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Designed and Development of Bluetooth Based Smart Home Automation System for Disabled People

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Abstract: This project is designed to control electrical appliances and monitor ambient temperature from a smartphone. This project actually can assist and provide support to kids, elderly and disabled at home. The design is using an Arduino Uno board and the home appliances are physically connected to input/output ports via relays. The main control system connected via wireless Bluetooth technology to provide remote access from a tablet or smartphone. Cytron BlueBee used to establish communication between an Android phone and the Arduino Uno board wirelessly. The system is intended to control electrical appliances and devices in home with friendly user interface and trouble-free installation. From the analysis, the most efficient Bluetooth connection for a close area is around 15m and 20m for the open area.

Keywords : Home Automation**;** Arduino; Android; Bluetooth; Disabled People

1. Introduction

In year 2018, Department of Social Welfare Malaysia reported that there are 497,390 disabled people in Malaysia [1]. People with physical disabilities contribute almost 36% of the statistic. They have limited ability to perform some task, for example, at home; people with wheelchair have difficulties to turn on and off a fan switch. This is because normally the switches are placed at a height of 1.5m while the comfortable height for a wheelchair user is up to 1.3m only [2]. Therefore, providing a very practical

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facility that can ease accessing home appliances is really required, which can greatly improve the lives of the disabled.

Recently, there has been a significant research devoted to a technology-based home security and automation systems. In [3] and [4], a Bluetooth based home automation is presented. In [3] the system has a main controller using Arduino BT board and a set of Bluetooth. The board connects the home appliances via relays. The set of Bluetooth is responsible to send a message to the main board. The advantages of the system are it is a low-cost and secure home automation system through the use of Bluetooth technology [3, 4] and password protection [3]. However, these advantages might introduce an access delay to the devices due to numerous devices sharing a single Bluetooth module and the presence of an authorised person at home is needed to access the system.

In [5] presents another Bluetooth based home automation system. The system is designed to lock/unlock the home door which an embedded controller board is physically connected to the home door. A Bluetooth module on the board is used to communicate wirelessly with the Bluetooth on Android smartphone. Although the system provides confirmation messages for every user's request, however, if the physical key is used to lock/unlock the door, the messages are not sent to the owner of the mobile device. The similar Bluetooth-based home door system is developed by [6] to lock/unlock the home door. However, the system is designed without a physical key hole and key as a precautionary measure in the event of losing the mobile device.

Wi-Fi based home automation system is developed in [7] on Android smartphone. All home appliances are physically connected to an embedded controller board via relays. The board is integrated into a home computer that acts as a database server. The database is designed to record the message send by the smartphone to the board, date and time of the message are received and what home appliances are controlled over the internet. The message is sent over the network from the user's smartphone to the board through the use of home computer's wireless internet connection. Although the system has equipped with the database to record the usage of home appliances it only records the current usage which makes monitoring of the usage is not possible.

From the overall paper reviews, home automation system proposed by researchers [2 - 8] never mentioned about the existing physical electrical switches in the system and controlling the operation of each device. Without the switches on the wall, the designed system limited the control only in the graphical user interface (GUI). Without controlling the operation of devices, the system limits the user to switch on/off the electrical devices only. These issues bring inconvenient to the people in the house.

This proposed designed system remains the physical switches and provides an alternative to the user to control their home appliances operation via GUI. Generally, this research uses the Android platform to develop the GUI for controlling electrical appliances such as a door, a lamp, a fan and speed of the fan. In addition, the developed application also displays ambient temperature. The system is designed with the aim to provide assistance to the disabled and the elderly to more easily control electrical appliances at anytime and anywhere as long as connected at the certain distance.

The paper is organised as follows. The development process of the application is explained in section 2. Results are discussed in section 3. Finally, concluding remarks and future works are drawn in section 4.

2. Materials and Methods

Figure 1 illustrates the architecture of the system which is divided into three main sub-systems; Android application development, main control unit (MCU) and Arduino Uno microcontroller programming.

