Environment Control and Measurement System using Internet of Things

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Abstract — Environment Control and Measurement System is used to measure the environmental parameters of a room such as temperature, humidity, gas levels and light intensity. The system tries to maintain the values of these parameter in a desired range or comfort range by automatically controlling the appliances of the room. Whenever a parameter value exceeds the threshold level of comfort range then an appliance gets automatically turned on to bring that value back in the comfort range. After the value is brought back to midpoint of the comfort range the appliance turns off. We can also control appliances manually via internet. The values of environment parameters are uploaded on an open database platform available on the internet. Here the data is represented in a graphical format which can be viewed anytime, anywhere. A gsm is used so that the user gets updates via sms when a particular parameter exceeds the comfort range. The user can also receive sms containing the current values of all the parameters. Thus an user friendly system is designed which is both cost effective and power efficient.

Index Terms— Environment control, Environment monitoring, Arduino Mega, Ethernet, GSM, IoT

1 Introduction

Environment control and measurement system has an important role especially where the environment factors should be kept between a comfort range[1]. The system uses Internet of Things and GSM Module which is integrated to Arduino Mega platform. The Internet of Things (IoT) is a computing concept that describes a future where everyday physical objects will be connected to the Internet and be able to identify themselves to other devices. Using IoT, the system is able to achieve the following :- live data analysis, taking data at regular intervals, storing data on the server, systematic representation of data using graph, better analysis and hence, better solution. This system is applicable in a number of places such as home, greenhouse, clean rooms, research labs, storage rooms (for storing grains, pulses, food), aircraft, surgery room, international space station etc. The system uses automation, which is a process control of industry machinery, thereby replacing humans. Our aim is to design a simple, easy to use arduino based circuit which monitors and records values such as temperature, humidity, air pressure and light intensity. These values are continuosly modified and controlled by the arduino mega platform which is the heart of the proposed system[2]. It communicates with a set of sensor modules in real time to control the environment parameters of a room by actuating air conditioner, lights, room heater, humidifier, dehumidifier and alarm. These appliances can also be controlled manually via internet. They can also be controlled semi aoutomatically where few appliances are controlled manually while others are controlled automatically. Thus there are three modes of operation - automatic, semi automatic and manual. The system enables control of devices without the actual presence of user at the place where the system is implemented. User can control the devices from anywhere, anytime. The system provides an economical, easy to use & low maintenance solution for the control and mesurement of environment.

2 System Overview

As shown in Fig.2.0, the sensors transmit the sensed value to arduino mega and based on whether the values lie in comfort range or not the action is taken by the arduino mega platform. For example if temperature is below the comfort range then room heater turns on until the value of temperature reaches to the midpoint of the comfort range range. Similarly if the temperature rises above the comfort range then air conditioner is turned on until the temperature reaches the middle of comfort range. The comfort range is set as per the requirement and can vary as per applications. RTC Module is used to keep check of time to control main light and night light. At night after a specific time main light is switched off while night light is switched on until morning.Similarly at evening after a specific time, main light is automatically turned on. Until this time during the day, the main light is switched on depending on daylight which is sensed by ldr sensor. The devices can also be controlled from the internet in a manual and semi automatic mode. This is done by Arduino mega being acting as a server and the web acting as a client. We can thus control devices by giving commands in the url of ip address of server.

There is 16x2 character LCD used for displaying information received from a set of sensors. Here a comfort rating which is calculated out of hundred is also displayed. There is also a GSM SIM 900A interfaced to arduino board to send an sms when smoke or gas is detected. Arduino is connected to the web using an ethernet module. The system will upload data on an open database platform known as thingspeak.com. The data is uploaded at every 30 seconds interval. Here the data pertaining to each sensor is shown in graphical format with respect to time. This allows better analysis of the past and present values. In this case the arduino acts as client while open database platform acts as a server. Thus the arduino mega platform acts as both client and server to fulfil the purpose.

