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A Study on SSDP protocol based IoT / IoL Device Discovery Algorithm for Energy Harvesting Interworking Smart Home

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Abstract

The spread of IoT (Internet of Things) technology that connects objects based on wired / wireless networks is accelerating, and IoT-based smart home technology that constitutes a super connected network connecting sensors and home appliances existing inside and outside the home is getting popular. In addition, demand for alternative energy technologies such as photovoltaic power generation is rapidly increasing due to rapid increase of consumption of energy resources. Recently, small solar power systems for general households as well as large solar power systems for installation in large buildings are being introduced, but they are effectively implemented due to limitations of small solar panels and lack of power management technology. In this paper, we have studied smart home structure and IoT / IoL device discovery algorithm for energy harvesting system based on photovoltaic power generation, It is possible to construct an efficient smart home system for device control.

Keywords: *Energy harvesting, SSDP, IoT/IoL, Smart Home*

1. Introduction

As the consumption of fossil fuels such as petroleum, nuclear energy, and natural gas increases rapidly, there is a need for research on environmentally friendly energy resources that can replace them. Representatively, research on energy harvesting based on photovoltaic power generation has been actively conducted. Also unlike a large-scale photovoltaic power generation system that is widely used in forests or metropolitan facilities in the early stage of introduction, a small-scale photovoltaic power generation system that can be used in ordinary households and homes by using small-scale solar panels such as 100W and 200W is gradually spreading [1].

In addition, through the development of IoT technology, the smart home technology is demanding from user-centric networks such as existing smart devices, PC-based WLAN/WPAN to refrigerators, TVs, and LED lights, and so on. Smart home technology, which is required in the market in recent years, is based on WSN (Wiress Sensor Network) which connects various context aware sensors such as human body sensor, temperature / humidity sensor and camera sensor as well as remote control and monitoring through network configuration between home appliances through the recognition technology, it means a system that senses meaningful changes in the environment inside and outside the smart home and can deliver it to the users in

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real time, and actively responds to changes in the environment of the smart home without user control [2].

In this paper, we propose a smart home structure for the energy harvesting system based on the photovoltaic power generation described above, interworking of smart home technology based on IoT / IoL, and efficient energy harvesting system, and also we propose a simple service discovery protocol (SSDP) based IoT / IoL device discovery algorithm to utilize various IoT / IoL devices used in smart home.

The order of this paper is as follows. In Chapter 1 introduces the background of this study, in Chapter 2, we will establish the background of the prior technology analysis and research by understanding the technology trend of the energy harvesting system and IoT / IoL based smart home, in Chapter 3, presents a constructure for efficient energy harvesting in a smart home, in Section 4, we propose an IoT / IoL Device Discovery algorithm to efficiently control and consume power acquired through energy harvesting in the smart home structure. Finally, Section 5 concludes this paper.

2. Related Work

2.1 Preliminary research on energy harvesting technology based on solar power generation for smart home structure

The energy harvesting system has been studied by the necessity of alternative energy due to the rapid consumption of fossil energy resources, and wind power, tidal power, geothermal power, solar heat, etc.,. Photovoltaic modules for solar energy-based energy harvesting systems are typically silicon flat panel modules, thin-film modules and concentrator modules, and generally silicon flat panel modules are widely used. Silicon solar cell modules have undergone a lot of research and development in the field of semiconductors [1][2].

