

Efficient and Alternative Approach for Android Based Mobile Remote Control in a Bluetooth Environment

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Abstract. The paper presents a novel method of design and implementation of a control system using Bluetooth technologies. The proposed system based on IOIO board, Bluetooth and android application endeavours to support user the ability to control the electrical devices from mobile devices, which must have android operating system. The proposed system design is simple, multifunctional, superior to previous approaches and can considerably economise the costs involved in developing such systems. The application has a variety of uses in offices, factories, laboratories and access controlled environments.

Keywords: Android, IOIO board, Bluetooth, SDK tools, ATD plugin.

1 Introduction

With the advent of mobile phones, a multitude of functions are added to such hand held instruments on a continuous basis, making such devices as ‘versatile master control device’. The uses of such devices are extremely divergent. Such uses range from photography, video chats, daily planner, e-mail facility and so on. As an extension to such advancements, the main objective of this paper is to design and implement a new control system for devices using mobile phones which run with the support of android operating system through the support of Bluetooth technology as a medium of communication. There are many controlling boards that can be used in these applications such as Arduino, mbed, IOIO board etc, and each one has its own specifications and applications. Among the control boards, IOIO board specially designed to work with android phones with version above 1.5. In this paper, IOIO board is used to control the electrical devices with the help of a simple hardware circuit and also it will be used to interface with Bluetooth dongle that can send and receive control signal from android based mobile phone. The mobile device can be High Tech Computers (HTC) phones, Samsung phones, Samsung tablet etc, which must have android operating system. The paper shows that the proposed system is efficient, simple and more cost effective in comparison with the existing similar

systems. This paper, after reviewing the prevailing literature, postulates how the proposed system is distinct. Further, the working of the proposed system, logic control circuit for controlling the electronic devices, flow chart of proposed system, results and conclusion are explained thereafter.

2 Literature Review

The proposed control system uses mobile devices with android operating system through the Bluetooth technology. Being one of the recent areas of research, papers dealing with similar systems are not considerable. There are studies which have looked into the android based control using different controller boards. In previous study [3], the authors presented various connection approaches to connect Android with the LEGO Mindstorms and NXT robotics system. The main approach can be classified into Microbridge, IOIO (which is pronounced as yo-yo board) and Google android open accessory development kit (Google ADK). Microbridge consists of some basic hardware which is an Arduino microcontroller board with USB host shield. The function of USB in this board is to connect with android phone using USB cable. It can interface the sensor and control actuators easily. The main advantage of this system is that it works with almost every android version but it requires the android debug bridge (ADB). The second approach is the IOIO board; it can be defined as a direct extension of the android devices. The main distinction is, it provides a PIC CPU with a fixed firmware. It provides a powerful application program interface (API) which benefits in including some specification, such as routines, data structure, object classes and variables. The API can be accessed to boards, for example, general input and output (I/O) pins or Serial Peripheral Interface Bus (SPI). It also provides an Inter Integrated Circuits bus (I2C), ADB protocol and a virtual Transmission Control Protocol (TCP) connection. Third approach is the Google ADK. This can be defined as a combination of the Microbridge and IOIO board. These boards consist of the hardware side of an Arduino microcontroller with USB host and an extension shield can be interfaced for buttons, joy stick, relays etc. It also provides a device API but it supports only newest devices like android version 2.3.4. The paper states that all three boards are under heavy development and it can be observed that applications based on such methodology are gradually entering the market.

In another study [2], the authors used the Bluetooth technology to turn a phone into controller for a toy-level car. The car has an operating lighting system, horn and motor system, which is controlled by using Arduino (similar to IOIO board). The Arduino board is connected to a Bluetooth modem which established a wireless serial communication to a remote device via Bluetooth.

