Study and Designing of Micro Controller Based Temperature Sensing System Along with Global System for Mobile (GSM) Interface and Alarm Mechanism to be Used in Different Temperature Sensitive Storehouses

Mahfuza A. Sultana, Md. Shajaratul B. Islam, and Md Mahbubul C. Alam
Military Institute of Science and Technology/Dept of Aeronautical Engineering, Dhaka, Bangladesh
Email: mahfuza.sultana@yahoo.com, shajarats@gmail.com, saqibmahbub2002@gmail.com

Abstract—In aviation sector safety is a prime concern. Temperature sensitive items such as aircraft rubber equipment, aircraft Propellant Actuating Device (PAD) items (such as Fire Extinguishing Cartridges, Ejection Seat Cartridges, Signal Cartridges etc.) are to be stored in controlled temperature in store houses. Storing of such valuable aircraft items in inappropriate temperature may affect their service life and the resultant serviceability of the aircraft. In this project, a system has been developed which will monitor the temperature in the storehouses and send a message to the concerned person when temperature crosses the maximum storage temperature level. This circuit can be used to build a temperature based alarm system where an SMS will be sent or a buzzer will be turned 'ON', when temperature goes above a particular level. For implementing this project, GSM Module – SIM900, Atmega328p-pu microcontroller based Arduino Uno, LM35 temperature sensor, DHT22 humidity sensor have been used. The data from the sensors is processed and displayed on a LCD display. Code and algorithms are developed which enables combining all of the required sensors and innovations to provide data in a controlled manner in order to build the real time package. This device is portable and can be shifted easily by changing maximum setting temperature manually using push button switch. Thus, this system can be installed in different storehouses even in industries to monitor the temperature rising and give signal to the user to activate the temperature controlling system if required.

Index Terms— **GSM, microcontroller, aviation, arduino-uno, sensor, display.**

I. Introduction

Temperature sensitive items used in aviation sectors such as aircraft rubber equipment, aircraft Propellant Actuating Device (PAD) items (such as Fire Extinguishing Cartridges, Ejection Seat Cartridges, Signal Cartridges etc.) are to be stored in controlled temperature in store houses.Storing such items in inappropriate temperature may affect their service life and serviceability of the aircraft in which those are fitted[1]. In a hot tropical country like Bangladesh, controlling the temperature in a storehouse is a big challenge. As such, to ensure specified service lives of temperature sensing items of aircraft and associated equipment during storage, this project has been taken. Temperature sensing and protection system is a combination of Electrical and Electronics Instruments. Wireless communication via GSM network is one of the most vibrant areas in the communication today. Efforts were made to build a project of Micro controller based temperature sensing system along with GSM interface and alarm mechanism to be used in different temperature sensitive storehouses. Basically this is a temperature monitoring system, which detects the temperature of a storehouse. If it goes beyond a certain critical point, it alerts the user by turning ON the buzzer and sending a text-alert to the phone number of the user so that he or she may be able to take necessary action to control the temperature if required.

By using the Atmega328p-pu microcontroller based Arduino Uno, LM35 Temperature sensor, DHT22 Humidity sensor, GSM Module – SIM900, SPDT Relays and Buzzer 5V the temperature sensing and controlling system has been developed. Several tests were carried out by setting maximum allowable temperature (such as 30 ℃, 40 ℃, 50 ℃ etc.). When the temperature was increased artificially, the indicating temperature was displayed, the alarm was activated and successfully SMS was sent to the concerned personnel (whose mobile numbers are recorded in the program memory) to inform them about the rise of the temperature.

II. Methodology

The required steps in implementation of any system are involved with :To identify the requirements, Design and optimum solution for the system by doing simulation, Component selection by comparing the facilities available in similar task oriented components, Hardware Implementation, Assembly, Coding, testing etc.

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A. To Identify the Requirements

The temperature monitoring system incorporation with GSM Network has already been invented previously with high price, lower resolution [2]. Existing system could not serve all the requirements for aviation based store houses. But in this project, design has been done in such a way that it can give better reading, lower cost and is feasible for developing and under-developed countries. In this project work, the program is written in Arduino IDE and facilitates the display of temperature in degree centigrade. And according to the temperature the Arduino gives input to the Relay, thereby cooling system on/off automatically depending up on the temperature. The steps to be taken to check the accuracy during and after the test are also of extreme importance. Temperature is the most often-measured environmental quantity. This might be expected since most physical, electronic, chemical, mechanical and biological systems are affected by temperature. Some processes work well only within a narrow range of temperatures. Certain chemical reactions, biological processes, and even electronic circuits perform best within limited temperature ranges.

