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DESIGN AND IMPLEMENTATION OF A MULTIPLE LOAD CONTROLLING DEVICE USING VOICE COMMAND SENSOR

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Abstract— **The living standard of modern society has significantly changed by the rapid growth of technology. The development of automated load control devices is becoming more popular for the home system. At present, the available automated load controlling devices in the market, have several drawbacks with high operating costs and incompatible standards. In this work, a wireless automatic load controlling device is developed based on Arduino microcontroller and cellular phone to operate different home appliances such as television, light, fan, and air-conditioner by voice command. The device is user-friendly and comparatively cost effective. The simulation is done by using Proteus 8 professional software. Finally, an experimental setup is developed, and the tested result shows that the device is working properly.**

Index Terms— **Home Automation, Arduino Uno, Mobile Phone, Voice Command, Wireless System.**

I. INTRODUCTION

The automated process of modern civilization is making human life more easily day by day. In this track, the automation system of home appliances is also progressed on. Different techniques are developed by many researchers to automate the controlling system of home appliances. The work in [1], a device using voice recognition and Arduino was designed and also described Android, Bluetooth, diode, voltage regulator operations. A GSM based home automation system was developed in [2] where the microcontroller is used as a controlling unit, and mobile and wireless communication are used for data signal processing. The work in [3], was developed an application of Bluetooth technology in home automation and networking environment, which contains a remote, mobile host controller and several home appliances. The work in [4], was developed by Bluetooth wireless technology and described the hardware and software simulation process for a home automation system using Bluetooth devices. The work in [5] was developed as a method for controlling different appliances for smart homes and Industries. In [6], the main four fields for Smart Home System (SHS) were investigated for home automation and remote monitoring, environmental monitoring, including humidity, temperature, fault tracking using the microcontroller. Where a wireless internet service was also used in different monitoring and control processing. The system result highlights about the high flexibility and reliability.

A flexible and secure SHS based on Bluetooth communication using mobile phone was investigated in [7]. Here the home appliances were controlled by microcontroller using on-off relay. The work in [8] a new SHS was developed for home safety purpose based on Android Accessory Development Kit (ADK). The work in [9], a microcontroller-based load controlling system was developed using mobile phone via Bluetooth communication. In [10], it was discussed about the complexity of designing and implementing a wireless sensor based SHS with multiple loads controlling facilities. From the above literature, it is found that the home automation system has become a popular research topic with increasing the demand for both home and industrial applications. Consequently, the system cost and complexity increased for hardware implementation of different applications. Therefore, in this work, a simple voice command sensor-based device is designed and implemented to on-off control of four different home appliances (television, light, fan, and air-conditioner). The main objective of this work is to develop the device to reduce the complexity of hardware implementation with optimal cost.

The layout of the remaining sections is given below. Section II describes the methodology of the work. Section III describes the simulation processes of the work by Proteus professional software. Section IV demonstrates the hardware implementation of the proposed work. The results and discussion are illustrated in Section V. In the last section conclusions are provided.

II. METHODOLOGY

In order to develop a multiple load controlling device microcontroller-based Arduino is used in this work. Air conditioner, television, fan and light are considered as load. These four different types of loads have been controlled by voice command using smart mobile phone and the control signals are communicated to microcontroller via a Bluetooth module. According to the voice command microcontroller operates the relay to switch on or off the corresponding load. The block diagram of the

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proposed multiple load controller is shown in Figure 1. At first the device is designed and simulated using a simulation software. After that the hardware implementation has been done to test its accuracy and compatibility with the mobile apps system.

