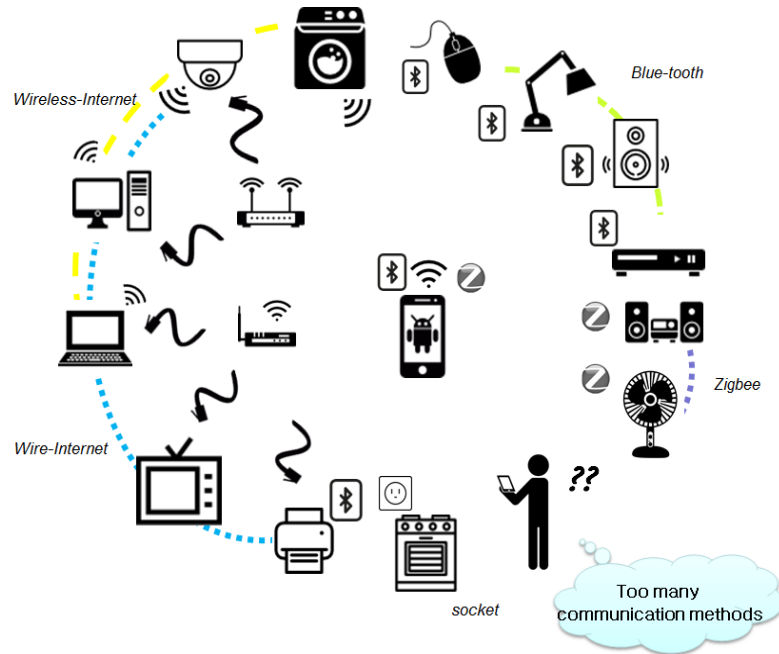


Competition Information

Topic (required)	Internet + Smart home system
Notes (including matters needed to be showed the organizing committee and issues regarding the Competition, not required)	<p>1. Introduction</p> <p>Various products that are capable of controlling IoT equipment with smart devices are available with recent popularity of IoT technology. Since those products adopt various communication protocols, including Wi-Fi, Bluetooth, and ZigBee, additional physical equipment that support different communication protocols are required to operate. Existing communication modules have issues with high production cost and high power consumption rate.</p> <p>To mitigate such drawbacks, this research will investigate and develop a new IoT equipment control system that uses Li-Fi communication protocol based on visible light such as LED. Communication cost can be reduced and controlling IoT equipment may be integrated when a Li-Fi based control system is adopted, since lightings are always available in smart home environment. Li-Fi based IoT equipment control system is environment friendly due to its low power consumption rate and low cost communication protocol.</p>

2. Motivation

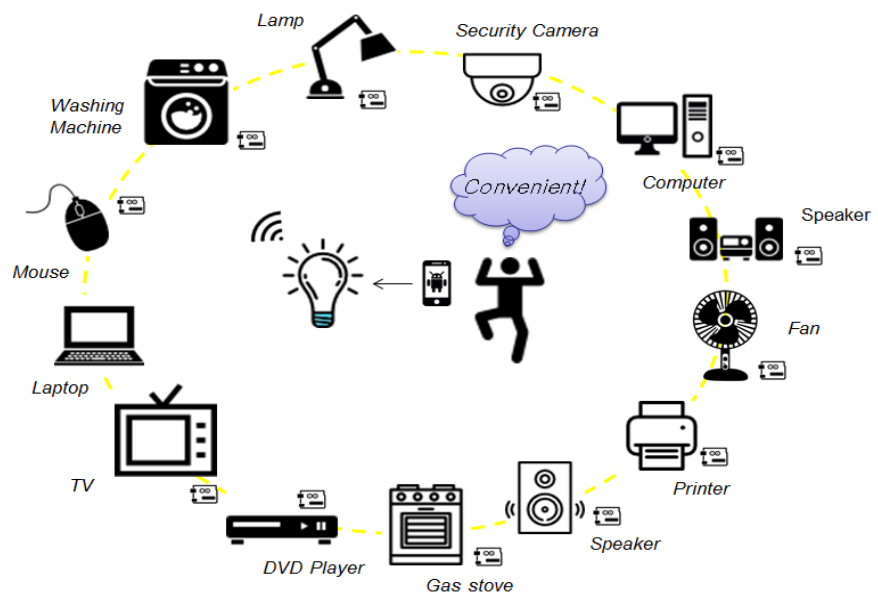
<Existing> Different communication protocols to control smart devices cause inconveniences