Another study [4] has proposed a new system to control higher temperatures inside the car and the user is capable of controlling some of the car accessories by using his/her mobile phone. Once the car is fit with the Bluetooth and the control system, the car accessories can be connected with (PIC 16F877A) micro-controller which will work with 5 V and control can be done by mobile application. The benefit of the

system is that the user has the ability to use the existing mobile devices for the controlling of the car accessories. The authors have used Java 2 micro edition (J2ME) in this system. Java [9] as a medium of communication uses technology of radio standard designed for less power consumption with a small range and supports low cost transceivers at each of the devices using the Bluetooth. In this type of radio technology, the physical layer used is frequency hopping spread spectrum (FHSS), which uses 79 channels of radio and continuously changes the frequencies in the rate of 1600 hops per second. In the basic mode, Bluetooth communication has a modulation of Gaussian frequency shift keying (GFSK). The Bluetooth transceivers operate in the license-free band which is used by the industrial, scientific and medical (ISM) radio band of frequencies of 2.45 GHz.; this is the band used in the wireless local area network (WLAN) devices and IEEE 802.11 compliant devices. The device that uses Bluetooth allows making communication each other through Bluetooth devices when they are setting in the range of the Bluetooth [5]. On the other hand, Android is a software stack for mobile devices that includes an operating system, middleware and key applications. It consists of kernel and low level tools, native libraries, Android Runtime and framework layer on top of all the applications. The first two applications and application frame work are written in Java and run in the Dalvik Virtual Machine and libraries. The Basic applications like contact, email, browser settings, Bluetooth etc., form part of the android package. Many of these applications can be multi-threaded depending upon their use and interaction. The Applications that can be added depends on the user requirements in Android Market, which is an online store for applications [1]. Further details on Android applications are available extensively in the standard literature. As evident from the previous studies, the latest advancement in this area uses a Bluetooth socket to interface WI-Fi with a system by using another mobile phone as server and such web servers are not economical. Hence, the proposed system is devised, which ensures direct communication without the involvement of server and superior to the systems explained in the previous studies.

3 Proposed System

In divergence of the system explained above, the proposed system uses two way switching, with reduced size without any complicated hardware parts. The proposed system also uses 3.0 Bluetooth version which provides data transfer speeds up to 24 Mbit/s. Further, the new system is multi-functional. The proposed system works with android version 1.5 and above. Further, the system design consists of four main parts, user interface, communication channel, controlling board and electronic circuits. The system structure is explained with the help of the following block diagram (Fig. 1 The proposed system).

Android Operating System. This is a type of operating system used for mobile handsets like smartphones, tablet computers like Samsung galaxy s2, HTC, Sony Ericson...etc. In the proposed system the authors have used Samsung galaxy S2 mobile with android operating system 4.0.3 (Ice Cream Sandwich) platform family

with Bluetooth version 3.0 which is the latest version of Bluetooth. The authors also designed an application with eclipse software. The android system is used to send signals through the Bluetooth to another Bluetooth module to switch ON or OFF.

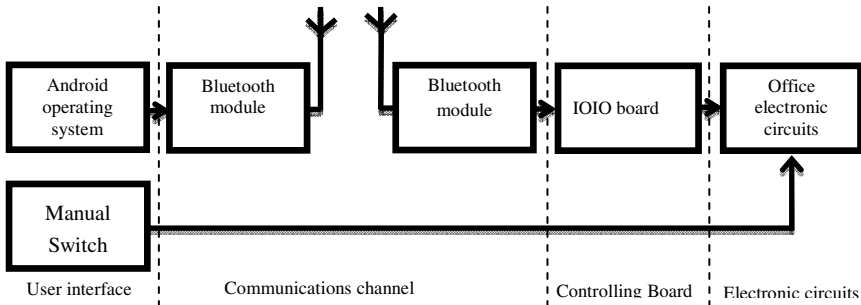


Fig. 1. The proposed system

Manual Switch. This block as shown in the figure identifies the alternative method to control office electrical appliance by using OR gate logic circuit. This will benefit the user incase the android system stops working for any reason. Thus, it is possible to switch on and off the electrical device by using two way switching.

