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Smart Home：Architecture, Technologies and Systems

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Abstract

The smart home service is a key part of the smart grid consumption. It is a real-time interactive response between the power grid and users, and enhances the comprehensive service capability of the power grid, also realizes the intelligent and interactive use of electricity, further improves the operation mode of the power grid and the users' Use patterns to improve end-user energy efficiency. The smart home is a residential-based platform that uses IoT, computer technology, control technology, image display technology and communication technology to connect various facilities through the network to meet the automation requirements of the entire system and provide more convenient control and management. This paper analyzes the characteristics of smart home, gives the smart home composition and the application of key equipment; and smart home key technologies to illustrate the design of smart home electricity service system and related communication systems.

Keywords: Smart home, Smart grid, Internet of things, smart socket

1. Introduction

Smart Home is an organic combination of various subsystems related to home life through advanced technologies such as fiber optic composite cable home [1]. It can both share resources and communicate within the home, and we can exchange information with your home external network through your home smart gateway. Its main objective is to provide people with an efficient, comfortable, safe, convenient and environment-friendly living environment integrating system, service and management.

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Smart home is the use of computer technology, control technology, image display technology and communications technology will be connected through the network of various facilities together to meet the automation requirements of the entire system to provide more convenient control and management [2]. The traditional smart home implementation generally controls and communicates building facilities through the wiring of wired lines, it is difficult to get rid of the restraints of various cables, the installation cost is high, and the scalability of the system is also poor. The smart home system based on wireless sensor network technology can not only get rid of the shackles of cables, reduce the installation cost, but also greatly improve the scalability of the system.

There are some main features for smart home as follows[1]:

(1) The smart home can realize the interaction between the user and the power grid enterprise, obtain the information of electricity consumption and electricity price, set the electricity consumption plan and so on, guide the scientific and rational electricity use and advocate the family's consciousness of energy saving and environmental protection.

(2) Smart home can enhance the comfort, safety, convenience and interactivity of home life, and optimize people's life style.

(3) Smart home can support remote payment.

(4) Smart home can monitor and interact with the home through telephone, mobile phone and remote network, discover the abnormal and timely processing.

(5) The smart home realizes the real-time meter reading and security service of water meter, electric energy meter and gas meter, which provide more convenient conditions for the high-quality service.

(6) Support "triple networks" business and the perfect intelligent service.

2. Architecture of smart home

Through the construction of indoor communication network in the family, we realize the home air conditioning and other smart appliances network by power fiber optic network interconnection. Through the intelligent interactive terminals, smart sockets, smart appliances, etc., we achieve household appliances automatically collect electricity information, analysis, management; and home appliances achieve economic operation and energy control [3, 4]. Through the telephone, cell phone, Internet and other means, the system can remote control home and other services. Through intelligent interactive terminals, we also achieve smoke detection, gas leak detection, anti-theft, emergency assistance and other home security functions, and carry out automatic collection and information management of water meters, gas meters, and support and property management center cell master network, and also achieve home security information authorized one-way transmission and other services. Fig 1 shows the structure of a smart home.

