

# User Information Based Smart Home Service Support System

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## Abstract

With the Fourth Industrial Revolution, new services are being created in various industries that converge with information technology. Existing industry and service businesses are combining with IT to create new value and also bring about various changes to industry and service structure. By introducing smart concept through IT convergence, it is possible to provide integrated services such as residential environment, transportation, web service and healthcare. Through the IT convergence technology, the smart industry is diversely developing. Smart technology can be applied to each industry to provide integrated services using services or collaboration that were not previously provided. In particular, smart home service is continuously developing due to the development of ICT and the spread of various IoT devices. Smart home service can provide integrated service in a single device service provision. This adds user information to Smart home service, and selectively provides necessary service according to user's situation. The ubiquitous concept has brought many changes to the flow of existing home services. As IoT technology develops, it is evolving from ubiquitous to smart home service concept.

**System:** Smart home services were mainly provided as a service type for simple functions such as control and operation of services provided by ICT devices. In other words, rather than providing services that consider users, services on the technology push side have been in progress. This service provision method causes a problem in the satisfaction and availability of the service. This paper proposes a system that can provide a suitable service when a user requests a service by using user information in providing an existing smart home service. Through the proposed method, the user can receive the service according to the situation. User information based smart home service support system collects user information by adding IoT device to existing smart home environment. User information is used to provide Smart home service through each service support module. Through the user information support, Smart home residents can be provided with appropriate services according to the situation.

**Keywords:** Smart home, ICT, IoT device, Smart home service, information.

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## 1. Introduction

Based on the development of IT technology, a new trend of the 4th Industrial Revolution has been reached. In the 4th Industrial Revolution, convergence with IT technology is an important factor. Smart technology is a representative technology that can be applied to various

industries and services. ICT environment such as smart farm, smart factory, and smart home can be said to be a form of convergence with existing industries[1]. With the development of ICT and continuous dissemination of IoT devices, the network flow in the home is spreading. In particular, smart homes are a convergence of computing environment and residential space, and

user demand and service demand are increasing. Smart home refers to the development of information and communication technology to provide home appliances connected to a wired or wireless network to provide services. This has been growing rapidly since the emergence of the home network market in the early 2000s [2,3]. Smart home can be said to be an expanded area that complements the limitations of existing home networks. Smart home is an advanced platform in that the limitation of user's time and space is removed due to the development of wireless communication technology and the expansion of connected devices. [4]. Smart home service is changing from IoT device dissemination and infrastructure construction to platform business based on inter-device linkage service. [5]. Most of the existing researches on smart homes are focused on research on residential type services and smart home security [6,7]. Thus, the necessity of research on user-centered smart home service is emerging [8]. Currently, Smart Home Service provides ICT environment and IoT device unique functions to users [9]. This service delivery method leads to continuous provider-oriented service production. Provider-oriented services put pressure on users by upgrading existing devices or developing new IoT devices for specific functions without considering each user's characteristics. In addition, devices that provide limited services are incomplete in providing integrated services through collaboration between devices [10]. Therefore, this paper proposes a User Information Based Smart Home Service Support System that can provide appropriate services to users. User Information Based Smart Home Service Support System additionally constructs IoT device that can collect user information in existing smart home service to collect user behavior analysis and information. Information collected from the IoT device is generated as information classification and analysis information by the support broker of the smart home service support system. When the service request of the smart home user occurs,

additional analysis information is provided to support the appropriate service according to the user's situation. User Information Based Smart Home Service supports user service by requesting external service support if proper service response is not performed internally. This paper is organized as follows. Chapter 2 introduces existing Smart technologies and their current status. Chapter 3 proposes a smart home service support system based on user information to solve the problems of the existing smart home service proposed in this paper. Chapter 4 describes the analysis and evaluation of the proposed system, and Chapter 5 consists of the conclusion including future studies.

## 2. Related Work

### 2.1. Smart technology and Technology trends

The technology required for a smart home is a home network system in which home appliances, multimedia and internet devices are connected for information sharing and efficient service provision [11]. Home network system performs functions to improve user convenience and safety [12]. It is also a technology related to context aware computing that can detect and recognize situations in the home. Context aware computing recognizes information such as user's situation, behavior, and environment changes so that smart home service can provide it to users through the network [13]. There are several base technologies to support the technology required in the smart home. Various base technologies are needed such as sensor technology to sense information and smooth communication of the sensed information, technology for networking, chip technology for the functions of IoT devices, software for implementing service functions, embedded system technology, platform technology for device operation and collaboration, technology for processing data generated by smart homes, data analysis and text mining technology, web service technology, and application technology[14]. In

addition, for security threats in the smart home, there is a need for technology to solve security vulnerabilities such as data forgery, unauthorized service and unauthorized user access,

authentication interference, information leakage, and replication attack. Table 1 shows the components of smart technology and the base technologies [15].

