Implementation of an automated control system for home appliances using bluetooth and smart phone

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Abstract

This paper presents an implementation of a home automation system using smart phone Bluetooth with Arduino for the switching and control of home appliances. It aimed at reducing stress for the physically challenged, elderly, and younger children with an easy control of the home appliances and likewise reduction of risk of electrocution from the source of control. With this automated control unit, users can comfortably operate their electrical installations or appliances from distances ranging from 30 m to 100 m away from the point of control using smart phone. The control unit comprises a four-channel relay module, an Arduino Uno board (AUB) based on the ATmega328 microcontroller, an HC-05 Bluetooth module, and a manual backup switch or alternative. The central processing unit is the Arduino Uno board to which every other component is connected. The Load (devices/appliances) to be controlled or operated is connected to the Arduino Uno board (AUB) via the relay. The Arduino board is programmed using the Arduino integrated development environment (IDE), with instructions that controls other units of the circuits. An Arduino Bluetooth controller is installed on the phone, to be used as a remote controller and to enable communication interface between the phone and the Arduino based control unit. In other words, the Bluetooth module connected to the Arduino board receives signals and/or instructions through phone Bluetooth via controller installed on the phone. An LCD (led crystal display) is used as display output of information uploaded on the Arduino Uno board to know the working state of the circuit. It was found that the automated control unit is of great benefit to users in terms of convenience in operating their appliances, including the elderly, and physically challenged people as it reduces their stress and difficulty in moving from point to point in order to control their home lightings and appliances.

Keywords: *Home automation, Arduino, Bluetooth, smart phone, microcontroller, control devices*

1.0 Introduction

Home automation is the act of using information and Computer technology for instructing and/or controlling home appliances and other devices (Antima, 2021), It is the use of information technologies and control system to reduce the human labor (Muthukumaran *et al*., 2019). It can be the control of light bulbs to a complex network system based on a computer or micro-controller, which can have varying levels of intelligence (Rahul *et al.,* 2017).

The application of automated control of home electrical and/or electronic appliances has received the attention of scientists and engineers in recent times due to its convenience for the operation of home appliances and intuition in control design. 1970s, the evolution of home automation began (Sharda and Dinesh, 2017) and with the increasing expectation of individuals more work has been carried out to improve the functionality of the home automation system (Gupta, 2020). In time past, the prevalent system of control in homes can be termed manual, it deals with the fact that every home appliance is being controlled with a lot of human input and effort. The switching ON and OFF of the lighting points, power supply points, as well as other electrical appliances, were all controlled manually at a specific position by individual at every time it is needed. This required a lot of energy and stress because the individual must get to a specific point before any such control can be done, this was not favourable or convenient to the elderly and disabled. Due to the drawback of this system of home control, it became imperative for a more convenient way to control home appliances and equipment from any point, hence the Implementation of an automated control system for home appliances using Bluetooth and smart phone (ACSHA) (Ransing and Rajput, 2015). Figure 1 is the block diagram of the ACSHA.

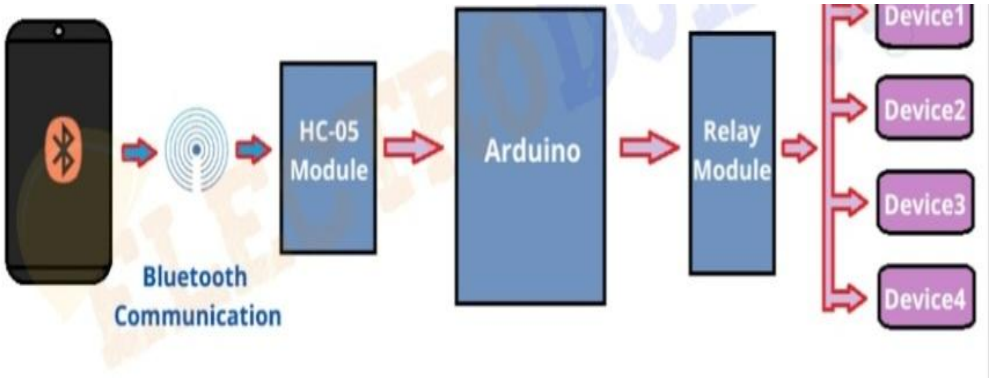

Fig.1*: Block Diagram of ACSHA (Circuit Digest, Accessed 2023)*

The previous and foremost home automation system was based on the wired communication system such as raspberry pi and Arduino based home automation system this was convenient at that time, however, due to advancement in technology, the wired system has now been replaced with the wireless system, which is more convenient. Examples include ACSHA using WiFi (Lokesh, 2017), Bluetooth (Neha and Yogita, 2017), Implementation of (IOT) Internet of Things (Rahul *et al.,* 2017), (Antima, 2021), Zigbee (Fang and Shuang-Hua, 2008; Sanjeeb and Vijayakrishnan, 2016).

