Development of Smart Home System Controlled by Android Application

Seree Khunchai and Chaiyapon Thongchaisuratkrul
Department of Electrical Engineering Education
Faculty of Technical Education
King Mongkut's University of Technology North Bangkok, Thailand

sereek2521@gmail.com

Abstract - **This paper presents a low-cost smart home system with an efficient system. The hardware consists of NodeMCU Arduino, PIR sensor, temperature sensor, light dependent resistor and a motion sensor in IP Camera. The software includes ArduinoIDE and MIT app inventor II for Android mobile phones. The system developed based on Android user Interface for controlling a smart home. The NETPIE platform, which is a network of IoT, is used for interfacing between a user and a smart home. This system consists of lighting system, fan and security system. The notification is through LINE Notify app. The system includes two control systems; manual and automatic. From the results, it is shown that the control system is well performance while it is developed just low-cost devices.**

Index Terms - ***Smart home, Android app, internet of things, NETPIE, LINE Notify.***

I. INTRODUCTION

In the 21st century, the internet of things is applied to the present lifestyle of all people in the world. Continuously, the smartphone is used more and more. Until it becomes one of the important factors. During the same time, the internet of things technology has become more developed in everyday life. The smartphones technology would be a link device between people and electric devices via the internet network. Also, it can apply for electric devices in the from anywhere. The smart home system was presented in [1] which the control system is via Bluetooth. There is research on smart home control with Android applications via the internet [2]-[3]. Moreover, there is another research which developed message alert [4]. Some research has proposed Microsoft speech recognition system in the voice-controlled smart home system [5]-[6]. Although Smart home system can be applied with home security system and has been rapidly developed recently, it is not popular enough because of its high cost and complicated functions [7]-[8].

To solve the problem, therefore this research presents a low-cost smart home system with an efficient system. The study's purposes were to develop automatic and manual control system via an Android application on the smartphone. The system consists of lighting system control by PIR sensor, fan control by a temperature sensor and security system by LINE Notify app.

II. RELATED WORK

A. Smart Home

In 2003, smart home definition published in [9] that is a communication network of homes that are integrated together. To connect electrical appliances are can be controlled remotely from any location in the world by smartphone or internet [10]. Smart home technology has started to develop even more but at present, the price is quite expensive.

B. Internet of Things (IoT)

Internet of Things (IoT) is a technology that connects items or devices through internet access [11]. Items of electrical appliances such a lighting system, refrigerators, televisions, fans, air conditioners Electric fence gate etc. can connect and communicate with each other. This is to enhance the level of daily life to be more comfortable.

C. Network Platform for the Internet of Everything (NETPIE)

NETPIE is a cloud platform that is designed and developed to facilitate communication between devices or things in the IoT network for industry developers. It allows the device to talk to each other no matter the device is located in both physical and logical terms. Simply put the NETPIE library to be installed on the device. NETPIE will take care of all the connections. No matter which device is in the network, or where it is moved developers can design remote access devices (remote access) [12].

D. MIT App Inventor II

App Inventor is a tool for creating an application on smart phones and tablets under Android operating system and open sources served by Google and Massachusetts Institute of Technology (MIT). It is a programing tool which operated by extending order blocks, dragging and dropping to design and create mobile applications. It consists of simple steps beginning with using App Inventor Designer to design the program on mobiles, and then users can program each function by using App Inventor Blocks Editor to extend order blocks. [13].

III. PROPOSED SYSTEM

In figure 1, it shows the technology of 3G/4G or wireless which is used to connecting smart home system on Internet of Things with cloud platform. By application layer, mobile or tablet users under Android operating system can control and obtain data from smart home via NETPIE cloud server

