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Design, Simulation and Implementation of a Microcontroller Based Autometic Home Appliances Control System

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Abstract

Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization, whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work. Automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasing important role in the world economy and in daily experience. This paper describes the design and development of an internet based home appliance automatic control system using ATmega328 microcontroller. The system is capable of controlling the ON/OFF mode of different home appliances such as light, fan, TV, air-condition and so on. The appliances are connected to a computer (act as a server) through a programmed microcontroller. Internet interface is used to connect the microcontroller with a computer. The program for the microcontroller has been written in micro C language. All the commands are carried out from a software layout running on a computer to control the home appliances.

Keywords: *ATmega328 microcontroller, Cascading Style Sheet, Home Appliances Control System , Hyper Text Markup Language.*

I. Introduction

Automatic home appliances control system is a system which offers various services to the operators who operate and monitor their home appliances such as television, fan, air-condition, microwave oven, doors etc through a remotely access device such as laptop, desktop and smart phone. In modern time it is very important to control and monitor different appliances through remote device.

Since the beginning of electrification, switching electrical devices has been done by means of connecting or disconnecting them to the power source. But in recent years the situation has changed. Automatic switching has become more popular than manual switching (E. Adetiba *et al.*, July 2011). The control technique using automatic switching for house hold appliances has improved gradually and is now in practical use (T. Nonaka *et al.*, 2010). Automation in the home appliances provides increased comfort especially when employed in a private home. For the case of commercial buildings automation not only increase comfort, but also allow centralized control of heating, ventilation, air condition and lighting. Hence, they contribute to an economical use of the electricity which results in overall cost minimization and reduction of the wastage (A. E. Shafee *et al.*, 2012 and S. P. Tseng *et al.*, 2014).

The goal of this paper is to provide an efficient internet based system to control everyday home appliances. The designed system will offer the following features:

- The conventional (HACS) are cable connected system as explained in (A. E. Safee *et al.*, 2012). So the installation cost will be reduced using this wireless system.
- The major advantage of the system will be, its control ability. It will be possible to control from anywhere using internet connectivity.
- According to (V. S. Gunge *et al.*, 2016) wireless network is especially useful when, changed requirements or an extension of the network is necessary. This system will provide easy accessibility and provision for future extension.
- A web page login system will ensure the security of the system.

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Thus the system will provide a powerful & versatile system which expands the mobility of users by granting them total control over their home without the need of physical presence.

This paper has provided a design procedure of automatic home appliances controller using ATmega328 microcontroller. As indicated in (Y. S. Kale *et al.*, 2014 and A. A. Mansur *et al.*, June 2016) the size and cost of this type of system can be reduced by the implementation of microcontroller instead of conventional controller.

The proceding part of the paper describes the frame work and programming steps of the system. A comparative analysis between simulation using Proteus professional software and the practical system is also given in the further part of the paper.

II. Framework of the Designed System

To understand the basic design of the system, this part has been spitted in to three different segments like Block Diagram, Flow Chart and Simulation model of the system.

A. Block Diagram of the System

Home Appliances Control System (HACS) as shown in Fig.1 includes main components which are:

- User interface: The devices for example smart phone, internet connected desktop or laptop which can give command to the server.
- Medium of transmission: WiFi connection.
- Central Controller: The central controller is the combination of Server computer i.e desktop and ATmega328 microprocessor connected through Ethernet module. This hardware interface communicates with user interface by controlling different loads through relay.
- Load: Different home appliances can be considered as load. In this project two lamps and one 3 phase induction motor have been tested as load.

As shown in Fig.1, the system uses the internet to enable remote access to the home appliances. Apart from merely turning the appliances ON & OFF, the scope of the system can be extended to regulate their output power & set their usage time (T. Nonaka *et al.*, 2010). A graphical user interface has been designed for the system.