**Table 1: Components of smart technology and the base technologies**

Element	Function	Technology
Sensor	User Environmental change detection	RFID, MEMS, UFD, Smart Dust, Smart Its, Active Badge
Processor	Data analysis / judgment	TRON, Tiny OS, PEER OS, Mantis, Qplus
Communication	Communication between devices	IPv6, wPAN
Interface	Information input and output	Display Technology, Paintable Computing
Security	Security certification	Sensor Authentication, Biometrics authentication, Action Authentication

## 2.1. Smart Home Service

Smart home service types can be classified into 6 types. They are Entertainment / E-Commerce, Healthcare Service, Energy Management, Remote Appliance Maintenance, Home Quality Service, and Security Service. Entertainment / E-Commerce provides information service on contents. Healthcare Service provides services to check and manage user health through the Internet of Things, and Energy Management provides energy conditioning and management within the smart home. Remote Appliance Maintenance

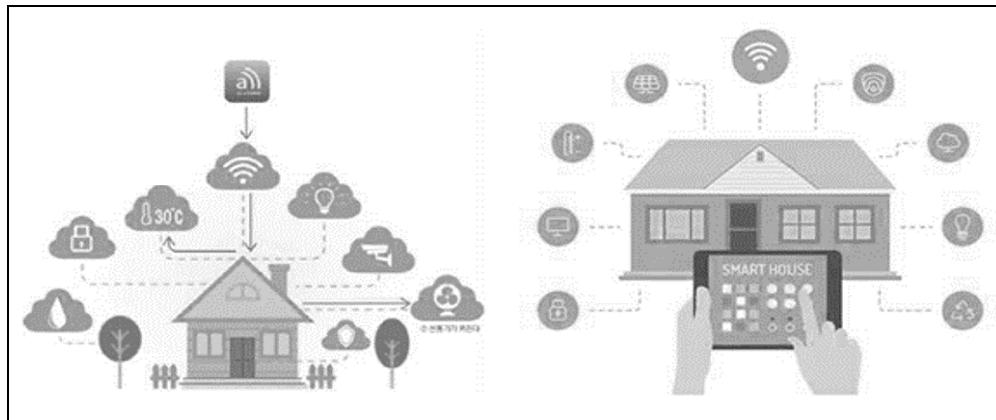
provides a service for displaying and controlling device operation in a smart home. Home Quality Service provides the optimal indoor environment, and Security Service provides access and safety services for smart homes. These services provide services using a network within a smart home. The provided smart home service provides convenient and efficient service environment to residents using IoT device by integrating IT technology in residential environment. Table 2 shows the types and features of smart home services [16].

**Table 2: Types and Features of Smart Home Services**

Service type	Features
Entertainment / E-Commerce	- Can provide information services on all programs and content
Healthcare Service	- Checks and measures the health condition by using medical equipment distributed to each household - Automated patient monitoring system can notify medical institutions for medical examination and medical measures
Energy Management	- Automatically puts unused energy into sleep mode - Provides a pleasant environment by suggesting appropriate energy consumption according to the season
Remote Appliance Maintenance	- Shows the status of the home and the operation status of the devices at a glance
Home Quality Service	- Centrally controls systems such as lighting, air conditioning, ventilation, and fire alarms - Automatically determines the optimal condition to maintain the indoor environment
Security Service	- Ensures the safety of the home, including access control and fire/gas alarms

There is active research related to Energy Management, Remote Appliance Maintenance, Home Quality Service, and Security Service. However there is a lack of research on Entertainment / E-Commerce, and Healthcare Services. This is because Entertainment / E-Commerce is related to the actual life of residents

and Healthcare Service is closely related to the health and disease information of residents. Research is needed to provide smart home service based on living environment, health information and disease information of residents. Figure 1 shows the smart home service conceptual diagram [17].



