Development of HCO6 Bluetooth Based Switching Automation of Domestic Electrical Powered Appliances through an Application Software on Android Phone Platform

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Abstract

Conventional mechanical switching of household electrical appliances is location bound. It is not without limitations such as arcing, bouncing, heat, noise and needs to directly 'ON' and 'OFF' the switch manually at every time of need. This paper present Bluetooth based switching automation of domestic electrical powered appliances through application software on android phone platform. The system makes switching boundless within the Bluetooth 10m coverage. The design was done in two major stages: hardware and software. The hardware involved the physical construction of the system while the software was the programming design of the application to suite android phone.

Keywords: *Android, Appliance, HC06 Bluetooth, Electrical, Microcontroller, Phone*

1. Introduction

In designing a domestic automation system, one or more suitable platforms are used in order to build a dependable and flexible system that can be easily operated and adapted for a new household appliance. Therefore, for the purpose of this project some specific deliberate choices were made on the type of platforms, hardware components and process mode of domestic automation system [1]. Bluetooth domestic automation is a project based on controlling of domestic appliances using Bluetooth module, microcontroller, and android phone. The designed domestic automation system uses PIC16F887 microcontroller, an android mobile phone that has Bluetooth hardware, UARTS standard for communication between the microcontroller, and the Bluetooth module of the domestic automation' system. The design will also use triac and a driver for interfacing. PIC16F887 controls the switch 'ON' or 'OFF'. The designed system describes how to use the android Bluetooth APIS to accomplish the four major tasks necessary to communicate using Bluetooth: setting up Bluetooth, finding devices that are either paired or available in the local area, connecting devices, and transferring data between devices. All of the Bluetooth APIS are available in the android Bluetooth package. In order to use Bluetooth features in application, it must declare the Bluetooth permission. Permission to perform any Bluetooth communication is needed, such as requesting a connection, accepting a connection, and transferring data. Before the actual design of the project work, specific deliberate choices in selection of appropriate implementation platforms and hardware components were made. Priority was given to low cost availability, reliability, flexibility and simplicity in all these selections [2].

1.1. Background Theory

Most advanced domestic automation system in existence today requires a big and expensive change of infrastructure. This means that it often not feasible to install a domestic automation system in an existing building. The domestic automation is a

Bluetooth domestic automation system that is supposed to be implemented in existing domestic environments, without any changes in existing infrastructure. Domestic automation lets the user to control his/her domestic load from a hand held android phone. In the android program the user can create actions of what should happen with electrical devices in the network depending on the Bluetooth module.

1.2. Problem Statement

Mechanical switches are not without limitations such as arcing, bouncing, heat, noise and needs to directly 'ON' and 'OFF' the switch manually at every time of need from one point to the other. There is a clear need to eliminate the stress of manual switching and to introduce flexibility of control without direct contact to switches even such that could be easily done via an android phone application at any comfortable point at domestic within the wireless coverage. Hence the need for this works to proffer solution to some of these mechanical manual switching restrictions. The domestic automation requires soft ware designing and programming of the PIC16F887 micro controller in the circuit. The purpose and scope of constructing this system is to use mobile android inbuilt Bluetooth facility for automation using Bluetooth module and by controlling the microcontroller to perform its function. The main aim was to control domestic appliances without stress.

1.3. Technology Consideration

The considerations for this system will include a choice of Bluetooth module, communication protocols and interfaces.

Bluetooth module: The widely available Bluetooth networks are based on android smart phones. This network provides wide area coverage and can be utilized more cost-effectively for this project.

Communication Protocols: The available communication protocol that was used was android phone. Android phone is the most efficient because this project requires an android based Bluetooth.

I/O interfaces between microcontroller and devices: Serial I/O is considered as options for connection between the Bluetooth module and the microcontroller. Using the microcontroller, a control circuit will be implemented to control the electrical appliances.[3]

The project has limitations: The controller must only operate device where the Bluetooth module strength can reach android phone. Only devices with electrical controlling input ports will be possible targets for control. Operation of the controlling unit is only possible through an android smart phone. The Control unit must be able to receive signals from the Bluetooth module [4]. The software application can only be installed in android smart phones.

2. Bluetooth Domestic Automation

Bluetooth Domestic Automation is a new technology project constructed with the present world technology. Scientist and Engineers has done lot of research to make life comfortable without been stressed. The Bluetooth domestic automation makes life easy for the owner, even if the owner finds it difficult to use the manual operation of any domestic appliances to control it but with an android phone with an inbuilt Bluetooth can easily communicate with Bluetooth module in the home automation so that the android can be used to control any of the domestic appliances. During the olden days no such device existed but by the help of the modern technology the device exists [5].

