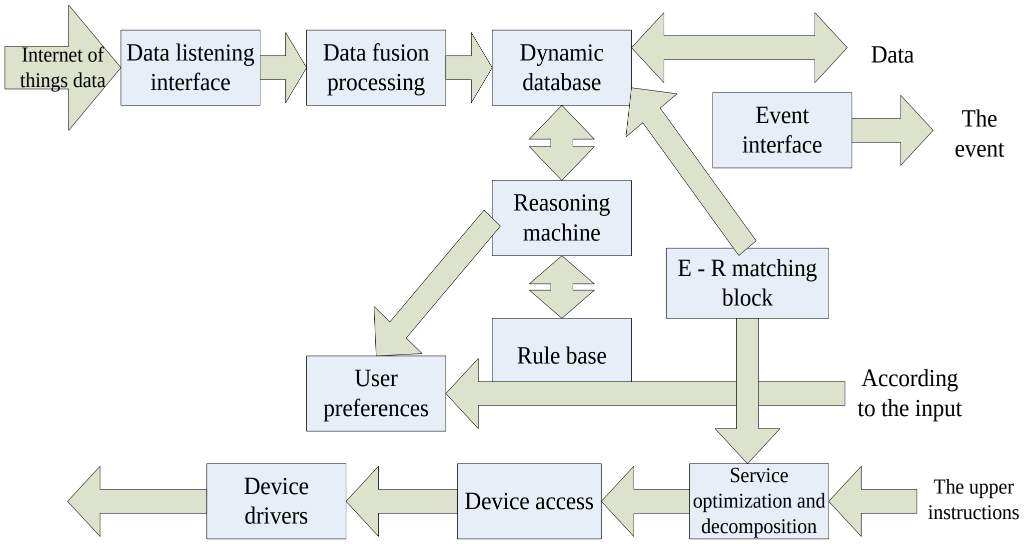

Figure 7: Global architecture diagram

In the data fusion middleware, the data receiving and processing module is responsible for the collection and preliminary processing of real-time data obtained from the Internet of things and other related sensing devices in the library to prepare for further fusion processing. The knowledge reasoning module is responsible for matching the data sent from the bottom into corresponding events according to rules; the event description module uniformly deals with the events sent from the knowledge reasoning module to form a form that is easy to transfer. The event decomposition module is used to translate the service requirements passed down from the upper level into instructions that the system can understand and then pass these instructions to the relevant lower level hardware devices for execution.

When the hardware is deployed in the library and the system is initialized, the staff will manually set the relevant attributes of the Internet of things sensors, such as installing several sensors in a room, and the user will display and set the user preference value. Experts will set some authoritative attribute values, such as the tendency to generate fire when the temperature is higher than what? At present, various attribute values set by staff, users and experts on the system constitute constraint conditions, while the reasoning module takes constraint conditions as the criterion, fuses the data collected from the Internet of things, and finally produces an event that can reflect the real-time environment state of the library, and informs the upper module of this event. The upper module sends instructions to the lower iot hardware, such as asking for someone's location.

5. Conclusions

In order to better provide personalized mobile reading services for readers under the mobile environment, this paper tries to apply the information recommendation based on situational awareness to the field of digital library, and proposes a collaborative filtering recommendation method based on situational awareness. This method measures readers' situational awareness through "situational entropy", and calculates the corresponding weight values of different situational attributes in information recommendation. On this basis, combining with the traditional collaborative filtering technology, it provides readers with personalized reading recommendation services in line with the current situation. Experimental results show that the method is superior to the traditional collaborative filtering recommendation method, can well predict the reader perception properties on the situation, and identify the different role in the different situation for information recommendation, which based on the current situation in mobile environment information, accurately provide personalized mobile reading service for readers. The research of this paper makes a beneficial exploratory research on the personalized information recommendation service of digital library based on context perception in mobile environment. It can be predicted that the mobile reading recommendation service, which centers on readers and provides them with situational awareness, will be a new direction for the development of digital library information service.

In this paper, the data collection and processing, listed the system can get the data types, and in order to facilitate understanding, the data needs to be processed. When processing data, considering the

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

unreliability and instability of single point data, four layers of processing are needed here before the upper layer can be used, including data type conversion, single sensor data de-noising, sensor fusion processing in a specific region, and post-fusion trend processing of sensors in a specific region. How to judge whether an event is triggered or not, it is necessary to know what is an event. Therefore, the definition and description of the event are given. When a series of events are defined, it is equivalent to defining the triggering mode of events. Therefore, binary search is adopted when matching rules in accordance with the conditional reasoning mode of the production system, which effectively improves the efficiency of rule matching.

In this paper, a lot of research work is carried out on the Internet of things information fusion technology oriented to the situation perception of smart library. This paper presents an effective data fusion model and algorithm for library.

