GSM BASED SOLAR POWER FOREST FIRE DETECTION AND PREVENTION SYSTEM

A report submitted to the Department of Electrical and Electronics Engineering, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronics Engineering.

Submitted by

Md Riad Hossain	EEE2103024024
MD Shifat Ud Dowla	EEE2103024033
Md. Abdul Awal	EEE2103024063
Saiful Islam	EEE2103024084
Md Musha Ali	EEE2103024118

Supervised by

Swadesh Vhakta

Lecturer

Department of Electrical and Electronics Engineering

Sonargaon University (SU)

Dhaka-1215, Bangladesh

May, 2025

DECLARATION

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

Md Riad Hossain
EEE2103024024

MD Shifat Ud Dowla
EEE2103024033

Md. Abdul Awal
EEE2103024063

Saiful Islam
EEE2103024084

Md Musha Ali
EEE2103024118

Under Superviosn of

Swadesh Vhakta
Lecturer
Department of EEE
Sonargaon University (SU)

CERTIFICATION

This is to certify that this project entitled **"GSM Based Solar Power Forest Fire Detection and Prevention System"** is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronics Engineering.

Supervisor

_____

Swadesh Vhakta

Lecturer

Department of EEE

Sonargaon University (SU)

ACKNOWLEDGEMENT

The report titled as **"GSM Based Solar Power Forest Fire Detection and Prevention System"** has been prepared to fulfill the requirement of our practicum program. In the process of doing and preparing our practicum report, we would like to pay our gratitude to some persons for their enormous help and vast cooperation.

At first, we would like to show our gratitude to the University authority to permit us to do our practicum. Specially, we would like to thank to our honorable supervisor Swadesh Vhakta, Lecturer, Department of Electrical and Electronics Engineering, SU – Sonargaon University Dhaka, for his valuable and patient advice, sympathetic assistance, cooperation, contribution of new ideas. Deep theoretical and hardware knowledge & keen interest of our supervisor in this field influenced us to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project.

The author are also grateful to Md. Rais Uddin Mollah , Head of the Department of Electrical and Electronic Engineering and all respect teachers of the Electrical and Electronic Engineering Department for their co-operation and significant help for completing the thesis work successfully.

Finally, we would like to thank again the respected Vice-Chancellor of SU, also thanks to the Head of the Department of SU, **Electrical & Electronics Engineering**, because they are designated such an environment for learning through which we got the opportunity to acquire knowledge under **BSc in EEE program**, and that will be very helpful for our prospective career.

We are, indeed, grateful to all those from whom we got sincere cooperation and help for the preparation of this report.

ABSTRACT

The GSM-based Solar Power Forest Fire Detection and Prevention System is designed to monitor and prevent forest fires efficiently using renewable energy and wireless communication. The system utilizes sensors such as temperature, humidity, and flame detectors powered by solar energy to continuously track environmental conditions in forest areas. When abnormal readings indicating potential fire risks are detected, the system immediately sends real-time alerts via GSM to concerned authorities, enabling rapid response. An integrated water spray mechanism can also be activated automatically for early fire suppression. The use of solar power ensures uninterrupted operation in remote forest regions without dependence on grid electricity. This solution provides a cost-effective, eco-friendly, and autonomous approach to forest fire management, significantly reducing response time and minimizing environmental damage. By combining renewable energy, smart sensing, and GSM technology, the system enhances forest safety and supports sustainable environmental protection.

INDEX

Declaration		ii
Certification		iii
Acknowledgement		iv
Abstract		v
List of Figures		viii
List of Table		ix
CHAPTER 01	**INTRODUCTION**	
1.1	Introduction	01
1.2	Background	02
1.3	Objectives	03
1.4	Research Methodology	03
1.5	Organization of Report	04
CHAPTER 02	**LITERATURE REVIEW**	
2.1	Introduction	05
2.2	Literature Review	05
2.3	Summary	08
CHAPTER 03	**HARDWARE ANALYSIS**	
3.1	Introduction	09
3.2	Required Instrument	09
3.3	Arduino Nano	09
3.4	Solar panel	13
3.5	Relay	14
3.6	Pump Motor	16
3.7	Temperature Sensor	17
3.8	Flame Sensor	18
3.9	Battery	19
3.10	Buck Converter	20
3.11	LCD Display	21

3.12	GSM Module	23
3.13	Buzzer	25
CHAPTER 04	**SOFTWARE ANALYSIS**	
4.1	Introduction	26
4.2	Software	26
4.3	Arduino Software	26
4.4	Easy EDA	28
CHAPTER 05	**SYSTEM ANALYSIS**	
5.1	System Analysis	30
5.2	Block Diagram	30
5.3	Circuit Diagram	31
5.4	Working Produce of Our Circuit	31
CHAPTER 06	**RESULT & CONSLUSION**	
6.1	Experiment Setup	32
6.2	Result	32
6.3	Cost Sheet	33
6.4	Advantages	34
6.5	Application	34
6.6	Limitation	34
6.7	Future Work	34
6.8	Conclusion	35
REFERENCE		**36**
APPENDIX		**38**