platform. In network layer, it is controlled by NETPIE cloud server platform to connect between smart phone/tablet users and smart home system. Physical layer relies on home NodeMCU wireless micro controller to collect and process data from each censor in order to control smart home system under automatic mode. When all data are transmitted via layer network to users, the users can control smart home system by using manual mode.
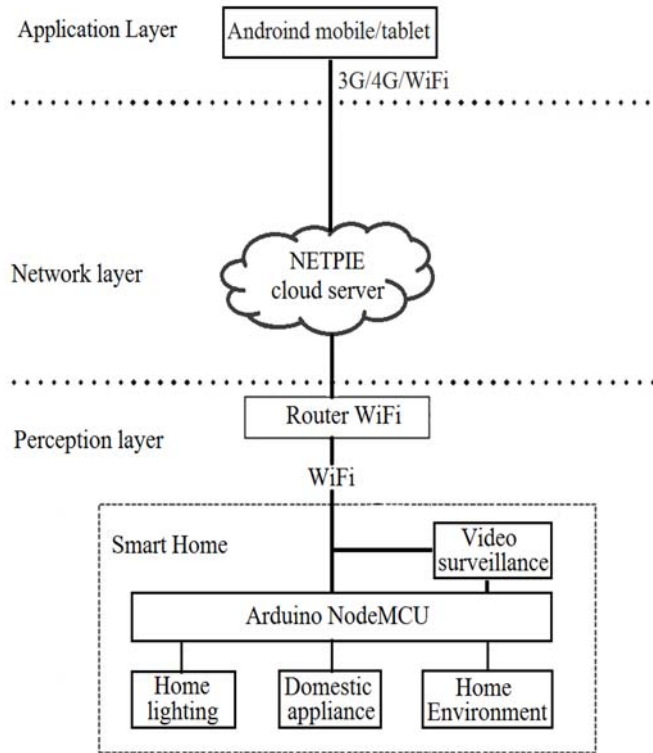

Fig. 1 Overall block diagram of the system

A. DESCRIPTION OF HARDWARE

Equipment of automatic control system for a smart home in the field section; various sensors were applied such as temperature sensor, PIR sensor, LDR sensor and IP camera shown in figure 2. The data from these sensors were connected to the microcontroller Arduino NodeMCU V1.0 connected to the input-output pin 12 pins. In this research, input pins were used to receive data from 4 sensors and connect the output pins to control the operation of the relays. The relays connected to various 8 electrical devices. The overview of the proposed architecture is shown in figure 3. Automatic control of home appliances remote control via smartphone, security system and LINE Notify.

a) NodeMCU V1.0   b) PIR Sensor   c) Temperature Sensor   d) LDR Sensor   e) IP Camera
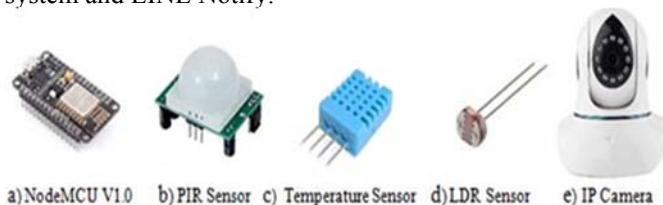
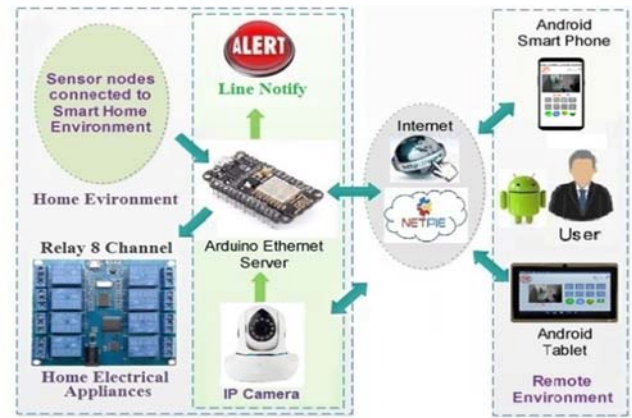Fig. 2 Equipment of the automatic control system

