Chittagong University of Engineering and Technology

Electronics and Telecommunication Engineering

GSM Based Home Automation

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INTRODUCTION

A smart home can be defined as intellectual system that allow the user to control home appliances. Smart home provides comfort, convenience, security, compatibility to user. For the development of remote control system in home appliances great efforts have been made. The GSM based home automation system uses mobile phone as controlling device which control the home appliances by sending SMS and receiving phone call. The main advantage of this system is it has wide coverage area and by using this system user can control devices from anywhere in the world under GSM network. Few limitations have been faced by people at the time of design and implementation of many home automation system such as difficulties in controlling multiple appliances and unable to verify the status of the appliances. This GSM based home automation system focuses on solving these limitations. The user can also add more loads to control more appliances if he/she wants to and can add more sensors.

Among the technologies, as this network has wide coverage people can use it all the time. It provides high security and it is another advantage of using GSM technology in home automation system. Other people cannot send and receive SMS and control devices for its high security. This system lower the costs and provides ease at controlling the whole system.

HARDWARE REQUIREMENTS

1. Arduino uno
2. SIM900 GSM/GPRS shield
3. 16*2 LCD display
4. I2C LCD display module
5. ULN2003 motor driver
6. 5V relay
7. DHT 11 Humidity & Temperature sensor
8. Adapter
9. Bulb with holder
10. DC FAN
11. Transistor

SOFTWARE REQUIREMENTS

1. Arduino IDE

HARDWARE DESCRIPTION

Arduino Uno:

The Arduino Uno is a microcontroller. It is connected to a computer with a USB cable to power it on. It is based on the ATmega328. Arduino has reset switch, USB connector, USB interface chip, crystal oscillator, voltage regulator, power port, 14 digital input/output pins, 6 analog input

pins and a USB connection. Arduino Uno works here as a bridge for controlling the home appliances and the GSM module.

Figure-01: Arduino Uno.

SIM900 GSM/GPRS shield:

SIM900 GSM module can be used for make phone call, send SMS, text message, receive phone call and connecting to internet through GPRS. SIM900 GSM/GPRS supports quad-band network & it works anywhere in the world. The Tx and Rx pin of GSM module is connected to Arduino's Rx and Tx pin respectively. A working GSM SIM card is also connected to the module. To state successful connection the NETLIGHT LED will blink periodically when the module is powered on. In this project, the commands are send from mobile phone to GSM module to control the home appliances.
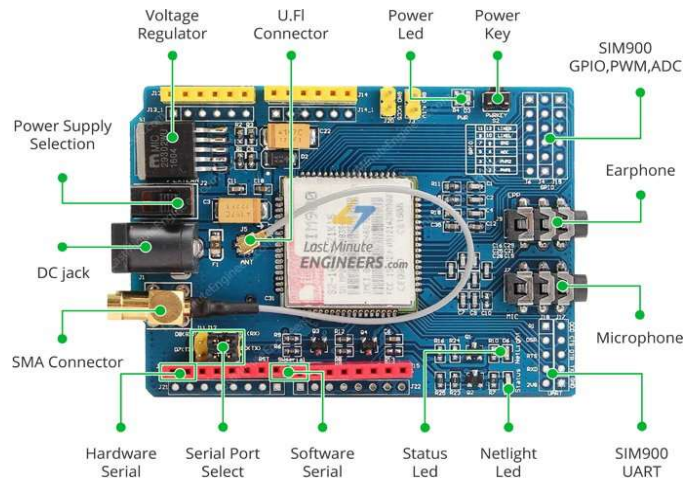

Figure-02: SIM900 GSM/GPRS Shield

16 x 2 LCD Display:

LCD displays are used for its cheap price and programmer friendly behavior. It is named as 16 x 2 LCD because it has 16 columns and two rows. It has 16 pins. It is used for displaying the commands. On the backside of the LCD module, an interface IC HD44780 is mounted on. This

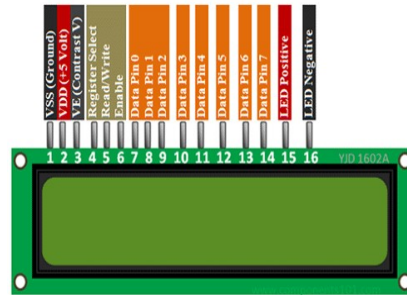IC get commands and data from the MCU. After processing them they display meaningful information on LCD.

