ISSN: 0975-766X
CODEN: IJPTFI
Available Online through *Research Article*
www.ijptonline.com

AN ARDUINO BASED SMART REAL TIME WEB APPLICATION FOR SERVER ROOM MONITORING AND APPLIANCES CONTROL

Yokesh Babu Sundaresan*[1], Saleem Durai M A[2]
School of Computer Science and Engineering Professors – SCSE, VIT University, Vellore.
Email: yokeshbabu.s@vit.ac.in

Received on 06-08-2016 *Accepted on 10-09-2016*

Abstract

Microcontroller-based embedded system play important role in web application control system. In Most of the modern manufacturing and processing industries like plastic, Textile, chemical, Pharmaceutical, Mixing-factory, server room need to monitor the environment physical data like temperature, intensity, humidity etc. through combination of hardware and software. This paper presents a way to build a low-cost customizable prototype for web application for server room monitor and appliances control based on Microcontroller and Wiznet W5100 ethernet chip through arduino ethernet shield. We can read the temperature and intensity data through sensor and monitor through LCD, Mobile or Desktop. Based on temperature we can control the appliances (like. Cooler, Fan, AC, Bulb.) from webpage. We can control more than one appliance at a time and store the temperature and intensity data in the database. We can analysis the past data of temperature and intensity after plotting the graph.

Keywords: Microcontroller; Ethernet model Router; Mobile App; Webpage; LCD; RJ45 Cable; Relay; Appliances.

Introduction

Monitoring the natural physical data (Like. Temperature, Light Intensity, Humidity) of any particular place or region cannot be calculated or predict without any sensor. Physical data (Like. Temperate, Light Intensity, Humidity) is different on different-different places. Sensor and other machine play a vital role in the industry, automation and agriculture field. Manufacturing plants in industries like plastic, textile, chemical, pharmaceutical, Mixing-factory all are required the monitor the room temperature, humidity in every second and in any server room also need to monitor the temperature, intensity and humidity. And most of the time we control the server room appliance (like Fan, AC, Cooler, and Bulb etc) based on light intensity and temperature.

This paper presents our design and implementation of a low-cost customizable prototype for web application for server room monitor and appliance control. By using mobile app we can control more than one appliance at same

time. We use Atmega328p Microcontroller and Wiznet W5100 with Arduino Ethernet Shield. Arduino ethernet shield Wiznet W5100 as the main component of the system. LCD (Liquid crystal display) is used in this system for display the current temperature and light intensity and led is used for indicating the current status of the appliances. We use RJ45 Cable (Ethernet Cable) for connecting the ethernet shied with the router. We define the static IP address for the arduino ethernet shield (ex. 10.0.0.8). In this project we are using Mobile Responsive website for monitor the real time temperature and light intensity and also used for the controlling the multiple appliances by using the checkbox. We can switch on-off any appliances at any time. We can access the control system globally after input the IP address in any browser address bar. We can also set the password on the router for particular user connection for the security purpose.

The remainder of this paper is organized as follows. In Section 2, we provide a short background on microcontroller, specifically the Atmega328P microcontroller and also Wiznet W5100, Arduino Ethernet Shield. The design and implementation of the system is described in Section 4. Section 5 provides the results of our experiments and discussion. Finally, Section 6 concludes the paper.

Background

Microcontroller is a single-chip special-purpose computer use to execute a specific application. As in general-purpose computer, microcontroller consists of memory (RAM, ROM, and Flash) I/O peripherals, and processor core. However, in a microcontroller, the processor core is not as fast as in general purpose-computer, the memory size is also smaller.

Microcontroller has been widely used in embedded systems such as, home appliances, vehicles, and toys etc. There are several microcontroller products available in the market, for example, Atmel Atmega family, Microchip PIC, and NXP, Intel, Advanced RISC Architecture (AVR). We discuss Atmega328p and Wiznet W5100 & Arduino Etheret shield, Router, RJ45 cable in this section.