Through the service interactive website to achieve customizable information on household electricity information, equipment remote control, payment, newspaper, can service guide and other interactive service functions.
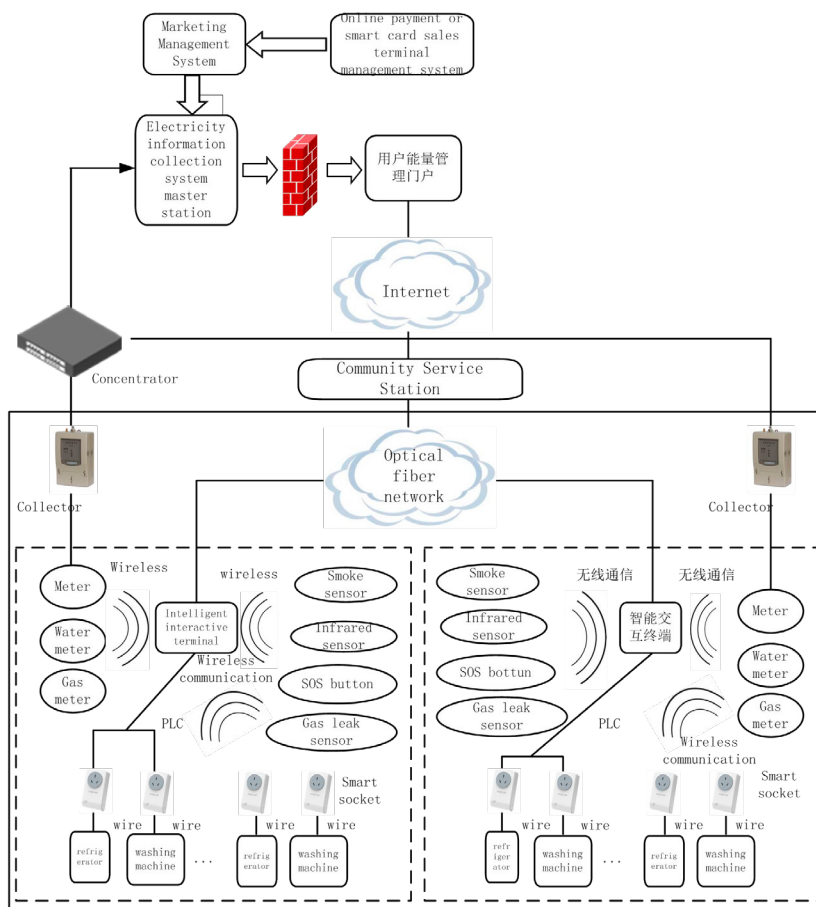
Fig. 1. Architecture of smart home

3. Technologies

3.1. Interactive Electricity Service Technologies

(1) Power information service [5]. The service includes grid operation and maintenance information, real-time electricity price, electricity policy, electricity service and other information release, user electricity consumption, remaining electricity, electricity, electricity, electricity balance and electricity purchase records and other information query service.

(2) Home appliances interactive control [6]. According to user needs, the analysis of household electricity load, develop and optimize the electricity program to guide users to rational use of electricity; in accordance with the request of the user to carry out hosting services, power equipment optimization operation program to the home intelligent interactive terminal, automatic management Household appliances reasonable electricity.

(3) Household electricity management[7]. Real-time access to household and household appliances electricity information, including electricity, voltage, current, load curve, etc., can view a variety of price information, including real-time price, time-of-use price. To provide users with tailor-made electricity program, set the specified electrical running time. Household and household appliances for electricity analysis, to provide users with energy-saving proposals.

(4) Self-service payment service. Multi-channel payment can be made by telephone, SMS, website, self-service terminal and other means.

3.2. Smart Community Support Technologies

(1) Residential property security services. According to the gas, smoke sensors and other alarm signals issued by the gas and fire alarm management; with intrusion alarm function, the family situation for remote monitoring; also can be set to a variety of security models to achieve scene management control; when the unexpected situation at home, Through the smart home system issued an emergency call for help, notify the relevant emergency department.

(2) Utilities Information Services (municipal, medical) [8]. Users can access to municipal information, construction and construction information, traffic and road information, health and epidemic prevention information; meanwhile, according to the needs of users, the system can also provide users with online medical services, the establishment of health care information platform for outpatient appointments, online consulting and other services.

(3) Business information services (information customization, information interaction, news subscription services, etc.). According to the needs of users and information publishers to specific users to send specific weather, stock, foreign exchange, product concessions and other real-time information, as well as the supermarket class distribution interaction, booking products and other information.