Figure-03: LCD Display

I2C 16 x 2 LCD Display:

The I2C 16*2 LCD screen uses I2C communication interface. It only needs 4 pins for LCD display. These pins are VCC, GND, SDA and SCL.VCC and GND are connected to Arduino 5V and GND pin. SDA and SCL are connected to A4 and A5 pins of Arduino. It saves at least 4 analog or digital pins of Arduino. It is used widely because Arduino Uno will run out of pin resouces easily.
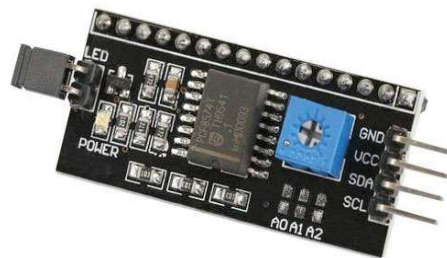

Figure-04: I2C LCD Display module

ULN2003 Driver Board:

The ULN2003 consists of an array of seven darlington pairs of transistors. In a darlington pair the second transitor amplifies the output current of first transistor. Each transistor pair is capable of driving the loads output up to 500mA & 50V. The ULN2003 drives the output of any motor or relay connected with Arduino. The ULN2003 is capable of converting low voltage and lo current output of a microcontroller to a high voltage & high current output. In this way it is capable of providing high current gain.

Figure-05: ULN2003 Relay Driver

5V Relay Module:

The relay module can be connected directly to a microcontroller by using a transistor to switch the relay on. The high voltage terminals (NC,C and NO) are connected to the controlling device. The low voltage pins (Ground, Vcc & signal) are connected to the Arduino. This relay module works from stable 5V signal. A 120-240V switch is connected to electromagnet inside the relay module. At the signal pin the relay receives high signal that charges the electromagnet. It moves the switch open or closed.

Figure-06: 5V Relay Module

DHT11 Humidity & Temperature Sensor:

DHT11 Humidity and temperature sensor features a resistive type humidity measurement & an NTC type temperature measurement component. It gives digital signal output. It has high reliability & long term stability. In this project it is used to control the room temperature & is connected to a microcontroller. It is small, consumes low power & makes signal transmission up to 20 meter.
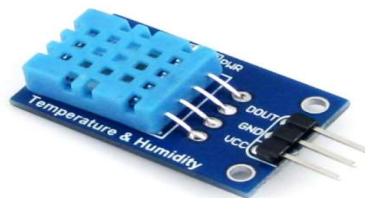

Figure-07: DHT 11 Temperature & Humidity Sensor

CIRCUIT DESCRIPTION

The GSM automation circuit connection is simple. A LCD is used to display the status of home appliances which is connected with I2C 16*2 LCD display module. I2c module is used here for the ease of connection because it needs only four pin for LCD display. For this reason it saves at least four analog/digital pins of Arduino. The GSM module's Rx and Tx pin is directly connected to Tx and Rx pin of Arduino respectively. The GSM module is powered by using a adapter. Light, Fan and TV is controlled by using three 5V relays. A DHT 11 Humidity & temperature sensor is connected directly to Arduino pin number 3 for measuring room temperature. The relays are connected to Arduino pin number 4, 5, 6 through a relay driver ULN2003 for controlling the device. A 12V DC FAN is used for controlling room temperature when it exceed 30^0C.In order to give the DC fan the required torque for starting two transistor is used here for signal amplifying. The DC FAN is connected to Arduino pin number 7 through the relay driver ULN2003.