There are two ways of implementing the *ACSHA*, the wired system and the wireless system. The wireless system was used in this paper. Every home automation system mostly will have three major components, which are control device, control unit, electrical system (Nikita and Prem, 2018). The control device acts as interface between the user and system. The control device can be smartphone, Infrared remote, Tablet, etc. The control unit takes information from the input device (control device), processes it, and then it gives an output (controls the electrical system). The electrical system may consist of fan, TV, lights, and other home equipment. (Praveen and Anjana, 2018).

2.0 Materials and Method

The wireless home automation system uses radio frequency signals, which encodes signals transferred between different devices for the control of appliances and other equipment (Anubhuti *et al*., 2016). The main controller used in this work is the 8 bit Arduino Uno board [Fig. 3] with the Atmega 328P micro-controller [Fig. 4]. It is used to interact and control other units of the system such as the HC-05 Bluetooth module 'which is the communication link between the phone controller and the Arduino' [Fig. 5], and the 4-channel relay module [Fig. 6] which controls the load or appliances. The HC-06 is a class 2 slave Bluetooth module. It operates with supply voltage of 3.6 V DC to 6 V DC. It has consists of 6 pins but 4 out of the 6 pins were connected and they are: RXD (receive data serially), TXD (data serially transmitted), GND (ground) and VCC (voltage common collector). The VCC and GND pins are connected to positive and ground pole of the power source respectively. The RXD and TXD pins are connected to TX and RX of Arduino Uno respectively. The communication interface in this work is the Android phone, upon which an Arduino Bluetooth controller is installed.

The complete circuitry for this work shows the assembly of all modules and components used, it representation is shown in Figure 2. We have the LCD module [Fig.8] that is the output display unit. The Arduino Uno Module is the Central Processing Unit of the complete circuit, it receives signal from the Bluetooth, processes it and sends the output signal to the relay to carry out the instruction. The power source, 220 V AC is connected to the COM of the Relay, the switch live (branch) is connected to the NO of the relay and the neutral line is connected to the neutral of the load/switch. A manual switch is added to provide a manual switching system which will serve as a backup system in an event of a person not having access to a phone for the automated control of the appliance.