References

[1] Ruslan Aleksandrovich Baryshev, Sergey Vladimirovich Verkhovets, Olga Ivanovna Babina. The smart library project: Development of information and library services for educational and scientific activity [J]. Electronic Library, 2018, 36(10). 81-94.
[2] Nícolas A.R.L. Netto, Carmen L.T. Borges. Enhancing the situational awareness of voltage security region via probabilistic reliability evaluation [J]. International Transactions on Electrical Energy Systems, 2019(5):663-674.
[3] Todd Martin, K.-C. Chang, Xin Tian. A probabilistic situational awareness and reasoning methodology for satellite communications resource management [J]. IEEE Aerospace Conference Proceedings, 2015, 2015(55):33-36.
[4] Alicia Kissinger-Knox, Patrick Aragon, Moti Mizrahi. Does Non-Moral Ignorance Exculpate? Situational Awareness and Attributions of Blame and Forgiveness [J]. Acta Analytica, 2018, 33(1):161-179.
[5] Pogrebnyakov N, Maldonado E. Didn't roger that: Social media message complexity and situational awareness of emergency responders [J]. 2018, 40(23):166-174.
[6] Campbell A A, Harlan T, Campbell M. Using Real-Time Data to Warn Nurses of Medication Administration Errors Using a Nurse Situational Awareness Dashboard [J]. 2018, 250(48):140.
[7] Gaohui Cao, Mengli Liang, Xuguang Li. How to make the library smart? The conceptualization of the smart library [J]. The Electronic Library, 2018, 36(8):210-234.
[8] Wang Jialing. Readers' Privacy Protection Technology under the Smart Library Mode [J]. Libraly Journal, 2017, 36(9). 90-112.
[9] Jongil Lim, Christopher J. Palmer, Michael A. Busa. Additional helmet and pack loading reduce situational awareness during the establishment of marksmanship posture [J]. Ergonomics, 2017, 60(6): 824-836.
[10] Yan Li, Guang-qiu Huang, Chun-zi Wang. Analysis framework of network security situational awareness and comparison of implementation methods [J]. EURASIP Journal on Wireless Communications and Networking, 2019, 2019(1):78-82.
[11] Elizabeth D. Rosenman, Aurora J. Dixon, Jessica M. Webb. A Simulation-based Approach to Measuring Team Situational Awareness in Emergency Medicine: A Multicenter, Observational Study [J]. Academic Emergency Medicine Official Journal of the Society for Academic Emergency Medicine, 2017, 25(2):61-75.
[12] Russell L, Goubran R, Kwamena F, et al. Agile IoT for Critical Infrastructure Resilience: Cross-modal Sensing as Part of a Situational Awareness Approach[J]. 2018, PP (99):1-1.
[13] Thays R. Gonçalves, Larissa N. Rosa, Alex S. Torquato. Assessment of Brazilian Monovarietal Olive Oil in Two Different Package Systems by Using Data Fusion and Chemometrics [J]. Food Analytical Methods, 2019, 90(683): 771-780.
[14] Zheng WANG, Zhihua MAO, Junshi XIA. Data fusion in data scarce areas using a back-propagation artificial neural network model: a case study of the South China Sea [J]. Frontiers of Earth Science, 2018, 12(2):156.
[15] Mohammad Al-Sharman, Bara J. Emran, Mohammad A. Jaradat. Precision Landing Using an Adaptive Fuzzy Multi-Sensor Data Fusion Architecture [J]. Applied Soft Computing, 2018, 69(45):412-436.
[16] LuMing Qi, Jieqing Li, Honggao Liu. An additional data fusion strategy for the discrimination of porcini mushrooms from different species and origins in combination with four mathematical algorithms [J]. Food & Function, 2018, 9(11):78.
[17] Xi D, Li L, Zhang J, et al. Improvement of Mammographic Mass Classification Performance

ISSN 2706-655X Vol.3, Issue 9: 16-29, DOI: 10.25236/IJFET.2021.030904

Using an Intelligent Data Fusion Method[J]. 2018, 8(2):275-283.
[18] Zhao T, Fu J, Wang Y, et al. An underwater measurement and control network centralized data fusion localization algorithm based on Chan-algorithm method [J]. 2018, 13(14):142.
[19] Ambra R. Di Rosa, Francesco Leone, Carmelo Scattareggia. Botanical origin identification of Sicilian honeys based on artificial senses and multi-sensor data fusion [J]. European Food Research & Technology, 2018, 244(2): 1-9.
[20] Aida Makni, Alain Y. Kibangou, Hassen Fourati. Data Fusion-Based Descriptor Approach for Attitude Estimation underaccelerated maneuvers [J]. Asian Journal of Control, 2019, 7(4):45.