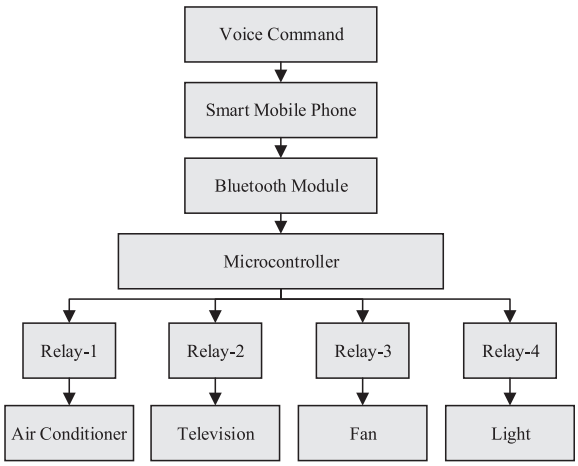

Fig.1. Block diagram of the load controlling process using voice command

III. Simulation Work

The simulation work has been carried out using Proteus 8 professional software. The schematic diagram is shown in Figure 2. Arduino is used here with built in microcontroller. The controller unit generates the load controlling signal according to the voice command. The voice command is received by the mobile phone apps and the corresponding signal will be executed via relay as a magnetic switch. Though the loads are considered as four different loads appliances (television, light, fan, and air-conditioner), but for simulation purposed LED are used as equivalent to the AC loads.

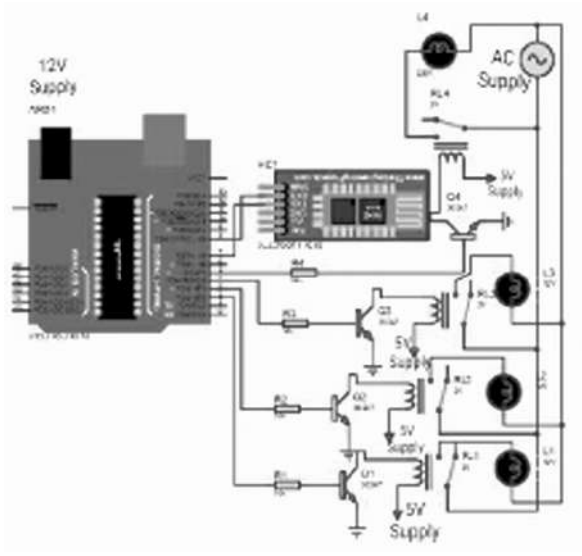

Fig.2. Schematic diagram of the proposed device

IV. Experimental Work

In this section, the experimental procedure is described step by step. The experimental setup which has been developed in this work is shown in Figure 3. The major components are Arduino UNO, DC-DC converter, Bluetooth module and Relay module, which have been used to develop the multiple load controlling system. At first, Arduino is connected with an AC to DC converter. The converter converts 220V AC to 12V DC with 2.5A. Two pins of Bluetooth module, transmitter (Tx) and receiver (Rx) are connected with Arduino pins P7 and P8 respectively. V_{CC} pin is connected to the +5V and GND pin is connected to virtual ground. The microcontroller communicates with the Bluetooth module using serial communication at rate of 9600 Hz. Four different color lamps are connected with individual relays 1, 2, 3, and 4 considering Light, Fan, TV, and Air-conditioner loads respectively. A 5V DC power is supplied to the relays by using a buck converter. Finally, the loads are (on-off) controlled by relay and relays are controlled by a programmed microcontroller using voice commands.

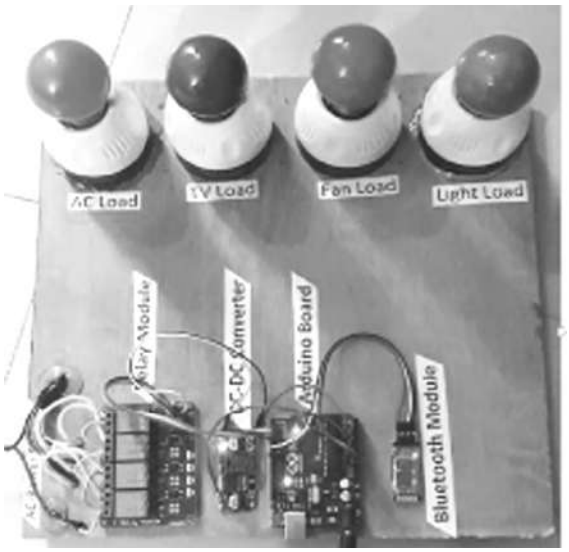

Fig.3. Experimental setup of the multiple load controlling system using voice command.