Communication Channel. The communication channel used with Bluetooth operates under industrial, scientific and medical radio band (ISM) at frequency 2.4 GHz. The authors have used Samsung galaxy S2 mobile phone with 3.0 Bluetooth version at the transmission end and Bluetooth version 3.0 is interfaced with IOIO board on the receiving side. Bluetooth range can be covered up to 100 meters.

Logic Control Circuit. The controlling board used in the proposed system is the IOIO board which gives opportunity to connect electronic circuits to an Android operating system like android phone, tablet etc. Further, it can be controlled from Android application. As already stated, the android application can be written by using eclipse software. In the proposed system, the authors use 3 input & output (I/O) pins from 48 total pins.

Office Electronic Circuits. This block considers the electronic circuits forming part of the proposed system like light control, fan control, door alarm etc. As already stated, it can work for 'two way' switching, either from android operating system or manual logic control.

3.1 Android in Proposed System

The android operating system is responsible for sending and receiving control signal by using the Bluetooth technology. The functioning of the android application based programme structure depends on two programming conditions. The first condition is switch case; in this condition, each case will represent specified function like light control, door alarm, fan control. Second condition is 'if & else'; by using this function the researcher achieves the purpose of switching ON and OFF. For example, when the

user activates any button that represents a particular electrical device like "switching on light", "on door alarm", "switching on fan" etc. it will send the signal through the Bluetooth to switch ON and display would show that it is switched ON. When the user wants to switch off any electrical device, the user can do so by activating the button and it will switch directly to OFF mode.

3.2 Logic Control Circuit for Manually Controlling the Electronic Devices

The authors have taken into consideration the criticality of using two way switching circuit in order to address any problem that might occur in android operating system. Accordingly, the authors have designed simple logic control circuit using an OR gate as it shown in the figure (Fig. 2 Logic control circuit for manually controlling the electronic devices). The truth table of the OR gate displays an output of ‘high’ only if the input is high. Otherwise, if both the inputs are low, the outcome will be zero which is equivalent to OFF. Generally this circuit is responsible for ‘two way’ switching, which gives opportunity to switch ON/ OFF the electrical devices either from the android phone using the Bluetooth or using the manual switch. The flow chart of the proposed system for door alarm, fan, and light is shown in the figure (Fig. 3 Flow chart of the proposed system).

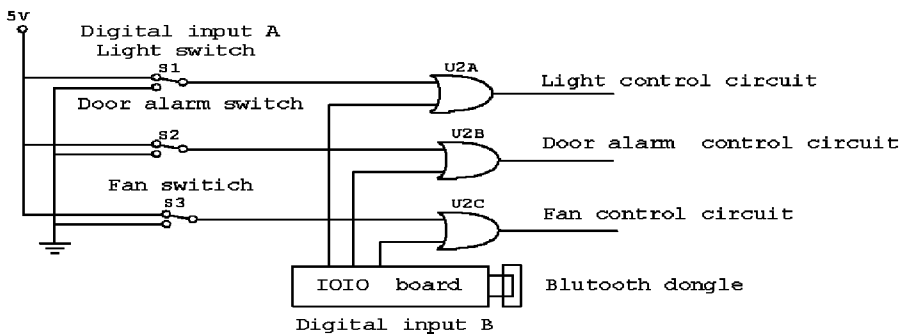


Fig. 2. Logic control circuit for manually controlling the electronic devices

4 Results and Discussions

The result of the designed system user interface is shown in the fig. 4. As evident from the figure, the system user interface acts like a switch. When the android user press any button that represents a particular electrical device, it will send a signal through the Bluetooth to switch ‘ON’ and display appears that it is ‘switched on’ and when the user wants to switch off any electrical device, the user can do it by activating another button on the handset. For controlling of fan, PWM controller is used. For example, when the user activates the first button, the display will change the status from ‘ON’ to ‘OFF’. Similar process repeats for other applications as well.

