Bluetooth Based Smart Home Automation System using Arduino UNO Microcontroller

Abdul Kareem Kasim Abdul Raheem*(Lecturer)

Abstract

There are different methods in wireless technology such as Bluetooth, WIFI, and GSM. In this paper, new design and different home appliances are presented. Bluetooth Based Home Automation System using Arduino UNO Microcontroller is design and implemented. PWM technique on Arduino is used to control the DC motor speed depending on the width of the Pulses and H-Bridge driver circuit is used to control the direction of the motor. The home automation applications that has presented in this paper is the ability to control the DC motor speed and its direction, bulb, fan and heater using a smart phone application with Bluetooth wireless technology. The relays is used to connect these appliances to the input/ output ports of the board .The design is a low cost, flexible and using a modern technology and devices for this application. Application of wireless Bluetooth connection in control board enables a simplified way to system installation. The system has been built and operated successfully.

Keywords: Bluetooth, Home Automation, Arduino UNO Microcontroller, H-Bridge

***University of Technology**

1. Introduction

Home automation allows to control house appliances like door, light, fan, oven… etc. It also provides emergency system and home security. It enables the consumer more control of his home it facilitates many conditions, for example, if the consumer is on his way to his home, controlling light turning on, or pre-heating oven when he got home, therefore, many manual actions is replaced by home automation which reduce human efforts and time saving[1].

B. Murali Krishna, et al, are present a home automation system using Android Smart Phone to control an application. A Bluetooth module is connected to FPGA board to control the home appliances [2].

Satish Palaniappan, et al, are offers a good features for home automation via remote access. A GSM network is specified as a candidate for this purpose. The system is available from all over the world to a user in real time [3].

Sadeque Reza Khan and Farzana Sultana Dristy are present an Android based control system which can maintain the security of home main entrance and also the car door lock [4].

Aniket Yeole et al, are represents the implementation and design of a secure RTOS based home automation system using ATMEGA where the important features like electrical appliances and sensors are connected to the board through the Input/output ports [5].

Nupur K. Sonawane, et al, are presents the design and implementation of a low cost ,tangible, flexible based device automation system depending on secure cell phone[6].

Lia Kamelia, et al, are proposed and prototyped a system called door locks automation system using Bluetooth-based Android Smartphone. [7].

D.Jaya Sree and M.Jhansi Lakshmi are presents the design of Home Automation System which remains the existing electrical switches which status is synchronized in all the control system with low voltage activating method that provides more safety control [8].

Sonali Sen,et al presents a voice controlled home automation system which consists of an Arduino Uno microcontroller. The smart phones is using for control the operation [9].

In this paper, different design and home appliances are presented. Many different electric applications is controlled by using Arduino UNO Microcontroller Based Home Automation System. The system is used to

control the DC motor speed and its direction, bulb, fan and heater using a smart phone application with Bluetooth wireless technology.

2. Technology

An brief introduction about Bluetooth and Arduino is presented. Android technique in smart phone is also presented. These components are the main parts of the proposed system design.

2.1 HC-05–Bluetooth

The standard feature for cellular phones is a Bluetooth technology which can be used in wireless connection for cellular phones and home appliances. Bluetooth technology gives an efficient method for controlling home automation. It is a low cost and a secured technology.

The Arduino Bluetooth board is used in the system. The cell phone is used python program to supply the user interface. The band frequency of working is over 2.4 GHz ISM with a range of 10 m and 1 Mbps speed [10]. This module HC-05 shows in figure (1) provides a good wireless transmission & a well receiving serial data; it can be used to provide a connection between MCU and PC for the data transferring purpose.

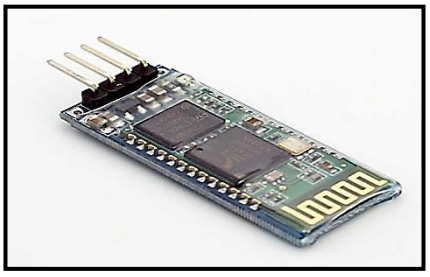

Figure (1): HC-05 Bluetooth Module

The I/O ports of the Bluetooth board and relays are used to connect the devices which be controlled. The Bluetooth simply is password protected. A Bluetooth device has the ability to scan and detect other devices easily. It has the ability of checking whether devices are working properly or not [3].