LIST OF FIGURES

Figures No	Figure Name	Pages
Figure 3.1	Arduino Nano	10
Figure 3.2	Arduino Nano Schematic Diagram	10
Figure 3.3	How Arduino Nano Looks Like	11
Figure 3.4	Micro-controller IC AT mea328p	12
Figure 3.5	Solar panel	13
Figure 3.6	Relay	14
Figure 3.7	Relay Module	15
Figure 3.8	Mains Voltage Connection	15
Figure 3.9	Voltage Connection	16
Figure 3.10	Pump Motor	16
Figure 3.11	DHT11 Temperature Sensor	17
Figure 3.12	Flame Sensor	18
Figure 3.13	3.7V Battery	19
Figure 3.14	DC-DC buck Converter	20
Figure 3.15	16*2 LCD Display	21
Figure 3.16	Pin out of 16*2 LCD Display	22
Figure 3.17	16*2 LCD Display interfacing with Arduino	22
Figure 3.18	GSM Module	23
Figure 3.19	SM Module Introducing	23
Figure 3.20	GSM Module pinout	24
Figure 3.21	Buzzer	25
Figure 4.1	Arduino Interface IDE	27
Figure 4.2	Easy EDA Software Interface	29
Figure 5.1	Block Diagram	30
Figure 5.2	Circuit Design	31
Figure 6.1	Our Complete Project Prototype Image	32

LIST OF TABLES

Tables No	Table Name	PAGES
Table 1	Battery Specification	20
Table 2	Project Cost Analysis	33

CHAPTER 1
INTRODUCTION

1.1 Introduction

The term ‘forest’ refers to a large area of land, densely forested with trees and other plants. For many reasons, forest ecosystems are critical. Millions of plants and animals call forests their homes. Additionally, they assist in climate regulation, filter air and water, and provide a variety of valuable resources. Despite their value, forests really face numerous threats, like destruction, wildfires, or deforestation. Numerous forests are eliminated to make room for agriculture or to extract valuable resources such as timber and minerals.Additionally, global warming poses a significant threat to forests. Because of fires, pests, and diseases, forests are increasingly threatened as the Earth's climate changes. It is critical to safeguard forests that are real homes of animals and plants. By adopting environmentally friendly choices, we can all contribute to forest preservation.

While forest fires spontaneously occur in a variety of ecosystems, they could be extremely destructive to people, properties, and natural resources. These fires are frequently sparked in wild areas by lightning or human neglect. With conducive environmental conditions, a wildfire can ignite quickly and broadly over large areas, fueled by dry vegetation. Forest firefighters often deploy all their efforts to contain and extinguish wildfires, it takes them days to stop it, and some of them die for this end. Wildfire smoke and air pollution can cause a real health risk, and the flames can destroy or damage homes and businesses. In order to safeguard homes and communities against wildfire dangers, it is critical to have a fire prevention policy and disaster response program.

The task of detecting and predicting wildfires is not obvious, as they can ignite anywhere and spread rapidly. However, with the help of technological solutions involving IoT and artificial intelligence, it is possible to develop early-warning systems with relevant accuracy.Using key sensors to measure changes in temperature, humidity, and wind speed, as well as to detect the presence of smoke and fire, is a relevant way to accomplish this task, according to our opinion. The collected data from these measures could be archived, and next used to develop ML models capable of forecasting the likelihood of a fire

igniting. We can develop models that predict how a given fire will progress under various conditions by analyzing data from previous fires. Built fire datasets will be a valuable mean to assist firefighters and other emergency responders facing efficiently wildfires. Additionally, it may aid in identifying areas at high risk of wildfires, allowing for the implementation of preventative measures

1.2 Background

Forests are the protectors of earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous and even impossible at times. The result is devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO2) in the atmosphere comes from forest fires), in addition to irreparable damage to the ecology (huge amounts of smoke and carbon dioxide (CO2) in the atmosphere). Among other terrible consequences of forest fires are long-term disastrous effects such as impacts on local weather patterns, global warming, and extinction of rare species of the flora and fauna.

The problem with forest fires is that the forests are usually remote, abandoned/unmanaged areas filled with trees, dry and parching wood, leaves, and so forth that act as a fuel source. These elements form a highly combustible material and represent the perfect context for initial-fire ignition and act as fuel for later stages of the fire. The fire ignition may be caused through human actions like smoking or barbeque parties or by natural reasons such as high temperature in hot summer day or a broken glass working as a collective lens focusing the sun light on a small spot for a length of time thus leading to fire-ignition. Once ignition starts, combustible material may easily fuel to feed the fires central spot which then becomes bigger and wider. The initial stage of ignition is normally referred to as "surface fire" stage. This may then lead to feeding on adjoining trees and the fire flame becomes higher and higher, thus becoming "crown fire." Mostly, at this stage, the fire becomes uncontrollable and damage to the landscape may become excessive and could last for a very long time depending on prevailing weather conditions and the terrain.

Millions of hectares of forest are destroyed by fire every year. Areas destroyed by these fires are large and produce more carbon monoxide than the overall automobile traffic. Monitoring of the potential risk areas and an early detection of fire can significantly shorten the reaction time and also reduce the potential damage as well as the cost of fire fighting. Known rules apply here: 1 minute—1 cup of water, 2 minutes—100 litres of water, 10 minutes—1,000 litres of water. The objective is to detect the fire as fast as possible and its exact localization and early notification to the fire units is vital.This is the deficiency that the present Invention attempts to remedy, by means of detection of a forest fire at the very early stage, so as to enhance or ensure the chance to put it out before it has grown beyond control or causes any significant damage.

1.3 Objectives

The objectives of this project:

- To design and construct an GSM Based Solar Power Forest Fire Detection and Prevention System.
- To detect early signs of forest fires using temperature humidity, and flame sensors.
- To ensure continuous system operation using solar power in remote forest areas.
- To automatically activate a fire prevention mechanism (e.g., water spray) when fire is detected.
- To provide real-time alerts to authorities via GSM communication.
- To reduce fire damage and promote eco-friendly solutions.
- To put the whole system into action so that we can observe its practical effects and verify our work.
- To study the system performance for future reference and improvement purpose.