The Arduino UNO controller unit is developed using a microcontroller (ATMEGA328). The IDM software (Integrated Development Environment) is used here to program the Arduino UNO microcontroller. This a JAVA based software. The Arduino Uno board is shown in Figure 4. Arduino UNO is a smart programmable controller device, which is compatible with software and hardware interfacing with low cost. Therefore it is used in this work to make the load controlling system with less complexity and cost effective. A voice recognition apps, Android Meets Robots (AMR_voice) is used in this work. It is a smart mobile phone app which is shown in Figure 5. AMR_voice can detect the voice command and generate corresponding signal. The signal is

transmitted by the built-in Bluetooth device in the mobile phone and received by the external Bluetooth module (HC-05) which is connected with the Arduino board.

Fig.4. Arduino UNO

The four relay switching module is used in this work, which can operate from minimum 3.5V to maximum 36V. However 5V is used to operate the relay module though the relay can operate AC load of 220V. As Arduino cannot operate this high voltage load directly, therefore the relay module has been used here as a controlled switch to operate different type of AC loads. The relay module is shown in Figure 6.

Fig.5. AMR_voice apps in smart mobile phone

The HC-05 is a class 2 Bluetooth module which is designed for transparent wireless communication. The Bluetooth module is shown in Figure 7. It is pre-configured as a slave Bluetooth device. Once it is paired to a master Bluetooth device such as smart phones or tablet, its operation becomes transparent to the user. The HC-05 can be re-configured by the user to work as a master Bluetooth device using a set of AT commands. Once configured as the master, it also can automatically pair with another HC-05 in its default slave configuration allowing a point to point serial communications.

Fig.6. Four relay switching module

A step down DC-DC converter is used in this work to convert the voltage from 12V to 5V DC. This is used as a supply voltage of the relay module.

Fig.7. Bluetooth module (HC-05)

V. Results Analysis

In this section the results are analyzed by with respect load operation by voice command. Besides the cost comparison has been made with different commercial devices. After implementation of the multiple load controlling device, it is tested by voice command. In order to control the loads (Light, Fan, TV, and Air-conditioner) via relay, four different voice commands are selected. Each relay operates with two voice commands to turn on and off the load. The voice commands for corresponding relay no and output results are illustrated in Table I. The relay module consists of four relay. Four relays are operated as a switch. For light load two voice commands "light on" and "light off" are sent via mobile phone, then Relay-1 goes to ON state and OFF state respectively. For fan load relay 2 is used. When the voice command "Fan on" is send via phone, then Relay-2 goes to ON state. When the voice command "Fan off" is send then Relay-2 turn-off. For television relay 3 is used. When the voice command "TV on" send via phone, then Relay-3 goes to ON state. The relay goes to OFF state to turn off the TV, when the voice command "TV off" is send. Similarly, relay 4 is used to turn on and off the Air-conditioner load. In the proposed system an additional facility is incorporated to turn on and off the four loads at a time by using the voice command “All on” and “All

off" respectively. At this time all the four relays will be operated at a time.

TABLE I
RELAY OPERATION AND VOICE COMMANDS FOR DIFFERENT LOADS

Sl no	Name of Load	Voice Command	Relay works	Output result
01	Light	Light on	Relay-1	Light on
		Light off		Light off
02	Fan	Fan-on	Relay-2	Fan-on
		Fan off		Fan off
03	TV	TV on	Relay-3	TV on
		TV off		TV off
04	AC	AC on	Relay-4	AC on
		AC off		AC off
05	All Load	All on	Relay-1, 2, 3, 4	All Load on
		All off		All Load off

TABLE II
COST CALCULATION OF THE MULTIPLE LOAD CONTROLLING DEVICE

Sl. No	Equipment list	Quantity	Price (BDT)
01	Arduino Board	01	700
02	Bluetooth Module	01	500
03	Four Channel Relay Module	01	300
04	Buck Converter	01	100
05	Bulb	04	125
06	Bulb Holder	04	140
07	Connecting Wires	--	100
08	Soldering Lead and others	--	200
09	Model Board	01	100
10	Others		600
		Total cost	2865

