An Android Based Home Electrical Appliance Control System

*John C. Ehiabhilli, Aduragbemi O. Oke, Olusayo Olubosede and Damilare O. Olobatuyi*

Department of Physics, Federal University Oye-Ekiti, Nigeria

{john.ehiabhilli|aduragbemi.oke|ulusayo.olubosede}@fuoye.edu.ng|olobatuyi25@gmail.com

Received: 11-JUN-2020; Reviewed: 23-JUL-2020; Accepted: 12-SEP-2020

http://dx.doi.org/10.46792/fuoyejet.v5i2.528

Abstract- Electric bulbs, television sets, fans and other home appliances are usually controlled largely with human effort using mechanical switches. However, over the past decade, there has been drastic improvement and advancement in consumer electronics and embedded systems. This has ensured a home environment where appliances can be connected and controlled using wireless technology and an Android smart phone. This study demonstrates the design of an automated system to assist and provide support in order to fulfill the needs of the physically disabled and elderly ones in controlling electrical appliances in homes. The heart of the control system is the wireless Bluetooth technology which provide remote access from a smart phone to a Bluetooth module and then to a control and switching unit. Bluetooth wireless connection enables the system to communicate with a Java application on an Android smart phone without cable. The user can easily touch on the phone screen to control the home appliances linked to the system. This method which requires minimal human effort is able to assist the disabled, sick and elderly people who have difficulties with locomotion. Thus, a control system has been designed which offer a low design, installation ease, quick response time and a user-friendly interface in controlling home electrical appliances.

Keywords- Android Phone, Bluetooth, Microcontroller, Relay and Switching

1 INTRODUCTION

Over the past few years, there have been so many inventions in the field of consumer electronics such as cellular phone, air conditioners, home security and alert devices, home theaters etc. All the appliances can be easily controlled by a single controller, using a simple network in a home environment (Al-Ali et al, 2004). Al-Ali et al (2004) designed a low-cost java-based automation system. However, the automation did not offer a low-cost system and the embedded system board had to be integrated on a PC based server. Hasan and Yavuz (2007) designed a PIC remote controlling communication with telephone but was not based on wireless communication. It introduced device pin check algorithm which was with a dedicated cable for communication. Piyare et al (2011) designed a wireless and low-cost automation system that supported phones with Symbian operating system only resulting in limited range and platform for use. As a result of busy environment in homes and offices, the market is going towards the Android based electrical appliance control networking system and Bluetooth is an ideal solution for this purpose (Greichen, 1992).

This work demonstrates a simple solution which consists of an Android phone, controller circuit and load which can be any home appliances. In many homes, operation (switch ON/OFF) of electrical and electronics appliances such as light bulbs, air conditioner, fans etc is usually carried out through switches. Switching home appliances manually is not a convenient method for the physically disabled, sick or elderly people when switching operation is frequently required. Thus, this conventional manual switching method has to be overcome by an easier method of switching (Mohammed et al, 2014). This can be done using an advance switching method like a switching control for electronic home appliances with the help of an Android operating System (Shiu, 2014).

A Bluetooth technology is a low powered radio communication wireless technology with high speed, capable of connecting phones, laptops or other portable devices together. It is a technology used to link phones, computers and other network devices over short distance without wires (Kamna et al, 2003). Wireless signals transmitted with Bluetooth cover short distances, typically up to 30 feet (10 meters). It is achieved by embedded low cost transceivers into the devices. It supports on the frequency band of 2.45 GHz and can support up to 721 Kbps along with three voice channels (Ramlee et al, 2013). This frequency band has been set aside by international agreement for application in scientific, medical and industrial devices (ISM).rd-compatible with 10 devices (Sriskanthan et al, 2002).

This work serves the purpose of aiding the aged, sick and handicapped people in controlling the operations of electrical appliances. It limits their mobility especially for the disabled but carry out the desired goal with a level of comfort. It provides an average user the comfort of enjoying the use of electrical appliances at home and in offices without the interruption of work and switching OFF or ON electrical devices and appliances with a tap on their Android phones.

2 RESEARCH METHODOLOGY

This work was achieved using many design approach including software and hardware components. These include all the steps in areas such as proper placement of components on board, soldering, testing and connection of components, testing of continuity of the various components, programming the microcontroller, troubleshooting the constructed circuits and analysis of results.

2.1 BLOCK DIAGRAM OF THE WORK

Figure 1 gives the block diagram of the android based home electrical device/appliance control system.