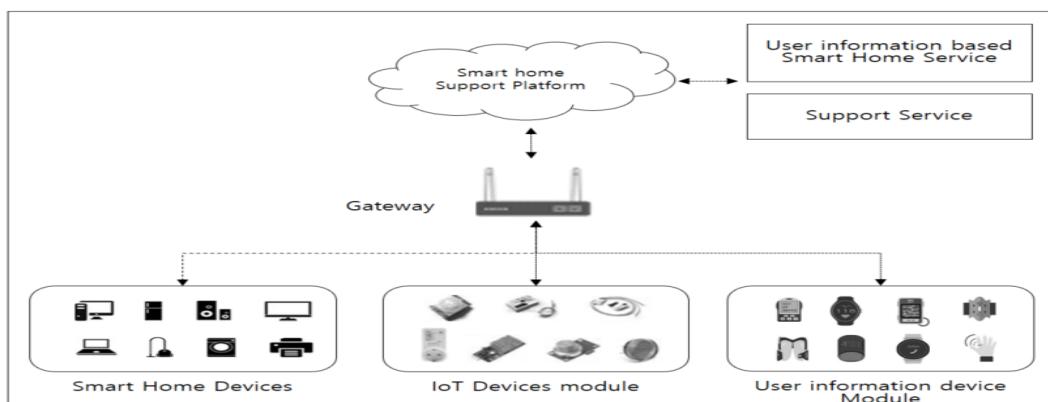
**Figure 1. Smart Home Concept.**

### 3. Proposal Methods

#### 3.1. User information based Smart Home Service Model

Smart home service provides services to check and control the status of network-based smart devices and IoT devices. A user connects to a smart server through a smartphone, a PC or a smart terminal. Smart server can receive and control smart device information through interface. Such a smart home service provides a single service of a smart device connected to a network by a user request. However, smart services that provide control of smart devices only provide

control for some smart device types. In addition, it does not provide services for various types of smart devices connected to the home network. To supplement these service provision limitations, a smart home service model by adding IoT support manager to Smart Gateway and Smart Device control is proposed. The proposed smart home service model can provide a user with a suitable service by providing additional user information to the existing service providing method. It also enables smart devices to support integrated services through collaboration. Figure 2 shows the smart home service model.

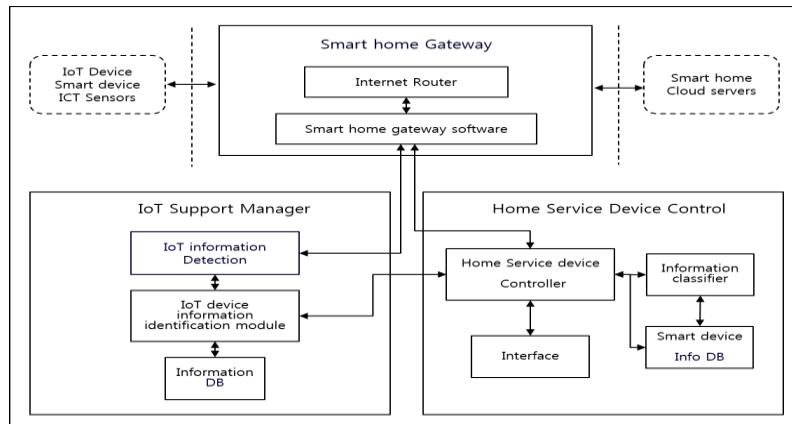


**Figure 2. User information based Smart Home Model.**

### 3.2. User Information Based Smart Home Service Support System

Smart home users use various smart home devices using smart terminals. User Information Based Smart Home Service Support System consists of Smart gateway server, Smart device control, and IoT support manager. Smart terminal accesses Smart Gateway Server through gateway, and smart gate server provides status information of each smart device through interface. Smart gate server manages smart device information and status. User checks smart device status information and requests necessary tasks and service functions. When the user requests additional service support, the smart gateway server requests user information from the IoT support manager and provides the appropriate service. Smart device control manages smart devices in a smart home. Through the smart gateway server command, smart device control

manages and controls the operation and service provision of smart devices. Smart device control collects information and data generated when providing tasks and services. Smart device information is provided to smart gateway server through analysis and classification and used when requesting integrated service of user. IoT support manager collects smart home user information. It collects and analyzes user's behavior, health information, environmental information, and mobile information using IoT devices. User information is monitored using sensors, CCTV, voice recorders, and wearables. Collected user information is provided upon request of Smart gateway server and can provide appropriate service to the user. Figure 3 shows the User Information Based Smart Home Service Support System.