Fig. 3 Overview of the conceptual architecture of the system

Hardware that shows in figure 4 is designed for Smart Home system. It contains NodeMCU V1.0 WiFi board which is interfaced with home lighting, fan, temperature sensor, PIR sensor, LDR sensor, and IP camera alarm I/O port. Figure 4 (c) represents hardware that is designed for Smart Home system.
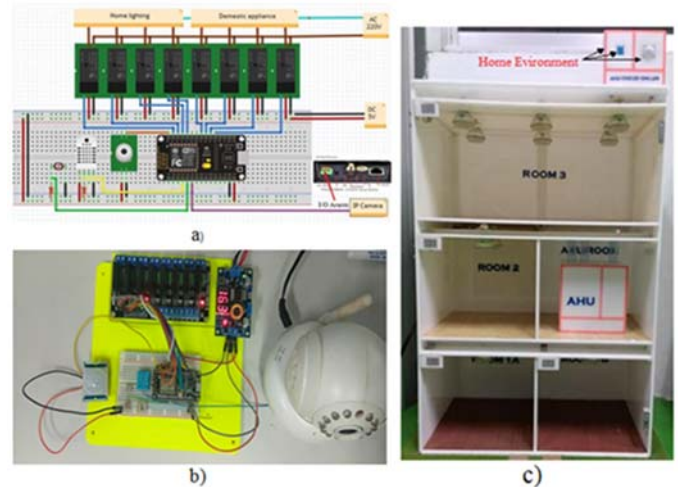

Fig. 4 Circuit connection and hardware implementation of the smart home prototype

B. DESCRIPTION OF SOFTWARE

1) The Android application automatically connects to the NETPIE service. When the user activates the microgear, runs on the MQTT protocol which will communicate with the NETPIE broker to communicate with each other. By confirming the identity of the device with its cloud, the identity of the device uses three components: AppID, App Key and Token. Creating an AppID helps various devices within the same AppID group know each status. As for the cloud identity authentication of NETPIE, it is the issuer of the license (Token) indicating that this device can communicate with any device itself. Microgear is a firmware that supports Arduino with Ethernet Shield for WiFi is the ESP8266 microcontroller used in this research. The connection would occur when microgear is connected to NETPIE successfully. Then receiving and sending information to the destination are

occurred by specifying the name of microgear with used to set the alias. The process of creating the AppID and the AppKey is shown in figure 5.
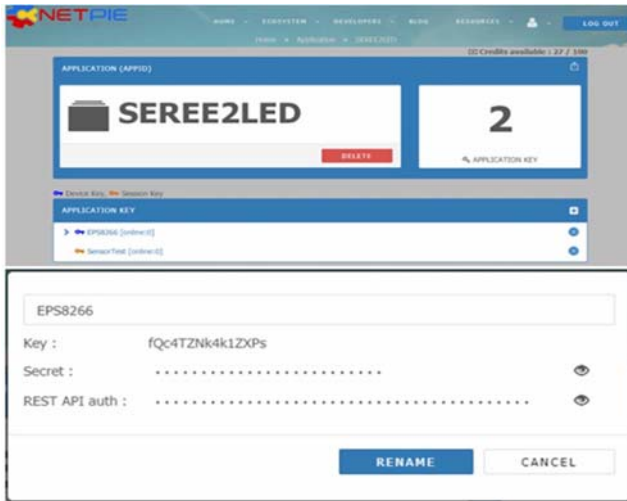

Fig. 5 Creating the AppID and the AppKey in NETPIE.

2) Arduino NodeMCU Software

This program is written by C language to control and inspect the operation of smart home system. It uses PIR sensor to detect movements at smart home. The main structure of Arduino program composes of three parts which are 1) head to define name, parts of equipment and connect with other parts, 2) setting to identify default value when switching on, 3) loop of smart home system program.
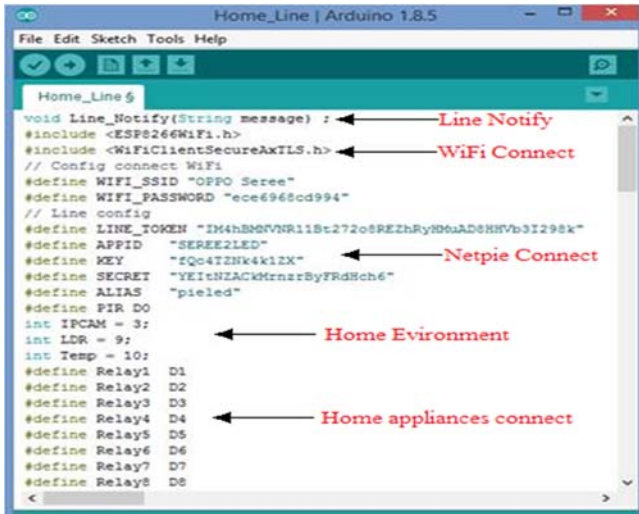

Fig. 6 Defining variables for connection.

