

# **HEMS (Home Energy Management System)**

## **Base on the IoT Smart Home**

**Junyon Kim**

Korea Nazarene University  
456 Ssangyong  
Cheonan, Chungnam 331-718  
Republic of Korea

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### **Abstract**

As buildings consume as much as 40% of the nation's total energy in advanced countries and 21% in South Korea, the need for an active and systematic building energy management system using the ICT technology is increasing on the long-term basis. In South Korea, BEMS installation was made mandatory for new public buildings over 10,000m<sup>2</sup> by 'the regulations on the reasonable energy use in public organizations' as of July, 2013. The development of the related industries has been accelerated led by the government since it announced the 'BEMS activation plan' in January 2014. As the need for an active and systematic building energy management system (BEMS) using the IoT technology is increasing, a HEMS(Home Energy Management System) model using Internet of Things (IoT) was constructed as a way to reduce energy consumption in houses, and the ways to utilize the model were studied.

**Keywords:** Smart home, IoT, HEMS (Home Energy Management System)

## **1 Introduction**

Currently, the energy supply crisis caused by unstable oil prices and mandatory greenhouse gas reduction requires the government to establish policies on energy saving. As buildings consume as much as 40% of the nation's total energy in advanced countries and 21% in South Korea, the need for an active and systematic building energy management system using the ICT technology is increasing on the long-term basis.

South Korea is an energy over-consuming country with its greenhouse gas emission ranked at 7th in the world, and its greenhouse gas emission growth ranked at 1st among the OECD countries, while it imports over 95% of its energy from overseas countries. The industry sector of Korea consumes 56% of the energy, the transportation sector 22.8%, and the building sector 21.2%. Homes consume about 56% of the building sector. Of the building sector, the residential buildings represent 66.5% of the total buildings, and the apartment houses account for the highest 71% of all houses.

As such, seeking ways to reduce energy consumption in houses is essential to minimize energy import and to comply with the international convention on climate change. The ways to reduce residential energy consumption were researched in this study by constructing a smart HEMS model using Internet of Things (IoT) as a method for reducing the energy of HEMS based on the existing BEMS-oriented studies and by seeking the ways to utilize the model.

## **2 Field study of Home IOT**

### **2.1 Internet of Things(IoT)**

#### 1) The concept of Internet of Things

Internet of Things (IoT) is a technology that connects things to networks and shares information as shown in the figure. It is used in various areas such as home appliance, smart homes, smart cars, and smart factories. Not only does it transfer information but it analyzes the collected data and predicts accordingly.

#### 2) The components of IoT

IoT consists of sensing, network infra, service interface, and security as shown in the figure. Sensing is the core technology. It acquires and transfers the real-time information by attaching electronic tags on the required objects or locations. It is being developed beyond the physical sensors for such data as temperature, humidity, heat, gas, and ultrasonic waves into smart sensors housing interfaces and data processing capabilities.



Fig. 1. Figure 1 shows the IoT case of LG telecom. (IoT@home App)

## 2.2 Smart home market status

Overseas smart home market is expected to grow from \$48 billion in 2014 to \$115 billion in 2019. The major local companies and overseas global corporates are aggressive in this smart-home business. The smart-home businesses by the major companies are shown in the following table. There is a rapid growth as seen in the table.

Table. 1. Smart home industry trend of major companies

Company	Contents
AT & T	<ul style="list-style-type: none"> <li>- Launched 'Digital Life'. Strengthened partnership with Samsung Electronics, LG Electronics, and Qualcomm</li> <li>- Supply Home Security &amp; Automation</li> </ul>
NTT Docomo	<ul style="list-style-type: none"> <li>- Released Docomo Smart Home to construct the in-house internet environment, connect home appliances, and provide entertainment contents.</li> </ul>
Samsung Electronics	<ul style="list-style-type: none"> <li>- Connect individuals and in-house devices with a single integrated platform through 'Samsung Smart Home'. It controls devices with an application.</li> <li>- Device control, home view, and customer service</li> </ul>
LG Electronics	<ul style="list-style-type: none"> <li>- Remote control and monitor home appliances with a smart phone through 'Home Chat' service</li> </ul>