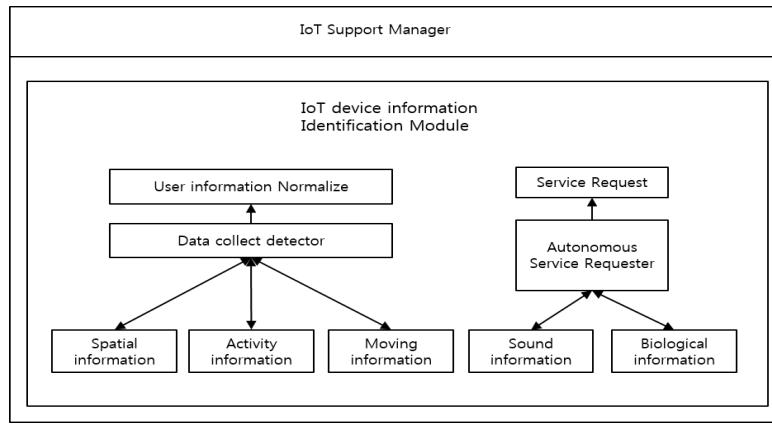


**Figure 3. User Information Based Smart Home Service Support System.**

### 3.3. User Information Identification Using IoT Devices

Smart home can be configured with various services using the User Based Smart Home Service Support System. Smart home service should be able to control autonomously using smart device status information and also have the function to control single service of smart device. When requests from users or smart devices occur,

complex control and service provision should be possible through collaboration. Smart home service support system generates user information using IoT device to support smart home integrated service. User information is provided when there is a need for collaboration between devices or when requesting a service suitable for a user's situation. Figure 4 shows the creation of user information using IoT devices.



**Figure 4. IoT device information identification module.**

User information is collected and generated in IoT device information identification module of IoT support Manager. Data collect detector collects and analyzes user's spatial information, activity information and moving information in smart home. The IoT device information identification module has a data detection function that extracts general data values or unnecessary data, and re-requests the data when data outside the standard value range is detected. The approved data is normalized and sent to the IoT support manager as user information. Autonomous Service Requester monitors user's Biological and Sound information in real time. When it detects sudden information of data or biometric information that is out of the range of user's set value, it requests service automatically. Service Request calls for medical and external support services of the Smart home service.

#### 4. Comparison Analysis

Existing home network system is composed of simple service provision methods such as device control, condition and provision of information, etc. by connecting the home appliances with network. The distribution of IoT device and the development of smart technology enable the provision of the service fit to diverse demands. Building the ICT environment enables the collaborative works among devices. That, is, new service can be provided from the single service provided by home network depending on the

device environment. Aiming at providing such services, diverse researches on the smart home services are under progress. Most of the researches on the smart home services provide the services to the user based on the device condition or device information. However, the research that provides the service based on the user environment or information is insufficient. Currently, many smart home services reflect service policy by device developer and supplier and the user received the service limited by the device supplier. The service policy by the supplier has a problem that the service can be expanded only when new device is purchased or additional IoT environment is built. In addition, since the smart home user uses the smart devices, the demand for the integrated service that can support the service fit to the user is being increased. In this paper, to complement the problems occurred in the home network and the smart home, the user information-based smart home service system is proposed. Smart home service support system proposed in this paper can provide collaborative services among the smart devices so that the service fit to the used can be provided based on the user information. In addition, it can enhance the user's satisfaction by providing the appropriate service for the user and can provide the customized service. Table 3. shows the information compared the existing service model with the proposed service method.

**Table 3: Comparison of existing research and proposal method**

Service Model Item \	Home Network	Smart home	Proposal method
Service provision method	Characteristic function	Supplier policy based	Collaboration service User information based
User information collection	Not collect	Partial collection	Collect user information
Device expansion	Partial expansion	Expandable	Expandable
Service integration	Device service	Integrated service support	Integrated service support

The proposed system was compared with home network and smart home system. The items to be compared are service provision method, user information collection, device expansion and service integration. In the service provision method, the home network provides only the characteristic functions and the smart home system provides the collaborative service based on the supplier policy. The proposed system can provide the device collaboration service based on the user information. For the user information collection, in the smart home system, it is collected partially and in the proposed system, the service is provided by collecting the user information. For the device expansion and service integration, in the home network, it is partially possible and in the smart home system and the proposed system the integrated service is provided.