B. Design an Optimum Solution for the System

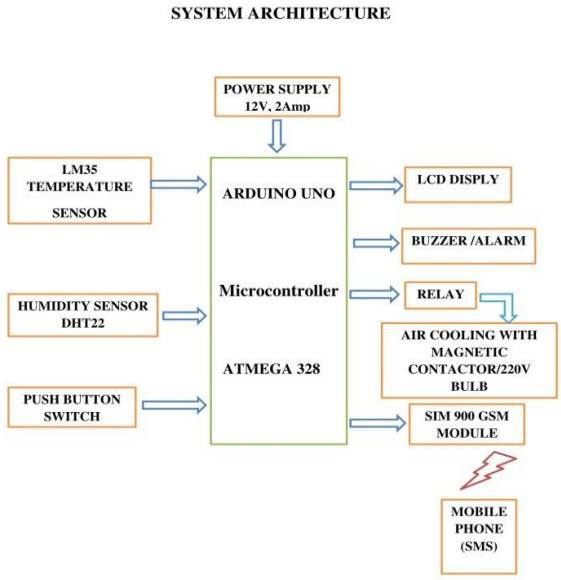


Figure 1. System Architecture

In this system, temperature sensor LM35 is used to detect temperature into appropriate voltage. This voltage is given to Arduino. According to program it process the analog signal into digital and forms a particular voltage level for a particular temperature[3].16x2 LCD is used to display the output i.e. surrounding temperature of LM35 in degree centigrade[4]. In additionally it can sense relative humidity by using DHT22 sensor and it shows in the LCD display [5]. At the same time, it also sends the data to Relay. If the temperature becomes more than the set point, relay becomes activated and it gives command to switch ON the Air cooler. In this manner it monitors and controls the temperature. It also sends SMS to the concern personnel to inform about the rise of the temperature[6]. Two push button switches are used as two inputs in order to set/change the maximum setting temperature. This facility enables this system to be used in different storehouses. A transistor and a diode are added between microcontroller based Arduino-Uno board and Relay for switching and guiding the current flow in one direction[6],[7]. When industrially production is concerned, bigger version of LCD display is recommended. The system Architecture of the system is shown next in Fig. 1.Which is illustrated that the Microcontroller (ATMEGA328) based Arduino Uno is the main controlling unit and it is connected with 3 inputs and 4 outputs. The microcontrollers takes the power supply of (12Volt, 2Amp) for its functioning.

The Flow chart of this work is inserted below in Fig. 2.The Coding for the system is done according to this flowchart.

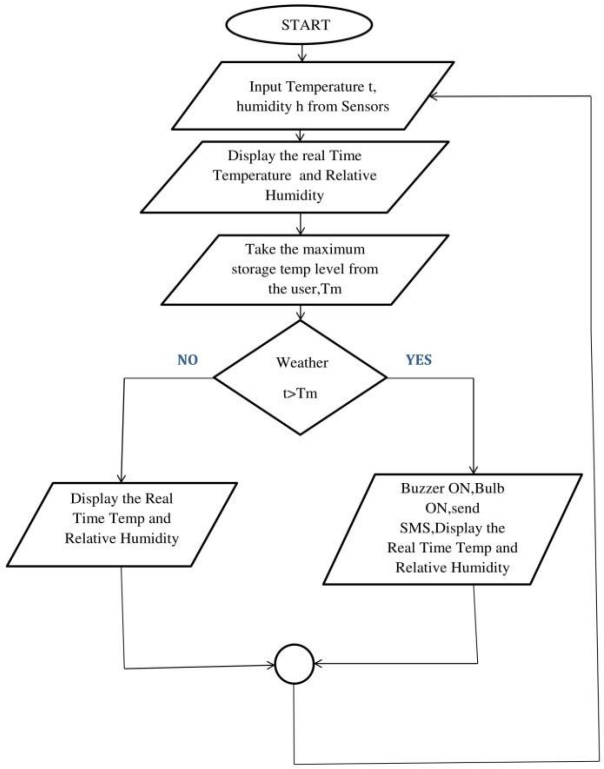


Figure 2. Flow chart

C. Component Selection

The following components were required throughout this work.