4. Smart Home Power Service System

The smart home electricity service system is a support platform for monitoring, analyzing and controlling the electricity consumption of residential users and is also an important way to realize the orderly electricity management and intelligent service of energy efficiency [9]. Fig 2 shows the structure of the smart home power service system.
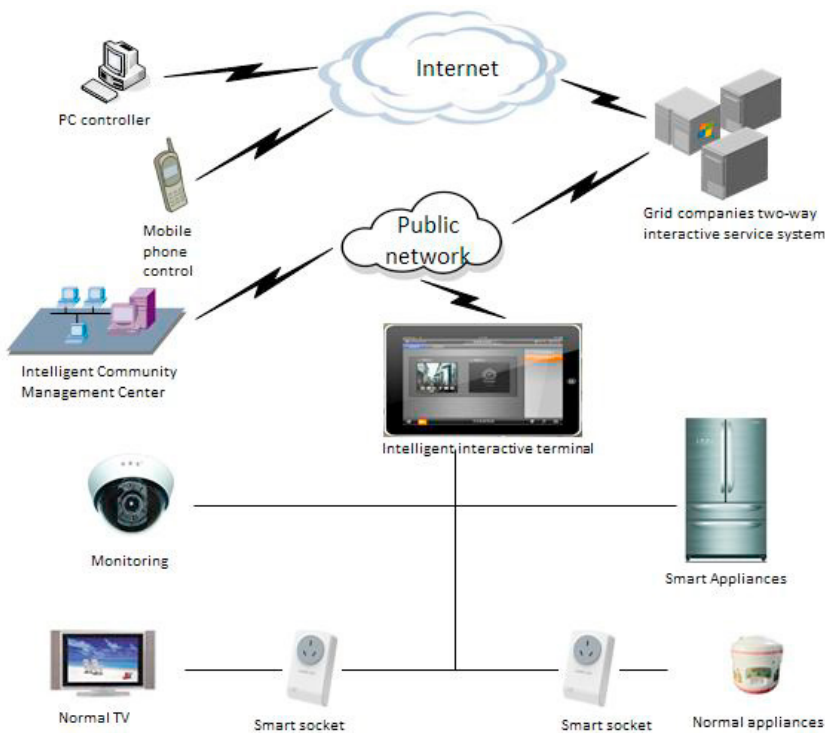

Fig. 2. Smart home electricity service system structure

The smart home electricity service system is mainly composed of a main station system, a communication channel, a home intelligent interactive terminal, and a smart electric device 4 parts:

(1) The main system consists of database server, application server, front-end machine, router, security equipment and so on.

(2) Communication channel is divided into long-distance communication network and local communication network. Remote communication using public network communications, local communications network selection of optical fiber composite cable, power line broadband communications, wireless communications.

(3) Home Intelligent Interactive Terminal is the core part of the smart home system, is the main station and user contact center, is also a smart electrical equipment control center.

(4) Intelligent electrical equipment includes smart appliances, security equipment and so on. At present, due to the lack of popularization of smart appliances, in order to satisfy the control of non-smart appliances and the collection of electric information, intelligent outlets may be used to control the home appliances or to collect the household appliances.

5. Smart Home Key Equipments

5.1. Key equipments

1.System master

The main system includes servers, communication networks, workstations and internal interconnection with the marketing system 4 parts. And marketing applications, sevice interactive websites and other applications interconnection mainly through the interface server, security equipment and other equipment to complete.

2. Family intelligent interactive terminal

The home intelligent interactive terminal is installed in a position convenient for users to operate and establish communication and interaction with a smart socket, a smart home appliance and a home security device.

3 smart electrical equipment

(1) smart socket. Installed between the power outlet and common household appliances and establish communication with the home intelligent interactive terminal.

(2) smart appliances. Including intelligent air conditioners, smart TVs, smart refrigerators, smart washing machines, smart cleaners, smart rice cookers, with two-way interactive features.

(3) home security. Select the appropriate location to install smoke sensors, infrared sensors, emergency buttons, gas leak sensors, cameras and other equipment, and establish a smart home interactive communication terminals.