1.4 Research Methodology

The methodologies we have used to build this project are given below:

- Creating an idea for GSM Based Solar Power Forest Fire Detection and Prevention System And designing a block diagram & circuit diagram to know which components need to construct it.
- Collecting the all components and programming for the micro controller to controlled the system.
- Setting all components in a PCB board & soldering. Then assembling the all block in a board and finally run the system & checking.

1.5 Organization of Report

This project book consists of six chapter. The first chapter contains the statement of the introduction, our background study for the project, objectives of the study in the project, methodology and the project organization. Chapter two contains literature review. Chapter three describes the Hardware details which is already used to complete this project. Chapter four contains the software details. Chapter five deals with the design of this project, block diagram and circuit diagram, working principle. In the final chapter, we discuss about the result, cost estimation, advantages, application, future scope and conclusion of our project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter is arranged on Literature Review. Here's a look at some of last year's literature, like our project. By reading them, we can overcome the mistakes of the previous project and make a more effective project.

2.2 Literature Review

"Forest Guardian" [1] is a system that detects the sound produced by deforestation activities using acoustic signal evaluation and network node communication principles. This system has brought improvements such as permanent monitoring of critical forest areas and rapid response to deforestation activities at a theoretical level. The proposed system architecture is a modular one, which means that system functionality can be extended by adding new modules (scalability). A set of sensors is used to record environmental sounds. In the case of detection of deforestation activities in the monitored area, Forest Guardian instantly sends a notification (e-mail, SMS, etc.) to those responsible so that they can intervene to stop the illegal deforestation. All areas in danger can be accessed on a map via a web application.

Rainforest Connection (RFCx) [2] is a Forest Guardian implementation that uses mobile phones as network nodes and solar panels to charge the battery. The nodes are individually mounted on the shafts and their position is set to allow their superposition for detection and communication purposes.

In [3] a method to identify areas suspected of forest fires occurrence is proposed. This kind of forest disaster is a nonlinear problem that is difficult to assess and predict. The proposed method uses artificial intelligence, namely the neurofuzzy interface, for classification in two classes, forest fire and non-fire. Furthermore, cloud computing can be used for processing time critical data [4].

A forest fire detection system is also described in [5]. The proposed system consists of a processing unit (Raspberry Pi) and three sensors: motion sensor, temperature sensor, and

a gas sensor. The motion sensor is used to prevent the destruction of the system from wildlife. The two environmental sensors (temperature and gas sensors) are configured to detect temperature value and gas concentration.

On the other hand, in [6] it is described how security in IoT can be managed using cryptographic operations. For implementation, an MSP430 ultra-low power microcontroller is used, proving that security issues can be managed with limited resources in terms of time and memory. This is a step further in protecting the IoT and WSN concepts since they may rely on such low-power, low-resources devices.

Dimitropoulos (2015) [7] proposed an algorithm where a computer vision approach for fire-flame detection is used to detect fire at an early stage. Initially, background subtraction and color analysis is used to define candidate fire regions in a frame and this approach is a non-parametric model. Following this, the fire behavior is modeled by employing various Spatiotemporal features such as color probability, flickering, spatial and spatiotemporal energy. After flame modeling the dynamic texture analysis is applied in each candidate region using Linear Dynamical Systems, Histogram and Mediods. LDS is used to increase the robustness of the algorithm by analyzing temporal evolution of pixel intensities. Pre-processing is done after this to filter non-candidate regions. Spatiotemporal analysis is done to increase the reliability of the algorithm. The consistency of each candidate fire region is estimated to determine the existence of fire in neighboring blocks from the current and previous video frames. Finally, a two-class SVM classifier is used to classify the fire and no fire regions.

Osman Gunay and Habiboglu [8] proposed a system based on Covariance Descriptors, Color Models, and SVM Classifier. This system uses video data. Spatio-temporal Covariance Matrix (2011) [9] is used in this system which divides the video data into temporal blocks and computes covariance features. The fire is detected using this feature. SVM Classifier is used to filer fire and fire-like regions. This system supports only for clear data not for blur data.

Cheng (2011) [10] proposed a fire detection system based on Neural Network; here neural network is used in detection information for temperature, CO concentration, and smoke density to determine probability of three representative fire conditions. RBF

neuron structure is used, the information regarding temperature, CO concentration, and smoke density are collected and data fusion is used to generate fire signal decision. The detectors have continuous analog outputs, when detection limit is exceeded the hardware circuit sends a local fire indication to fusion center, this force the system detectors to generate final decision. Single-sensor detector is used to generate the final decision.

Hamed Adab [11] proposed another system which is based on Indexing. GIS techniques and remote sensing [12] provides further assistance. The indexing may be structural fire index, Fire risk index, Hybrid fire index. Depending on the geographical condition of the area the indexing differs. Validations of indices are based on hot spot data. Structural fire indices show static information and it does not change over short time span and used to predict the risk in advance. Fire risk index changes as the vegetation or climate changes. Hybrid index is a combination of Structure and Fire index. The disadvantage of this indexing is that way of combining.

P. Piccinini, S. Calderara, and R. Cucchiara [13] proposed a method based on the wavelet model and a color model of the smoke. The proposed method exploits two features: the variation of energy in wavelet model and a color model of the smoke. Smoke is detected based on the decrease of energy ratio in wavelet domain between background and current. The deviation of the current pixel color is measured by the color model. Bayesian classifier is used to combine these two features to detect smoke.

Surapong Surit, Watchara Chatwiriya [14] proposed a method to detect fire by smoke detection in video. This approach is based on digital image processing approach with static and dynamic characteristic analysis. The proposed method is composed of following steps, the first is to detect the area of change in the current input frame in comparison with the background image, the second step is to locate regions of interest (ROIs) by connected component algorithm, the area of ROI is calculated by convex hull algorithm and segments the area of change from image, the third step is to calculate static and dynamic characteristics, using this result we decide whether the object detected is the smoke or not. The result shows that this method accurately detects fire smoke.