2.2 Arduino

Arduino UNO shown in figure (2) is a single board computer. Arduino is an open source physical computing platform based on a simple input/output (I/O) board. The type of the Arduino board used in this paper is ATMega328P Arduino Uno Microcontroller having 2KB static RAM, 32KB flash memory, 8 bit CPU, 6 Analog I/O pins and 14 Digital I/O pins [9].
The language used to program the Arduino microcontroller is C/C++. Programs are created in the Arduino development environment that compiling and linking source code and downloaded to the Arduino board where it start running [11].

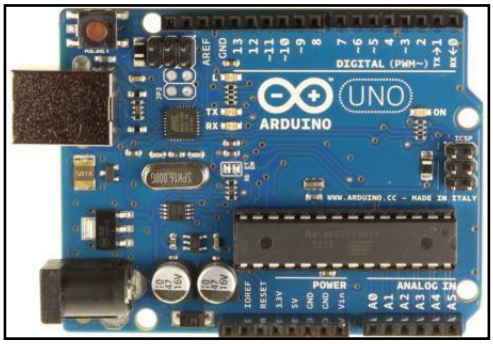

Figure (2): The Arduino Uno board

2.3 Android

Android operating system is primarily designed for smart phones and tablets. Android applications are written in Java programming language using the Android software development kit (SDK) and run in virtual machines [9]. The ATMega328P Microcontroller is connected by HC-05 Bluetooth Module using wireless technique to the Bluetooth Controller Android application, and the Input/output ports of the embedded system board are connected to home appliances. Android is the base of the application software, which has the largest base of Smartphone. The Smartphone screen of Android application is shown in figure (3).

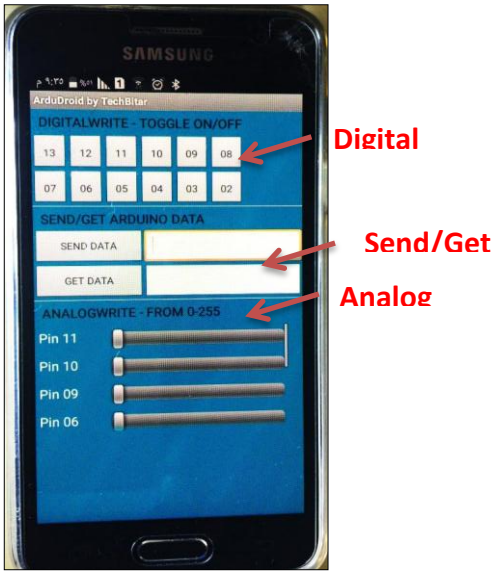

Figure (3): Smartphone screen of Android application

3. Theory

The home automation system allows people to control home appliances by using a smart phone application. It is necessary to look on hardware and user's smart phone software for developing a home automation system. The product can deal with many home appliances such as lights, door lock…etc.

3.1 Bluetooth Wireless Technology

Bluetooth is designed as a short range, low energy, low cost wireless connectivity that uses radio technology. Bluetooth devices work with 2.4 GHz frequency. A channel hoping technique is used to divide the 2.4 GHz band into 79 channels. In this technique the data is separates into smaller pieces called packets. The data packets exchanges between the transmitter and receiver at one frequency, then at another frequency the transmitter and receiver exchange another packet. This process will be continue by repetition until all data is transmitted. The channels changes every 625 microseconds. Usually it performs 1600 times per second BWT devices use seventy-nine 1-megahertz frequencies in the ISM band as shown in figure (4).The ISM frequency bands, having a range of 2.4 GHz

and 2.483 GHz in the radio spectrum, has been reserved for industrial, scientific and medical purposes [12].

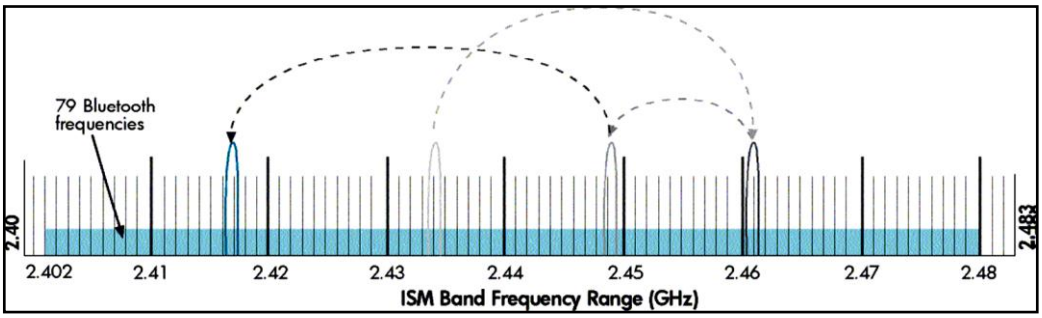

Figure (4): BWT devices frequencies hop up to 1600 times per second.