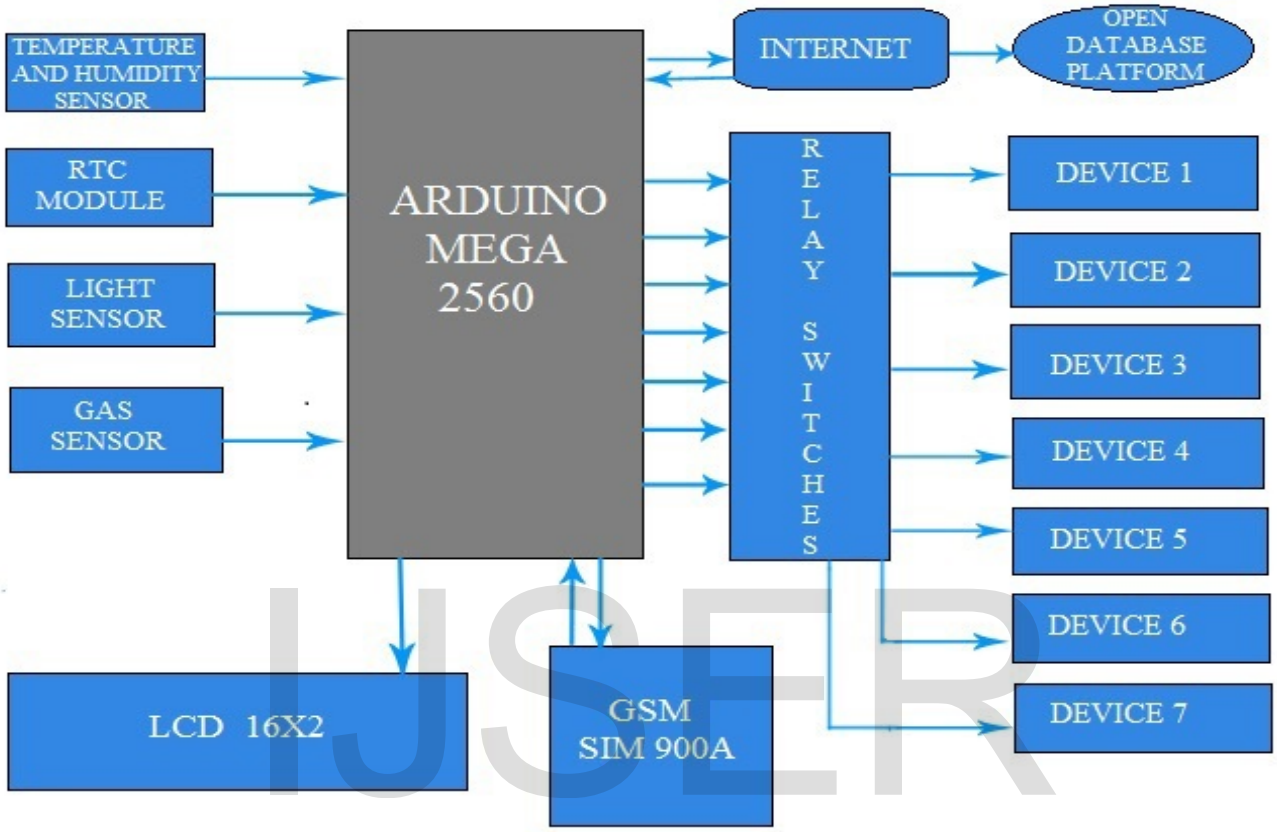

Fig. 2.0. Block Diagram of the system.

3 HARDWARE USED:-

3.1 Arduino Mega 2560

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button..[3]

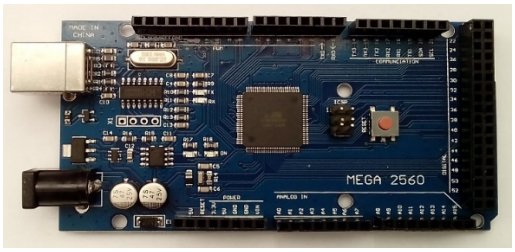

Fig. 3.1. Arduino Mega 2560

3.2 Ethernet Module ENC28J60:-

This ethernet board is a simple way to give Arduino or other electronics project a network connection. It works with all Arduino boards, including UNO, MEGA, and Nano. It has 25MHz crystal onboard. With this Ethernet Shield, Arduino board can be used to connect to internet. There is an open-source TCP/IP protocol stack as an Arduino library.[4]