Paulo Vinicius Koerich Borges [15] proposed a fire detection method based on probabilistic method and classification. Computer vision based approach is used in this approach. Though this approach is used surveillance it is also used to automatic video classification for retrieval of fire catastrophes in databases of newscast content. There are large variations in fire and background characteristics depending on the video instance. The proposed method observes the frame-to-frame changes of low-level features describing potential fire regions. These features include color, area size, surface coarseness, boundary roughness, and skewness within estimated fire regions.

2.3 Summary

The above has been discussed in detail in the past few literature's which has given us a lot of motivation to do this project.

CHAPTER 3
HARDWARE ANALYSIS

3.1 Introduction

In this chapter we introduce the components which are used in our project to complete project. This project is a combination of software and hardware. The whole system controlled by Arduino Nano. Here we use various kind of hardware. Power supply, sensor and controller. This hardware and software which we use to make this project is given below.

3.2 Required Instrument

- ✓ Arduino Nano
- ✓ Battery
- ✓ GSM Module
- ✓ LCD Display
- ✓ Buck Converter
- ✓ Solar panel
- ✓ Relay
- ✓ Pump Motor
- ✓ Flame Sensor
- ✓ Temperature Sensor
- ✓ Buzzer

3.3 Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

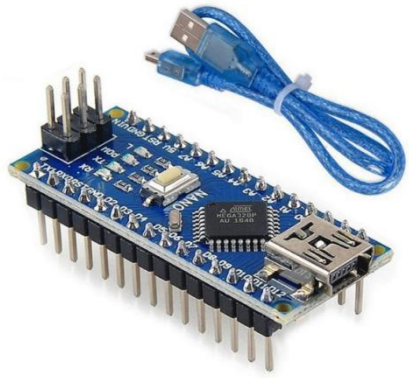


Figure 3.1: Arduino Nano

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Maxims'). Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a small, complete, and breadboard friendly component. It has everything that Decimal/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano can automatically sense and switch to the higher potential source of power.

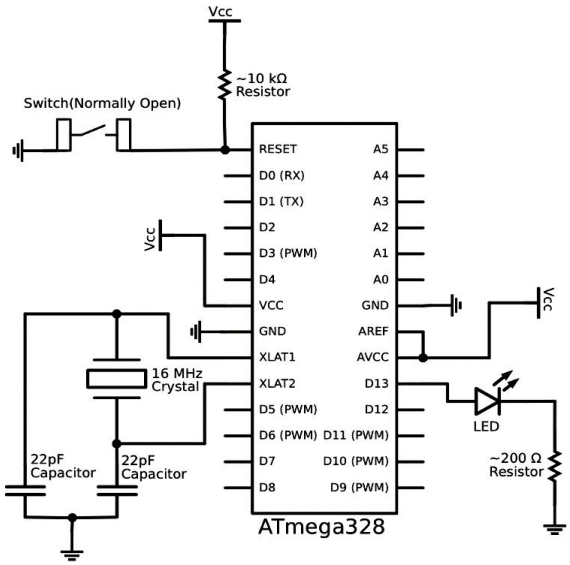


Figure 3.2: Arduino Nano Schematic Diagram

Nano's got the breadboard-ability of the Boarding and the Minibus with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It has two layers. That make it easier to hack and more affordable. One of the best features of Arduino Nano is, it's easy to use, compact and also small.

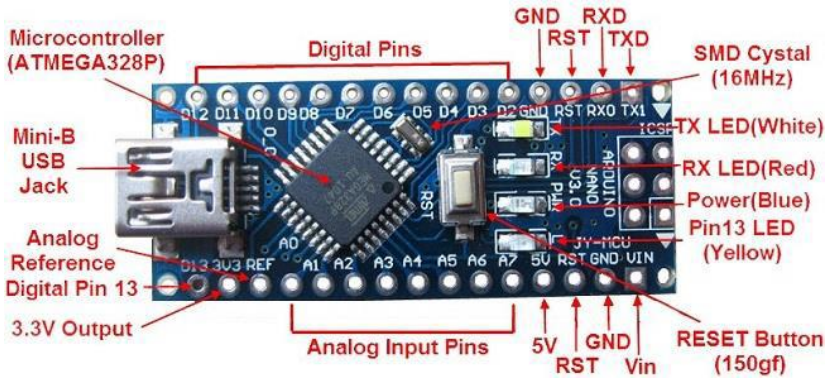


Figure 3.3: How Arduino Nano looks like

Specifications

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70" x 1.70"

Features

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Manual reset switch

Micro-controller IC ATmega328p



Figure 3.4: Micro-controller IC AT mega 328p

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB 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, a 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. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz, balancing power consumption and processing speed.

3.4 Solar Panel

This solar panel is used to make it expose towards sunlight and to show that harvesting of energy occurs.A solar panel is a technology that uses the photoelectric effect to transfer charge carriers between two separate layers. The separated charges create a volt- age difference. The two voltage levels can be connected to an electrical circuit to generate a direct current through the circuit.Concentrated solar panels have optics that capture sunlight directly, so the solar panel must be positioned at the correct angle to capture the energy. The concentrated solar energy systems are equipped with tracking systems, as the systems cannot generate energy if they are not correctly aligned with the sun. The voltage of the solar panel may not be constant at all times since the light intensity of the sun changes throughout day.

$$P = V * I$$



Figure 3.5: Solar Panel

Where,

- ✓ P as power (W)
- ✓ V as voltage (V)
- ✓ I as current (A)

According to Lambert's cosine law, the radiant energy measurement on a Lam- bert reflecting surface is directly proportional to the cosine of the angle formed by the measurement point and the surface normal. Accordingly, the illuminance incident on a surface varies as the cosine of the angle of incidence. At an oblique angle, the measurement area perpendicular to the incident light beam is much.Smaller, so the energy is distributed over a larger area than when the incident radiation is perpendicular to the

surface. Assuming a fixed surface, the amount of exposed energy decreases significantly as the source approaches the grazing incidence. Grazing incidence refers to situations where the irradiance or illumination is almost parallel to the incident surface, i.e. the angle of incidence is very close to 90 degrees .