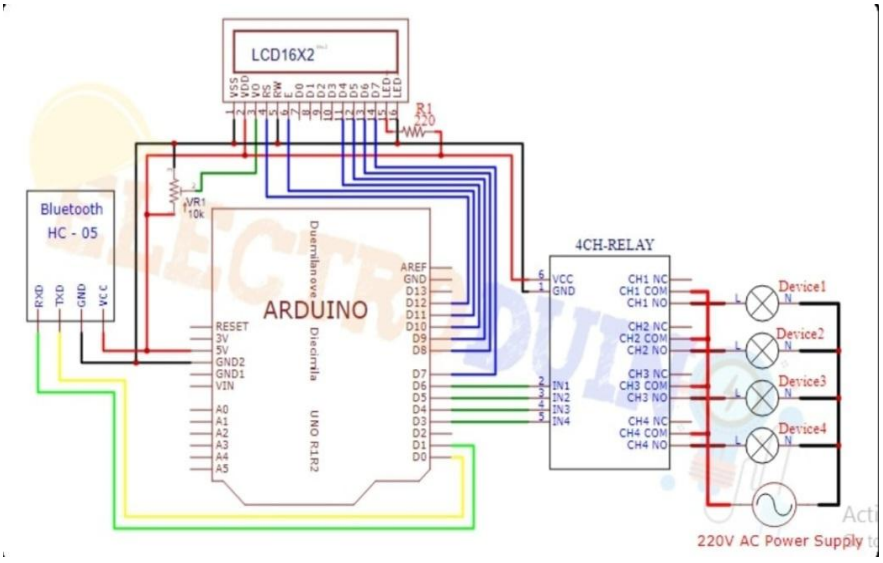

***Fig.2**: Complete* ACSHA *Circuitry (Circuit Digest, Accessed 2023)*

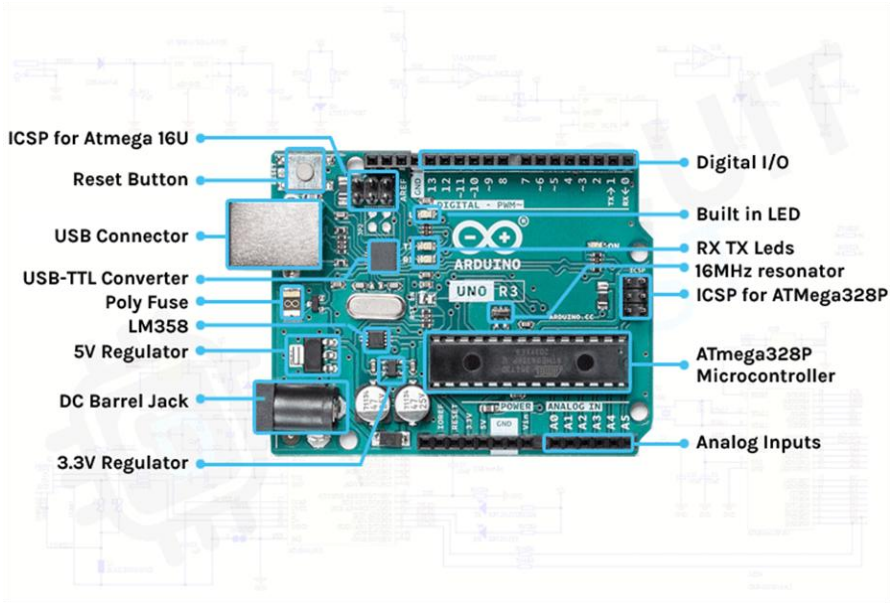

***Fig.3:** Arduino Uno Board (*https://*store.arduino.cc* Accessed *2023)*

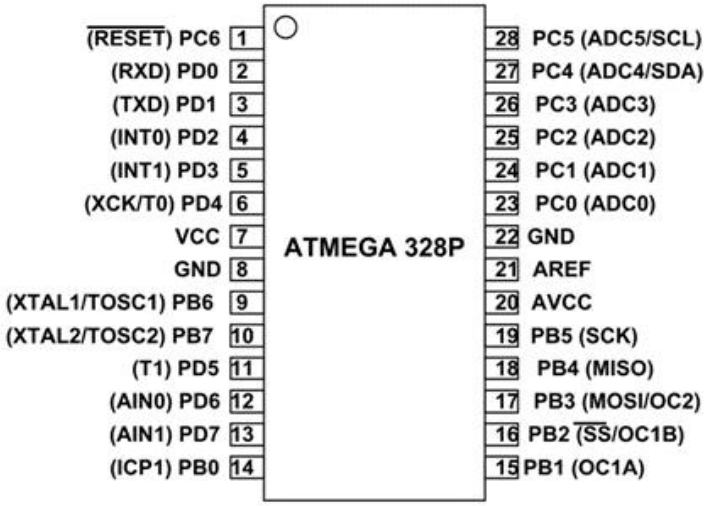

Fig.4: *Microcontroller Atmega328* **(**https://component101.com Accessed 2023)

