



Android-based Low Cost Control System for Smart Home using Raspberry Pi

안드로이드 기반의 라즈베리파이를 이용한 저 비용 스마트홈 통제시스템

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Abstract

According to the application demands and characteristics of smart home control system, the home smart system is analyzed and studied. The kind of smart home control system based on Raspberry Pi is also designed. Our system is designed to assist and provide support in order to fulfill the needs of elderly and disabled in home. Also, the smart home concept in the system improves the standard living at home. This paper presents the overall design of Home System with low cost: we used a Raspberry Pi Kit that communicates with an Android application. Wifi module in Raspberry Pi received the signal and processed the input signal to control the home devices. The proposed system intended to control electrical appliances with relatively user-friendly interface and ease of installation.

1. Introduction

The continuous growth of mobile devices in its recognition and functionality has led to an increase in the demand for advanced ubiquitous mobile applications in people's daily lives. Smart phones are more than just phones in today's life having a broad range of applications, such as education, health care, and entertainment. Smart homes aim to provide enhanced convenience and comfort, energy efficiency, security and surveillance. In term of cost, this system implemented low cost tiny computer Raspberry Pi Kit and Wifi module as the system main core. The total cost of one unit of this system hardware is estimated less than 50 USD. With this low budget, this system is still performed with powerful remote functions to make our life in home become easier.

The rest of the paper is organized as follows.

Section II presents current works related to our system as a whole. In section III, we present our design. Finally, Section IV discusses some implementation details.

2. Related Work

There has been a significant research and numerous approaches for the home automation systems. In [1], X10 industry standard, developed in 1975 for communication between electronic devices, is identified as the oldest standard in home automation systems by providing limited control over household devices through the home's power lines. Baris Yuksekkaya *et al* [2] implemented GSM, Internet and voice as wireless HAS. The system implemented microprocessor and GSM SMS control method by a GSM modem. The system [2] mentioned as low cost but the cost of GSM modem and microcontroller is not

considered. Also, long term cost by the GSM is not fully accepted by every user. Wen-Tsai Sung *et al* [3] proposed through Wifi, the user can operate the hand-held mobile devices for the control of the system. In order to establish an intelligent LED lighting control system you can easily control power as well as other related electrical device.

3. The Proposed System Architecture

A low-cost and flexible standalone smart home control system is proposed and designed. The proposed system uses Wifi and REST ful based web services as the interoperable layer. It consists of an Android compatible smart home app, a micro web-server running on Raspberry Pi as the main controller, and the hardware modules. The overview of the proposed architecture is shown in Figure 1.

In this system, 5 relays are used to control the home devices. Normally open circuit concept has been implemented in the input control home appliances with Android application. Based on this concept, the output are functioned when the current are given to the circuit to trigger the relay.

4. System Implementation



Fig. 2: Graphical User Interface (GUI) guideline screenshots of the smart control application

The instruction screenshot for the first time user use an application is shown in Figure 2. Android application act as interface between smart phone and Wifi connection. The user has to enter the IP address and a password to authentication. Access is only

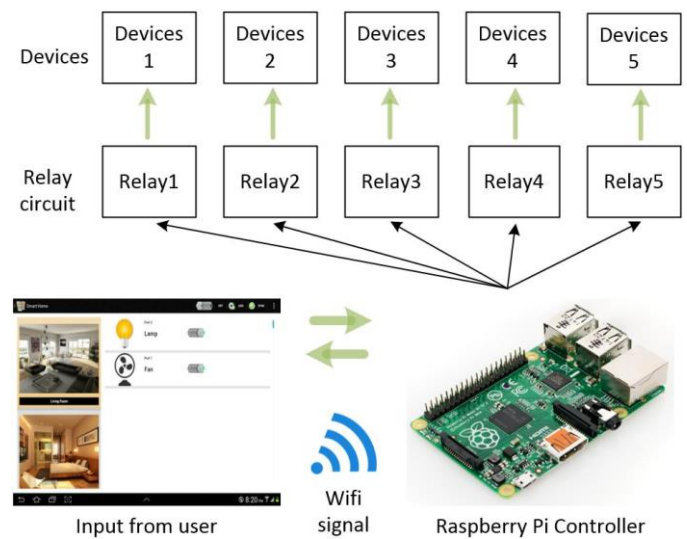


Fig. 1: Overview of System Architecture

granted if the requested details are correct upon which the GUI statuses on the main controls screen. After that the current status of devices are updated and the user can perform the desired action using the GUI.