3.2 PWM on an Arduino

Pulse Width Modulation (PWM) is a technique used to change the pulse width of signal, which in turn, changes the duty cycle to controls the effective voltage level to the attached component.Figure (4) shows a voltage signal with pulses of duration τ_o that repeat every τ_c units of time. If this signal with a response time larger than τ_c is supplied to a device, then the device will test the signal as a DC input with an effective voltage V_{eff} of [13]:

$$V_{eff} = V_s \frac{\tau_o}{\tau_c} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where $\frac{\tau_o}{\tau_c}$ is the duty cycle ratio of the square wave pulses

By adjusting the duty cycle (figure 5) of signal, the effective DC output voltage is controlled. PWM of digital input/output pins either a High (5V) or Low (0V) depending on coding it. The I/O pins is controlled with the programming of pin Mode, digital Write and digital Read functions.

Figure (5): PWM duty cycle.

Analog Write function generates a square wave that can be varied in the function. It is 8-bit value that corresponds to voltage range between 0 and 5 volts for the values varied between 0 and 255. A value 0 gives a duty cycle of 0% and a value 255 gives a duty cycle of 100%.The analog Write value can be calculated as shown below:

Analog Write value= Duty cycle * 255

The PWM output level is particular with the analog Write. Figure (6) describes the scaling relationships between the parameters of PWM outputs. The quantities are linearly related. Thus,

$$PWM_{out\ level} = 255 \times \frac{\tau_o}{\tau_c} = 255 \times \frac{V_{eff}}{V_s}$$

Since V_s = 5V, the formula became:

$$PWM_{out\ level} = \frac{255}{5} \times V_{eff} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{2})$$

Therefore, an effective voltage of 3V can be calculate as following:

$$PWM_{out\ level} = \frac{255}{5} \times 3 = 153$$

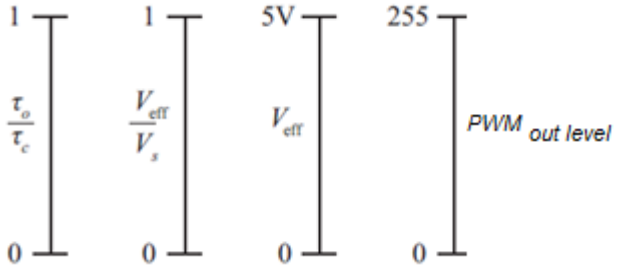

Figure (6): Scaling relationships for PWM parameters.

3.3 H-Bridge

A D.C. Motor requires a voltage difference between its terminals to rotate in which, the direction is depending on the side connected to the negative or positive terminals. Swapping will change the rotate of motor in the opposite direction. The H-bridge enables the DC motor to rotate in forward and reverse direction and also provide enough current for the motor to run. It is named as H-Bridge according to its shape of connection as shown in figure (7). An H-Bridge is basically a set of 4 switches which leads to different motions or actions if it is combined that can be controlled by an Arduino. Using a couple simple digital output signals, you can open or close these switches. When the switch A1 and switch A2 are closed, the motor rotates clockwise. When the switch B1 and switch B2 are closed, the motor rotates anti-clockwise [14].

The SN754410 Quadruple Half-H Driver Integrated Circuit (IC) is used to control the direction of a DC motor. figure (8) shows the pin configuration of the IC, and table (1) is the function of its working.