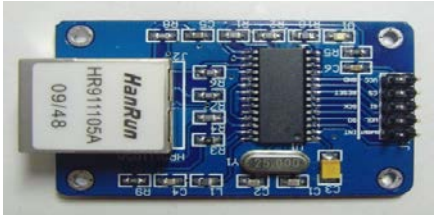

Fig. 3.2. Ethernet Module enc28j60.

3.3 Sensors:-

3.3.1 Temperature and Humidity Sensor SHT15

The SHT15 Breakout shown in Fig.3.3.1, is an easy to use, highly accurate, digital temperature and humidity sensor. This board has been fully calibrated and offers high precision and excellent long-term stability.

Fig. 3.3.1 SHT15 Sensor Module

3.3.2 Photoresistor Light Sensor

As shown in Fig.3.3.2, a photoresistor (LDR, or photocell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity.

Fig. 3.3.2 LDR Sensor Module

3.3.3 Gas Sensor

The Gas Sensor (MQ2) module shown in Fig. 3.3.3, is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or Propane.

Fig. 3.3.3 MQ-2 Gas Sensor Module

3.4 Character LCD

LCD (Liquid Crystal Display) screen shown in Fig.3.4, is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits.

Fig 3.4 16x2 LCD

3.5 RTC Module DS3231

The DS3231 shown in Fig.3.5, is a low-cost, extremely accurate I2C real-time clock(RTC) with an integrated temperature-compensated crystal oscillator(TCXO) and crystal. The device incorporates a battery input, and maintains accurate timekeeping when main power to the device is interrupted.

Fig. 3.5. RTC Module DS3231

3.6 GSM SIM 900A

The GSM Modem shown in Fig.3.6, can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Applications like SMS Control, data transfer, remote control and logging can be developed easily.

Fig. 3.6. GSM SIM900A

3.7 Other Components

Relays, Jumper Wires, Buzzer, Breadboard and seven different colored light bulbs.

4 Software Used

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board.