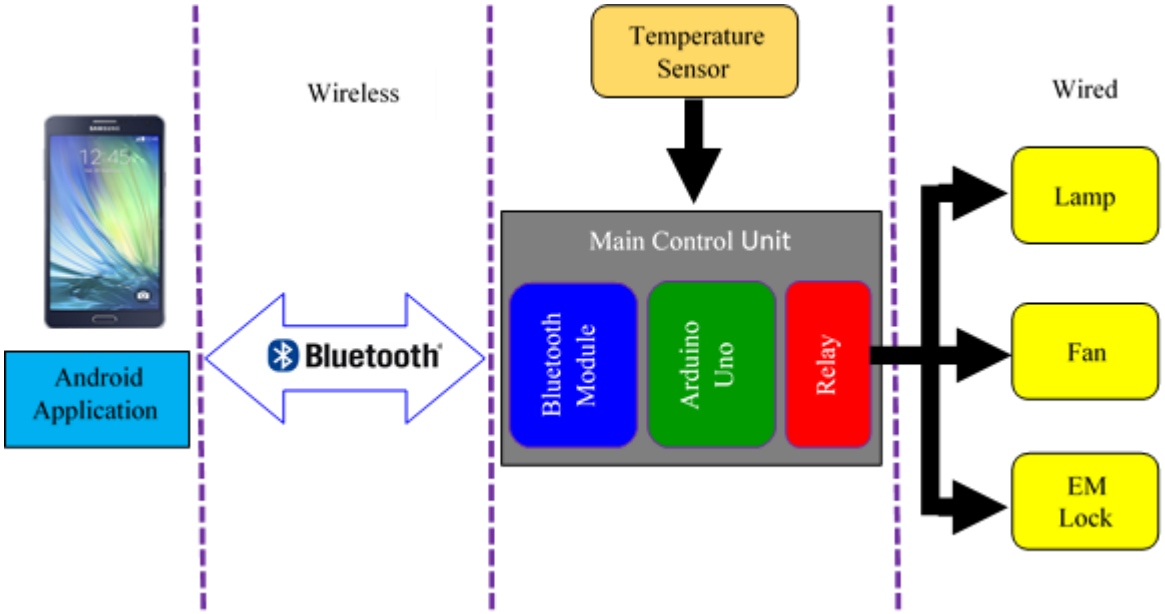

Figure 1: System architecture

An Android based graphical user interface (GUI) application had been invented to communicate a smartphone and MCU via Bluetooth. An Android phone will be act as a portable remote control since most of us have at least one Bluetooth compatible smartphone. The MCU is designed to integrate several components such as Arduino Uno, Bluetooth module, relays and temperature sensor. The signal received from smartphone will be processed by the Arduino Uno microcontroller to control the electrical appliances such as a lamp, fan and door lock through relays that operate as an electromechanical switch. A temperature sensor was linked to the Arduino to measure the ambient temperature. The analogue signal from the sensor will be converted into digital signal by the Arduino and send to the smartphone to display the temperature. General configuration of the MCU and electrical appliances are shown in **Figure 2**.