<New> Convenience from new unified smart device control protocol - LoT (Li-Fi Internet of Things)

LOT

Li-fi Internet Of Things System



3. Procedure

- Compatible operation is guaranteed via unified control protocol by developing Li-Fi based Smart Home System
 - ⇒ Unified communication protocol is required, because currently available IoT based Smart Home System needs various communication protocols, such as Bluetooth, ZigBee, and TCP/IP.
- Does not incur any additional cost because the system is based on LED lightings that already exist at home.
 - ⇒ Existing Smart Home Systems require additional communication equipment to support different communication protocols.
- We built a Li-Fi based Smart Home System prototype to evaluate and verify the proposed system.
 - ⇒ Wrote an Android application for the prototype built with Arduino switch and Raspberry Pi server.

4. Benefits

- Existing systems with different communication protocols need to support all the protocols as well as need to have additional physical equipment that support all the protocols.
- However, using Li-Fi communication protocol eliminates the need of supporting other ones. As Li-Fi is based on LED that can be found in all the smart homes, additional physical communication equipment are no longer required.

5. Tools & Languages

<Software>

- Android Studio with JAVA, SQLite, Json, PHP
- MySQL, Apache web server



- Arduino IDE with C

<Hardware>

- Raspberry pi 2
- Arduino UNO

6. Design and Implementation

<Hardware>

6-1-1. Arduino

- Connected a photocell as the receiver and a relay as the power supply to an Arduino Nano
- Case was built by 3D printing:
 - Modeling by 123D Design
 - Conversion to Gcode by Cura

6-1-2. Raspberry Pi

- LED as the transmitter: connected to a Raspberry Pi

<Software>

6-2-1. Arduino

- Communication protocol: Combined existing Arduino Serial communication protocol and Manchester encoding for a stable communication
- Manchester encoding enables stable transmission with fewer flickers.
- Each LOT module has unique ID
- Transmitter: Start bit (1 bit) is followed by ID (4

bits), then ON/OFF bit (1bit) is transmitted.

- Receiver: Once all the bits are received, it checks the unique ID to decide whether the signal belongs to itself. ON/OFF toggling is done only when the ID matches.

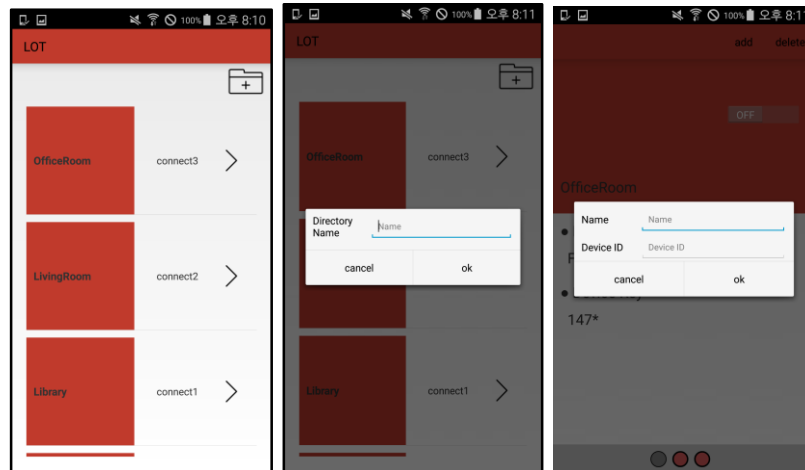
6-2-2. Raspberry Pi with Database

- number field: The number of signals to send to the device where Name and Device ID matches
- Name field: User defined device name
- Device ID and Location: Unique device ID with location information
- On/off State field: Current state of the device

6-2-3. Raspberry pi with web server

- Web pages for the following:
 - Transmits the current snapshot of the database to the Android App when it starts
 - Add device
 - Delete device
 - Toggle state of a device