Atmega328p Microcontroller

Atmega328p is a AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KBEEPROM, 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 channel 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 throughputs approaching

1 MIPS per MHz. Details of Atmega328p microcontroller are described in [1].

Ethernet Module (Wiznet W5100)

W5100 is a full-featured, single-chip (SoC) Internet-enabled Ethernet controller designed for embedded system applications where stability ease of integration, performance, area and system cost control are required. W5100 has been designed to provide easy implementation of Internet connectivity without any Operating System. W5100 includes fully hard-wired, TCP/IP stack and integrated Ethernet MAC Address & Physical Address. Hardwired TCP/IP stack supports IPv4, TCP, ICMP, UDP, ARP, PPPoE and IGMP. 16KB internal buffer is included for data transmission. No need of consideration for handling Ethernet Controller, but simple socket programming is required. The W5100 is used for many embedded system applications ex: i) Medical Monitoring Equipment ii) Factory and Building Automations iii) GPIO-to-Ethernet: Home Network Sensors iv) USB to Ethernet: Storage Devices, Network Printers. etc Wiznet W5100 support the following features i) Small 80 Pin LQFP Package ii) Lead-Free Package iii) Support Serial Peripheral Interface(SPI MODE 0, 3) iv) Multi-function LED outputs (TX, RX, Full/Half duplex, Collision, Link, Speed) v) Internal 16Kbytes Memory for Tx/Rx Buffers vii) Supports 4 independent sockets simultaneously etc.

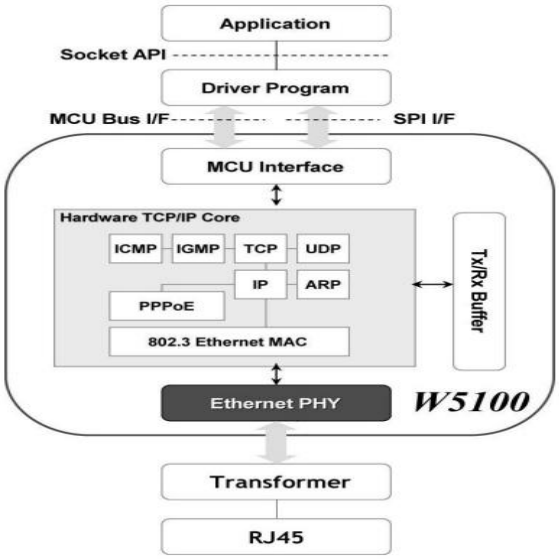

Figure.1 Block Diagram of Wiznet W5100.

Arduino Ethernet Shield

Arduino is the platform of every element like-hardware, software and documentation and it's freely available and open-source. Arduino Ethernet Shield connects your Arduino to the internet very easily. The Arduino Ethernet Shield allows an Arduino board to connect to the internet. It is based on the Wiznet W5100 ethernet chip. 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 program which connect to the internet using the Arduino shield. The ethernet Arduino 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. Arduino Ethernet Shield has a standard RJ-45 cable connection, with an integrated line transformer and Power over Ethernet enabled. Arduino ethernet shield has onboard micro-SD card slot, which can be used to store data files for serving over the internet. The onboard micro SD card reader is accessible through the Arduino SD Library. When working with this library, SS is on Pin 4. Arduino ethernet shield also includes a reset controller, to ensure that the W5100 Ethernet module is properly reset on power-up. Arduino communicates with both the wizened W5100 and SD card using the SPI bus (through the ICSP header). This is on digital pins 10, 11, 12, and 13 on the Uno and pins 50, 51, and 52 on the Mega. On both boards, pin 10 is used to select the W5100 and pin 4 for the SD card. These pins cannot be used for general I/O. On the Mega, the hardware SS pin, 53, is not used to select either the W5100 or the SD card, but it must be kept as an output or the SPI interface won't work. The shield provides a standard RJ45 ethernet jack. The reset button on the shield resets both the W5100 and the Arduino board. The shield contains a number of informational LEDs:

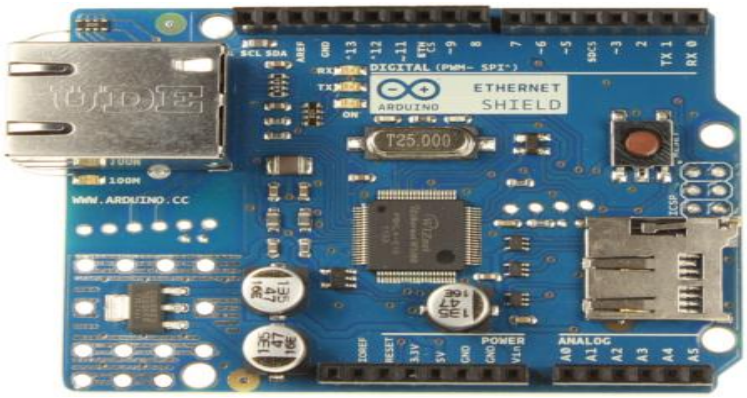

Figure.2 Arduino Ethernet Shield.