CIRCUIT REPRESENTATION
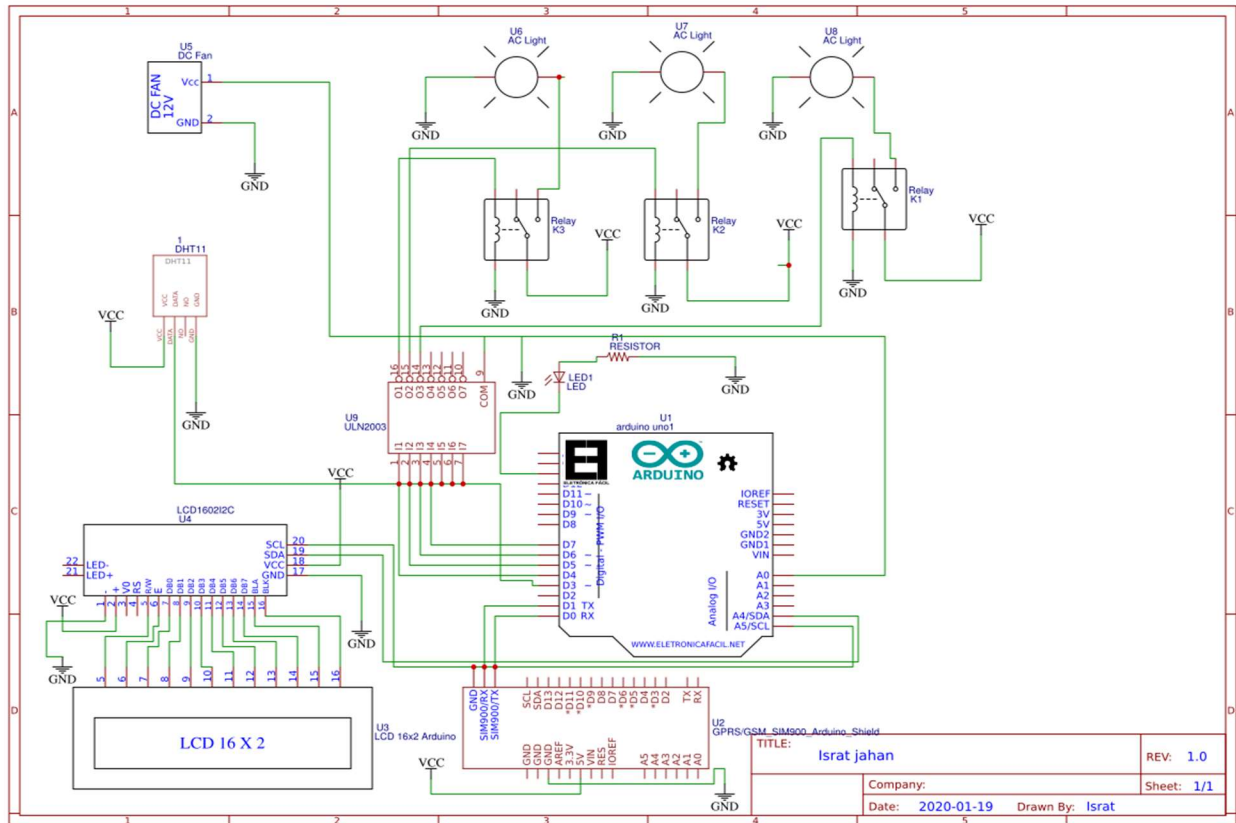
The model of circuit is shown as below:

Figure: Circuit Model

BLOCK DIAGRAM

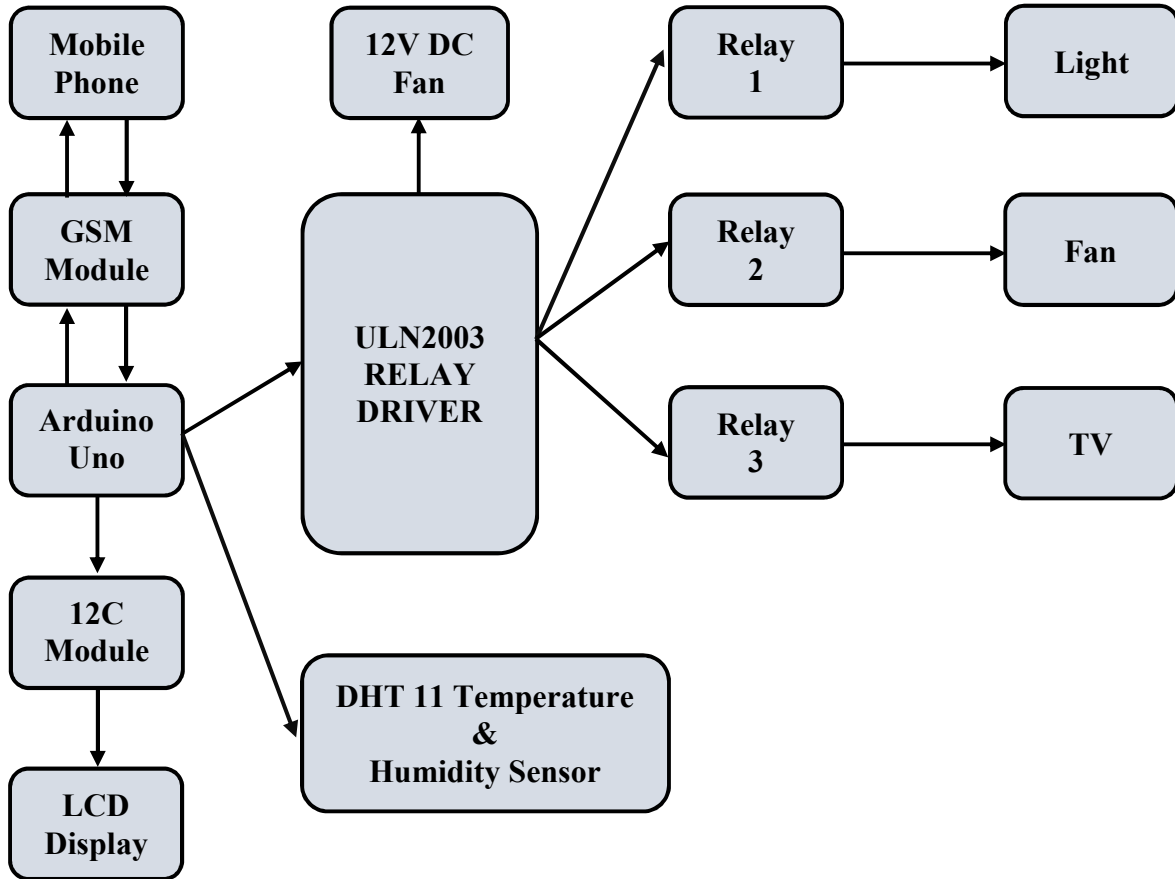The block diagram of the circuit is shown below:

Figure: Block Diagram

METHODOLOGY

The Arduino Uno is working as the bridge for controlling the home appliances via SIM900 GSM/GPRS shield. The SIM900 GSM/GPRS shield is a wireless communication device which is used here for the automation purpose. The user can control the home appliances from any corner of the world by using this GSM module. #A light on, #A fan on, #A.tv on commands are used to turn on light, fan & TV individually. Similarly #A light off, #A fan off, #A.tv off commands are used to turn off light, fan & TV respectively. By using the commands #A all on & #A all off all the home appliances can be turned on or turned off simultaneously." #A." is used here as a prefix command, it is identifying that the main command is coming following it.