3.5 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

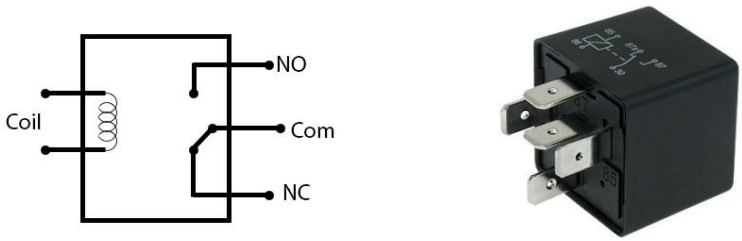


Figure 3.6: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts. Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is

reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands. The relay module is the one in the figure below.

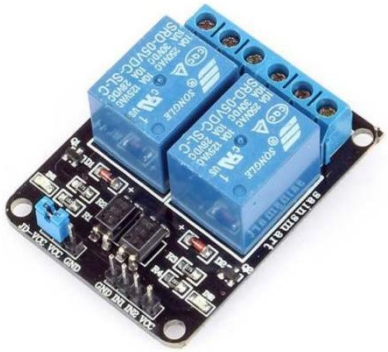


Figure 3.7: Relay Module.

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Main's voltage connections.

In relation to mains voltage, relays have 3 possible connections:

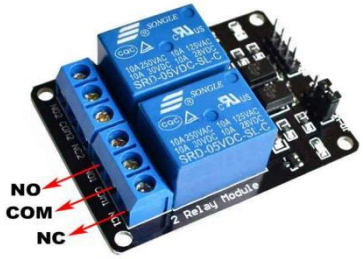


Figure 3.8: Main's voltage connections.

COM: Common pin

NO (Normally Open): There is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): There is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.



Figure 3.9: Voltage Connections

Pin wiring

The connections between the relay module and the Arduino are really simple:

GND: Goes to ground

IN: Controls the first relay (it will be connected to an Arduino digital pin)

IN2: Controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it)

VCC: Goes to 5V

3.6 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.



Figure 3.10: Pump Motor

Feature

- Operating Current : 130 ~ 220mA
- Flow Rate : 80 ~ 120 L/H
- Maximum Lift : 40 ~ 110 mm
- Continuous Working Life : 500 hours
- Driving Mode : DC, Magnetic Driving
- Material : Engineering Plastic
- Outlet Outside Diameter : 7.5 mm
- Outlet Inside Diameter : 5 mm

3.7 Temperature Sensor

The DHT11 is a basic, ultra-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). It's fairly simple to use, but requires careful timing to grab data.

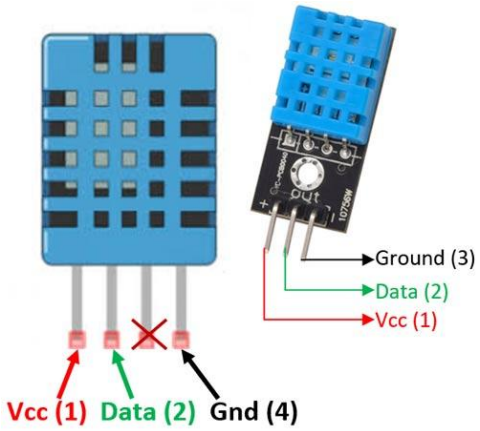


Figure 3.11: DHT11 Temperature Sensor

DHT11 Specifications

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%

- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

3.8 Flame Sensor

The flame sensor can detect flame and infrared light sources with wavelengths ranging from 760 nm to 1100 nm. It uses the LM393 comparator chip, which gives a clean, stable digital output signal and driving ability of 15 mA. This flame detector that can be used in fire alarms and other fire detecting devices.

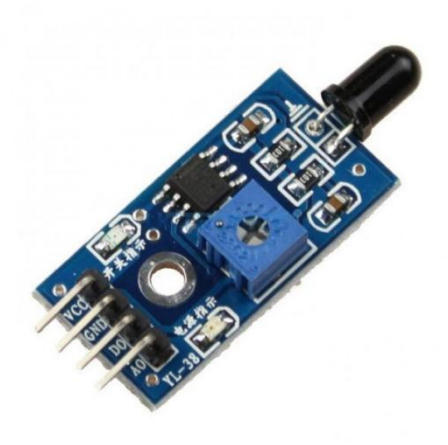


Figure 3.12: Flame Sensor

Specifications

- LM393 comparator chip
- Detection Range: 760 nm to 1100 nm
- Operating Voltage: 3.3 V to 5 V
- Maximum Output Current: 15 mA
- Digital Outputs: 0 and 1
- Detection Angle: about 60 degrees
- Adjustable sensitivity via potentiometer
- LED lights indicators: power (red) and
- digital switching output (green)
- Fixed bolt holes for easy installation
- PCB Size: 32 x 14 mm

3.9 Battery

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium-ion or a lithium-polymer,[1] which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound.



Figure 3.13: 3.7V Battery

Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistry, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode, that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

Product Specification

Table 1: Battery Specification

Voltage	3.7 V
Product Type	Lithium-Ion
Battery Capacity	2200mAh
Weight	45 g
Model Number	ICR 18650

3.10 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.