*Corresponding Author
The power supply unit provides 5 V supply which is used to power the microcontroller unit, Bluetooth module, display unit (LEDs) and the switching unit consisting of relays, transistors and resistors. The power supply unit was designed using a transformer (12 V → 0 → 12 V), bridge rectifier diode, capacitors, resistors, an LED and a voltage regulator IC, which ensured an almost constant voltage of 5 V, and was supplied to other units. The display unit consists of two light emitting diodes and current limiting resistors. The load (two light bulbs) is connected to the display unit and microcontroller unit through the switching/control unit. When one load is ON and the other OFF, the associated LEDs goes ON and OFF respectively. Both LEDs are ON when both loads are ON and vice versa.

With the Java application on the Android phone running, a tap on the screen of the Android phone sends a signal to the microcontroller through the wireless connection (Bluetooth module) and switches on the relay which in turn engages the electrical load.

**2.2 THE COMPLETE CIRCUIT DIAGRAM**

Figure 2 shows the complete circuit diagram of the design with each unit connected to give the desired output.

A software application using java code was written on an Android phone/pad that was used to communicate with the microcontroller when the Bluetooth of the phone is interfaced with the Bluetooth of the Bluetooth Module (HC - 05) used in the circuit design. This Android application on the Android phone/pad is used to turn ON or OFF the electrical load with the help of the Bluetooth module, microcontroller and relays. Figure 4 gives the flow chart of the designed automation circuit.

![Fig. 1: Block Diagram of an Android-based home control system using Bluetooth](image1)

![Fig. 2: Schematics of an Android-based home control system](image2)

![Fig. 3: Simulation of the designed circuit](image3)

![Fig. 4: Flow chart of designed system](image4)
3 Circuit Analysis and Calculations
In this section, each of the unit making up the circuit are explained in details from the power supply unit to the microcontroller unit to the display to the switching/control unit and then to the electrical loads.

3.1 Power Supply Unit
A rectifier circuit is a circuit that converts an AC voltage to a DC voltage of any level. The output current is a function of the current of the transformer and the current demand of the circuit. The DC voltage required by the automatic control for the domestic appliances control circuit is 5 V DC (Poonam et al, 2017). The relays, microcontroller and other units will be powered with the 5 volts. Naturally, the design calculations were done using 5 V and the values of the components are chosen as shown in figure 5.

TR1: This is the step-down transformer. The required DC voltage for the circuit is: 12 volts/300 mA. A transformer voltage of 12 Vac or above is required. The current must be enough to supply the requirement of the circuit and a 300 mA or above current rated transformer is required.
BR1: This is a bridge rectifier IC. The rectifier chosen must have a peak inverse voltage (PIV) that must be able to withstand twice the peak voltage (Vp) of the transformer output and total forward current of output of transformer. BR1 is KPG206G. It is a 4-pin bridge rectifier IC.
C1: This is a filter capacitor. Electrolytic capacitors come with capacitance & voltage rating. The capacitance of capacitor used after the calculation is 1000 μF /35 V.

3.2 Microcontroller Unit
The microcontroller unit circuit is the heart of the project. This is where the program for the control part of the study is written and uploaded using assembly language (M-IDE) and a universal programmer, respectively. The circuit diagram is as shown in figure 6.

3.3 Display Unit
This unit shows the status of the system. It serves as an interface between the user and system. It consists of light emitting diodes (LEDs) and current limiting resistors (2 each). A resistance value of 330 Ω is used as the current limiting resistor.

3.4 Switching/Control Circuit
This is the circuit the system uses to turn ON and OFF the electrical load in accordance to the program run in Read Only Memory (ROM) of the microcontroller. The circuit, as shown in figure 7, consists of a switching transistor, biasing resistor, diodes and switching relays.

Since output of a microcontroller has only 2 mA source current, the pull-up/biasing resistor aids current output. This unit is a mirror circuit for turning ON and OFF the electrical load. When there is a base current, the transistor goes into saturation and the relay is energized. When base current is zero, the transistor goes into cut-off and the relay is de-energized. The free-wheeling or spike diode provides a path for the stored current in the relay (due to the presence of an inductor) in other to avoid damaging any component. The value of Rb must be greater than Rr (Rb>Rr). Hard saturation occurs when Rb = 10Rc, where Rc is the impedance of the relay (Sharon et al, 2013).

