A Pilot Study: Development of Home Automation System via Raspberry Pi

M. MAHADI ABDUL JAMIL
Biomedical Modelling & Simulation Research Group
Universiti Tun Hussein Onn Malaysia
Johor, Malaysia
mahadi@uthm.edu.my

M. SHUKRI AHMAD
Biomedical Modelling & Simulation Research Group
Universiti Tun Hussein Onn Malaysia
Johor, Malaysia
mshukri@uthm.edu.my

Abstract— **Automation is not a new idea in our modern life. Large businesses and wealthy homeowners have already implemented this technology for years now. In recent years saw this concept getting more accessible to very home owner, due to cheaper cost, easier to setup and used modular concept and also higher internet penetration rate. However, none of this system really focused on the needs of the handicapped and the elderly, thus the aim for this project. This niche group of people has different needs than other type of user. Similar to other home automation system, it is able to control electrical appliances remotely from a Smartphone, laptop or any Wi-Fi enabled device, but it can be configured to do specific task depending on the user needs. Furthermore, monitoring features can be added to enable other family member to monitor the disable and the elderly via the internet, and remotely control attached devices. It is hoped that it will provide a better quality of life, while reducing the electricity wastage by giving user the power to control, conserve and react according to user needs, or also can be done by using the scheduling function for automatic operation of home appliances.**

Keywords-component; home; automtion; disable; elderly

I. INTRODUCTION

This system provides a wireless remote control solution for controlling the lights and fan via Wi-Fi capable handheld devices such as Smartphone, adding convenience and also reducing electricity wastage. While this concept is not new, all of this only appeals to tech savvy user, due to the complexity, feature and price, which are not important for this project target user. In this project, appliances such as light and fan that connected to the Main Control Unit (MCU) still can be controlled remotely from a computer screen or a smart phone [1-4]. This is performed by using a very simplistic Graphical User Interface (Graphical User Interface, GUI), which is easily used and understandable for the target user. This system can also be equipped with the monitoring function by including a web camera to the MCU for a live video feed, or from wearable electronics wore by the user which for example include heartbeat sensor.

II. RELATED WORKS

According to R. A. Ramlee [5], smart home system via Wireless Bluetooth is the introduction of technology that is focusing more on motivating disable person by making it possible for them to carry out the daily activity, safely and comfortably. In the research by G. Khusvinder [6], ZigBee–based home automation system is introduced which can be controlled either through the Internet or by remote controller. The concept of project presented by Muhammad Fahim [8] include a daily life tracking application for smart home using Android Smartphone to assists elderly people for independent living in their own home and avoids certain accidents.

III. SYSTEM OVERVIEW

Figure 1 shows the architecture of the system that consists of the main units; the MCU which includes Raspberry Pi and Input/Output Interface (IOI) unit. Raspberry Pi, which has the size of a credit card, is equipped with ARM microprocessor and has all the common ports of a normal PC or laptops, such as video and audio out, HDMI port for high definition display, two USB host port and a RJ-45 Local Area Network (LAN) port. The USB port is connected to a Wi-Fi dongle to add wireless connectivity to the MCU. What differentiates the Raspberry Pi with normal everyday computer is the availability of general purpose input-output port (GPIO) which allows easy connectivity with external hardware that makes home automation easier. The GPIO are then connected to the IOI unit which contains the switching circuit and power ports for easy appliances installation.

The GUI designed and created using Python Tkinter. It act as the medium between the user and the MCU for both control and monitoring the current status of the home appliances connected to the IOI unit, and also for surveillance and security monitoring using the webcam. In this prototype system, it has two different outputs, which is the light, fan and one input, which is the webcam. For the light, user able to turn it on or off while for the fan, user can also control the speed either speed 1, speed 2 or speed 3 according to his requirements. Moreover, the web camera is also placed in the system for monitoring purposes and can be placed at any desired point or location.

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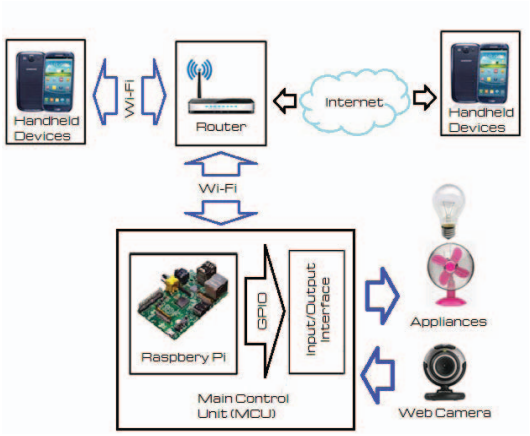

Figure 1: System Architecture

IV. METHODOLOGY

Figure 2 shows the flowchart of the system programming for the overall process to turn on, off and control the speed of the output device by using the GUI. The GUI can be accessed from a PC/Laptop or Smartphone using several option, remote networking application or virtual desktop apps or using web browser, thus enabling a versatile or flexible system.