**Table 1. (Continued): Smart home industry trend of major companies**

SKT	<ul style="list-style-type: none"> <li>- Monitor in-house situations in real-time through ‘B Home CCTV’. Call security companies in an emergency</li> <li>- Cooperated with Hyundai Livart and launched ‘Smart Furniture.’ Through the touchscreen wired or wireless internet functions built in mirrors and walls, provide various life conveniences including music, movies, cooking information, and food prices.</li> </ul>
KT	<ul style="list-style-type: none"> <li>- Co-developed IoT-based ‘Smart Home Care Service’ with Coway. Initiated ‘Smart Air Care’ service through a 24-hour air quality control system.</li> <li>- Check real-time individual workout information through ‘Olleh Giga Home Fitness’ smart-phone app.</li> </ul>
LGU+	<ul style="list-style-type: none"> <li>- Check the gas valve status from outside with a smart phone though ‘U+ gas lock’, and can lock the gas valve in an emergency</li> <li>- Clients can check their skin types while looking at mirrors through ‘Magic Mirror.’ The system recommends skin care solution and beauty products that fit the skin type.</li> </ul>

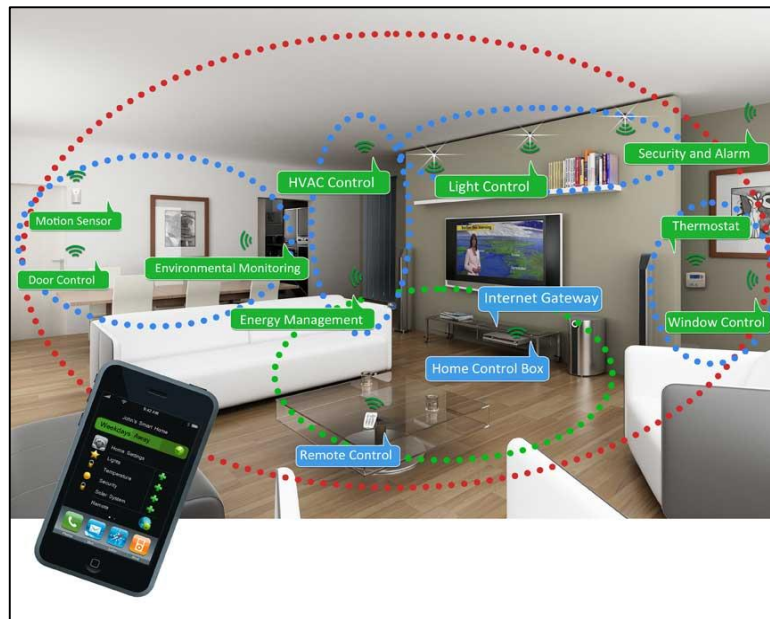
## 2.3 Smart Home

### 1) The concept of smart home

Smart home is a technology that can connect everything to networks to monitor and control them in various areas such as home appliances, energy-consuming devices, and security devices as shown in the figure. Consumers can check and control the current status in their homes regardless of time and space through the smart-home service. The service constructs an environment where digital information terminals can check and control the in-house devices through the identical interfaces. This can contribute to better quality of life and cost saving.

### 2) The components of the smart home

Smart home comprises wired or wireless network, smart devices, IoT communication standard, operational platform, control devices, and contents. First, as for wired or wireless network, the wired or wireless internet environment in Korea is the best in the world, thus considered most optimal for smart home. Second, smart devices are divided into two categories, one of which is home appliances such as TV, refrigerator, and washing machine that have internet communication functions, and the other is smart devices such as CCTV, security, energy, heat, and health that have smart functions. Third, IoT communication standard is for the standardization of smart home. It is expected that the standard integration will take much time and numerous standards will be supported. Fourth, a platform controls devices and contents from the center, and connects them. It has power to control contents. There are platforms by the global IT industries, platforms by the global home-appliance manufacturers, and platforms by the telecommunication companies. They will be composed and developed according to consumers’ needs. Fifth, control devices are expected to be consumer-oriented PCs, TVs, and smart phones.



**Fig. 2.** Figure 2 shows the Smart Home

### 3 HMES (Home Energy Management System)

The smart-home market in South Korea is growing rapidly fueled by the active use of smart phones, which is caused by the world's best internet environment. According to the Korea Smart Home Industry Association, the smart-home market is experiencing a high growth at an annual average of 28%. It is expected to exceed KRW11 trillion in 2015, and KRW18 trillion in 2017.

The smart home using IoT is a system that manages energy and resources collectively, and it can support efficient consumption of the everyday energy and resources.

#### 3.1 IoT Smart Home System Components

1) Environmental sensors: temperature sensor, smoke sensor, current measurement sensor, flame sensor, the image sensor

- Environmental sensors: temperature sensor, smoke sensor, current measurement sensor, flame sensor, the image sensor

- It is an element that detects information from the measuring object on behalf of the five senses of humans and converts it to an electric signal. As one of the important cutting-edge science technologies, such as automation, precision, remote control, and multi-functions, it detects and measures such information as sound, light, temperature, and pressure.