Table II summarizes the cost of different equipment of the multiple load controlling device. The total cost is estimated BDT 2865, which is comparatively low-price device with respect to the commercial devices. A comparative analysis is illustrated in Table III. Where Three different commercial multiple load controlling devices are compared with the proposed device. Among them SENSIBO smart remote controller is highly expensive. Though the load controller device RM Pro+ is less expensive but the proposed one is lesser then MOES Smart Remote Controller by BDT all other three devices. Moreover, the reliability of the proposed device is reasonably high due to the use of the commercial controller, Arduino UNO. The sensitivity and compatibility of the proposed device is high enough because the experimental result demonstrate that the voice recognition and the load controlling system is very fast.

TABLE III
COST COMPARISON OF MULTIPLE LOAD CONTROLLING DEVICE

Device	Price (BDT)	Shipping (BDT)	Total (BDT)
RM Pro+	3560	2237	5797
SENSIBO Smart Remote Controller	10089	24269	34358
MOES Smart Remote Controller	4493	7301	11794
Proposed Controller	2865	250	3115

VI. CONCLUSION

The proposed multiple load controlling device is cost effective enough, as the per unit cost is BDT 2682 less then PM Pro+. On the other hand, the proposed device is lesser (BDT 5997) than a popular load controller MOES smart remote controller. Smart home security system and development of smart appliances are increasing in a rapid growth. Therefore, the use of multiple load controller is increasing day by day. Hence the proposed cost-effective multiple load controller device can full fill the demands. Finally, the experimental result shows that the device is working precisely. Therefore, in future this device can be manufactured commercially.

REFERENCES

[1] C. S. Tyagi, M. Agarwal, and R. Gola, "Home Automation Using Voice Recognition and Arduino," ed: IJRTER, 2016.

[2] B. Yuksekkaya, A. A. Kayalar, M. B. Tosun, M. K. Ozcan, and A. Z. Alkar, "A GSM, internet and speech controlled wireless interactive home automation system," *IEEE Transactions on Consumer Electronics,* vol. 52, pp. 837-843, 2006.

[3] N. Sriskanthan, F. Tan, and A. Karande, "Bluetooth based home automation system," *Microprocessors and microsystems,* vol. 26, pp. 281-289, 2002.

[4] A. Gaddam, K. Kaur, S. Mukhopadhyay, and G. S. Gupta, "Selection and optimization of wireless sensors in a smart digital home for the elderly," in *Sensors, 2009 IEEE*, 2009, pp. 1382-1386.

[5] S. Kumar and M. A. Qadeer, "Universal digital device automation and control," in *Computer Science and Information Technology, 2009. ICCSIT 2009. 2nd IEEE International Conference on*, 2009, pp. 490-494.

[6] M. A. E.-L. Mowad, A. Fathy, and A. Hafez, "Smart home automated control system using android application and microcontroller," *International Journal of Scientific & Engineering Research,* vol. 5, pp. 935-939, 2014

[7] S. Panth and M. Jivani, "Designing Home Automation system (HAS) using Java ME for Mobile Phone," *International Journal of Electronics and Computer Science Engineering,* vol. 2, pp. 798-807, 2013.

[8] D. Javale, M. Mohsin, S. Nandanwar, and M. Shingate, "Home automation and security system using Android ADK," *International Journal of electronics communication and computer technology (IJECCT),* vol. 3, pp. 382-385, 2013.

[9] S. Panth and M. Jivani, "Device Control in an Ad-hoc Network Environment by using MoSync for Multiple Platform Mobile Application Development," *International Journal of Computer Science & Engineering Technology,* vol. 4, pp. 1145-1152, 2013

[10] K. Y. Lee and J. W. Choi, "Remote-controlled home automation system via Bluetooth home network," in *SICE 2003 Annual Conference*, 2003, pp. 2824-2829.

BIBLIOGRAPHY

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