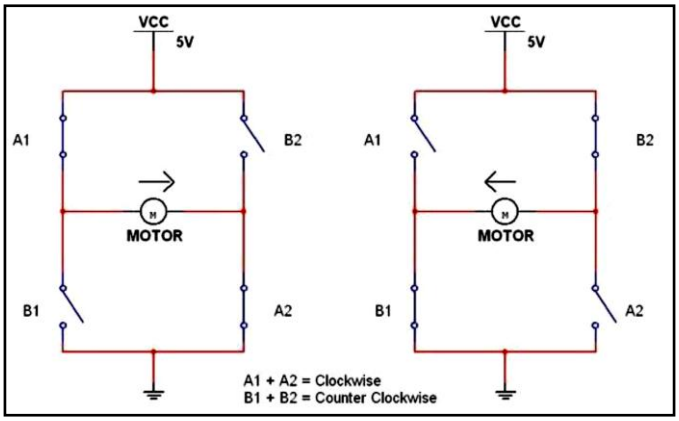

Figure (7): H-bridge theory

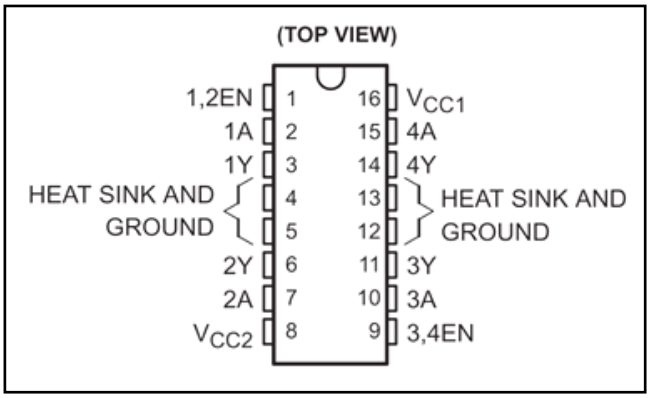

Figure (8): Pin configuration of SN754410 Quadruple Half-H Driver IC

Table (1): Function Table

INPUT		OUTPUT
A	**EN**	**Y**
H	H	H
L	H	L
X	L	Z

H=High Level, L=Low Level, X=irrelevant, Z=high impedance (off)

4. Methodology

4.1 The parts needed for the proposed system

1- Arduino Uno
2- Android Phone
3- Bluetooth module (HC-05)
4- Android application to control the arduino via Bluetooth
5- Motor.
6- Relays Modules
7- Light Bulbs
8- Portable Fan
9- Heater
10- H-Bridge Motor Drive(SN754410 IC)
11- DC Power Supply

4.2 System design:

Figure (9) shows the block diagram for the proposed system with some of home appliances.

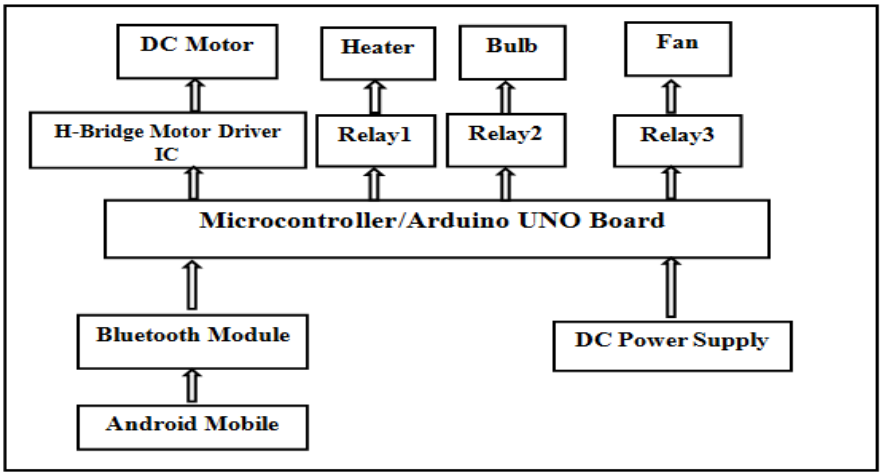

Figure (9): The Bock Diagram of the System

The H- Bridge motor driver IC (SN754410) allow controlling the direction of a DC motor with only one PWM output for controlling the speed. Relays (1, 2, and 3) is used to control the work of Heater, Bullb and Fan. Figure (10) shows the connections of Arduino board between these appliances and Bluetooth module.

The Bluetooth simply is password protected, and by using Bluetooth wireless connection, the system is established on serial data transmission in order to facilitate on wireless communication. It also supports convey Android makes the mobile phone capable of offering system connection and control facilities.