3) Android app

For the interface of Android users, it is created by MIT App Inventor II. Its programming steps start from designing program on mobile with App Inventor Designer in order to design controlling buttons and an on-screen display on smart phones or tablets, as shown in figure 7. Then, the users will program each function by using App Inventor Blocks Editor to specify the conditions of each order block which are related to buttons and display, as shown in figure 8.

Fig. 7 Component designer and GUI button layout design

Fig. 8 blocks editor and control of home appliances

The testing of an Android app is performed on/off 20 times for light and fan system. To test the result, the user has to switch on/off lights and fan by pressing the button in the Android app developed shown in figure 9. In automatic mode, the smart home system takes switched on/off automatically if the value sensors exceed the initiation point.
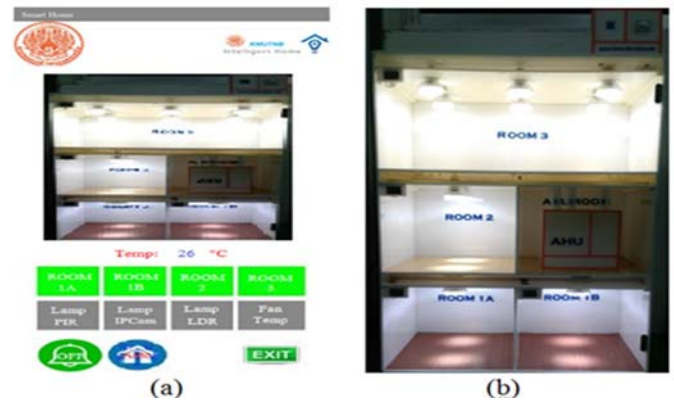

Fig. 9 Smart home performance test results

For the security system and Line Notify, sensors detect data and IP camera, if there is a change in the status or intrusion, the system will interrupt for on/off the lights and domestic appliances as specified and send notification information to the user's LINE Notify. All light system would turn on. For example, Fig. 10 shows the LINE Notify. Users have received notification from Android smartphone if there is an intruder in the home in case of an automatic Line notify system. The user can either switch off the lighting from the smartphone after a period of time.
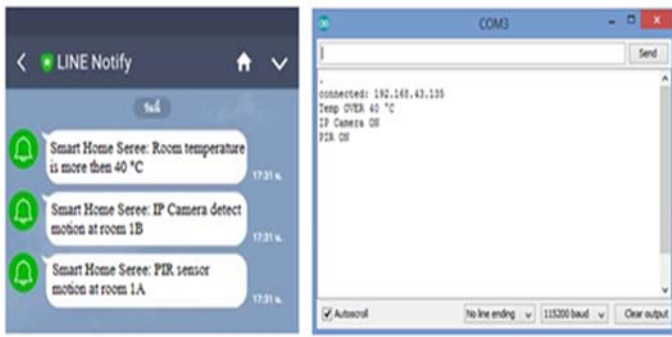
Fig. 10 Smart home line notify from Arduino NodeMCU

IV. RESULTS AND DISCUSSION

The result in table 1 shows the testing results of automatics control. The smart home could be used to turn on/off the power with Intrusion detectors. LDR sensors, PIR sensor, IP Camera, Temperature sensors and Android app on the smartphone for a control system can performance well.

The testing of automatics control has illustrated that the control in the light system by LDR sensor could be worked well. The PIR sensor could be worked at a distance of fewer than 4 meters while the sensor could not detect at more than 5 meters. The PIR sensor could work at the distance of fewer than 5 meters while the sensor could not detect at more than 10 meters and the fan system could control room via temperature sensor also could be worked well.