The commands are written in hexadecimal form in code. When the user sends message to the GSM module from mobile phone, Arduino reads the command in hexadecimal form which is equivalent to the message sent. Arduino receives the main command by extracting it from the prefix" #A.". Then it stores the command in a variable. The received command is compared to the predefined command by Arduino. Arduino sends the message to the relay through the motor driver & switches ON or OFF the home appliances if the commands are matched. It also shows the command in the LCD display. The temperature & humidity sensor collects the room temperature and sends the data to Arduino. If room temperature is greater than 30 degree Celsius the GSM module will make a call to mobile phone. For controlling the room temperature the DC fan will be turned on automatically. If the room temperature is under control the GSM module will stop making call & the fan will be turned off. Dc Fan is connected to transistors for achieving the required torque.
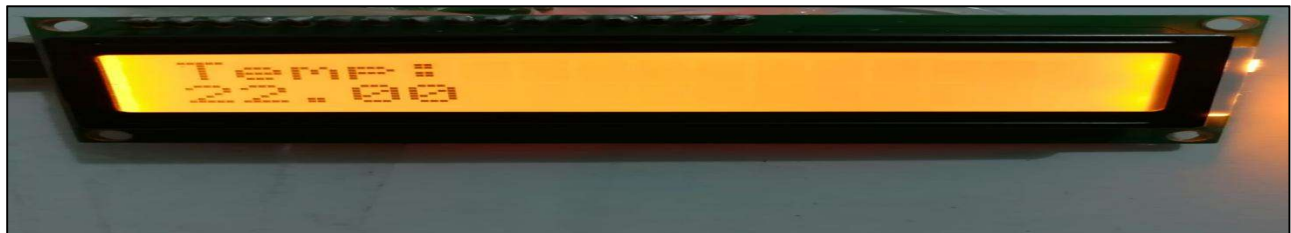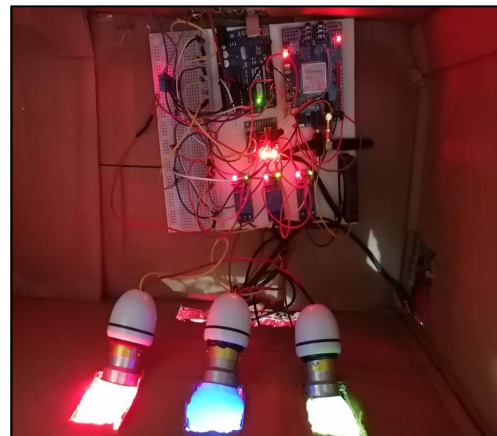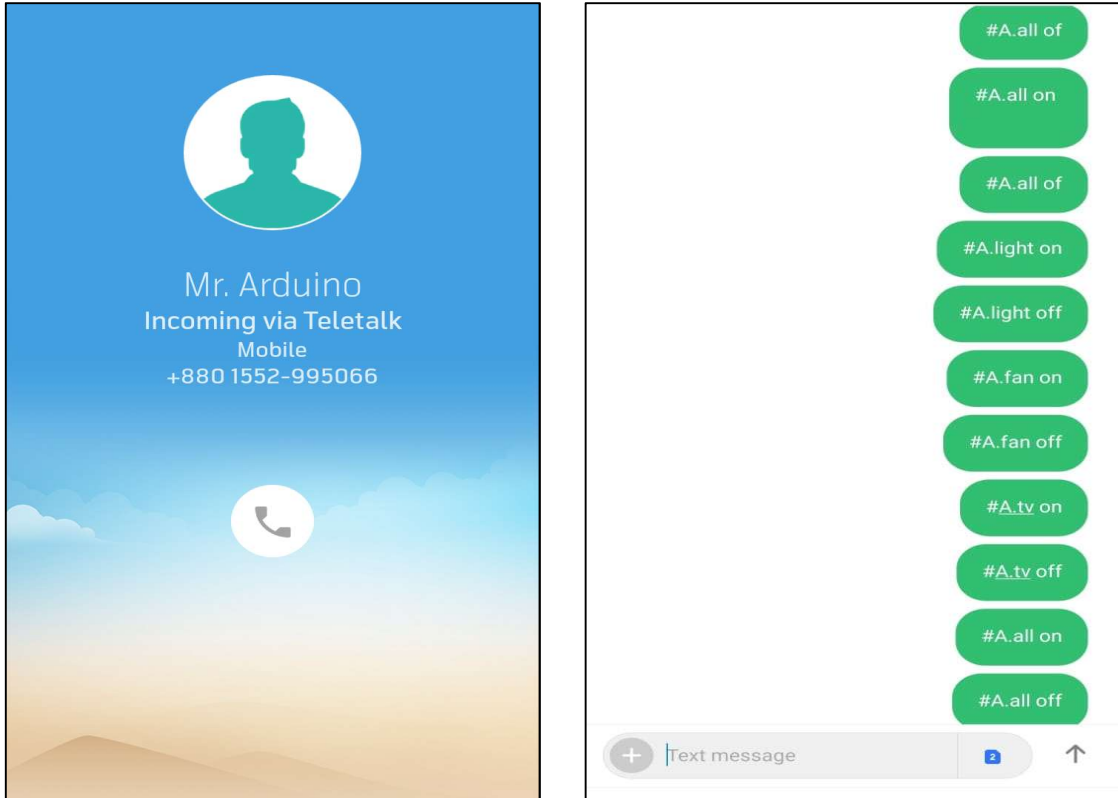

Figure: Output of GSM based home automation

Figure: Sending call from GSM module to mobile phone & sending message from mobile phone to GSM

ALGORITHM

Algorithm of interfacing between GSM module & controlling devices

STEP 1: Start the program.