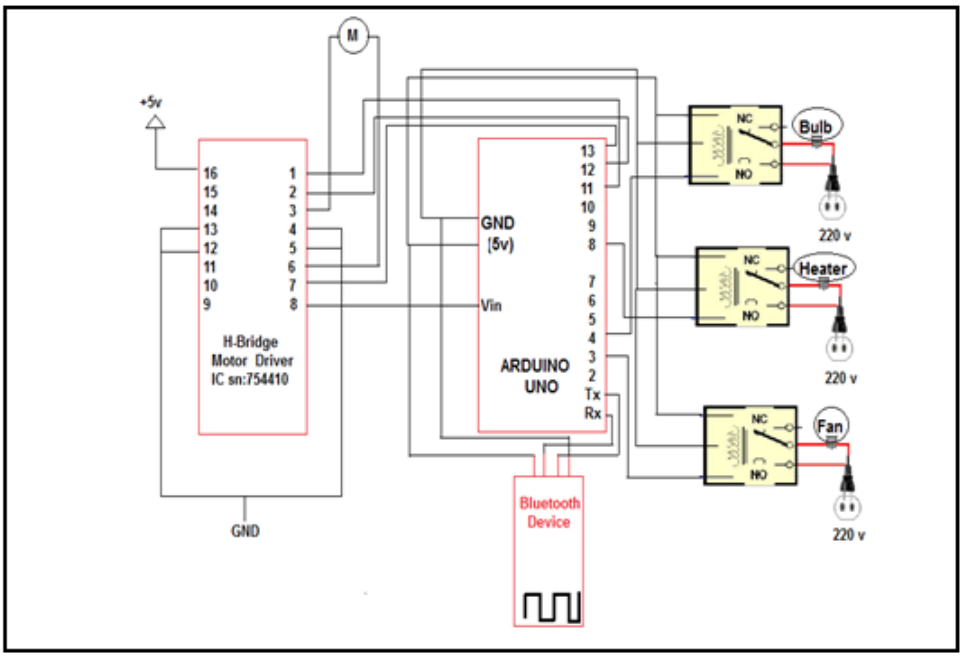

Figure (10): The Circuit Diagram

4.3 Hardware impelementation

The system is integrated using Arduino Uno board, a HC-05 Bluetooth module, relays modules, an android device, and other electronic components. Figure (11) shows the system architecture of the proposed system which indicates the connection between the Arduino card and the peripheral devices which is Fan, Bulb, Heater and DC Motor. A connection between the Arduino Uno and the Bluetooth module is required in order to enable the android to control the Arduino Uno .The VCC and GND pins of the Bluetooth module are connected to the VCC and GND port in the Arduino-Uno board respectively. Then connect the receiver of the Bluetooth module to the transmitter of the Arduino-Uno board and the transmitter of the Bluetooth module to the receiver of the Arduino-Uno board.

Using wires and connector blocks connect the positive end of the home appliance (eg. Heater) to the normally open port in the relay module and the negative end of the appliance to a power source ,Then connect the

other port of the same relay module to the wanted Arduino-Uno port Apply the same for the other appliances only use different relays and different Arduino Uno Ports.

The SN754410 Quadruple Half-H Driver is an Integrated Circuit (IC) that allows you to control the direction of a DC motor. Pins 1,2 and 7 from IC is connected to pins 11,12 and 13 in Arduino, pins 3 and 6 in Arduino is connected to motor.