1) Microcontroller (ATMEGA328P-AU)
2) GSM MODULE SIM900
3) LM35 temperature sensor
4) DHT22 humidity sensor
5) Pushbutton switch
6) LCD 16x2 display[8].
7) Resistor(1k)
8) Variable resistor (10K)
9) Power supply Adapter
10) bread board

11) Connecting wire(M-M,M-F,F-F)
12) Veroboard
13) Ply wood
14) Acrelic sheet
15) Glue
16) Screw
17) Soldering Iron,wire,rosin
18) Glue gun,Glue stick.
19) Transistor
20) Diode
21) Relay Switch
22) Buzzer

D. Hardware Implementation

1) Connecting process of LM 35 Temperature Sensor to Arduino Uno.

The LM35 Temperature sensor IC has 3 pins; 2 pins are used for the power supply and one for the analog output. It is a low voltage IC which uses approximately +5VDC of power. The output pin provides an analog voltage output that is linearly proportional to the Celsius (centigrade) temperature. Pin 2 gives an output of 1 millivolt per 0.1 ℃ (10mV per degree). So to get the degree value in Celsius, all that must be done is to take the voltage output and divide it by 10-this give out the temperature value in degrees of Celsius.The circuit connections are made as shown in Fig.3.Pin 1 of the LM35 goes into +5V of the Arduino.Pin 2 of the LM35 goes into analog pin A0 of the Arduino.Pin 3 of the LM35 goes into ground (GND) of the Arduino.

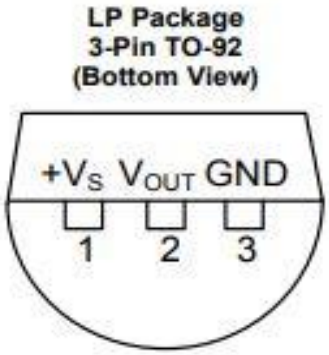
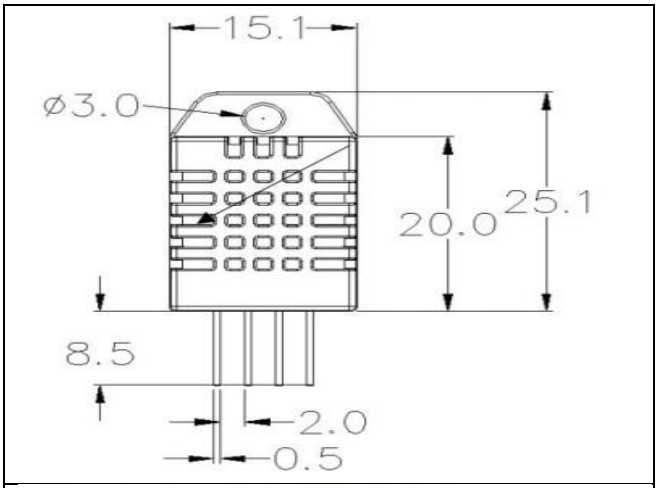


Figure 3. Pin Diagram Lm35 [9]

2) Connecting process of DHT22 Sensor to Arduino Uno.

Relative humidity also a considerable parameter for storage equipment. So, in later part of this project, one relative humidity sensor is added. The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).Connections are simple.Which can be seen from Fig.4, the first pin on the left to 3-5V power, the second pin to the data input pin (pin 10 of the Arduino) and the right most pin to ground. Power: 3-5V, Max Current: 2.5mA, Humidity: 0-100%, 2-5% accuracy, Temperature: -40 to 80 ℃, ±0.5 ℃ accuracy.



Pin sequence number: 1 2 3 4 (from left to right direction).

Pin	Function
1	VDD----power supply
2	DATA--signal
3	NULL
4	GND

Figure 4. Pin Diagram DHT22 [10]

3) Connecting process of GSM Sim900 module to Arduino Uno.

GSM stands for Global System for Mobile Communications and is the global standard for mobile communications. **GPRS** stands for General Packet Radio Service. GPRS is a mobile service on the 2G and 3G cellular communication. The GSM GPRS Sim900 module is particularly useful as it allows –Connection to the Internet over GPRS network and can Sends SMS [11].For this, the circuit connection is made according to Fig.5.TXD of GSM Sim900 module goes into pin 7 of the arduino. RXD of GSM Sim900 module goes into pin 8 of the arduino .Ground(GND) of GSM Sim900 module goes into pin 7 of the arduino . The GSM Sim900 module takes the power supply of (5Volt, 2Amp) for its functioning.