5.2. Smart socket

The smart socket can collect real-time, accurate and sensitive load data of electricity consumption, select the most suitable communication mode according to the actual situation [10], and the main functions are: measurement display, on-off control and transparent transmission of home appliance control commands.

Non-smart home appliances model: (Recommended for external use)

● Collect the real-time value of voltage, current, power and power factor of home appliance and save it, and upload the required data;

● intelligent socket on the appliance through the power control, to achieve the purpose of energy saving;

● The smart socket can be controlled by the intelligent interactive terminal, collection host, network client, mobile phone and other media, and then the switch of the household appliance can be controlled by the smart socket.

Smart home appliance mode:

Network appliance mode: (recommended embedded)

Comes with short-range wireless communication module and smart socket (using the matching wireless communication module) used in conjunction with the realization of the following functions:

● Collect the real-time value of voltage, current, power and power factor of home appliance and save it, and upload the required data;

- intelligent socket on the appliance through the power control, to achieve the purpose of energy saving;

- Control commands initiated by the intelligent interactive terminal are transparently transmitted to the home appliance through the wireless module of the smart socket, and are used for starting, adjusting and controlling home appliances.

- The smart socket can be controlled by the intelligent interactive terminal, collection host, network client, mobile phone and other media, and then the switch of the household appliance can be controlled by the smart socket.

- Integrated network appliance mode

- All functions of the smart socket fully integrated into smart appliances, to achieve direct control of the terminal smart appliances. The specific functions are as follows:

- It can not only collect the real-time value such as voltage, current and power of home appliances, but also switch on and off the home appliances, and can start, adjust and control home appliances to complete all the functions of non-smart appliances and network appliances and achieve the maximum Intelligent.

Priority to PLC communication, cost savings, and stable and reliable in the home

6. Grid-friendly Appliances

Grid-Friendly Appliances (GFAs) mainly use embedded technology to automatically disconnect the electrical network from the power grid when the frequency signal of the power grid is detected below a preset threshold by tracking the AC voltage or frequency signal of the grid in real time. . When many GFAs perform this function, it helps to protect the grid and prevent grid oscillations.

It is foreseeable that GFAs will respond to voltage or frequency signals as well as price signals and demand-side management signals.

1.GFAs function

GFAs equivalent to a small electronic control platform, which calculates the AC fundamental frequency of the grid voltage signal, to prevent distortion of the output signal and grid frequency oscillation.

Response time

The response time of GFAs needs to consider the frequency measurement mode, and should take into account the influence of the low-pass digital filter.

3.GFAs signal output

The output of GFAs is a binary signal used to control the delay switch.

4.GFAs the main components

(1) Load Control Module - Monitor GFAs.

(2) Home gateway - wirelessly communicates with the load control module and forwards the signal to the backend server over a broadband cable modem or ADSL connection.

(3) Background Server - receives data periodically from each home gateway.

7. Smart Home Communication System

7.1. Architecture of communication system

Smart home communication system can be divided into external network, gateway and internal network 3 parts. External network can be a cell LAN, cable television networks, telephone networks and the Internet, mostly using more mature technology. Intranet is used to interconnect the various household appliances within the family, equipment, LAN, due to the vast diversity of connected devices, the network also showed a great diversity of forms. Home networks are largely divided into three categories according to their functions: a control network for controlling functions, a data network for exchanging data messages, and a multimedia network for transmitting audio and video. The home gateway is a network connecting device that connects the home intranet and the extranet, and accesses the intranet to the extranet to provide the extranet with the control function of interconnecting devices in the home. At the same time, the home gateway allows the home to adopt different networking technologies and

utilize Gateways provide bridging capabilities for different communication subnets so that networked devices within each subnet can communicate with each other.

(1) Home Appliances Network: Home appliances (refrigerators, air conditioners, TVs, microwave ovens, washing machines, lighting, etc.) make up networks through wired or wireless connections to exchange information.

(2) Security: Including the surrounding area protection, home video intercom, access control, burglar alarm, fire, gas leaks, water spills, etc.).