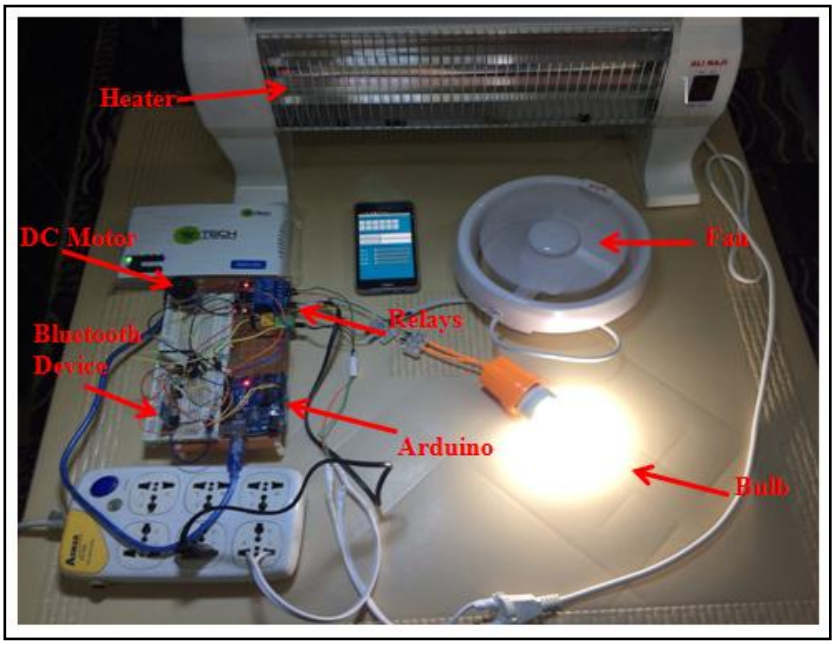

Figure (11): System Architecture

4.4 Program flow chart

The software is written in C-language for android applications and the flowchart as shown in figure (12). At first checks if Bluetooth is already enabled on the phone, then the device will run. The software will check the devices stored in the phones memory, also it stores the addresses of all the controller modules connected to arduino, then the home appliance is chosen for the application. At last the signal sends to arduino to connect it.

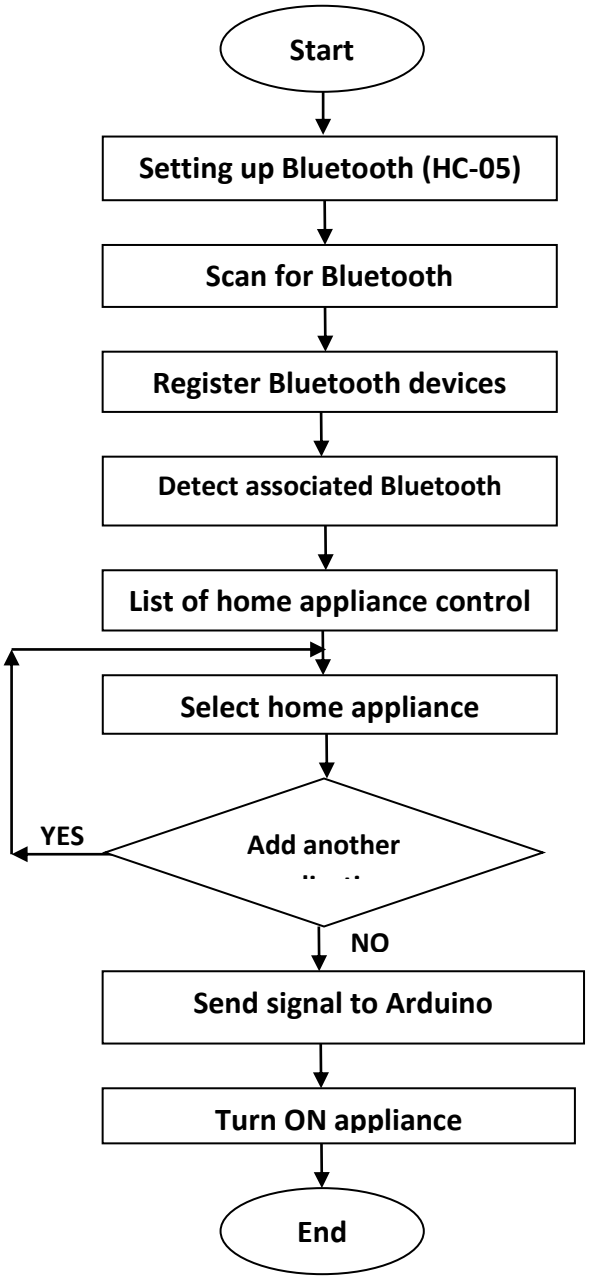

Figure (12): Program Flow Chart

5. Conclusion

It can be concluded that Home Automation System using Arduino has been successfully designed and prototyped. This system consists of an Arduino Uno board, a Bluetooth Module, an Android phone, home appliances and an android Application. Bluetooth (HC-05) Based Smart Home Automation System was presented in this paper. The system. PWM technique is used to control the DC motor speed, and H-Bridge driver circuit is used to control the direction of the motor. Also the system is used to control switching ON/OFF the bulb, fan and heater using a smart phone application. It is provide easy control the home appliances, it is help the people who have locomotion difficulty. Moreover, implementation of wireless Bluetooth connection gives a simple way of system installation.

References

[1] D. Naresh, B. Chakradhar, S. Krishnaveni, “Bluetooth Based Home Automatic and Security System using ARM9”, International Journal of Engineering Trend and Technology (IJETT), Vol. 4 Issue 9, Sept. 2013.