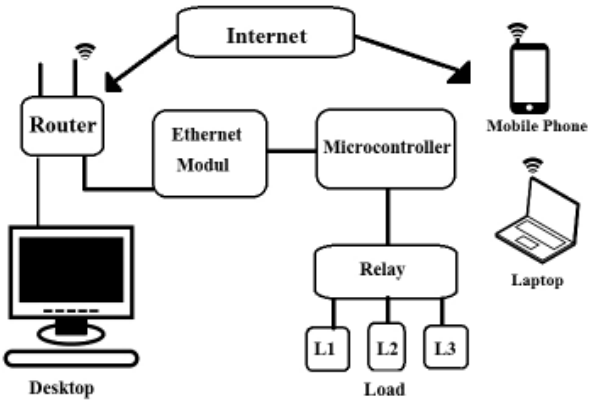

Figure 1: Block diagram of Home Appliances Control System (HACS).

B. Flow Chart of the System

The flow chart of the system is shown in Fig. 2. The initialization of input data is performed through the input devices. If the decision is yes, information signal goes to the server otherwise the process ends. The server transfers the incoming information to the microcontroller through Ethernet. The microcontroller has been programmed in such a way, that it understands this signal and thus converts it to an electrical signal and transmitted to the switch controller of the home appliances. The ON/OFF action of the load is detected by the sensor. This information transfers to the server through a feedback path (microcontroller to server). The end result of the whole process is a simple action, switching ON/OFF of a load.

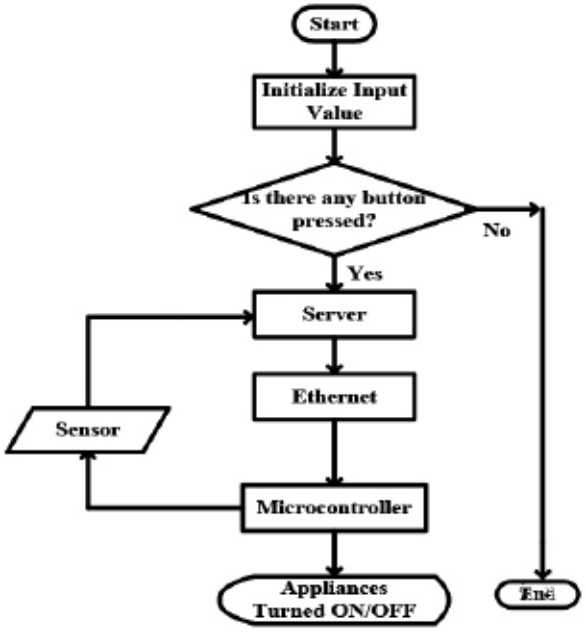

Figure 2: Flow Chart of the System.

C. Simulation Model of the System

Before building the prototype of the system a simulation model has been developed using Proteus professional software which is very renowned and user friendly for this type of project. The simulation model consists with the following components:

1. Arduino UNO R3
2. Virtual Timer
3. Relay
4. 3 Phase Motor
5. Light 1
6. Light 2
7. Alternator (220 V AC)

Arduino UNO R3 pin 12 & 13 are connected to the Virtual Timer TX and RX pin respectively. Output pins 2,3,4 of Arduino UNO R3 are connected to the relay pins. Supply voltage of the output pin is 5V. The common pins of the relay are connected to the ground pin. A220 V AC, 50Hz connection is given to the relay and other line is connected to the motor, light 1 & Light 2. RL1 (Relay 1) is connected to 3 phase motor, RL2 (Relay 2) connected to Light 1 and RL3 (Relay 3) is connected to Light 2.The connection of sensor 1 is completed by connecting pin 5 and 2. Similarly for sensor 2 connect pin 7 and 3 and for sensor 3 connect pin 8 with pin 4. When the simulation play button is press the lights and motor start to run and the Virtual Timer give the signal to the window.