4 Results and Discussion
Table 2 gives the performance description of some parameters which were considered during and after the design of the Android-based home electrical appliance control system.
The designed circuit is such that a java code written as a mobile application on an Android phone is interfaced with several units of the circuit. The mobile application sends signals to a Bluetooth module linked to a programmed Atmel 8052 microcontroller which interpret the signals to control electrical loads connected to it through resistors, transistors and relays. The system uses a power supply with a 5 V dc output. The power supply unit consists of a transformer that was used to step down a 220 V ac to 12 V ac supply, a bridge rectifier to convert the ac to pulsating dc supply, a filter capacitor to remove the ripples in the supply and then a voltage regulator to hold the dc output voltage constant at 5 V. The function of the light emitting diodes in the display unit of the constructed circuit is given in Table 3.

| Parameter       | Performance          |
|-----------------|----------------------|
| System response | < 6 seconds (adjustable) |
| Load switching  | < 2 seconds (adjustable) |
| Number of loads | 2                    |
| Input voltage   | Output voltage       |
| (<= 240 V)      | (<= 240 V)           |
| Power supply    | 5 V                  |
| Proximity       | <= 10 meters         |

Table 2. System Results

5 CONCLUSION
This work has presented a cost effective home electrical appliance control system, since all components used in the design are quite cheap and easy to purchase. The designed circuit is a quite simple and easy to use interface for physically disabled people and decrepit by enabling control of home appliances with aid of an Android phone with minimal delay. By using this method, home appliances can be controlled to keep away from dangers of electric shock and bring about convenience for users. The Android based electrical appliances control system has been practically designed with a quick response time and fast switching operation when electrical appliances were connected to it, and is successfully controlled using an Android mobile device.

Since the automated control system works with wireless Bluetooth technology, designed circuit did not function beyond a distance of 10 meters using HC-05 Bluetooth module. However, within a distance of 10 meters, response time of designed system was not affected. This makes the designed circuit very reliable and effective.

REFERENCES
Al-Ali, M. and Al-Rousan, M. (2004). Java-Based Home Automation System, *IEEE Transactions on Consumer Electronics*, Vol. 50, No. 2.

Ehiabhili, J.C., Ezeh, C.V., and Orji, O.V. (2018). Single Phase Microcontroller-Based Changeover Switch, *International Journal of Electronics, Communications & Instrumentation Engineering Research and Development* Vol. 8(1), pp 7-16

Greichen, J.J. (1992). Value based home automation or today's market, *IEEE Transactions on Consumer Electronics*, vol. 38, no. 3, pp.34-38.

Kanma, H., Wakabayashi, N., and Kanazawa, H.I. (2003). Home Appliance Control System over Bluetooth with a Cellular Phone. *IEEE Transactions on Consumer Electronics*, vol. 49 (4), pp.1049-1053.

Mohammed, A., El-Latif, M., Ahmed, F., and Ahmed, H. (2014). Smart Home Automated Control System Using Android App and Microcontroller. *The international journal of Engineering and research*, vol. 5. pp. 935-939.

Piyare, R. and Tazil, M. (2011). Bluetooth Based Home Automation System Using Cell Phone. 2011 IEEE 15th Symposium on Consumer Electronics

Poonam, M., Gaikwad, V., Yoginath, R., and Kalshetty, R. (2017). Bluetooth Based Smart Automation System Using Android, *International Journal of New Innovations in Engineering and Technology*, Volume 7 Issue 3.

Ramlee, R.A., Leong, M.H., and Singh, R.S.S. (2013). Bluetooth Remote Home Automation System Using Android Application, *International Journal of Engineering and sciences*, vol. 2. pp. 149-153.

Sharon, P., and Mahesh, J. (2013). Home Automation System (HAS) using Android for Mobile phone. *International Journal for Electronics and Computer science Engineering*, Vol. 3 (1) pp. 1-10.

Shiu, K. (2014). Ubiquitous Smart Home System Using Android Application. *International Journal of Computer Networks & Communications (IJCNN)*, Vol. 6, No.1.

Sriskanthanan, N., and Tan, K. (2002). Bluetooth Based Home Automation System, *Journal of Microprocessors and Microsystems*, Vol. 26, pp. 281 - 289.

Yavuz, E., Hasan, B., Serkan, I., and Duygu, K. (2007). Safe and Secure PIC Based Remote Control Application for Intelligent Home. *International Journal of Computer Science and Network Security*, Vol. 7, No. 5