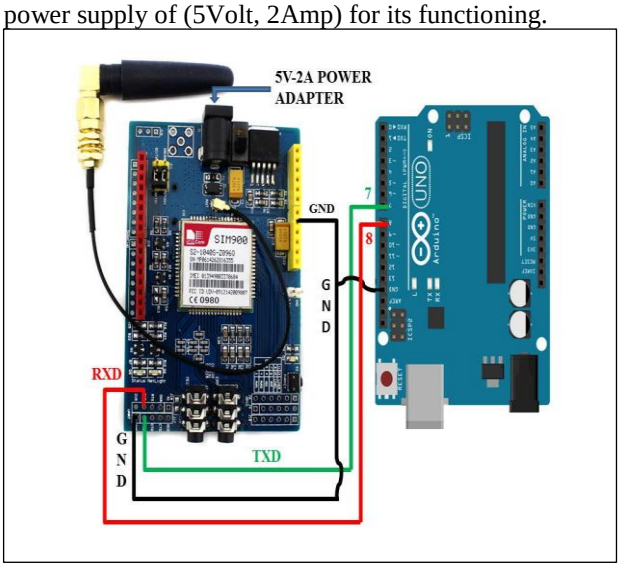


Figure 5. Connecting process of GSM Sim900 Module to Arduino [12]

4) Connecting process of Pushbutton switch to Arduino Uno.

Two pushbutton switch are connected with pin2 and pin 3 of Arduino microcontroller according to pull down switch connection as shown in Fig 6.When the push switch goes down only then Arduino input pin 2 or pin 3 gets high signal as input otherwise, Arduino input pin 2 or pin 3 gets low signal as input.

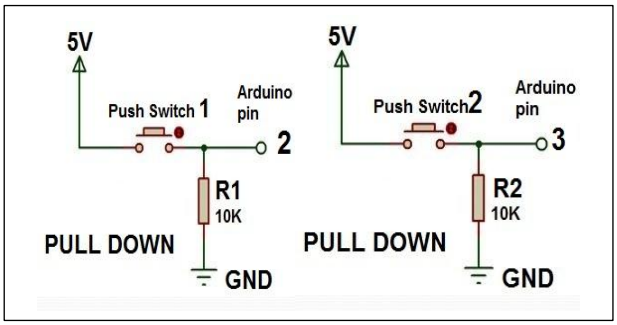


Figure 6. Circuit of pull down switch connection

5) Connecting process of Buzzer to Arduino Uno.

5V Buzzer is used for this purpose .The Buzzer has two lead, the positive lead is connected with the pin 9and the negative lead is connected with GND as depicted in Fig.7

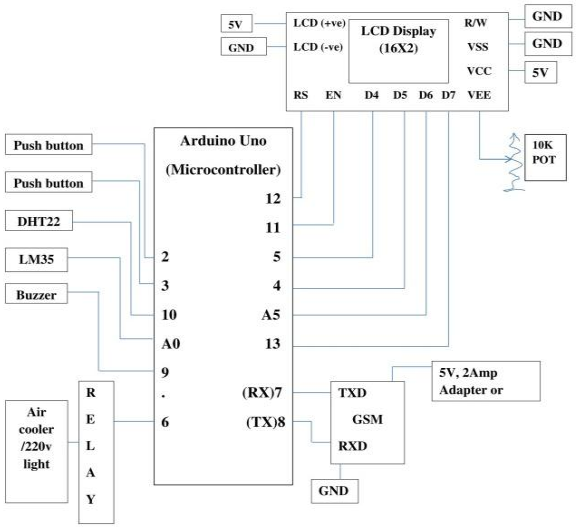


Figure 7. Circuit Diagram of the Project

6) Connecting process of LCD Display to ArduinoUno.

The connection is given according to Fig 7.The serial communication is existing between ArduinoUno and LCD Display as four data pin of LCD Display D4,D5,D6,D7 are connected with pin 5,4,A5,13 respectively of ArduinoUno.Here,10Kilo Ohm potentiometer is used to adjust the LCD Display Contrast.

7) Connecting process of *an Air cooler/220V Bulb to Arduino Uno.*

A transistor and a diode are added between microcontroller based Arduino-Uno board (pin 6) and Relay for switching and guiding the current flow in one direction. A SPDT 5V to 220V relay is used for this purpose .The output of the relay will be connected with magnetic contactor and there after one Air Cooler can be connected with the magnetic contactor .However, for testing purpose 220 V bulb is connected with the relay as output.