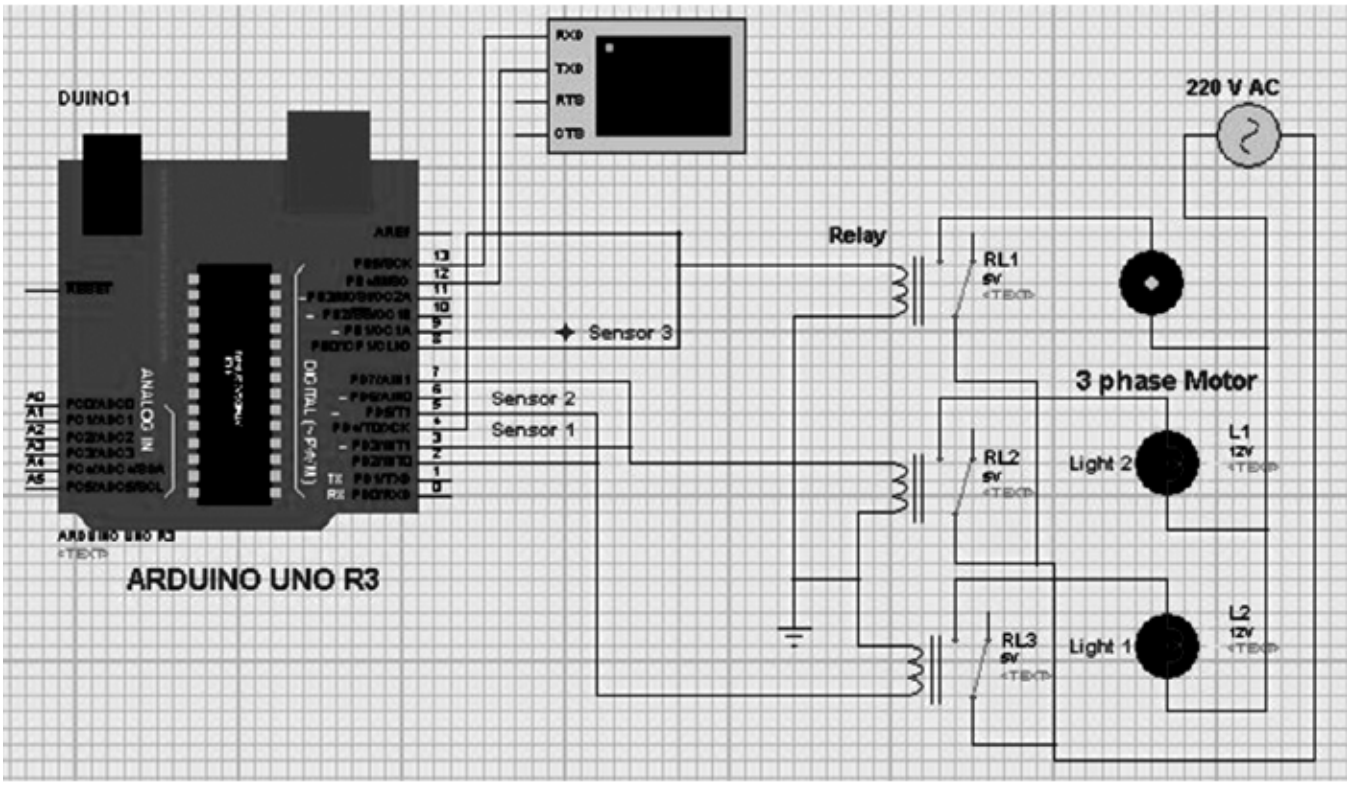

Figure 3: Simulation Model of the System.

III. System Programing Steps

A. Configuring Arduino System

To run the whole system according to the flow diagram of Fig.2 an interfacing between microcontroller and input output devices are essential. The required steps to run an Arduino program are given in Fig.3.

- At first the router is configured by providing IP and MAC addresses.
- In step 2 microcontroller pins are assigned for the input (sensors) and output (different loads).
- Then in step 3 HTTP server is configured by generating a configuration code so that the server can identify the requested input information and can provide the corresponding responses as output.
- In step 4 HTML and CSS codes are created, which has been explained in the later part.

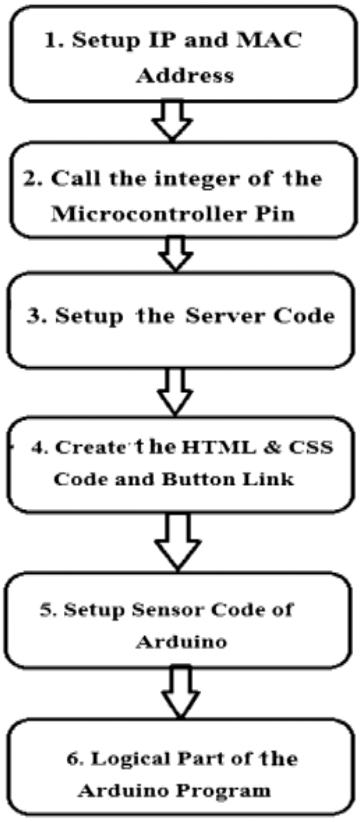

Figure 4: Steps for Arduino program.