2.1. Earlier Ways of Controlling Domestic Appliances

In the earlier days no such device was been designed or constructed. In the earlier days domestic appliances are controlled manually by their switches. Remote controller was used for controlling Television, DVD, and DSTV. These simply means in the manual days, domestic appliances where controlled manually [6].

2.2. Market Survey

The project is scarce in market only related project can be found in the market today due to the fact that the project is a newly constructed project and as not been made public in Nigeria market.
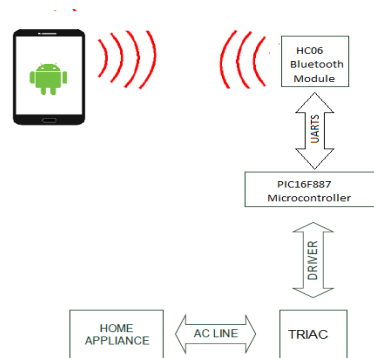
3. Method and System Design

Figure 3.1. The System Block Diagram

Description of the Block Diagram

The block diagram Figure 3.1 demonstrates the design sections of Bluetooth based switching automation of domestic electrical powered appliances through an application ware on android phone platform.

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i. MICROCONTROLLER (PIC16F887) : PIC16F887 is the 'heart beat of the system' The PIC micro controller contains a CPU (Central processing Unit) , RAM (Random Access Memory) , ROM (Read Only Memory) , I/O (Input/Output) lines , serial and parallel ports , timers and sometimes other built in peripherals such as A/D (Analogue / Digital) converters. It is been programmed using the PIC so as to perform is function.

Figure 3.2. Microcontroller (PIC16F887)

Central Processing Unit (CPU)

CPU is responsible for all the computing, it fetches, decodes and executes program instructions and directs the flow of data to and from memory. It performs the calculations required by program instructions and places the results of these calculations, if required, into memory space.

Random Access Memory (RAM)

The RAM, random access memory, is used to write and read data values as a program runs. Manipulating large data structures and using pointers, re-entrant or recursive functions use large amounts of RAM and are techniques which are generally avoided on microcontrollers

Read Only Memory (ROM)

ROM, read only memory, is non-volatile memory used for program information and permanent data. The microcontroller uses ROM memory space to store program instructions it will execute when it is started or reset.

Input and Output Ports (I/O)

The input and output ports are used to pass data in and out of the microcontroller in a controlled manner, often according to a standard protocol. The diagram below represents the block diagram of a microcontroller.

ii. HCO6 BLUETOOTH MODULE: HCO6 Bluetooth module is the selected Bluetooth module for the designed system. HCO6 Bluetooth module can cover a range of 10 meters. The HCO6 Bluetooth module creates the connection between the Domestic Automation and the android phone. It made the project workable, because without the HCO6 Bluetooth module the android would not be able to have communication interaction with the system [7].

Figure 3.3. HCO6 Bluetooth Module

iii. ANDROID PHONE: The Android Phone was used as host to the domestic automation system. The android phone uses a Bluetooth hardware that will make it have communication interaction with the domestic automation system through the HCO6 Bluetooth module and microcontroller (PIC16F887). The android platform includes support for the Bluetooth network stack, which allows a device to wirelessly exchange data with other Bluetooth devices. The application frame work-provides access to the Bluetooth functionality through the android Bluetooth APIS. These APIS let applications wirelessly connect to other Bluetooth devices, enabling point-to-point and multi point wireless features.

Figure 3.4. The Installed Application on Android Phone

iv. DOMESTIC APPLIANCES: Domestic Appliances are also known as electrical/electronics appliance used at domestic such as point of Light, Fan, Fridge, Air Conditioner and Cooker. The designed system is constructed to control the above listed examples of domestic appliances for demonstration purpose.

v. Triac: It is a three terminal semi conductor thyristor device for controlling current. The triac is used in the system to control the amount of current entering the system in order to avoid damage in the automation system. The code of the triac is BT139.

Figure 3.5. The Triac

In an attempt to implement the proposed system, it was divided into two parts which includes:
I.   Hardware design
II.   Software design
The designed domestic automation system uses PIC16F887 microcontroller, any android mobile phone that has Bluetooth hardware, UARTS standard for communication for communication between microcontroller, and the Bluetooth module of the Domestic automation system. The design will also use a relay and a driver for interfacing the relay. PIC16F887 controls the triac state via a driver and this in turn determines the state of the connected appliance, whether switched ON or OFF.