STEP 2: GSM module wait for the reception of SMS from user's mobile phone.

STEP 3: GSM module checks if the SMS is received.

STEP 4: If the SMS is received it decodes the received SMS.

STEP 5: Then it activates the specific relay.

STEP 6: The home appliances changes its SMS according to the received SMS.

STEP 7: If the message is not received, go to step 3.

STEP 8: Display the status of home in LCD.

Algorithm for GSM based home automation system.

STEP 1: Start the program.

STEP 2: Select variables for the program. Arduino pin 2 and 3 is selected for serial communication. Defining LCD library for the program.

STEP 3: GSM control home automation is printed on the LCD display.

STEP 4: The temperature & humidity sensor measures the room temperature & temperature is printed on the LCD display in degree Celsius.

STEP 5: If the temperature is greater than 30 degree Celsius, the user will receive phone call from GSM module. This phone call would be continued until the room temperature is under control & LCD will display the message,"Calling". The DC fan will be started automatically until the temperature is under control.

STEP 6: If the temperature is less than 30 degree Celsius, it will return to step 4 and simply display the temperature.

STEP 7: The command is sent to the GSM module through SMS from user mobile phone.

STEP 8: If the command is right, the operation is executed.

STEP 9: As per the command through the mobile phone the activation or deactivation of the device is done.
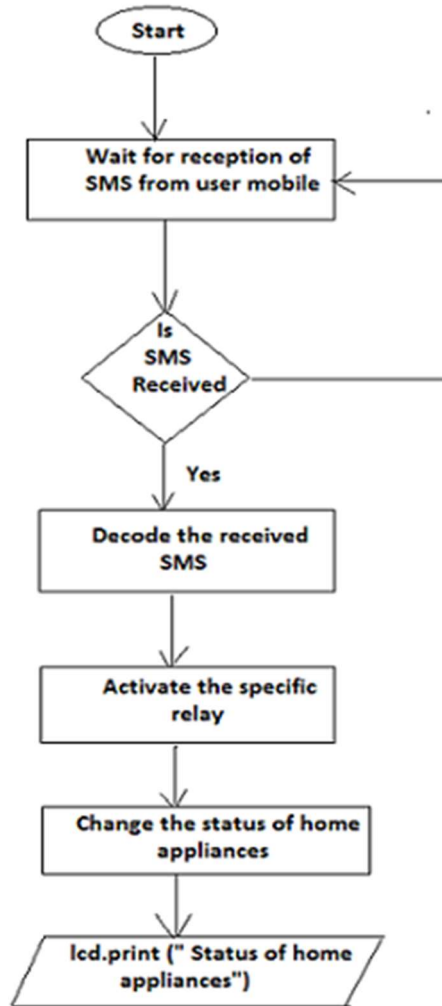
FLOWCHART