[2] B. Muralikrishna, V. Narasimaha Nayak, K. Ravi Kishore Redd B. Rakesh, P. Manoj Kumar, N.Sandhya, "Bluetooth Based Wireless Home Automation System using FPGA", Journal of Theoretical and Applied Information Technology, Vol. 77, No.3, 2015.

[3] Satish Palaniappan, Naveen Hariharan, Naren T Kesh, VidhyalakshimiS, Angel Deborah S, "Home Automation Systems – A Study "International Journal of Computer Applications Vol. 116 , No. 11, Apr. 2015.

[4] Sadeque Reza Khan and Farzana Sultana Dristy ," Android Based Security and Home Automation System", International Journal of Ambient Systems and Applications (IJASA) Vol.3, No.1, Mar. 2015.

[5] Aniket Yeole, Sapana Bramhankar, Arjun Gaikwad, Abhijeet Bansod, Atul Borade," RTOS Based Home Automation System Using ATMEGA", International Journal of Innovative Research in Computer And Communication Engineering, Vol. 3, No 2, Feb. 2015.

[6] Nupur K. Sonawane, Payal D. Waghchavare, Kajal A. Patel ,"Bluetooth Based Device Automation System Using Cellphone", International Journal of Computer Applications Information Technology, Vol. 7,No I Oct. - Nov. 2014.

[7] Lia Kamelia, Alfin Noorhassan S. R. , Mada Sanjaya and W.S. , Edi Mulyana, "Door-Automation System using Bluetooth-Based Android for Mobile Phone", ARPN Journal of Engineering and Applied Sciences, Vol. 9, No. 10, Oct. 2014.

[8] D. Jaya Sree and M. Jhansi Lakshmi ," Android Mobile Based Home Automation using Bluetooth", International Journal of Advanced Research In Computer Engineering & Technology (IJARCET) Vol. 3 No. 9, Sep. 2014.

[9] Sonali Sen , Shamik Chakrabarty , Raghav Toshniwal, Ankit Bhaumik," Design of an Intelligent Voice Controlled Home Automation System ", International Journal of Computer Applications, Vol. 121, No.15, Jul. 2015.

[10] Prashant R. Chandre, Aarti R. Salunke," Home Automation using Android Application & Bluetooth", International Journal on Recent and Innovation Trends in Computing and Communication, Volume:3 ,No. 2, Feb. 2015.

[11] John Boxall, " Arduino Workshop", 2013.

[12] Simranjit Singh Chadha, Mandeep Singh , Suraj Kumar Pardeshi , " Bluetooth Technology: Principle, Applications and Current Status", IJCSCIJ, Vol.4 , No. 2 Sept. 2013.

[13] Gerald Recktenwald, " Basic Pulse Width Modulation", Gerry@me.pdx.edu, Sept. 16, 2011

[14] Vincent Sieben, " A High Power H-Bridge", Sept. 2003.

نظام اتمتة المنزل الذكي اعتمادا على البلوتوث باستخدام المسيطر الدقيق Arduino UNO

م.عبدالكريم قاسم عبدالرحيم*

المستخلص

هناك طرق مختلفة في التكنولوجيا اللاسلكية مثل بلوتوث، WIFI وGSM في هذا البحث، تم عرض تصميم جديد وتطبيقات منزلية مختلفة. تم تمثيل نظام اتمتة منزلي يعتمد على البلوتوث باستخدام المسيطر الدقيق Arduino UNO . تم استخدام تقنية تضمين عرض النبضة في ال Arduinoللسيطرة على سرعة الماطور اعتماداعلى عرض النبضات وتم استخدام دائرة سوقH-Bridgeللسيطرة على اتجاه الماطور .ان التطبيقات المنزلية المعروضة في هذا البحث هي القدرة على السيطرة على اتجاه وسرعة ماطور تيار مستمر ، مصباح ، مروحة ومدفأة حرارية باستخدام تطبيق تلفون ذكي مع تكنولوجيا بلوتوث لاسلكي . تربط هذه التطبيقات الى اطراف الادخال والاخراج للبطاقة بواسطة مرحلات .ان التصميم منخفض التكاليف ، مرن ، وتم استخدام اجهزة وتكنولوجيا حديثة لهذا التطبيق . ان تطبيق ربط بلوتوث لاسلكي في لوحة السيطرة يعطي طريقة مبسطة في التركيب . تم بناء المنظومة وتشغيلها بنجاح.

*الجامعة التكنولوجية