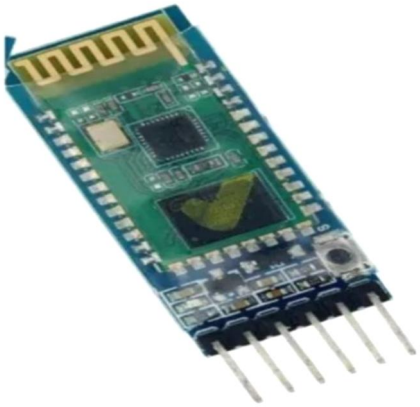

Fig.5: *Bluetooth Module HC-06*

ig.6:
Four
Channel Relay Module

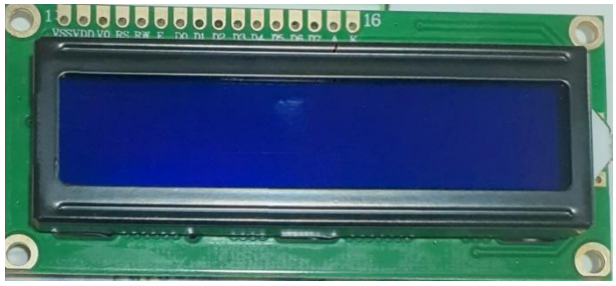

Fig.7: *Liquid Crystal Display LCD*

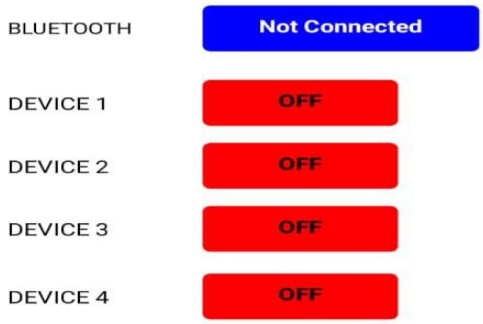

Fig.8: *Arduino Phone controller interface*

3.0 Results and Analysis of Automated

A personalized Arduino program code was written for the ACSHA.

```
void loop()
 {
  lcd.setCursor(0,0);
  lcd.print(" D1  D2  D3  D4 ");


  if (Serial.available () > 0)
  {
    char Val = Serial. Read();
    // Print Bluetooth Module data on serial monitor
    Serial.print("VAL: ");
    Serial.println(Val);


   if (Val == '1')
     {
      digitalWrite(Device1,LOW);
      lcd.setCursor(0,1);
      lcd.print(" LIGHT ON ");
      delay(200);
```

}

The LCD [Fig. 7] is the output display of the information inputted into the Arduino. It displays the state of operation of the entire automation circuit. The LCD is connected to the 5 V input supply of the AUB while the D1, D2, D3; D4 on the LCD is used for signal connection with the AUB. When a HIGH (1) signal is sent to the AUB then LCD displays that the device is OFF and when a LOW (0) signal is received the LCD displays the device ON, this is done for the number of devices used at a given time. The controller interface as shown in [Fig. 8] above, indicates that the Bluetooth is not connected, therefore all the devices are OFF, and the devices are turned ON when Bluetooth is connected as this gives access for the control of the appliances. [Fig. 9] below shows the pictorial representation of the constructed ACSHA.

Fig.9: Pictorial representation of the constructed ACSHA

The devices are labeled device 1, 2, 3 and 4 respectively. In this set up, the devices are connected to the AUB and the relay as follows:

A white light bulb (device 1) is connected to the PIN 6 of the AUB and the relay (relay 1) is connected to the PIN 1 on the AUB. A blue light bulb (device 2) is connected to the PIN 5 of the AUB and the relay (relay 2) is connected to the PIN 2 on the AUB. A socket (device 3) is connected to the PIN 4 of the AUB and the relay (relay 3) is connected to the PIN 4 on the AUB. It is displayed as D3. The socket (device 4) is connected to the PIN 3 of the AUB and the relay (relay 4) is connected to the PIN 3 on the AUB. This is shown as D4. The Bluetooth is connected to the AUB for receiving and transferring data, the TX (Transmit serial data) of the Bluetooth is connected to the PIN 0 of the AUB, while the RX (Receive serial data) of the Bluetooth is connected to the PIN 1 of the AUB. The Bluetooth is connected to the 5 V power supply of the Arduino Uno board for its operations.

The AUB is powered with a 12 V power adapter for it operation, it is programmed and compiled using the Arduino IDE (Integrated development environment). The AUB is the central processing unit of this project, it sends and receive signals from the Bluetooth and relay module, and it instructs the other units on how it will function based on the program uploaded to the AUB.

The Arduino controller [Fig. 8] indicates that the controller has not been connected with the Bluetooth of the system. The controller used is an android application that was built and design specifically for this system to further improve the security of the home automation system. There are similar applications that can be downloaded from the google play store; the application is installed on the smart phone. Then it is connected to the HC-05 Bluetooth module via the phone Bluetooth.

To use this home automation system, the circuit must first be connected to the power source, that would automatically turn on the HC-05 Bluetooth module, then the smartphone Bluetooth is turned on also and a search is made for the HC-05 Bluetooth module. When found the phone Bluetooth is paired with the Bluetooth module, once pairing is successful the installed Android Arduino controller on the phone is opened. The Arduino controller interface will show on the phone showing the number of devices assigned to the application. On this interface, we would see four devices with names as device 1, device 2, device 3 and device 4 respectively. There is a switch attached to each device. When any switch is pressed on the phone, the relay turns either off or on the load / device corresponding to the device being controlled.

It was observed from the experiment that the relays can only be connected to one particular device for separate control except otherwise, when more than one devices are connected to one relay they are controlled simultaneously by the same switch, it is possible to control the devices from different locations not minding the walls on the different rooms that serves as obstacles.

4.0 Conclusion

As technology is advancing so are our homes getting smarter by the day, therefore this home automation is a form of smart home. In this work, we used a smart phone for the control of our home electrical devices and appliances, from a distance up to 100 m. This is an automation to replace the manual control of home electrical devices and appliances. It is efficient, easy to operate and more convenient for use by the elderly and physically challenged people. It is quite cheap and easy to maintain.

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