## 5. Conclusion

The continuous development of the ICT environment, convergence of IT technology, and the spread of various smart devices and IoT devices have brought about many changes in the residential environment. With the proliferation of smart technology and devices, and the development of home networking technology through wired and wireless network communication, existing service provision methods and new service needs are required for the user. Smart home service is mainly composed of simple service provision that provided only a single service or work status shown by the device.

Smart device provider-oriented services do not have much consideration for service expansion and users because they are mainly provided separately and independently. In other words, service provision in the form of responsive service to new demands or the construction of additional smart environment cannot provide adequate services to users. IoT-based smart home services can provide new services through collaboration between smart devices. In addition, it is possible to provide various types of services by expanding new information. However, the IoT-based service provision method can provide services through collaboration between smart devices, but user consideration is still not reflected. To solve this problem, this paper proposes a smart home service support system based on user information. The proposed method collects user information in the smart home by supplementing the IoT device that can collect user information in the existing smart home service provision method. IoT devices collect user's spatial information, behavior information, situation information and health information and provide them as additional information when smart home service is requested. If it is determined that a smart device or a collaboration service suitable for a user's situation is needed, appropriate services are provided to the user based on the user's information. The smart home service support system proposed in this paper aims to provide a suitable service for users based on user information, rather than providing a service corresponding to service demand. By providing services that consider users, service

satisfaction and availability can be increased. Future research will expand the smart home service support system proposed in this paper to study smart city service access model plan through external support service connection and regional linkage.

## References

- [1] Okano MT. IoT and industry 4.0: the industrial new revolution. International Conference on Management and Information System. 2017 Sep;25:75-82.
- [2] Dobrev P, Famolari D, Kurzke C, Miller BA. Device and service discovery in home networks with OSGi. IEEE Communications magazine. 2002;40(8):86-92.
- [3] Kim BJ, Kim YI, Song JE, Kim YK, Cho CH. A Study on the open platform of the home IoT device. Proceedings of Symposium of the Korean Institute of communications and Information Sciences. 2016 Jan; 1125-1126.
- [4] Gu HM, Kim SW. A Study on discontinuance Intentions towards Smart Home IoT service. Journal of basic design&art. 2017; 18(2):1-12.
- [5] Lim CM. Domotics Service User Type Analysis using Q Methodology : focusing on user experience[master's thesis]. Yonsei University; 2015.
- [6] Park JH, Choi JH. Smart security surveillance technology for the home network environments. Communications of the Korean institute of information scientists and engineers. 2012 Aug;30(8):26-33.
- [7] Choi JH, Jung YH, Lee SH, Seo JH, Han TD. Designing user interface for smart home server system. The korea institute of information scientists and engineers. 2011 Jun; 5-8.
- [8] Shim SG, Park HJ, Park JH. Status and Strategies of Standardization in Smart Home. Communications of the Korean institute of information scientists and engineers. 2012 Aug;30(8):19-25.
- [9] Miller BA, Nixon T, Wood MD. Home networking with Universal Plug and Play. IEEE Communication Magazine. 2001 Dec;39(12):104-109.
- [10] DLNA. The DLNA Networked Device Interoperability guidelines expanded Digital Living Network alliance. Digital Living Network Alliance(DLNA). 2006 Oct.
- [11] Lee KS, Lee KC, Lee S, Oh Kt, Baek SM. Network configuration technique for home appliances based on LnCP. IEEE Transactions on Comsumer Electronics. 2003;49(2):367-374.
- [12] Rose B. Home networks: A standards perspective. IEEE Communications Magazine. 2001;39(12):367-374.
- [13] Ha KN, Kim HH, Lee KC, Lee S. Survey on Location Based System for Smart Home. 2007 Jun;24(6):7-14.
- [14] Beverungen D, Matzner M, Janiesch C. Information systems for smart services. Information Systems and E-Business Management. 2017;15(4):781-787.
- [15] Cho HG. A Research for Proposing the Roadmap Based on the Scenario of Smart Home Service for the Elderly[master's thesis]. Dankook University; 2007.
- [16] Kang EH, Park NC. Developing Smart Home Service Scenario Based on Contextual User Research. Journal of Digital Design. 2014 Jan;14(1):43-53.
- [17] Won JW. A Study on Utilization of Smart Home UX Design for internet of Things(IoT) Environment. Journal of Communication Design. 2016;57:117-128.