Table 1
The testing results of automatics control

The Lists of Testing	The Condition	Check
Lighting system (LDR sensor Setpoint 350 lux)	The illuminance room at 50 lux	On
	The illuminance room 250 lux	On
	The illuminance room 380 lux	Off
Lighting and alert system. (PIR sensor)	The motion occurred at 2 m	On
	The motion occurred at 4 m	On
	The motion occurred at 6 m	Off
Lighting and alert system. (IP Camera)	The motion occurred at 5 m	On
	The motion occurred at 10 m	On
	The motion occurred at 15 m	Off
Fan and alert system. (Temperature setpoint 25 ºC)	The temperature room at 40 ºC	On
	The temperature room at 30 ºC	On
	The temperature room at 23 ºC	Off

The manual control system testing by an Android app has the result the lighting system and fan system worked well and right at 100 %, but the delay time was a little bit about 2 seconds. The delay time depended on the speed of information transfer.

Table 2
The testing results of manual control by Android app

The Lists of Testing	Performance	Times	Results	Reliable percent
Lighting system	On	20	20	100%
	Off	20	20	100%
Fan system	On	20	20	100%
	Off	20	20	100%

V. CONCLUSIONS

The smart home controlled by the Android application in this research is investigated. This result showed that electric appliances could be controlled well. The weak point was the delay time is about more than 2 seconds depended on the speed of information transfer. On the other hand, the automatic control was work well and reliable. Because the sensor was installed on site, so it performed quickly. Both manual and automatic control could monitor by the Android app.

This prototype of the smart home system is designed to be simple and low cost. It is developed from NodeMCU with 13 input/output pins to connect with various relays or sensors such as PIR sensors or LDR sensors, etc. The development of NETPIE cloud platform service, which is a stable and good security system. It is can support up to 100 Node of the microcontroller. For future works, the system can be improved for a larger system or a more intelligent system.

REFERENCES

[1] R. Piyare and M. Tazil, "Bluetooth based home automation system using cell phone," in IEEE 15th International Symposium on Consumer Electronics, Singapore, 2011, pp. 192–195.
[2] S. Kumar, "Ubiquitous Smart Home System Using Android app," International Journal of Computer Networks & Communications, vol. 6, pp. 33-43, January 2014.
[3] R. Piyare, "Ubiquitous Home Control and Monitoring System using Android-based Smart Phone," International Journal of Internet of Things, vol. 2, pp. 5-11, 2013.
[4] M. S. H. Khiyal, A. Khan, and E. Shehzadi, "SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security," Issues in Informing Science and Information Technology, vol. 6, pp. 887-894, 2009.
[5] M. R. Kamarudin, M. A. F., and M. Yusof, "Low Cost Smart Home Automation via Microsoft Speech Recognition," International Journal of Engineering & Computer Science, vol. 13, pp. 6-11, June 2013.
[6] K. P. Dutta, P. Rai, and V. Shekher, "Microcontroller Based Voice Activated Wireless Automation System," VSRD International Journal of Electrical, Electronics & Communication Engineering, vol. 2, pp. 642-649, 2012.
[7] Zhang, Y., Zhao, G., & Zhang, Y. A smart home security system based on 3G. In Computer Science-Technology and Applications, 2009. IFCSTA'09. International Forum on (Vol. 2, pp. 291-294).
[8] Obaid, T., Rashed, H., El Nour, A. A., Rehan, M., Saleh, M. M., & Tarique, M. ZigBee Based Voice Controlled Wireless Smart Home System. International Journal of Wireless & Mobile Networks, 2014, 6(1).
[9] N. King. "Smart home. A definition" Intertek Research and Testing Center, 2003, pp. 1-6.
[10] A. McEwen, Designing the Internet of Things, London: John Wiley & Sons, 2013.
[11] J. Clark, "What is the Internet of Things?" IBM, [Online]. Available from: https://www.ibm.com /blogs/internet-of-things/what-is-the-iot/ [Accessed 25 7 2018].
[12] Netpie, "Getting Started with NETPIE" Nectech, [Online]. Available from: https://netpie.io/Getstarted [Accessed 25 7 2018].
[13] H. Larry, "The MIT roots of Google's new software". MIT News Office, [Online]. Available from: http://news.mit.edu/2010/Android-abelson-819 [Accessed 2 8 2018].
[14] Li Yueheng, Duan Zhiqiang, Yang Dongwei. "Design of smart home system based on Android and Cloud services," Microcomputer & Its Applications, 2016, vol. 14, pp. 79-82.