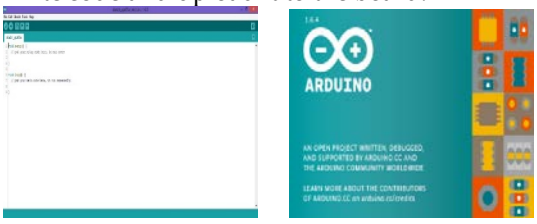

Fig. 4. Arduino IDE Software

5 Design and Implementation

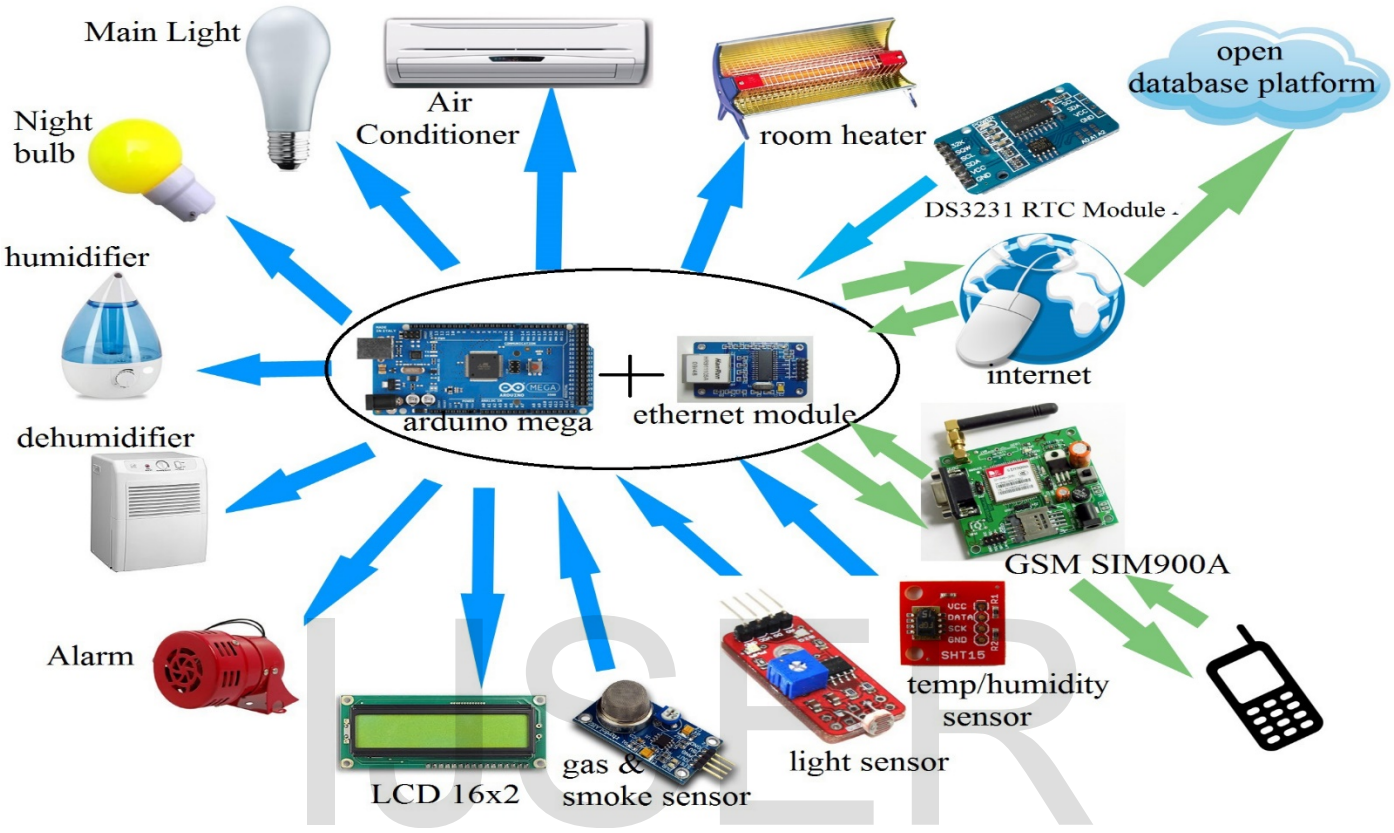

Fig. 5. System Architecture

As shown in Fig. 5, a set of sensors, namely, temperature sensor, light sensor, humidity sensor and gas sensor is connected to analog pins of arduino. The sensors sense the value and transfer it to the arduino board where analog to digital convertor converts these values. The arduino is programmed such that a comfort range of the sensor values is set and if the values exceed this range then the corresponding appliance which is simulated by light bulb turns on. These bulbs are connected to PWM pins of the board where relays are used to amplify the current and turn the light on.

The sensor values which are analog are converted into digital by a 10 bit ADC of the arduino board. The reference voltage of arduino board is 5V and hence it will convert analog values to digital values of range 0 to 1023.

The values of environment parameters are uploaded to the server thingspeak.com which is an open database platform. Here the values are displayed in a graphical format as shown in Fig.5.1. For this purpose Ethernet module is connected to the arduino board. A mac address is entered in the program after which a static ip address is set. Then the Ethernet client library is initialised. Following which a serial communication is opened and we program to wait for serial port to connect. Then the program starts the Ethernet connection. If it gets connection then we program to report back via serial and then upload values by giving GET command and using the public channel api key.

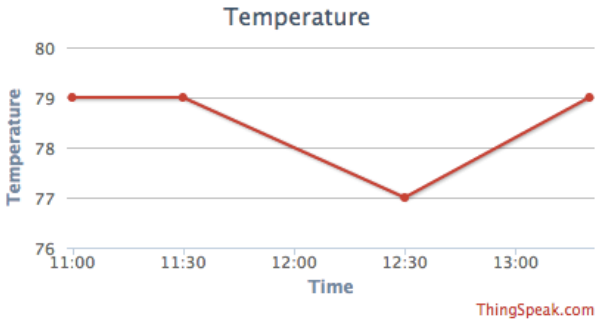

Fig. 5.1. ThingSpeak graph for temperature.