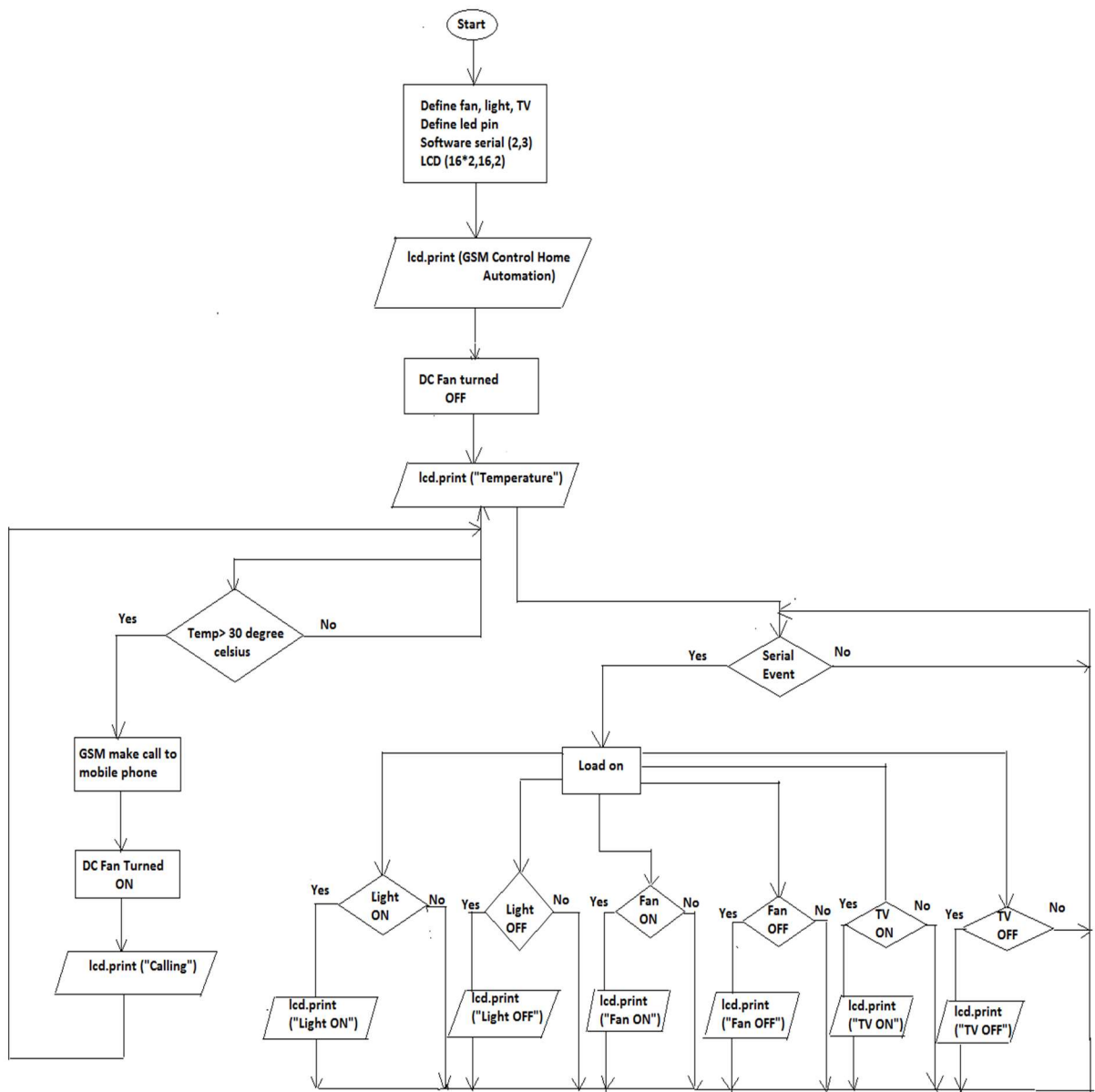**Figure: Interfacing between GSM module and controlling devices**

Figure: Flowchart of GSM based home automation system

RESULT

The proposed system turns on/off light, fan, TV. DHT11 measures the temperature and humidity of the home. For controlling the room temperature DC fan is used. The result of GSM based home automation system is given below.

Serial No.	Temperature (⁰C)	Commands	Appliance Status
1	22	# A light ON	Turn ON Light
2	22	# A light OFF	Turn OFF light
3	22	# A fan ON	Turn ON fan
4	22	# A fan OFF	Turn OFF fan
5	22	# A TV ON	Turn ON TV
6	22	# A TV OFF	Turn OFF TV
7	22	# A all ON	Turn ON light, fan, TV
8	22	# A all OFF	Turn OFF light, fan, TV
9	32	No command	Turn ON DC fan
10	25	No command	Turn OFF DC fan

CONCLUSION

The design and implementation of a simple, cost effective, user friendly and flexible home automation system is presented here. The importance of internet cannot be avoided but an alternative and temporary solution must be taken in consideration in some critical situation. The major benefit of this system is the GSM technology is worldwide and the user can control the home appliances through an android application. This system is implemented with four loads and a temperature and humidity sensor. The control of the home appliances is done through the SMS sent through the GSM network and the hardware. This system can also be used in hospitals for disabled people and in places where human interference is not possible.