Figure 3.14: DC -DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

3.11 LCD Display

The LCD (liquid crystal display) screen is an electronic display module and looks for various applications. A 16x2 LCD display is a very basic module and it is very commonly used in various devices and circuits. These modules are preferred over seven sections and many other segments.



Figure 3.15: 16*2 LCD Display

The reasons for having LCD are economic; Easily programmable, special and even custom characters (different in seven sections), there are no restrictions on displaying animations. A 16x2 LCD means it can display 16 characters per line and contains 2 lines. Each character on this LCD is displayed in a 5x7 pixel matrix.

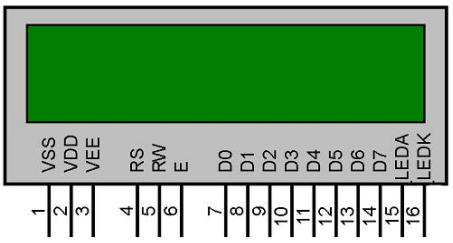


Figure 3.16: Pin out of 16*2 LCD Display

This LCD contains two articles called Command and Data. The command register stores the command instructions on the LCD. The command is a command given to the LCD to perform a predefined task such as starting it, clearing its screen, locating the cursor, controlling the display, etc.

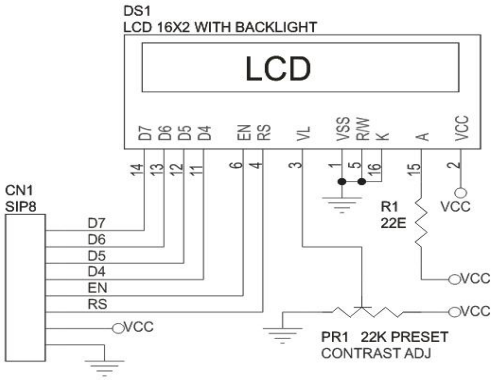


Figure 3.17: 16*2 LCD Display interfacing with Arduino

Feature

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers

3.12 GSM Module

At the heart of the module is a SIM800L GSM cellular chip from Sim Com. The operating voltage of the chip is from 3.4V to 4.4V, which makes it an ideal candidate for direct LiPo battery supply. This makes it a good choice for embedding into projects without a lot of space.



Figure 3.18: GSM Module

All the necessary data pins of SIM800L GSM chip are broken out to a 0.1″ pitch headers. This includes pins required for communication with a microcontroller over UART. The module supports baud rate from 1200bps to 115200bps with Auto-Baud detection.

The module needs an external antenna to connect to a network. The module usually comes with a Helical Antenna and solders directly to NET pin on PCB. The board also has a U.FL connector facility in case you want to keep the antenna away from the board.

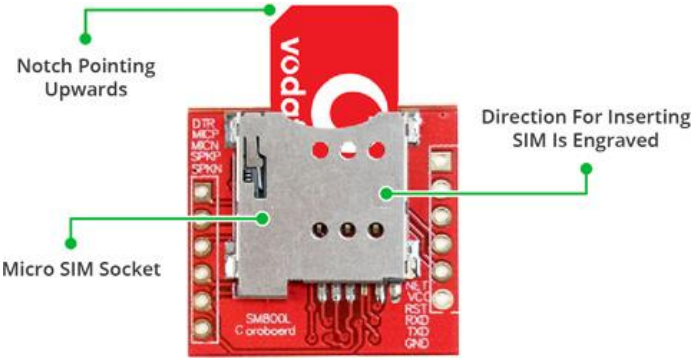


Figure 3.19: GSM Module Introducing

There's a SIM socket on the back! Any activated, 2G micro SIM card would work perfectly. Correct direction for inserting SIM card is normally engraved on the surface of the SIM socket. This module measures only 1 inch² but packs a surprising amount of features into its little frame. Some of them are listed below:

- Supports Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Connect onto any global GSM network with any 2G SIM
- Make and receive voice calls using an external 8Ω speaker & electret microphone
- Send and receive SMS messages
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- Scan and receive FM radio broadcasts
- Transmit Power:
    - Class 4 (2W) for GSM850
    - Class 1 (1W) for DCS1800
- Serial-based AT Command Set
- FL connectors for cell antennae
- Accepts Micro SIM Card

SIM800L GSM Module Pinout

The SIM800L module has total 12 pins that interface it to the outside world. The connections are as follows:



Figure 3.20: GSM Module Pinout

- NET is a pin where you can solder Helical Antenna provided along with the module.
- VCC supplies power for the module. This can be anywhere from 3.4V to 4.4 volts. Remember connecting it to 5V pin will likely destroy your module! It doesn't even run on 3.3 V! An external power source like Li-Po battery or DC-DC buck converters rated 3.7V 2A would work.
- RST (Reset) is a hard reset pin. If you absolutely got the module in a bad space, pull this pin low for 100ms to perform a hard reset.

- RxD (Receiver) pin is used for serial communication.
- TxD (Transmitter) pin is used for serial communication.
- GND is the Ground Pin and needs to be connected to GND pin on the Arduino.
- RING pin acts as a Ring Indicator. It is basically the 'interrupt' out pin from the module. It is by default high and will pulse low for 120ms when a call is received. It can also be configured to pulse when an SMS is received.
- DTR pin activates/deactivates sleep mode. Pulling it HIGH will put module in sleep mode, disabling serial communication. Pulling it LOW will wake the module up.
- MIC± is a differential microphone input. The two microphone pins can be connected directly to these pins.
- SPK± is a differential speaker interface. The two pins of a speaker can be tied directly to these two pins.

3.13 Buzzer

Piezo elements are actually one of the coolest crystals you'll play with. Flex them, they generate a voltage (pretty high, actually). Pass power through them, and they'll flex. Do it fast enough, and they'll start to make a sound! So besides making annoying little `beep` noises, you could use it as a sensor to detect a knock or other similar vibration.