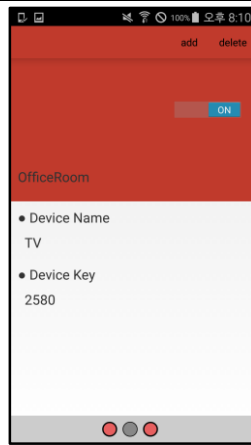
6-2-4. Android Application UI



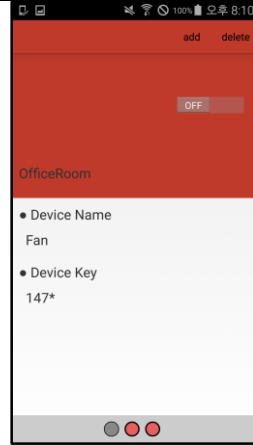
<Directory list view>

<Directory add view>

<Device add view>



<Device view1>



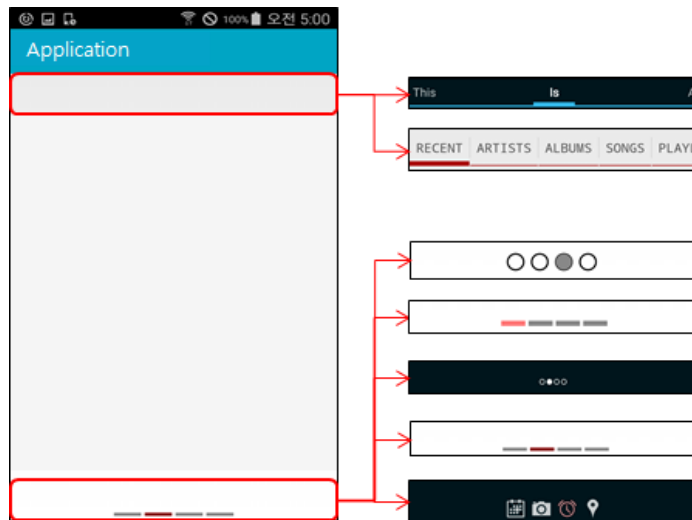
<Device view2>

6-2-5. Android Application

- ViewPagerIndicator Library

<http://viewpagerindicator.com/>

: A library that shows page indicator in various ways on the UI as shown below.



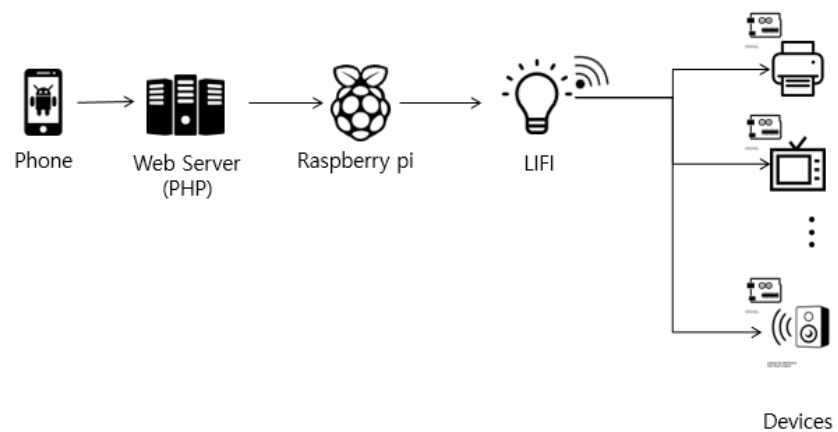
- SQLite for the database
: Directories and devices are stored as one database. Identified with the Name field

field \ category	id	Name	KeyID	onoff State	Location
directory	int primary auto_increment	directory name	"Directory"	2	connected device number
device	int primary auto_increment	device name	unique device key	on : 1 off : 0	contained directory name

- PHP and Json for server communication

7. Scenario

7-1. System flow



7-2. Operation Scenario

- Smart Home lighting as LED that has integrated Li-Fi and the devices that are controlled by LoT modules are required.
- Devices need to be registered to the App database.
- Registered devices can be controlled via the App through the nearby LED lightings.
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