Router

A router is a networking device that forwards data packets between computer networks. A router is connected to two or more data lines from different networks (as opposed to a network switch, which connects data lines from one single network). When a data packet comes in on one of the lines, the router reads the address information in the packet to determine its ultimate destination. Then, using information in its routing table or routing policy, it directs the packet to the next network on its journey. This creates an overlay internetwork. Routers perform the "traffic directing" functions on the Internet. A data packet is typically forwarded from one router to another through the networks that constitute the internetwork until it reaches its destination node.

Figure.3 Router.

RJ45

The RJ45 connector is standardized as the IEC 60603-7 8P8C modular connector with eight conductors. The RJ45S, a similar standard jack once specified for modem or data interfaces, uses a mechanically-keyed variation of the 8P8C body with an extra tab that prevents it from mating with other connectors; the visual difference from the more-common 8P8C is subtle. The original RJ45S keyed 8P2C modular connector had pins 5 and 4 wired for tip and ring of a single telephone line, and pins 7 and 8 shorting a programming resistor but is obsolete today.

An installer may wire the jack to an arbitrary pinout, or use it as part of a standardized generic structured cabling system such as ISO/IEC 15018 or ISO/IEC 11801, using 8P8C patch panels for both phone and data wiring.

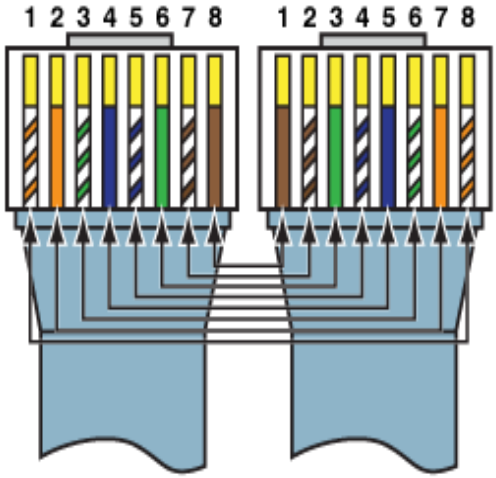

Figure.4 RJ45 Connecter.

Proposed Method

This system consist the Atmega328P microcontroller, Wiznet W5100 on Arduino Ethernet Module, LCD Display[3], Route ,RJ45 Connecter, Relay, Webpage, Relay driver[5], LM35 Sensor, LDR Sensor, LED, Motor .We can operate the device by any device (mobile, laptop).

Sensor data transfer to MCU

For monitoring current temperature and light intensity, we are using temperature sensor (LM35) and LDR. As we know than temperature and light intensity is an analog type signal but microcontroller cannot read the analog signal. So in this project sensors are connected to analog pin of microcontroller because sensor read physical data in the form of voltage but microcontroller cannot read the data in voltage form, microcontroller can only read and write the digital data in the form of 1& 0. In this project we are using Atmega328P microcontroller which have on-chip ADC (Analog and Digital Converter). So LM35 & LDR Sensor connected to analog pin of Atmega328P microcontroller sensor send the data to ADC through analog pin and then ADC convert the physical data (Voltage form) in digital format and send to the display through serial port pin.

Appliances Connections

In this project we are controlling the appliances (Like. Fan, Light, AC etc.) through mobile and laptop. We know that microcontroller need maximum 5V for operating but appliances cannot be operate on 5V we need 240V (Home Voltage) for operating the appliances. So Appliances are connected to relay (actuator) pin (NO & P) through relay driver ULN2003. Relay driver input pin connected to programmed of microcontroller and the output pin connect to the cathode pin of relay coil. Relay work like a switch. After getting the output signal through the driver the relay activated automatically and node transfer from NC to NO and appliances start performing. We can control more than one appliance through mobile or laptop using relay and relay driver (ULN2003) at a time. (Note: In ULN2003 there are only 8 Input and 8 Output pin so this we cannot operate or control more than 8 appliances.)