Using ethernet module three modes of operation can be selected. These modes are Automatic, Semi Automatic and Manual. We can select these modes by giving command in the url of local ip of server which is Ethernet. For this we enter the mac address and ip address of our controller in the program.

Then we initialize Ethernet server library. Then we write code to open serial commumnication and wait for the serial port to connect. Then we write code to start Ethernet connection and server. Following this we write code to find the local ip of server. We consider url as string where we can select our command using substring function. If we enter AutoControl as a command then the appliances simulated by lights will be automatically controlled by the board. If we enter AutoLiAc then the light and ac are manually controlled while other appliances are automatically controlled by the board. 'Li' indicates light ON while 'li' indicates light OFF. Similarly 'Ac' indicates AC on while 'ac' if given in the command indicates AC off. The third command is where all the appliances are controlled manually. If we give command aDhLprw then the capital letter indicates that particular device to be set ON while small letter indicates that particular device to be set OFF. Here 'D' stands for dehumidifier, 'r' stands for room heater and so on.

GSM board is used to send sms alert whenever gas levels go beyond threshold value of the comfort range. GSM is connected to the communication pins of the arduino board for transmission and reception. We can also get instant values of all the parameters via sms if we send an sms demanding these values to GSM from the mobile phone[6].

6 HARDWARE MODULE

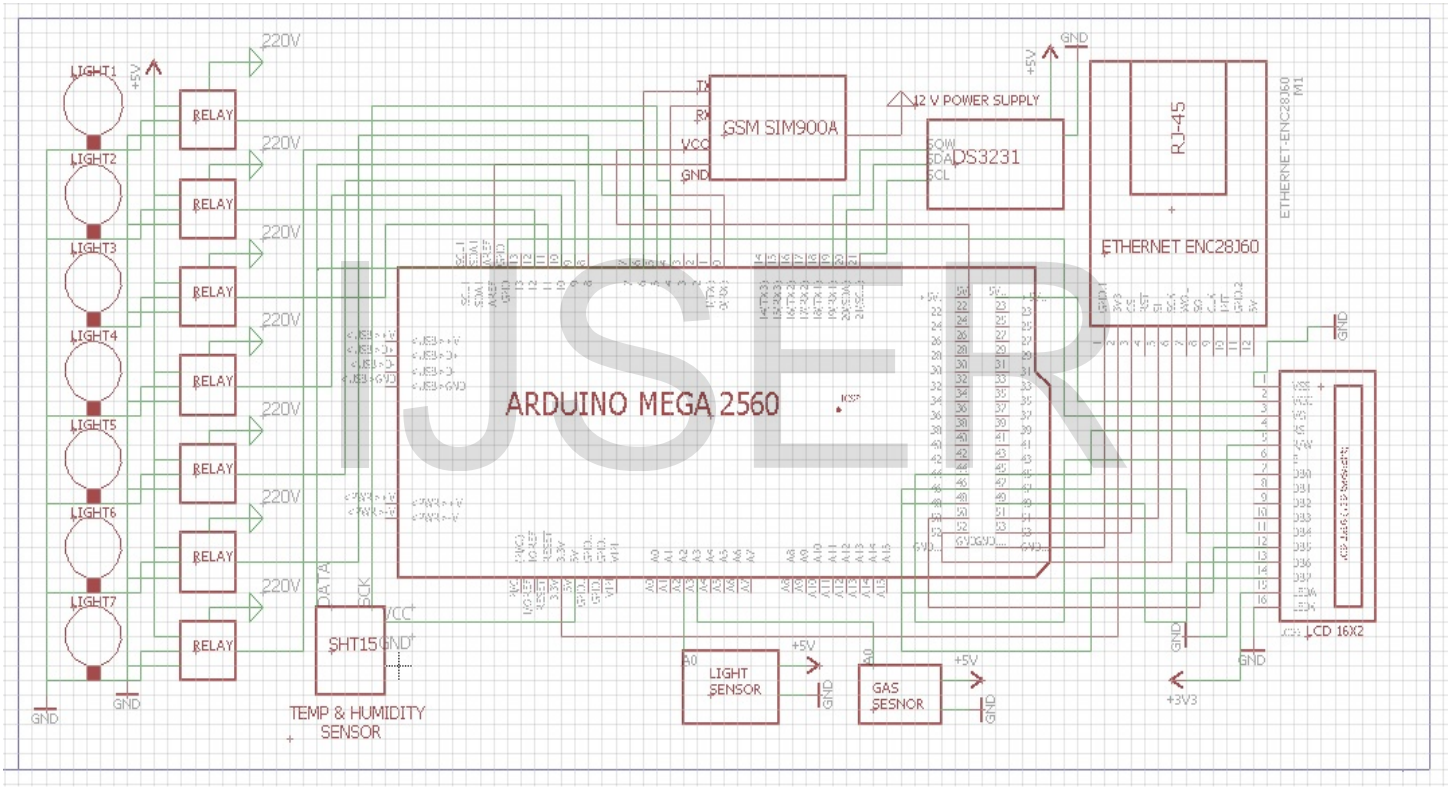

Fig. 6. Circuit Diagram of the Proposed System.

As shown in Fig. 6, the sensors LDR Module sensor and MQ-2 gas sensor are connected to analog pins of Arduino Mega.The ldr sensor has 10k potentiometer connected in series for sensitivity modulation. The lux value is calculated by using formula : lux=500/(10*((5-Vout)/Vout)) where Vout = analog reading x (5/1024). In SHT 15 sensor two data lines SDA and SCL are connected to digital i/o pins of Arduino platform. The two wire communication enables sensing relative humidity and temperature of the surrounding. The two sensors built into the SHT15 have been seamlessly