E. Assembly

All component and part has been assembled according to the circuit diagram which can be seen from Fig.7 is illustrated in Fig. 8.

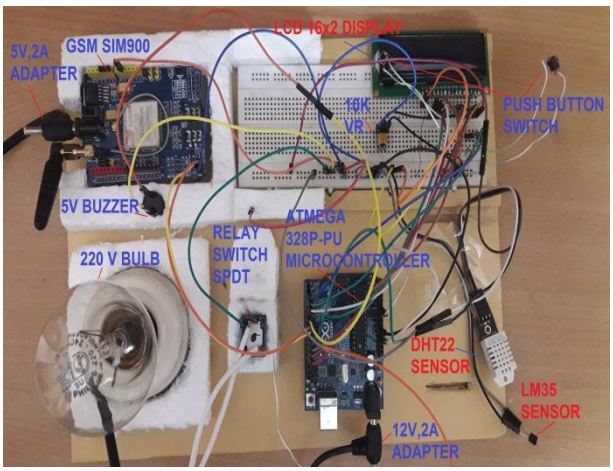


Figure 8. Assembly of the Project

F. Testing

Testing was done with each and every component ,in several time to increase the performance of the system .

G. Fabrication of the Project

To fabricate the total system, initially a casing is made with plywood to give a proper shape easily via anticutter as shown in Fig.9,then to make the system robust and to give strengthen the casing the plywood was replaced by an acrelic sheet which can be seen from Fig.10.

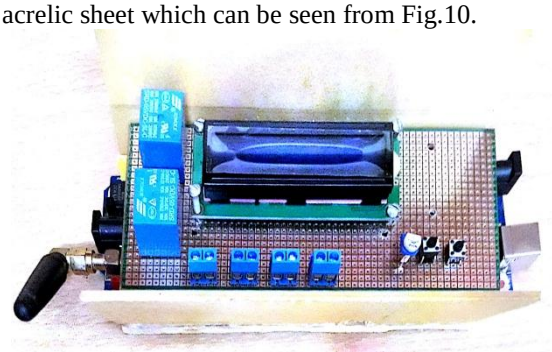


Figure 9. Fabrication of this Project (initial Casing-ply wood)

Figure 10. Fabrication of this Project (Casing-acrelic sheet)

III. Result And Observation

The project about Temperature monitoring and controlling gives four outputs. One is displaying the temperature on LCD screen. Second output is given to relay, the relay switches ON and OFF the device connected across it. Here, the 220V bulb is used which gets ON/OFF by the output of relay. Third one is the 5V Buzzer and fourth output is Connected to GSM module.

A. Step1

When temperature is below set point (i.e. 50degree Celsius) the relay is OFF. Consequently, 220V bulb is connected across it is OFF. Buzzer is OFF, No SMS is sent. Only the real time temperature and relative humidity shown on the LCD display.

B. Step2

When temperature goes above set point (i.e.55 degree Celsius) the relay is ON. Consequently, 220V bulb, as connected across it, glows. Buzzer goes ON, SMS sent to the concerned personnel who can be seen from Fig.11. The real time temperature and relative humidity is also shown on the LCD display as illustrated in Fig.12.

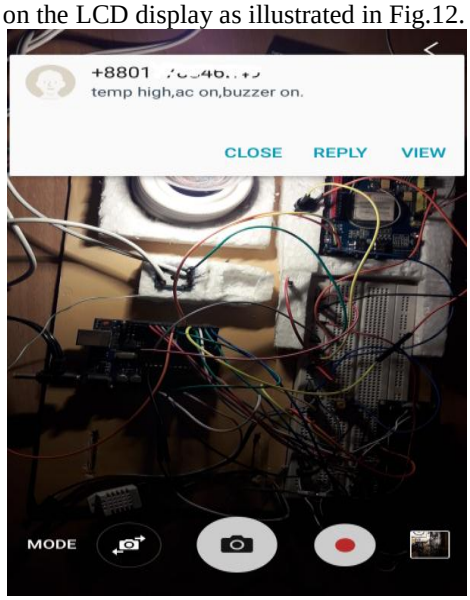


Figure 11. SMS Notification

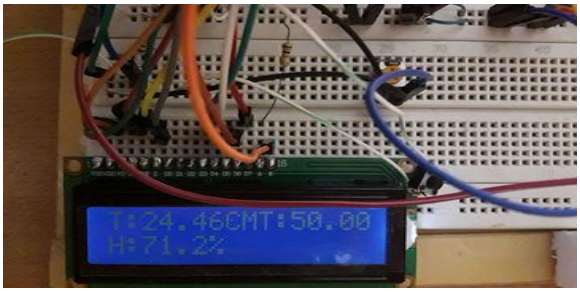


Figure 12. LCD display is showing the parameters

Several tests were carried out by setting maximum allowable temperature (such as 30 ℃, 40 ℃, 50 ℃ etc.). When the temperature was increased artificially, the indicating temperature was displayed, the alarm was activated and successfully SMS was sent to the concerned personnel (whose mobile numbers are recorded in the program memory) to inform them about the rise of the temperature.