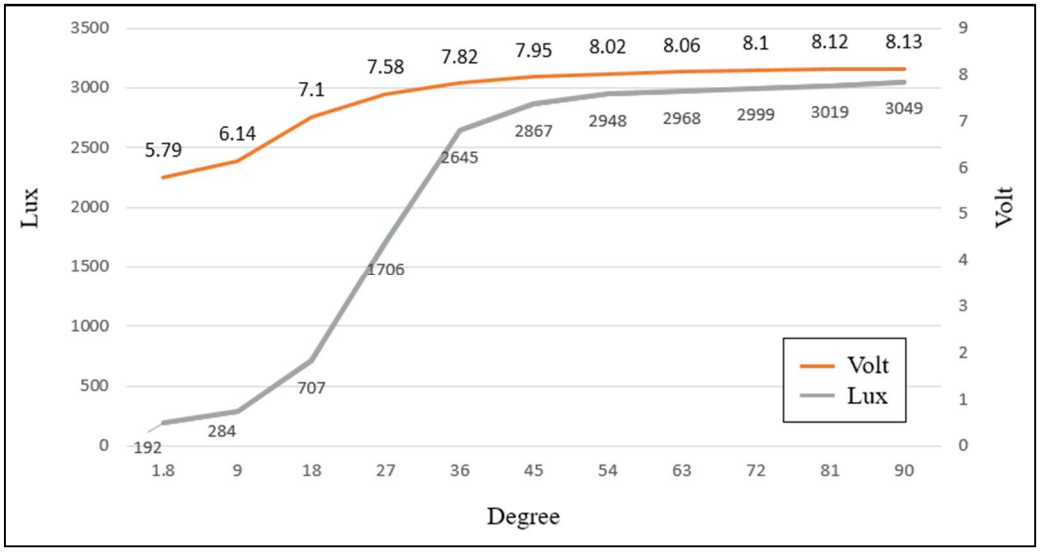

Figure 1. Efficency of photovoltaic cells according to sun light angle[3]

The efficiency of the solar energy-based energy harvesting system is continuously changing by various variables such as season, angle, time, and illumination. According to Nayantai's study using HBE-Green-Energy, is changed from 1.8 degrees to 90 degrees, the production voltage increases from 5.79 V to 8.13 V, which shows the highest efficiency when the angle between the solar cell and the solar panel reaches 90 degrees. The graph of the production voltage according to the angle of the sunlight and the solar panel is as shown in the above figure and it can be applied to the smart home of energy harvesting to improve the efficiency of the solar panel [3].

The above-mentioned solar energy-based energy harvesting system is being popularized as a small solar cell panel for household use is being commercialized due to the improvement of efficiency through continuous product development of the solar panel and the increase of the production yield. However, the

absence of an organic voltage management system and the structural and geographical location of the solar panel and the variation of the energy harvesting system efficiency due to the climatic environment.

2.2 Analysis of IoT / IoL based communication scheme for smart home network construction

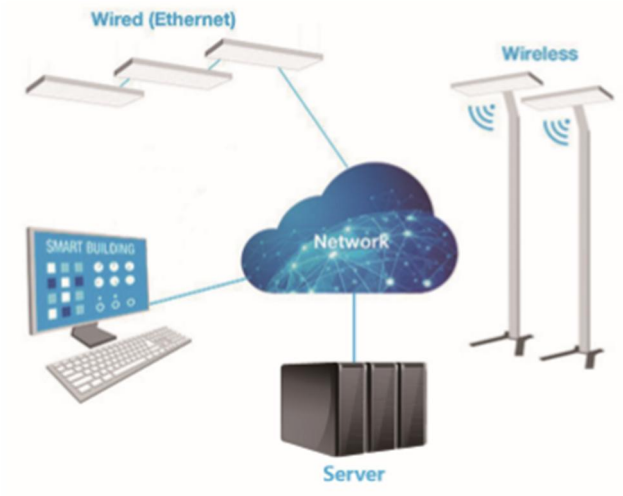

Figure 2. Internet of Lights Infrastructure[4]

Interlocking of household appliances and context sensors for various applications through IoT technology is now being commercialized and related products are increasingly being used. Moreover, not a simple on/off control of LED lighting or dimming based illumination control through combination with wired and wireless networks, IoL(Internet of Lights) technology using OWC(Optical Wireless Communication) based on visible light communication including LiFi(Light Fidelity), which is currently being used as the next generation network, researches on wireless communication technology are being actively carried out. The IoL-based visible light communication technology has excellent accessibility because it can display data for visible light communication using LED light or display as a transmitter and use a camera image sensor mounted on gerneral smart device or PD(Photo Diode) as a receiver, it is advantageous to be able to integrate with general-purpose ethernet based wired network and WiFi, Bluetooth, and so on. wireless network and it can be applied to IoT infrastructure which is applied to general smart home network[5][6].

2.3 Protocol analysis for smart home based IoT / IoL devices

A dedicated network is required for interworking of various kinds of situation awareness sensors and home appliances installed in a smart home. Such a network is not a simple peer to peer (P2P) network type, but various nodes the device discovery protocol that can be used to build a star network and to build a smart home network for each IoT / IoL device is typically SNMP, SSDP, etc.

The SNMP protocol is a standard protocol of the application layer for management and transmission of network elements based on UDP / IP. It is mainly used for short message exchange network management and is composed of management information protocol and transmission/reception protocol. The SNMP protocol consists largely of SMI and MIB, SMI(Structure of Management Information) represents the information structure, and the MIB (Management Information Base) means a set of variable objects representing management characteristics. SMI and MIB are grouped together to form management information protocol. The UDP protocol is also used as the sending / receiving protocol.