3.1. Hardware Design

Each platform has a set of hardware components over which it is implemented. An HC06 Bluetooth module is selected. HC06 module can cover a range of 10meters. Any android phone with a Bluetooth hardware, will be used as host to the domestic automation system. Finally, for Microcontroller, the popular ones are those produced by Microchip, ATMEL, Motorola and Texas Instruments, of all these Microchip manufactured.
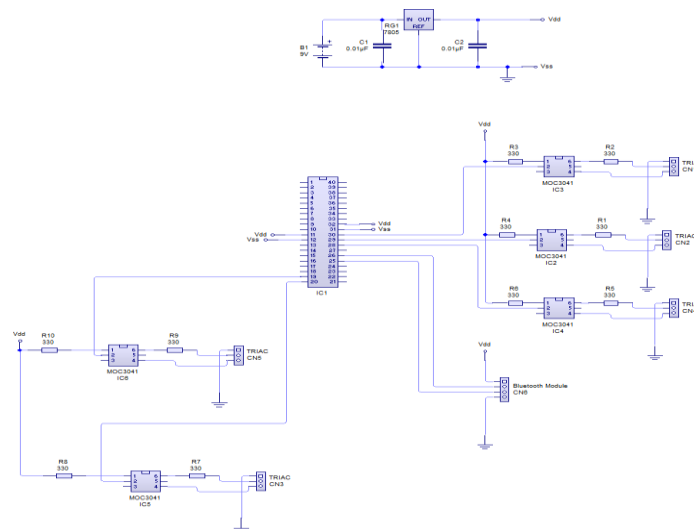

Figure 3.6. The System Circuit Diagram

Description of the Component

i. Microcontroller (PIC16F887):   This is the heart of the system wherein central processing of data takes place. PIC microcontroller collects the data or information from the Bluetooth and compares it with appropriate prescribed limits. By receiving the Bluetooth signals, it takes the corresponding course of action by sending commands to the output devices.
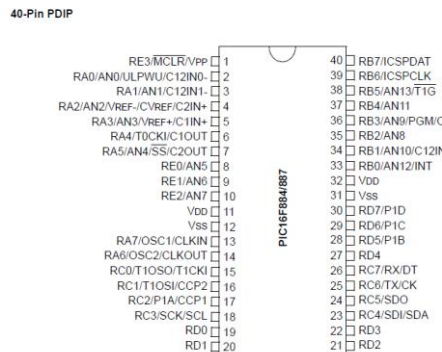

Figure 3.7. Microcontroller (PIC16F887)

ii. Bluetooth Module : HCO6 Bluetooth module was the selected Bluetooth module for the designed. HCO6 Bluetooth module can cover a range of 10 meters. It creates the connection between the domestic automation and the android phone.

Figure 3.8. Bluetooth Module

iii. Triac: It is a three terminal semiconductor device for controlling current. It 'opens' and 'close' electric current path to the appliance.

Figure 3.9. Triac

iv. Resistor: Resistor is a two terminal electronic component that limits electric current in the circuit. [1]
v. Capacitor: In the circuit, the capacitor performs is function by storing charges.
vi. 9V Battery: The 9v battery is the DC supply that powers the circuit as appropriate.
viii. Optocoupler (MOC34041): This allows signal transfer without making a direct ohmic contact between the controlling circuit (Microcontroller) and the switching circuit.
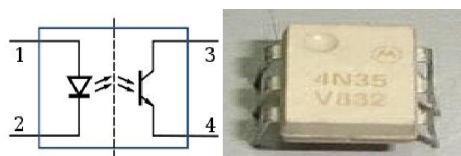

Figure 3.10. The Component and Circuit Diagram of an Opto-coupler

3.2. Software Design

The project software could be described as the 'blood stream of the system'. The microcontroller algorithm is as follows.

Algorithm for the Program Activities of the Microcontroller

1. Start
2. Microcontroller Configuration
3. UART configuration
4. Bluetooth Module Configuration
   a. Set Bluetooth Name
   b. Set Baud rate
   c. Set PIN No
2. Infinity loop
3. If (LIGHT_ON MESSAGE RECEIVED)
   a. Turn on LIGHT SWITCH
   If (LIGHT_OFF MESSAGE RECEIVED)
   b. Turn off LIGHT switch
4. If (FAN_ON MESSAGE RECEIVED)
   a. Turn on FAN SWITCH
   If (FAN_OFF MESSAGE RECEIVED)
   b. Turn off FAN switch
5. If (FRIDGE_ON MESSAGE RECEIVED)
   a. Turn on FRIDGE SWITCH
   If (FRIDGE_OFF MESSAGE RECEIVED)
   b. Turn off FRIDGE switch
6. If (COOKER_ON MESSAGE RECEIVED)
   a. Turn on COOKER SWITCH
   If (COOKER_OFF MESSAGE RECEIVED)
   b. Turn off COOKER switch
7. If (AC_ON MESSAGE RECEIVED)
   a. Turn on AC SWITCH
   If (AC_OFF MESSAGE RECEIVED)
   b. Turn off AC switch
8. END infinity loop
9. END

4. Result and Discussion

While constructing a microcontroller based system, it basically involves design and validation, veroboard implementation, testing and result and packaging.