(3) High-speed access to information: Internet, video phones, cell LAN access to the home through the gateway.

(4) Residential Services: Community Management Center can monitor and manage equipment and environment in its jurisdiction.

The main consideration of smart home system is the home internal communication network, which mainly includes two parts: smart home gateway and home smart sensor node. Smart Home Gateway is a family resource management and configuration center to complete the home networking and node control and other functions. The gateway of the smart home connects each sensor switch node in the home network through the networking technology, realizes the management and control of the internal network of the smart home through the standard communication protocol, and serves as the interactive interface of the information of the home network and the external network. Intelligent home can achieve a variety of functions, such as: home monitoring, internal and external information exchange, energy management, home security, scene settings are inseparable from the smart home gateway support, many of the features are based on smart home gateway and achieved.

7.2. Network model

The smart home system is a kind of control system based on the one-chip computer that can access and control home devices through the telephone and internet. Intelligent home network control system through the data acquisition, command control module and TCP / IP protocol module to achieve safety monitoring network, command control is divided into three modes: 1) telephone remote control; 2) network remote control; 3) on-site operation. The system structure is shown in Fig 3.
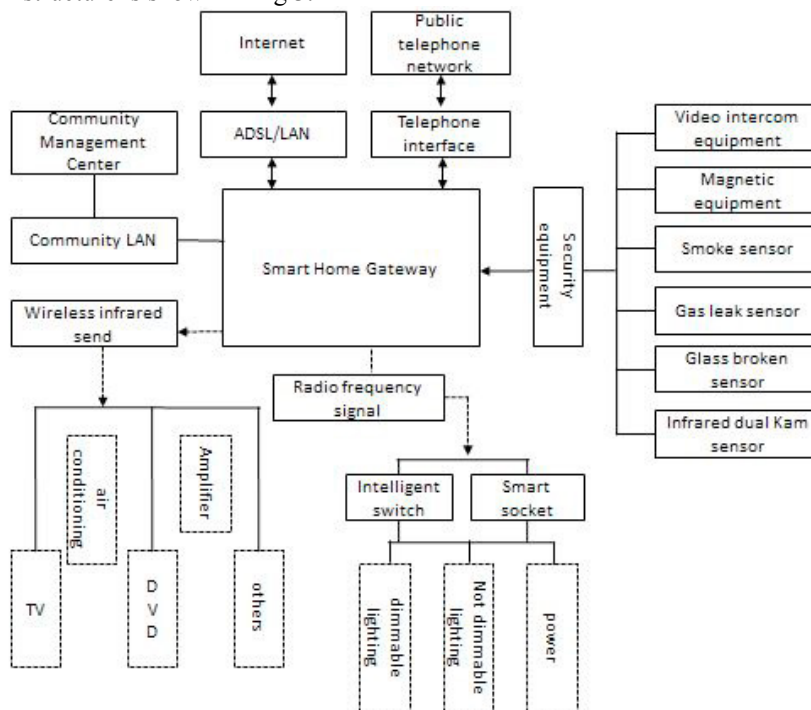

Fig. 3. System structure

8. Conclusion

As a key part of smart grid electricity consumption, smart home service is an important means to realize real-time interactive response between grid and users, enhance comprehensive grid service capability, meet the demand of interactive marketing and improve service level, and strengthen information between users and grid Integrated sharing and real-time interaction, to realize intelligent and interactive use of electricity, to further improve power grid operation mode and user's utilization mode of power, and to improve energy efficiency of end users. According to the actual needs of users completed smart interactive terminals, set-top boxes, smart sockets and other home smart sensor devices, networking programs and intelligent electricity service management platform research and development of related equipment and software platforms to achieve the smart home appliances Management and energy utilization; completed the typical design of the electric power information collection system under the hybrid networking mode, and developed the electric power information acquisition device and system based on the wireless network and the broadband hybrid power network mode to provide residential users Reliable power supply while extending the smart home experience.

Acknowledgements

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