The SNMP protocol has a simple structure compared to other protocols and has a low implementation difficulty. On the other hand, the hackers are vulnerable to security because they can acquire administrator authority through the NMS(Network Management System). There is a concern that information data is transmitted and received as Plain Text and snipping [7].

In the other hands, SSDP is one of the techniques for device discovery in LAN(Local Area Network) and is mainly used for device discovery in wired / wireless network environment in public facilities. In transmitting a broadcast message to each node connected in the network environment, identification of each node is required in order to prevent packet transmission to an unnecessary node. In order to do this, SSDP is required to actively zero configuration function that recognizes the information of each existing node can be provided. This enables information to be easily recognized by a printer or a PC existing in the network without any additional operation. If the information of each device is needed, the IP multicast query message including the device information, unique information such as IP address and MAC address is transmitted. At this time, each device included in the SSDP network updates the information in the cache after receiving the IP multicast query message. Through these processes, even when various devices such as wireless printer, PC, and smartphone are connected to the network, it is possible to identify unique identification information without user's individual manipulation. By using these characteristics, it is considered suitable for application in IoT/IoL device discovery the algorithm.

3. Research of smart home structure with energy harvesting

Based on the results of the prior technology analysis of the solar energy-based energy harvesting field mentioned above, the structure of the energy harvesting system based on the photovoltaic power generation is applied and the smart home network based on the IoT / IoL device used a 3D modeling tool to design a smart groove structure for energy harvesting.

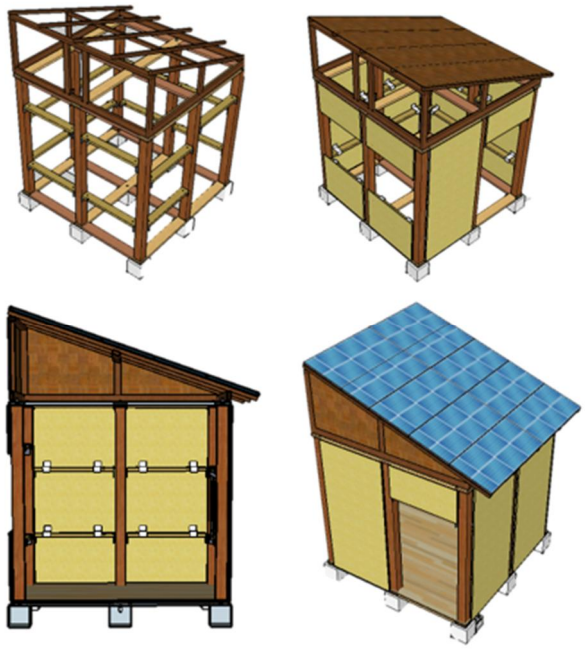

Figure 3. Smart home modeling based on energy harvesting interlocking IoT / IoL device

The smart home structure modeling is based on the solar energy-based energy harvesting technology described above, and the sloped angle roof is applied for the efficient operation of the solar power generation panel, and the flat panel solar power generation panel is applied thereon. In addition, there is an advantage that the use of wood and the use of an independent power source through the application of solar panels do not require additional distribution work in the future migration.

4. Research of IoT / IoL device discovery algorithm applicable to smart home

We have studied algorithms for applying the SSDP protocol based IoT / IoL device discovery method to the smart home for energy harvesting based on the photovoltaic power generation described above. The SSDP protocol is considered to be suitable for a smart home network for linking various types of home appliances and sensor modules that do not provide a user's direct network setting interface, unlike a PC / smart phone. The IoT / IoL device discovery algorithm is shown in the figure below.