After completing the logical part of the arduino program as shown step 6 of Fig.4, a user can turn ON of OFF light or fan through the controlling Device.

B. Assembling Software Components

The system contains both hardware & software components. The whole system has been compiled by a web server. The web control server is a system that controls the home appliance through internet. The server will receive the input data from the user and send it to the microcontroller through Ethernet. There are many systems to make an arduino web control system (Design concept of webserver).

B.1 Arduino Open Source setting: According to the instruction given in (Introduction to Arduino), the project has been implemented. Arduino is an open-source prototyping platform which is very easy to use in hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning ON an LED, publishing something online (Introduction to Arduino). One can tell the board what to do by sending a set of instructions to the microcontroller on the board. To do so it is needed to use the Arduino programming language (based on wiring) and the Arduino Software (IDE), (based on processing)are essential (Introduction to Arduino). A set of digital and analog I/O pins are needed to interface with various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) which is based on a programming language named Processing, which also supports the languages C and C++.

B.2 Development of web server: The web server pays a very vital role in this project which has been developed in HTML. HTML is a markup language for describing web documents. It is a set of markup tags. All the documents are described by HTML tags. Each HTML tag describes different document content (HTML introduction). Different button links have been constructed by different HTML codes.

B.3 Development of button's outlook: Through a complete CSS code the outlook of different buttons has been developed. CSS is a style sheet language used for describing the presentation of a document written in HTML language. The CSS font-family property defines the font to be used for the HTML element. To design layout and variations in display for different devices and screen sizes CSS has been used in the project.

C. Assembling Hardware Componemts

Various hardware components such as, Microcontroller, Ethernet and Relay are used in the project. So assembling of hardware components are also played a very crucial role in the project.

C.1 Microcontroller Programming: ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family as indicated in (Arduino ATmega328 Pinout). The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

C.2 Ethernet setting : Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 ethernet chip (IEEE 803.2). The Wiznet W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. The ethernet shield connects to an Arduino board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top. The most recent revision of the board exposes the 1.0 pinout on rev 3 of the Arduino UNO board. The Ethernet Shield has a standard RJ-45 connection, with an integrated line transformer and Power over Ethernet enabled. There is an onboard micro-SD card slot, which can be used to store files for serving over the network. It is compatible with the Arduino Uno and Mega (using the Ethernet library). The onboard microSD card reader is accessible through the SD Library.

C.3 Relay setting: A relay is a mechanical switch which can control high voltage by low voltage. Relay is the one of the important parts of this project. Microcontroller IC is operated in 5V DC but maximum electrical component operated in 220V AC. A relay has been implemented to control 220V.

D. Security features

Two types of security system can be designed for this device

1. Web login based
2. Web server login based

1. Web login based: This is a web page login system, in this system user can control the device through an IP address such as 196.198.0.2, if the user search the IP in the internet the user can see the web page with a login option, containing user name and password. This web page is designed through an HTML program. The outlook of a web based login system is shown in Figure 6.

Figure 6: Outlook of a web based login system.

2. Web server login based: This system is also known as website based system. There are hosting and domain name for this type of system. The user can use the domain name to control the device such as www.homeappliancecontrol.com, and a login option is also available here.

IV. Results and Discussions

The performance of the device can be analyzed form the data given in Table 1 and Table 2. Two stes of data have been collected. Data for Load Response Time is given in Table 1 and for Sensor Response Time of the device in Table 2, considering both practical and simulation models.

It is clearly seen from the tables that for the case of practical model the surver time and load response time for 3 phase load has a time delay. For 1 Mbps network connection there is a delay of 0.5s compare to the simulation model. It has increased about 0.7s for 250kbps internet connection. There has been no time delay for the case of light loads. The time delay can be reduced to a significant amount using high speed internet connection.