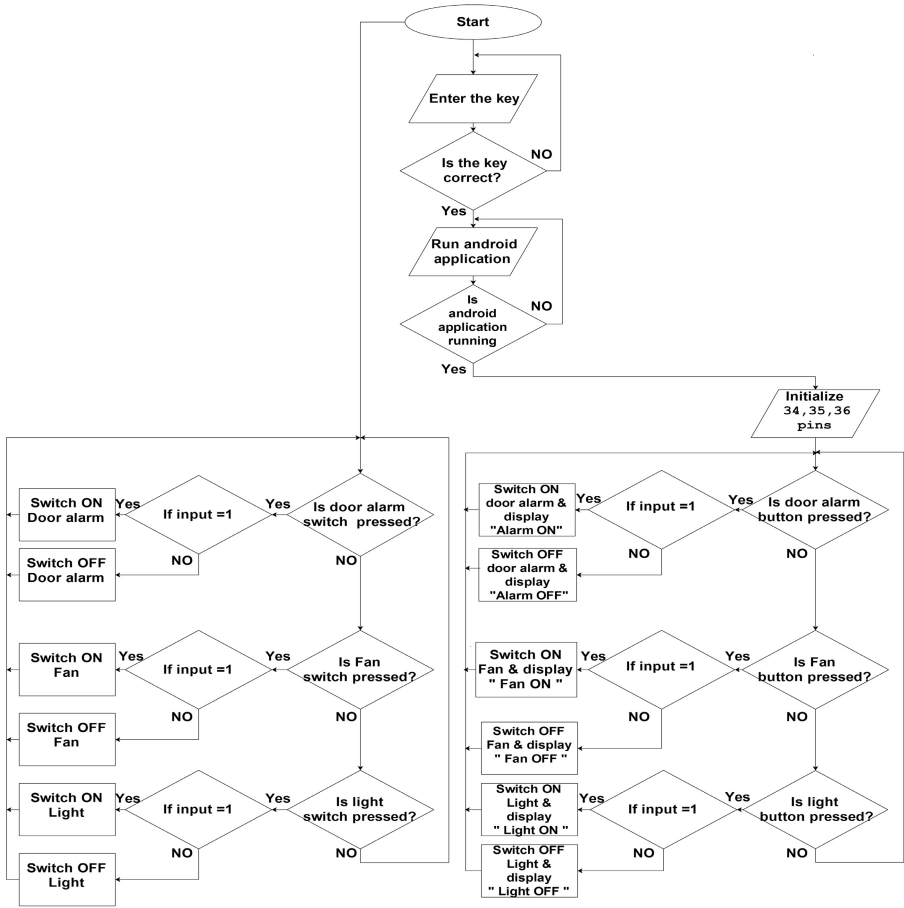


Fig. 3. Flow chart of the proposed system

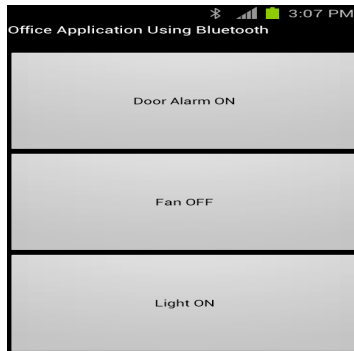


Fig. 4. The android application

5 Discussion and Conclusion

The paper has presented a novel design based implementation of a new control system for office or other electrical devices using mobile phone equipped with android operating system through Bluetooth technology as a medium of communication. The android program structure is built with the help of android software development kit (SDK) tools and android developer tools plugin (ADT). The system provides 'two way' switching either from android mobile phone or through simple switch. This has multiple applications at the office and other premises and the device can be used for appliances which can be remotely controlled. Hence, the design would lead to hardware reduction as well as cost savings, which would make such applications highly affordable to the users. Future work in this field that the authors would be pursuing is to implement a system which integrates a wireless fidelity (Wi-Fi) technology with the mobile phone as a server, which would enable anywhere connectivity.

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