coupled to a 14 bit analog to digital converter and a serial interface circuit. The sensor values are displayed on the LCD which is interfaced to the Arduino platform. The LiquidCrystal Library is which allows to control the LCD display. Foolowing pins of LCD are interfaced to the Arduino platform : 1)A register select (RS) pin that controls where in the LCD's memory you're writing data to. 2) A Read/Write (R/W) pin that selects reading mode or writing mode. 3) An Enable pin that enables writing to the registers. 4) 8 data pins (D0 -D7). The states of these pins (high or low) are the bits that you're writing to a register when you write, or the values you're reading when you read. 5) There's also a display constrast pin (Vo), power supply pins (+5V and Gnd) and LED Backlight pins that can be used to power the LCD, control the display contrast, and

controlling backlight respectively.[7]

Ethernet Module pins are connected to the digital i/o pins of Arduino. This enc28j60 module is used to connect Arduino to a network connection. It has 25 MHz crystal onboard. Genuine Microchip's ENC28J60 SPI ethernet controller and HR911102A RJ45 socket is used to build the module. Open-source TCP/IP protocol stack is used as an Arduino library. A Real Time Clock Module DS3231 is connected to SDA, SCL and Rx pins of Arduino. The Module gives time similar to real clock, though it gives exact time even if power of the system goes off. The GSM SIM900A is connected to Tx and Rx of Arduino. It uses serial communication. The module supports communication in 900MHz band. The GSM is powered by 15 V DC power supply. 5V relays are used to drive the appliances running on 220 V power supply. These appliances are simulated by using light bulbs.

7 Conclusion

This system is used where the environmental parameters should be kept in a comfort range. Such places include greenhouse, storage rooms (for storing grains, pulses, food etc.), mushroom farming, factories, aircraft, clean rooms, surgery rooms, home, research lab etc. The system provides easy to use, cost efficient and low maintenance solution. The system keeps user notified with current status of environment parameters by using internet and gsm. The main advantage of the system is that it saves power and uses appliances only as per need.

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