Figure 3.21: Buzzer

Specifications

- Operating Voltage: 1.0 ~ 20.0V
- Rated Voltage: 3.0V
- Diameter: Ø12.5mm
- Total Height: 6.3mm
- Capacitance: 15,000pF
- Current Consumption: ≤2mA
- Resonance Frequency: 4,000Hz
- Sound Pressure Level at 10cm: ≥75db

CHAPTER 4
SOFTWARE ANALYSIS

4.1 Introduction

In this section the product utilized and the language in which the program code is characterized is referenced and the program code dumping devices are clarified. The part likewise reports the improvement of the program for the application

4.2 Software

- Arduino IDE
- Easy EDA

4.3 Arduino Software

The digital micro-controller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the micro controller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer. Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the micro controller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. The Arduino Nano is one of the latest digital micro controller units and has a number of facilities for communicating with a computer, another Arduino, or other micro-controllers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as

a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs.

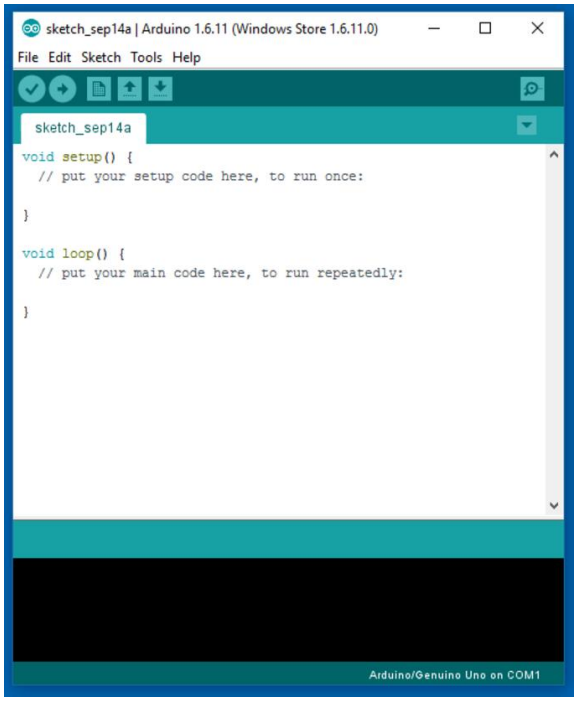


Figure 4.1: Arduino Software Interface IDE

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by

the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, boot-loaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "Arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

4.4 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

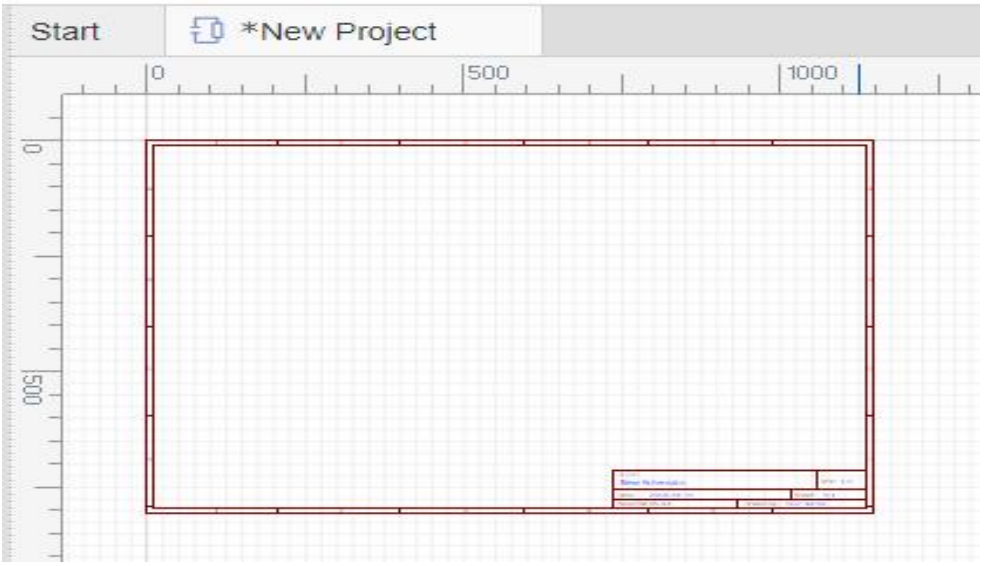


Figure 4.2: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER 5

SYSTEM ANALYSIS

5.1 System Analysis

The complete system is built around the Arduino Nano, which uses the ATmega328P microcontroller as its CPU. It operates on a constant 5V DC supplied to the VIN pin, powered by a battery and regulated through a power supply. Flame and temperature sensors are connected to the I/O pins of the Arduino Nano to detect fire conditions. The system is designed for efficient fire monitoring and real-time response in remote areas.

5.2 Block Diagram

Here is the block diagram of the GSM Based Solar Power Forest Fire Detection and Prevention System with all the essential components. All of the components are shown in below as a block in this diagram.Here we use Arduino Nano Micro-controller of our project. Other equipment's are attached with this micro-controller and work together for perform as our desire outcome.