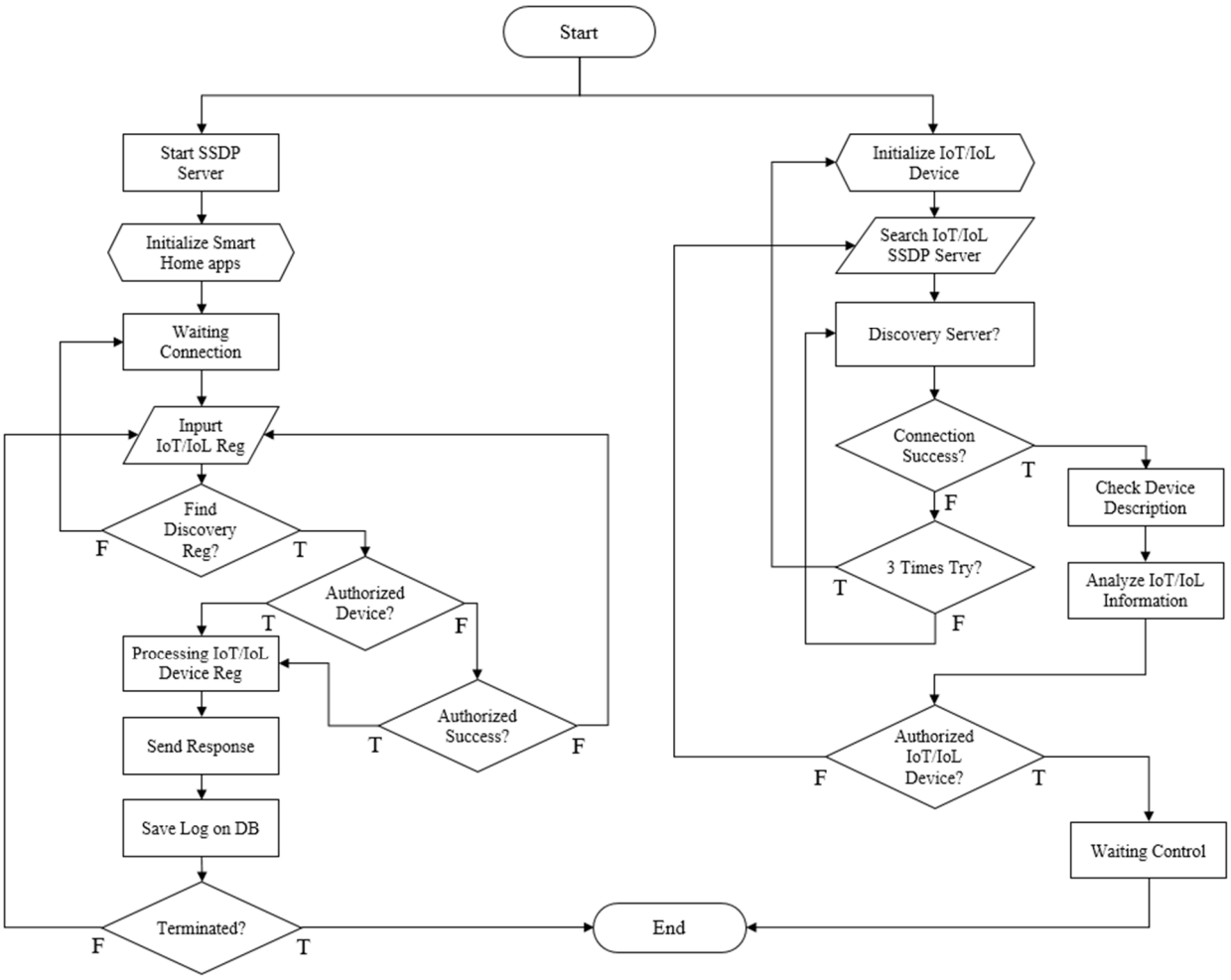

Figure 4. SSDP protocol based IoT / IoL Device Discovery Algorithm

The SSDP protocol-based IoT / IoL device discovery algorithm for energy harvesting interlocking smart home is designed to control the connection of various IoT / IoL devices and does not require user's direct network setup. This algorithm is divided into SSDP protocol server section and IoT / IoL device section. In case of server section, when IoT / IoL device tries to connect after application to smart home application, / IoL device sends a response and stores the record in the database, and refuses the connection if it is an unauthorized device.

The IoT / IoL device section process searches the SSDP server, tries to connect when the server exists, and returns to the initial process after analyzing the IoT / IoL information according to whether authentication is successful or not when a connection is successfully established.

By applying the IoT / IoL device discovery algorithm to the energy-harvesting smart home, it is possible to efficiently consume the power obtained through the solar-based energy harvesting system and there is an

advantage that integrated control of IoT-based devices and IoL-based devices exists.

5. Conclusion

In this paper, we propose a housing structure that can apply solar energy based energy harvesting system through prior art analysis for efficient energy acquisition of solar panel, and IoT / IoL Device Discovery algorithm.

First, we analyzed the previous researches for efficient arrangement of solar panels and the case of smart home structure exhibited at the international exhibition. IoT / IoL device discovery algorithm based on SSDP protocol is proposed through research on general purpose device discovery technology that can support both IoT device and IoL device.

The results obtained from this study show that solar energy can be efficiently obtained from the solar energy hovering interlocking type smart home, which makes it easy to construct independent power state of the smart home. In addition, we can secure diversity of sensors and modules applicable to smart home through integrated device discovery of IoT / IoL devices, and it can be effectively used for efficient smart home service construction in the future.

Acknowledgement

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