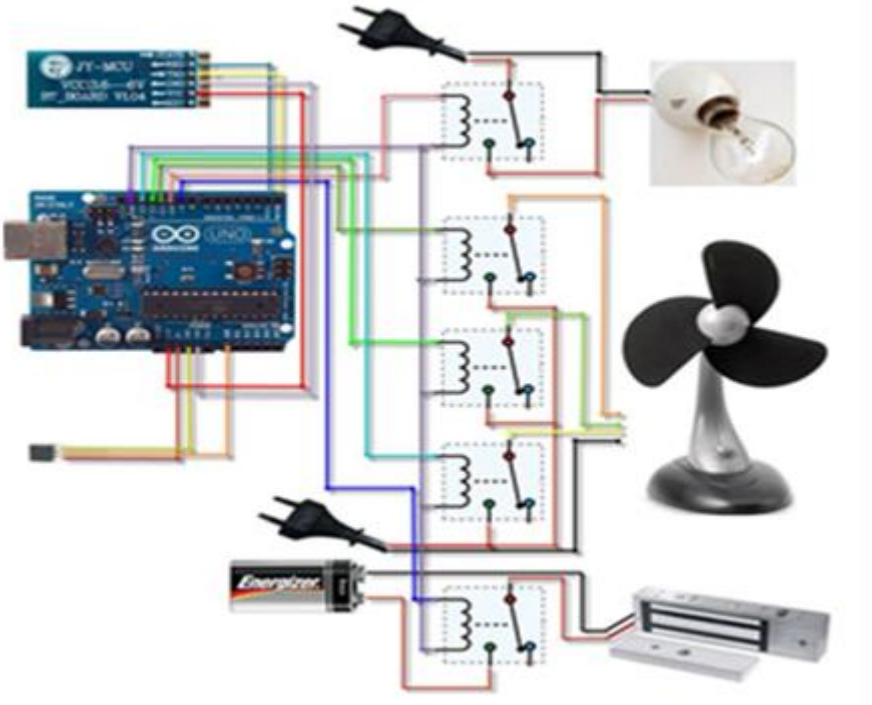

Figure 2 : General configuration of MCU and electrical appliances

The MIT App Inventor 2 software was used to develop an Android application. To build the application, user need to drag-and-drop visual objects in graphical interface form. The user also need a Google email account and an internet connection in order to develop the application. User needs to pair the smartphone and Bluetooth module by entering a pairing password before he/she can access the application. This is required for once only. **Figure 3** shows the main page and the controller page of the smart home application that developed using MIT App Inventor 2. For security purpose, the user must enter the user name and password before he/she can use the application. Once the username and password are granted, user needs to choose the Bluetooth button to connect with the MCU via Bluetooth shield. From the GUI page, user can control fan speeds, lamp and door lock. The user may know the current surrounding temperature status by referring to the temperature displayed on the smartphone screen. **Figure 4** represents the block communication for Android application with MCU.

Figure 3 : GUI of the Android application

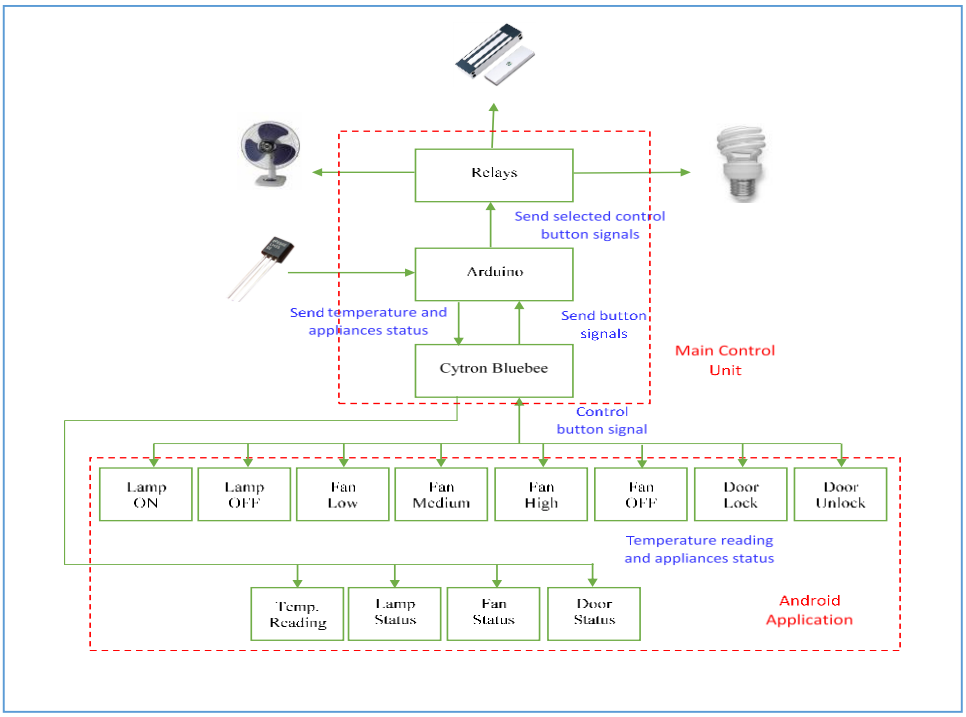

Figure 4 : Block communication for Android application with MCU

3. Results and Discussion

Figure 5 shows the results obtained during buttons of the lamp, door lock and high speed were pressed on the application. The surrounding temperature also displayed.

Figure 5 : Results of buttons pressed on the application and electrical appliances status

The inputs for this system are set to lamp status – on and off, fan status – low, medium, high and off, door – lock and unlock. Each input have been assigned to a unique code in order to integrate the Android and Arduino. **Table 1** shows the results of inputs and outputs.