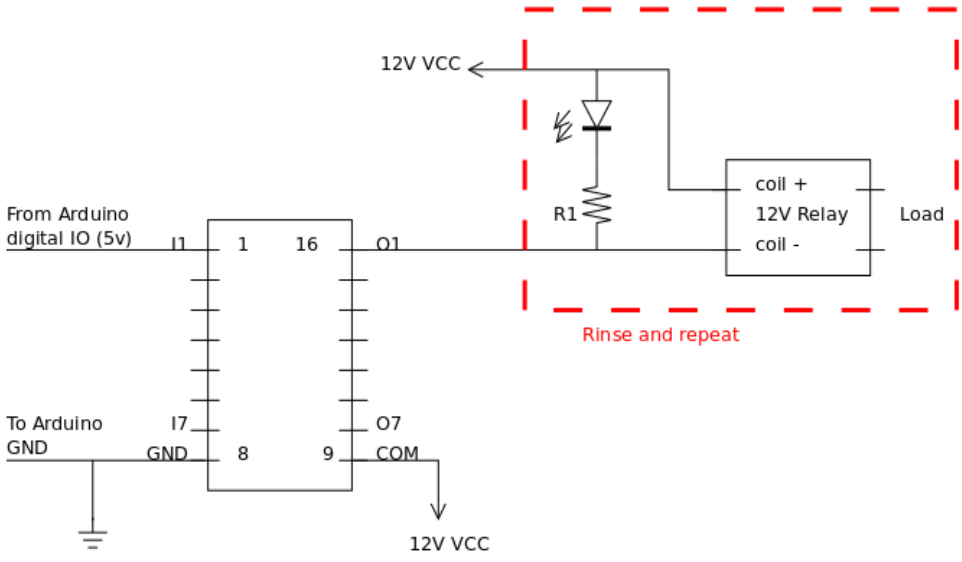

Figure.5 Relay Connection through MCU and Driver.

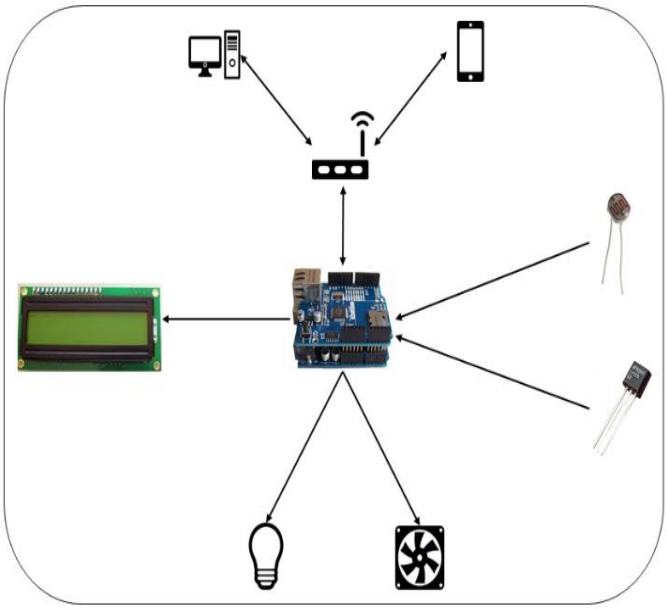

Figure.6 System Block Diagram.

Router and Ethernet Shield

In this project we are using arduino ethernet shield which are integrated with Wiznet W5100 ethernet chip with easily interfacing and ethernet socket. First we need to connect the ethernet shield to arduino board which is very easy. Simply put the ethernet shield on arduino board and connect the ethernet shield to router through RJ45 connecter and connect the arduino board to power supply. We need to define a static IP Address for the router. And dumb the code to the arduino microcontroller through Arduino IDE

Save data in database and analysis past result

Through XAMPP local server create one database with temperature and intensity column. After that we need to connect the database through arduino programming and save the data in every 5 sec in database and plot the graph of temperature v/s time and intensity v/s time.