- Infrared sensors detect bodies and ultrasonic sensors check if a person still stays in the space. They operate and control LED lighting.

2) Image sensor: CCTV cameras, Web cameras, IP cameras, etc.

- An image sensor, based on the imaging processing that recognizes and analyzes the movements of various objects by using real-time monitoring and image processing for object(body) tracking, detects and responds to the changes of an object (body).

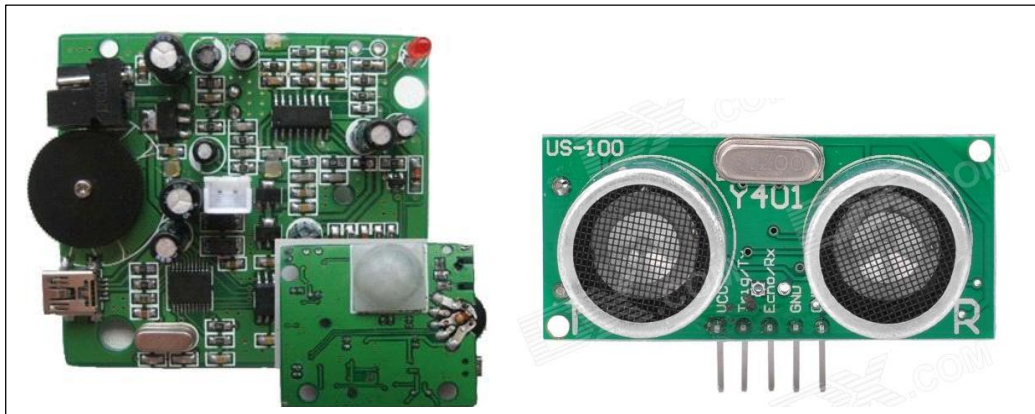
3) Infrared and ultrasonic sensors

- Infrared sensors detect bodies and ultrasonic sensors check if a person still stays in the space. They operate and control LED lighting.

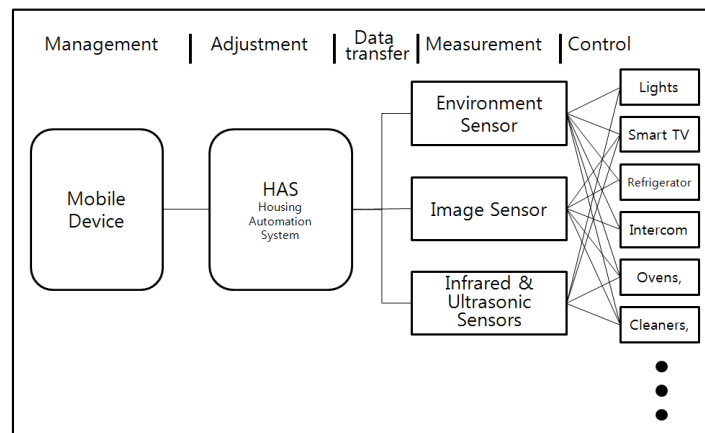
4) Device: Refrigerator, Smart TV, computers, vacuum cleaners, microwave ovens, video intercom, etc.

### 3.2 HMES Configuration

HMES is composed of sensors, devices, and an integrated control server that controls sensors and devices as shown in the previous components. The system detects data coming through various sensors and maintains optimal level of energy consumption by automatically activating or deactivating the data.



**Fig. 3.** Figure 3 shows image sensors(left) and ultrasonic sensors(right)



**Fig. 4.** Figure 4 shows HMES Configuration

The smart HEMS model using IoT as a way to reduce home energy is the housing energy management system using mobile devices. By controlling various data through the use of various body detecting sensors, ultrasonic sensors, infrared sensors, image sensors, and environment monitor sensors, the system helps maintain the optimal housing energy consumption level regardless of time and place. The administrator or the user can manage, regulate, and control the system in a mobile environment.

## 4 Conclusion

As the need for an active and systematic building energy management system (BEMS) using the ICT technology is increasing, a smart HEMS model using Internet of Things (IoT) was constructed as a way to reduce energy consumption in houses, and the ways to utilize the model were studied. A HEMS model, which helps maintain the optimal housing energy consumption level regardless of time and place by controlling various data through the use of various body detection sensors, ultrasonic sensors, infrared sensors, image sensors, and environment monitor sensors, was suggested in this study. The administrator or the user can manage, regulate, and control the system in a mobile environment with the model. This HEMS model is expected to help control and manage energy use in houses. The continuous studies linked with other related fields, such as greenhouse gas reduction technology, energy saving technology, and renewable energy technology, based on this model need to be carried out in the future to resolve the global environmental problems.

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