Table 1 : Results for inputs and corresponding outputs

Inputs	Submit Data (ASCII)		Arduiono Uno Output Pin Status	Output Results
	Decimal	Character		
Fan Off	49	1	Pin 11,12, 13 Low	Fan Off
Fan Low	50	2	Pin 13 High	Fan Low Speed
Fan Medium	51	3	Pin 12 High	Fan Medium Speed
Fan High	52	4	Pin 11 High	Fan High Speed
Lamp Off	53	5	Pin 10 Low	Lamp Off
Lamp On	54	6	Pin 10 High	Lamp On
Door Unlock	55	7	Pin 9 Low	Door Unlock
Door Lock	56	8	Pin 9 High	Door Lock

An analysis of Bluetooth signal strength over the distance was conducted and the results are shown in **Table 2**. The experiment was performed in two conditions; non line of sight (NLOS) and line of sight (LOS). For NLOS we tested in a house and open space area for LOS conditions.. Each test was conducted with different level of distance between 5 to 25 meters. The aim of the experiment was to examine the efficiency of Bluetooth transmission over NLOS and LOS. From the results, the maximum range for Bluetooth communication is 15 meters for in house (NLOS) and 20 meters for open space (LOS).

Table 2 : Bluetooth signal strength over distance results

Condition	Distance (m)	Signal Strength			% Efficiency
		Test 1	Test 2	Test 3	
In house (NLOS)	5	OK	OK	OK	100
	10	OK	OK	OK	100
	15	OK	OK	NG	66.67
	20	NG	NG	NG	0
	25	NG	NG	NG	0
Open space area (LOS)	5	OK	OK	OK	100
	10	OK	OK	OK	100
	15	OK	OK	OK	100
	20	NG	OK	OK	66.67
	25	NG	NG	NG	0

3. Conclusion

In this study, the proposition of Bluetooth technology implementation in controlling home appliances using graphical application in a smartphone is accomplished. Furthermore, this system is designed with a simple GUI and user friendly to elderly and disabled people. Consequently, it will improve the lifestyle of target users and society generally.

Instead of connecting to the main system controls using Bluetooth, internet connection should be considered as well for future work. From this, we can control the electrical appliances from afar as long as there is an internet connection. Next, we recommend to develop a program that can adjust the fan speeds depending on the surrounding temperature. Therefore, the user will no longer have to adjust the speed manually.

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References

[1] Jabatan Kebajikan Masyarakat (2018*). Laporan Statistik 2018 Kebajikan Masyarakat.* Retrieved from http://www.jkm.gov.my/jkm/uploads/files/penerbitan/inlay_statistik_v5_final.pdf

[2] R.A. Ramlee, D. H. Z. Tang, M. M. Ismail, "Smart Home System for Disabled People Via Wireless Bluetooth", in Proc. of IEEE International Conference on System Engineering and Technology, pp. 1-4, 2012.

[3] Piyare, R. and Tazil, M. "Bluetooth based home automation system using cell phone", IEEE Conferences of Consumer Electronics Engineering, pp. 192-195, 2011.

[4] Abraham, K., and Sandeep Rao, K.P. (2009). "Implementation of a Low-Cost Home Automation System", K.C.G. College Of Technology, Anna University, Chennai. Final Year Report : Bachelor of Computer Science and Engineering

[5] Potts, J. and Sukittanon, S., "Exploiting Bluetooth on Android Mobile Devices for Home Security Application", in Proc. of IEEE Southeastcon, pp. 1-4, 2012.

[6] Ismail, N. H, Tukiran, Z., Shamsuddin, N.N. and Saadon, E.I.S., "Android-based Home Door Locks Application Bluetooth for Disabled People", in Proc. of IEEE International Conference on Control System, Computing and Engineering, pp. 227-231, 2014.

[7] Kang Wei Shen (2013). Aplikasi Berasaskan Android Bagi Kawalan Rumah Berautomasi, Universiti Tun Hussein Onn Malaysia. Final Year Report: Bachelor of Electrical & Electronic Engineering.

[8] P. Swamy Vivek;P. Venkata Sai Rahul;E.S Dyuthy;Sudha Yadav, "Arduino based Smart System for Control and Effective Billing", 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), pp 1-4, 2021