Design and Implementation

We define our system to have specification as follows

1) Controlled through Responsive Web Application. 2) Sensor Data displayed on the LCD module, Mobile, Tab, Laptop etc.3) Create the internet network using wireless router. 4) Switching on/off the appliances using web application check box. 5) Providing delay in between processes (set by input keys). 6) Applying input to on/off type open-loop control system. 7) Repeat (continuous) and single operation 8) Fully Web Controlled application within Wi-Fi range (range depend on the frequency of Wi-Wi-module. 9) User-friendly front-panel Web application and display panel with LCD. 10) Emergency stop buttons 11) Provision of potential-free relay contacts for connecting any 230VAC at 10A or 28V DC at 10A device/application.

This system consists of Hardware and software part. Simplified block diagram of the system is depicted in figure-6 As shown the microcontroller is connected with RPS (Regulated power supply) for proper power. LCD and LED display are connected with I/O pins of the microcontroller for display the current status of system. Relay driver connected to the microcontroller for energize and de-energize the relay and appliances. The Temperature sensor and humidity sensor are connected to microcontroller input pins for selection of appliances and operation setting of system. Arduino ethernet shield model are connected with microcontroller through arduino board, for receiving the sensor data and sending command to LCD and Web. Router connected with the Arduino ethernet shield and power supply. Mobile, Laptop are connected to wireless router through Wi-Fi.

Regulated Power Supply

All TTL/CMOS chip are operated between 3.3V & 5V. So for safety purpose we use the RPS (Regulated power supply). A RPS is used to produce the constant linear voltage. It's generally used with AC/DC power supply. And also it can be used as well as DC to DC voltage converter. RPS contain the step-up transformer for down the High HhIGHinput AC voltage (230V) to LOW output AC voltage (12V) by magnetic induction principal. And output AC current is convert into DC by rectifier and this DC voltage sent to voltage converter chip 7805 and 7806 and this IC convert 12V DC input to 5V & 6V DC and give the constant smooth result (by help of capacitor) to TTL/CMOS chip. Detail of RPS is described in [8].

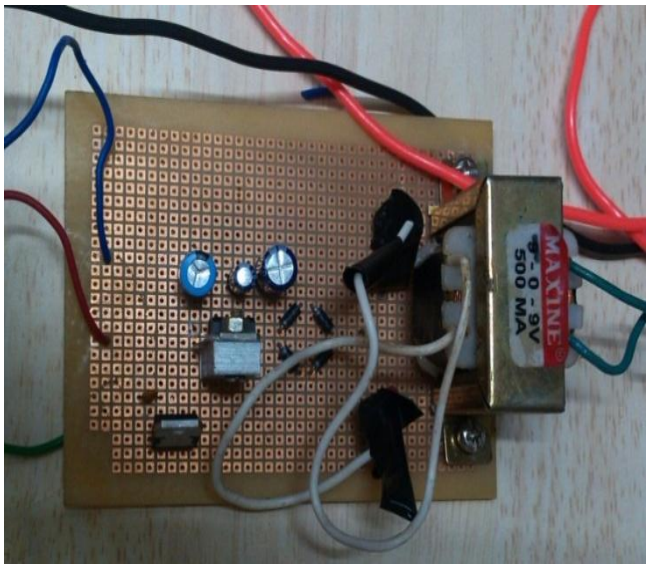

Figure.7. Regulated power supply.

Ethernet Shield with MCU Relay and LCD

The ethernet shield connects with the arduino board and LCD connects to MCU through ethernet shield. Relay, Temperature Sensor (LM35) & LDR connect with the MCU through ethernet shield.

Figure.8 Ethernet Connect with MCU, LCD, Sensors, Relay.

Results

Appliances Control Using Webpage

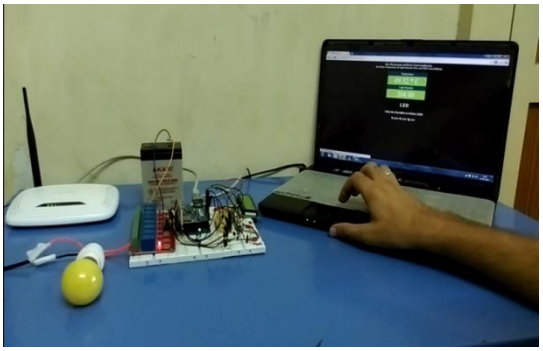

Figure.9 Appliances in OFF State via Web Control.

Figure.10 Appliances in ON State via Web Control.

Appliances Control Using Mobile.