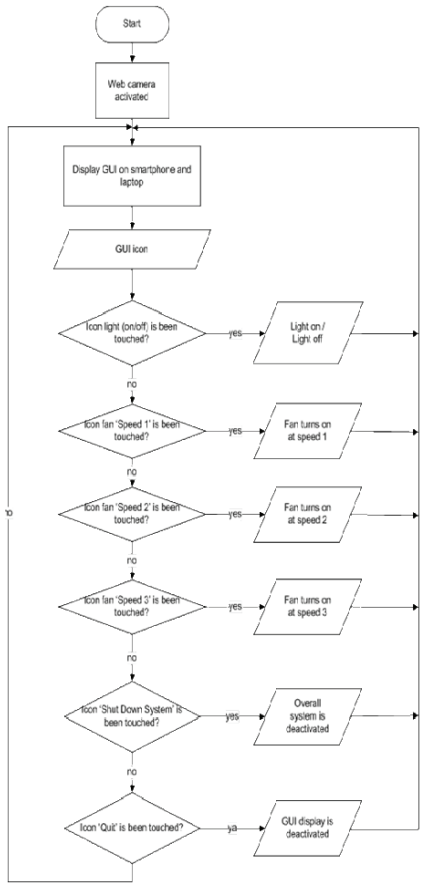

Figure 2: Overall process of Raspberry Pi for Home Automation System

V. RESULT AND ANALYSIS

This section will discuss the results for the whole system and analysis to these outcomes. The results of this project are divided into three parts, hardware result, graphical user interface result, and web camera monitoring result.

A. Hardware Result

In order to test the functionality of the system, the MCU of this prototype were connected with a lamp and a fan. The IOI unit consist of several DC 6V relay switching circuit to control 240V output AC, but only two are used for the demonstration. The GPIO pins used to connect the Raspberry Pi to the IOI unit, and the pin were assigned as shown in table 1.

TABLE I. GPIO pins for each output [2]

Input	Button	GPIO	Output
Light	On Light Off Light	18	The lamp change its state On to Off and Off to On
Fan speed 1	Fan : Speed 1	7	Speed 1 activated
Fan speed 2	Fan : Speed 2	4	Speed 2 activated
Fan speed 3	Fan : Speed 3	23	Speed 3 activated
Turn off fan	Off fan	-	Fan deactivated
Turn off fan and light	Shut Down System	-	Light and fan in the off state simultaneously
Exit from GUI	Quit	-	Deactivate GUI display

Each pin represents a control button function to turn on/off the lights and fan plus the fan speed control. Figure 3 shows the prototype of the system.

B. Graphical User Interface Result

Figure 4 shows the interface that will be displayed on the smartphone when the user uses the Home Automation applications.

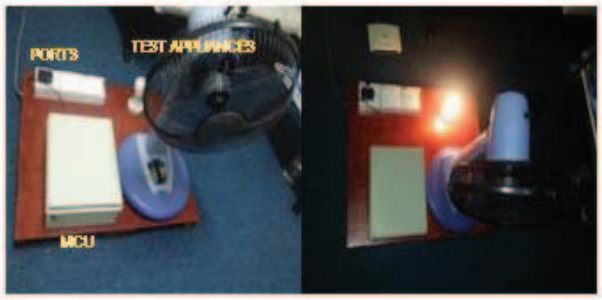

Figure 3: Prototype of Raspberry Pi based Home Automation System

This GUI resides on the raspberry pi. What we can observe here is the SSH connection, from client device such as android phone. The advantage of this is regardless of what the client device is, the GUI is always the same. This also true when this system been accessed from the internet. More than one client can access this system at any given time.

The GPIO pins used to connect the Raspberry Pi to the IOI unit, and the pin assignment are shown in Table 1.

C. Web Camera Interface Result

Web camera used as monitoring device and can be placed at any desired point of location by the user. This added security and safety functionality to this system. Figure 5 show the camera web display. Web camera in this prototype is connected to the USB port of the Raspberry Pi.