Default password is set to 1111. The packet layout of the commands sent from the app (in the form of a single string) to the smart home micro-web server is given in Figure 3. The micro-web server is able to easily extract all the required action information from the command packet. The structure of request packet includes password, name of home devices which the user would want to control and the action in this case is ON/OFF. For example, the command packet "#1111#Fan#1#ON" will be sent for turning on fan number 1.

#	Password	#	Device	#	Number	#	Action
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Fig. 3: Structure of request packet from application

The ability of Wifi signals to transmit and receive data was analyzed as depicted in Table 1. The results of the analysis has been measured at outdoor. For the distance of 5 meter, 10 meter, 15 meter and 20 meter the of Wifi signal communicate successfully. However at 25 meter distance Wifi signal cannot communicate with the circuit.

We have measured the value evaluation of the smart home control apps using some phone statistic tool. For CPU usage (like percentage of time spend in individual methods), we check out trace view. It's an

executable in tools directory that comes with the Android SDK. For memory usage, you can use Eclipse Memory Analyzer (MAT) and for battery usage, there's a project called PowerTutor [4] which helps estimate power consumed by the CPU, display, and GPS. The system evaluation is shown in Figure 4. The amount of RAM, CPU and battery used just a small part of the memory system.

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6. Conclusion

This paper proposed the overall design of Home System with low cost using a Raspberry Pi Kit that communicates with an Android application. The implementation of the proposed system is evaluated based on the criteria considered after the requirement analysis for an adequate home control system. According to the evaluation results, the proposed home automation system, which uses Android applications, is adequate in overall. Features such as low cost, user authentication and devices control make the proposed system unique.

7. References

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- [4] PowerTutor, PowerTutor App. <http://powerTutor.org>.

TABLE I: Distance of Wifi ability to send and receive data

Distances (m)	Ability send and receive data
5	Success
10	Success
15	Success
20	Success
25	Failed

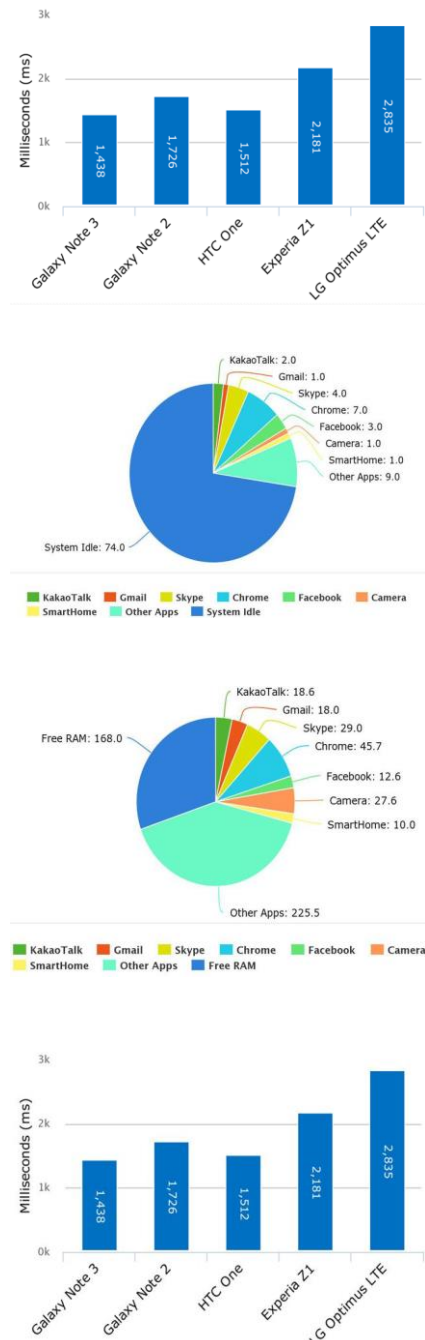


Fig. 4: System evaluation: (a) Battery Consumption Comparison over 5 hours; (b) CPU Utilization (%); (c) RAM Utilization; (d) Comparison of Delay Time on several devices (ms)