C. Scope for Future Development

Different types of sensors such as smoke sensor, gas sensor, pressure sensor etc. also can be used with this device in future. The GSM Modem can be replaced by Bluetooth Transmitter. Installation of triggering mechanism to trigger the air conditioner and other cooling device with this system may be considered as a future work. Also, efforts may be taken to incorporate voice feedback mechanism along with this system in future.

IV. Conclusion

In aviation sector safety is a prime concern. Temperature sensitive items such as aircraft rubber equipment, aircraft Propellant Actuating Device (PAD) items (such as Fire Extinguishing Cartridges, Ejection Seat Cartridges, Signal Cartridges etc.) are to be stored in controlled temperature in store houses. Storing of such valuable aircraft items in inappropriate temperature may affect their service life and the resultant serviceability of the aircraft. In this project, a system has been developed which will monitor the temperature in the storehouses and send a message to the concerned person when temperature crosses the maximum storage temperature level. Efforts were made to build an efficient temperature monitoring and controlling system with a microcontroller based Arduino board. By using the Atmega328p-pu microcontroller based Arduino Uno,LM35 Temperature sensor, DHT22 Humidity sensor, GSM Module – SIM900, SPDT Relays and Buzzer 5V, the temperature sensing and controlling system has been developed. During the project work, output was verified by setting the temperature at different levels. When the temperature was increased artificially, the indicating temperature was displayed, the alarm was activated and successfully SMS was sent to the concerned personnel to alert them. However, there is still room for future development that would enhance the performance of the system to be used on commercial aspect if found necessary.

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Mahfuza Sultana
Birthplace: Bangladesh.
Date of Birth:26 July,1995.
Educational qualification :
B.Sc in Aeronautical Engineering (Avionics), Military Institute of Science and Technology,2018.Attended in the Short course on microcontroller in Dec,2013 , Short course on Programmable logic controller Dec/2014 got 2nd merit position on it's complition exam, Short course on Fluid power and control System Aug/2015 got 3rd merit position on it's complition exam, short course on Electrical Service design in Dec,2016 - Jan/2017 .
She is a technical and non-technical writer, Blogger, volunteer(ICMEAS-2017,Robolution), organizer and team leader in different project team . Field of Interest: Microcontroller, IT, Robotics, Avionics,Automation.
Ms. Sultana is a member of IEEE, MIST Robotics club ,MIST Literature Club.

Md. Shajaratul Islam
Birthplace:Bangladesh.
Date of Birth:12 december,1995.
Educational qualification:
B.Sc in Aeronautical Engineering (Avionics), Military Institute of Science and Technology,2018. He is a author of 2 Journal papers in IJSER-August-2017, IJAIS-November 2017 and 1conference paper in ICMEAS- February 2017.
Field of Interest: Navigation, IT
Md. Islam is a Member of MIST Robotics club.

Md Mahbubul Alam
Birthplace: Bangladesh.
Date of Birth: 26 April, 1970.
Educational qualification:
B.Sc: Electronics and Electrical Engineering from Bangladesh University of Engineering and Technology (BUET) in 1994. M.Sc: Electronics Engineering from Beijing University of Aeronautics and Astronautics, China in 2000. PhD: Currently he is pursuing PhD in Power System Engineering.
He had served as Maintenance Engineer in Bangladesh Air Force for about 22 year. Since November, 2016 he has been serving as an Instructor in Aeronautical Engineering Department in Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. He is a technical writer, organizer, involved in different project team. As an instructor, he supervises under-grade thesis. In his M.Sc Engineering, he published a thesis paper entitled "Study and Design of a set Partitioning in Hierarchical Trees (SPIHT) Encoder as a part of an Image Compression System". Field of Interest: Digital Signal processing, Power System Engineering.
Md.Alam is a member of IEEE.