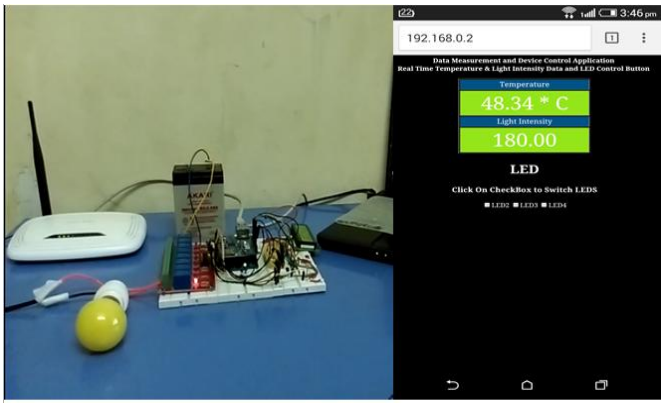

Figure.11 Appliances in OFF State via Mobile Control.

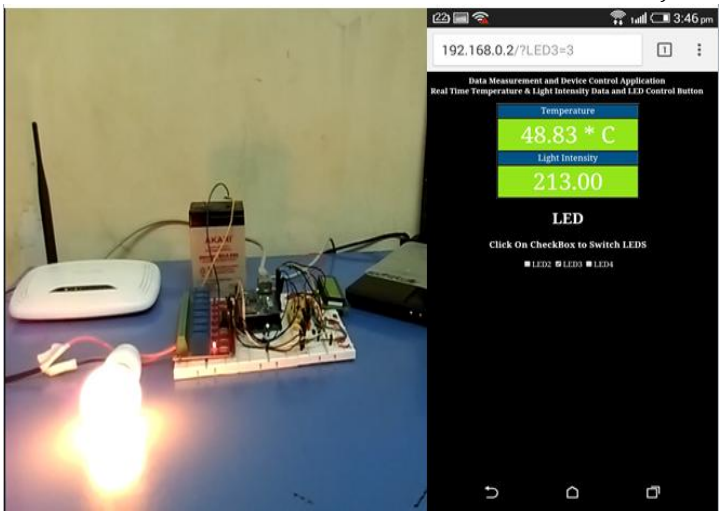

Figure.12 Appliances in ON State via Mobile Control.

Conclusion

In this paper, we have designed and implemented "Web Application for server room monitor and appliances control". We utilized Atmega328P microcontroller and Arduino 18480thernet shield module. Based on the testing results, the system works according to our predefined specification. This system can be used to help the employee, people who works in industries or home owner for safety purpose. The system also can control by mobile, tab, laptop, desktop etc with Wi-Fi range. We can include more than one number of appliances and operate particular appliance according to program.

References

1. Maxim Integrated Products. Rev 3. ASK434 RF Receiver-Transmitter. Datasheet. http://datasheets.maximintegrated.com/en/ds/MAX7034.pdf.
2. Vishay Intertechnology, Inc. 16*2 LCD. Datasheet. http://www.vishay.com/docs/37402/lcd016o002f.pdf
3. Texas Instruments. Relay and Motor Driver. ULN200, L293D. Datasheet. http://www.ti.com/lit/ds/symlink/uln2003a.pdf.
4. Regulated Power Supply. RPS. Details. http://en.wikipedia.org/wiki/Voltage_regulator.
5. Microchip, application notes on brushed Dc motors, AN905,2004,pp.1-7.
6. Maxim Integrated Product, Inc. 2010. +5V-Powered, Multichannel RS-232 Drivers/Receivers. http://datasheets.maxim-ic.com/en/ds/MAX220- MAX249.pdf.
7. P. C. Sen, "Electric Motor Drives and Control": Past, Present andFuture", IEEE Transaction on Industrial Electronics, Vol. IE37, No. 6,1990,pp-562-575.
8. STMicroelectronics, application notes on brushed Dc motors, AN380,2003,pp.1-14.

9. Muhammad H. Rashid,"Power Electronics Circuits, Devices, AndApplications", Pearson Education, 2004,pp.190-191.
10. B.C. KUO and J. TAL, "Incremental Motion Control, Vol. 1, DCMotors and Control Systems", SRL Publishing Co., Champaign, IL, 1979.

Corresponding Author:

Yokesh Babu Sundaresan[*],

Email: *yokeshbabu.s@vit.ac.in*