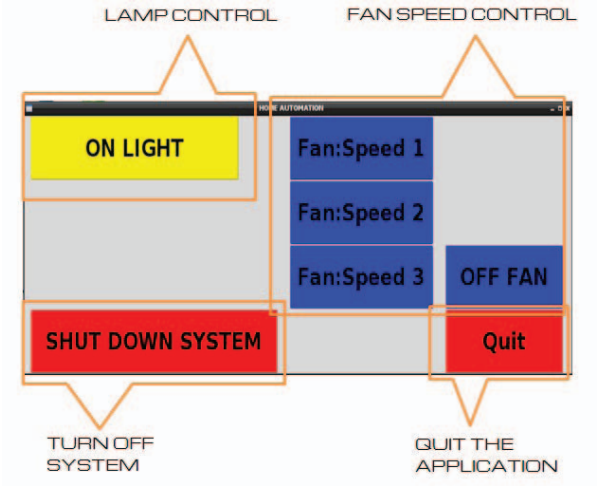

Figure 4: GUI System of the prototype

Figure 5: Web camera display via the prototype

VI. DISCUSSION

This proposed solution, which allows the user to monitor and control different appliances connected over a wireless network in home environment has been demonstrated to be functioning by developing a on and off control system. With the explosion of internet based and related technologies, and all the supporting internet framework, the home system looks feasible to enter this arena. Efforts in such direction will help to realize a truly wireless, fully automated home automation system for the benefit of elderly and disable people or day care centre.

VII. CONCLUSION AND RECOMMENDATION

This project demonstrate the possibility of implementing a system that will helps the elderly and also people with disability, and not just normal home owner. Furthermore it can also be used in the increasingly popular Small-Office-Home-Office (SOHO) environment. When the user touches the icon from the GUI on their android Smartphone [10], lights and fans will switch ON and OFF uniformly and fan's speed can also be remotely controlled.

For more reliable system for future use, several improvements could be introduced. Inclusion of infra-red (IR) transmitter which can support several different protocol, will enable the MCU to control appliances with IR or RF remote control, such as television, radio and air conditioner, which eliminates the need of carrying several different remote control around. Another function which could be added is the timer function. The timer can control the appliances time to 'ON' and 'OFF'. This will give expandable option to the consumer in controlling their home appliances. Furthermore, addition of sensors, magnetic door locks and alarms may enhance the function of this project even more. Finally, this project provides a flexible and customizable design and implementation for many application with low cost thus, not limited to home automation only.

REFERENCES

[1] Kang Wei Shen, "Android-based Application for Home Automation Control(HAC)", Faculty of Electrical and Electronics Engineering Universiti Tun Hussein Onn Malaysia,

[2] "Simple Guide to the RPi GPIO Header and Pins" on Nov 25,2013.Website:http://www.raspberrypi-spy.co.uk/2012/06/simple-guide-to-the-rpi-gpio-header-and-pins/

[3] "Home Automation Technology" on Nov 28, 2012. Website:http://www.seefe.net/file/page/forum/presentations/D2S4P4.pdf

[4] "Raspberry Pi" Retrieved on 12 October 2013. Website:http://en.wikipedia.org/wiki/Raspberry_Pi

[5] R.A.Ramlee, D.H.Z.Tang dan M.M.Ismail(2012), "Smart Home System For Disabled People Via Wireless Bluetooth", IEEE International Conference on System Engineering and Technology ,pp. 978-983,2012.

[6] G. Khusvinder, Y. Shuang-Hua, F. Yao, and X. Lu, "A ZigBee-Based Home Automation System", IEEE International Conference on Consumer Electronics, pp. 422-430, 2009.

[7] M. Van Der Werff, X. Gui, dan W.L. Xu. "A Mobile-Based Home Automation System", IEEE Conference on Mobile Technology, Applications and Systems, pp1-5, 2005.

[8] Muhammad Fahim, Iram Fatima, Sungyoung Lee and Young-Koo Lee. "Daily Life Activity Tracking Application For Smart Homes Using Android Smartphone", International Conference on Advanced Communication Technology (ICACT), pp19-22, 2012.

[9] Baris Yuksekkaya, A. Alper Kayalar, M. Bilgehan Tosun, M. Kaan Ozcan, and Ali Ziya Alkar, Member, IEEE. "A GSM, Internet and Speech Controlled Wireless Interactive Home Automation System", IEEE Conference on IO Electronics, Ankara, Turkey, pp837-843, 2006.

[10] "GUI with Raspberry Pi Tkinter and GPIO", Retrieved on 26 October 2013. Website:http://www.youtube.com/watch?v=xfxSH790rZ0