4.1. Design and Validation

It has now become possible to program microcontrollers; gone are the days when circuits are built around chips, now we can build chips around circuits. PIC16F887, 8 bit, microcontroller was used for this project. In order for the microcontroller to be able to perform its function in this project, it required writing of a code of program onto it and designing an android phone based application for the control. This code will allow the PIC to do the required job within 10 meters of Bluetooth coverage. The code of program could be written in High Level Language (HLLs) or Assembler language (Low Level Language). HLLs compilers for PIC microcontroller include: MikroC, PicBasic and PICC18. The assembly language for PIC microcontroller is MPLAB from MICROCHIP. HLLs were used over assembly language.

4.2. Veroboard/PCB Implementation

After proper verification, the design application 'apk' file was transferred to the phone and the hardware construction was PCB for permanent structure. The components were arranged and soldered on the veroboard such that each component can easily be identified. Before proper soldering, component layout plan was drawn paying particular consideration to reduce the distances involved between point to be connected and the prevention of the overcrowding. The veroboard was inspected of wrong linkages of its line which may be fault from the producers. The holes of the board were made sure to be through for passing the terminals of the components for soldering and an abrasive paper was used on the soldering segment of the board for easy binding of the terminals on the board.
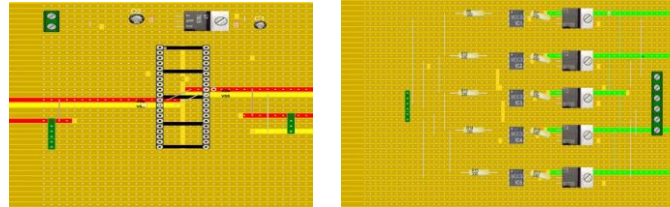
Figure 4.1. Diagrams of the Vero Board Implementation of the Components in the Circuit

4.3. Testing and Result

TESTING: Each component in the circuit where tested before been used by using a multimeter. The circuit was equally tested stage by stage and after the construction was concluded. The android application ware was installed on several android phones to ascertain it reliability and suitability.

RESULT: After testing the overall construction and component, the circuit functioned accurately without any problem or fault. The application software works well as required within the Bluetooth 10m coverage distance.

4.4 Packaging

The constructed was packaged as in Figure 4.2 and sealed in a case to prevent it from been exposed and protect against external damage.
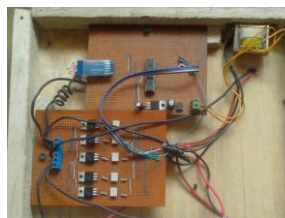
Figure 4.2. The Constructed System Packaging

4.5. Application of the Project

The project can be used in any place where switching 'ON' and 'OFF' of electrical/appliances (Domestic Appliances) are been used. It can be used in the following place:
>   1. Houses
>   2. Office
>   3. Banks
>   4. Industries

4.6 Advantages of the Project

Among numerous advantages of this system are:

1. It reduces human effort/stress and saves time.
2. It brings total flexibilities to electric power switching within a locality.
3. It reduce mechanical switch bouncing and noise
4. Contact arcing is eliminated.
5. It does not cost for text message charges unlike previous work of using GSM.

5. Conclusion and Future Work

Through the medium, how to develop a Bluetooth based domestic automation using Android smart phone has been described, designed and constructed to control 220V+5% ac load. It is rated 2KW, 50Hz. The developed system eliminates the stress of human manual switching and to introduce flexibility of control without direct contact to switches even such that could be easily done via an android phone application at any comfortable point at domestic premises within the wireless coverage distance. The system makes switching boundless within the Bluetooth 10m coverage. Thus this paper has achieved its target using the architecture of a Bluetooth based switching automation of domestic electrical powered appliances through application software on android phone platform. With this, user can switch appliances 'ON' and 'OFF' on his/her bed or any comfortable spot through hand android phone. Nevertheless, the user usage distant is limited to the Bluetooth coverage length of about 10 meters. Future research may be geared towards developing a household switching device that can beyond 10m coverage however without charges. Two layers circuit board can be designed and used in place of single layer circuit board for easier soldiering work and neatness to commercialize the product.

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