Table 1: For Load Response Time

Practical model				Simulation model		
Connection	**Button**	**Server Time**	**Load response Time**	**Button**	**Server Time**	**Load response Time**
1 Mbps	Light 1	1s	1s	Light 1	1s	1s
	Light 2	1s	1s	Light 2	1s	1s
	3 Phase Motor	1.5 s	1.5 s	3 Phase Motor	1s	1s
250 kbps	Light 1	1.5s	1.2s	Light 2	1s	1s
	Light 2	1.5s	1.2	Light 2	1s	1s
	3 phase Motor	1.7s	1.7s	3 Phase Motor	1s	1s

Table 2: For Sensor Response Time

Practical model				Simulation model		
Connection	**Sensor Name**	**Sensor Time delay**	**Server Response time**	**Sensor Name**	**Sensor Time delay**	**Server response time**
1 Mbps	Light 1 Sensor	1 ms	1 ms	Light 1 Sensor	1ms	1ms
	Light 2 Sensor	1 ms	1 ms	Light 2 Sensor	1ms	1ms
	3 Phase Sensor	1.5 ms	1.5 ms	3 Phase Sensor	1ms	1ms
250 kbs	Light 1 Sensor	1.5 ms	1.5 ms	Light 1 Sensor	1ms	1ms
	Light 2 Sensor	1.5 ms	1.5 ms	Light 2 Sensor	1ms	1ms
	3 Phase Sensor	2 ms	2 ms	3 Phase Sensor	1ms	1ms

V. Conclusions

The main purpose of the system is to provide a cost effective and user friendly automatic home appliances control system. After analyzing the performance of simulation and prototype system it can be conclude that the system performance is satisfactory. Adding some control parameters the system can be implemented to monitor and control industrial equipment as well as smart home control. The system can be easily integrated into an existing electrical system of a building because of its simplified design. It can be easily installed in a single room if one so desires. The scope of this work is huge. It can be used also street light management, hotel power management and high voltage grid control.

References

A. A. Mansur, B.C. Shil and M.H. Bhuyan,"Design and Development id PC Based Control System via Atmega32 Microcontroller", SEU Journal of Science and Engineering, Volume 10, No 1, June 2016, ISSN: 1999-1630.

A. E. Shafee, K. Alaa Hamed,"Design and Implementation of a WiFi Based Home Automation System", International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol:6, No:8, 2012.

Arduino ATmega328 Pinout (http://www.hobbytronics.co.uk/arduino-atmega328-pinout . Visited: 6.8.16)

Design concept of webserver (https://www.arduino.cc/en/Tutorial/WebServer. Visited: 4.7.16)

E. Abetiba, V.O. Mattews, A.A. Awelewa, I.A. Samuel and J.A. Badejo, "Automatic Electrical Appliances Control Panel Based on Infrared and Wi-Fi: A Framework for Electrical Energy Conservation", International Journal of Scientific & Engineering Research Volume 2, Issue 7, July-2011, ISSN 2229-5518.

HTML Introduction (http://www.w3schools.com/hTml/html_intro.asp. Visited: 10.8.16).

IEEE 802.3, "Standard for Ethernet' Marks 30 Years of Innovation and Global Market Growth" (Press release). IEEE. June 24, 2013. Retrieved January 11, 2014.

Introduction to Arduino (https://www.arduino.cc/en/Guide/Introduction Visited: 9.8.16)

S. P. Tseng, B.R. Li, J.L. Pan, and C.J. Lin, "An Application of Internet of Things with Motion Sensing on Smart House", Orange Technologies (ICOT), IEEE International Conference, 2014, ISBN: 978-1-4799-6284-6.

T. Nonaka, M. Shimano, Y. Uesugi and Tomohiro, "Embedded Server and Client System for Home Appliances on Real-Time Operating Systems", IEEE (2010).

V. S. Gunge, P.S. Yalagi, "Smart Home Automation: A Literature Review" International Journal of Computer Applications (0975– 8887), RTDM 2016.

Y. S. Kale,P.M. Jumle, K..N. Dongre,R. Kamdi,"Graphical LCD based Digital Oscilloscope using ATmega32", International Journal of Electronics, Electrical and Computational System, ISSN:2348-117X,Volume 3, Issue 4,June 2014.