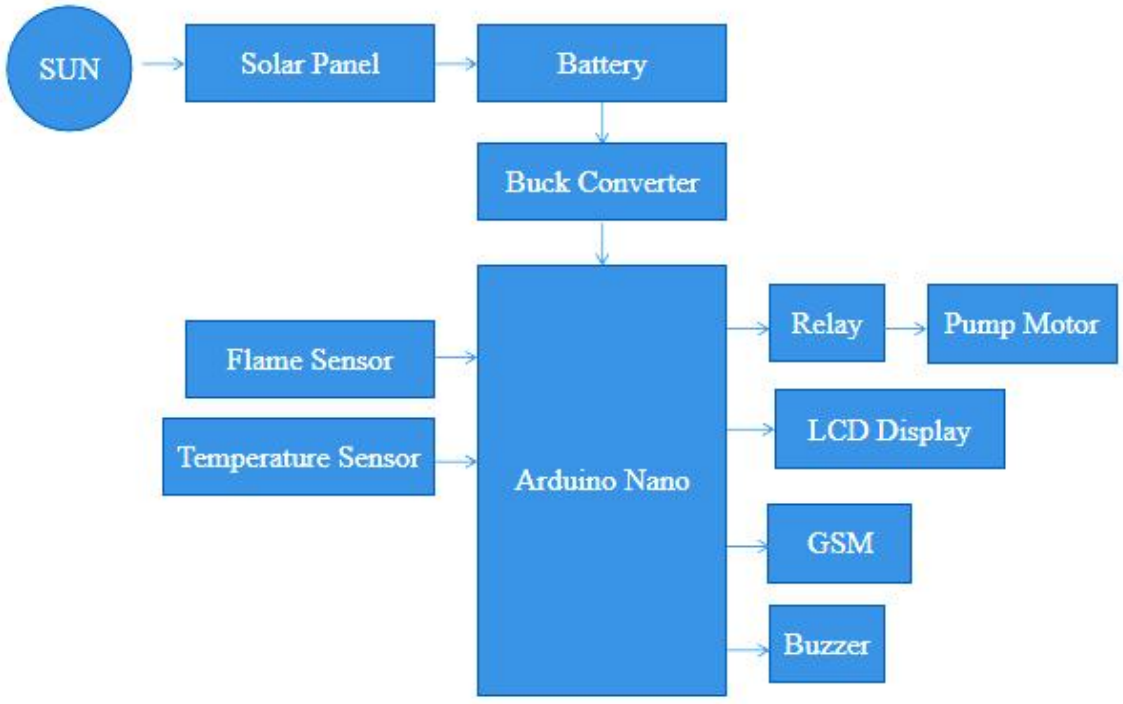


Figure 5.1: Block diagram

5.3 Circuit Diagram

The schematic diagram here is representing the electrical circuit and the components of the GSM Based Solar Power Forest Fire Detection and Prevention System. Here we connect equipment with he smart wire connection.

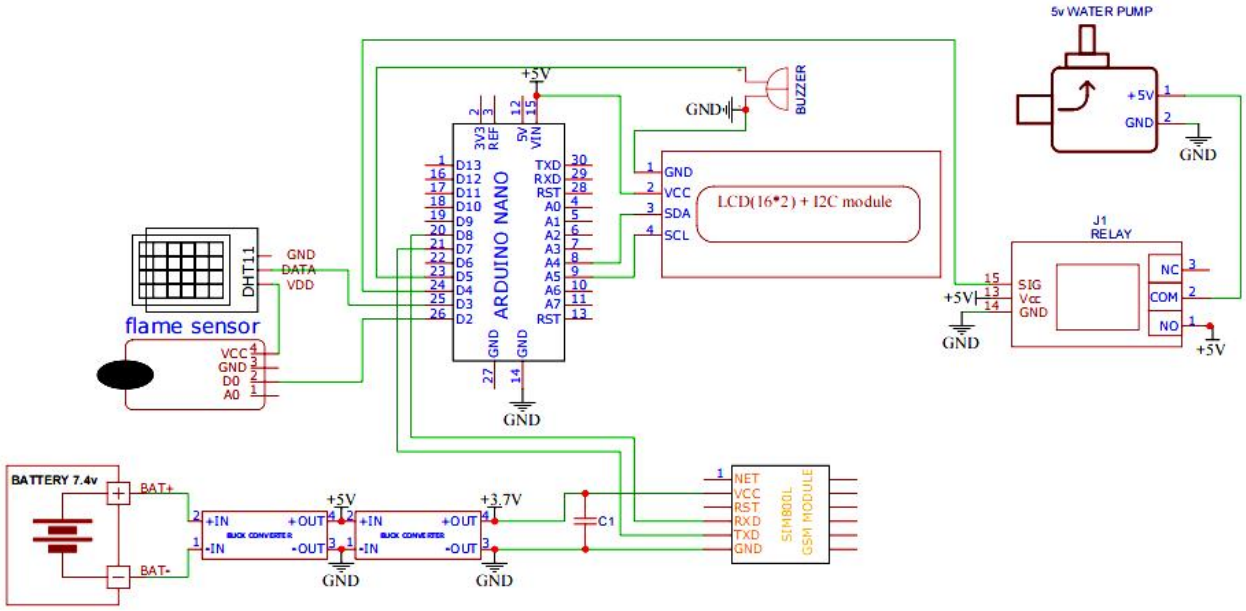


Figure 5.2: Circuit Design

5.4 Working Principle

The GSM-Based Solar Power Forest Fire Detection and Prevention System uses an Arduino Nano as the main controller, powered by a battery charged through a solar panel. A buck converter regulates the voltage to ensure stable 5V supply. Flame and temperature sensors continuously monitor the environment for signs of fire. When abnormal readings are detected, the Arduino activates a relay to turn on the pump motor for fire suppression and triggers a buzzer for local alert. Simultaneously, the GSM module sends an SMS notification to forest authorities for immediate action. The LCD display shows real-time temperature and flame status for easy monitoring. This autonomous, solar-powered system ensures reliable fire detection and prevention in remote forest areas, enhancing safety and environmental protection.

CHAPTER 6

RESULT & CONCLUSION

6.1 Experimental Setup

Node MCU is the base of the system. The inputs given to the microchip are the outputs of module which we used in our system.

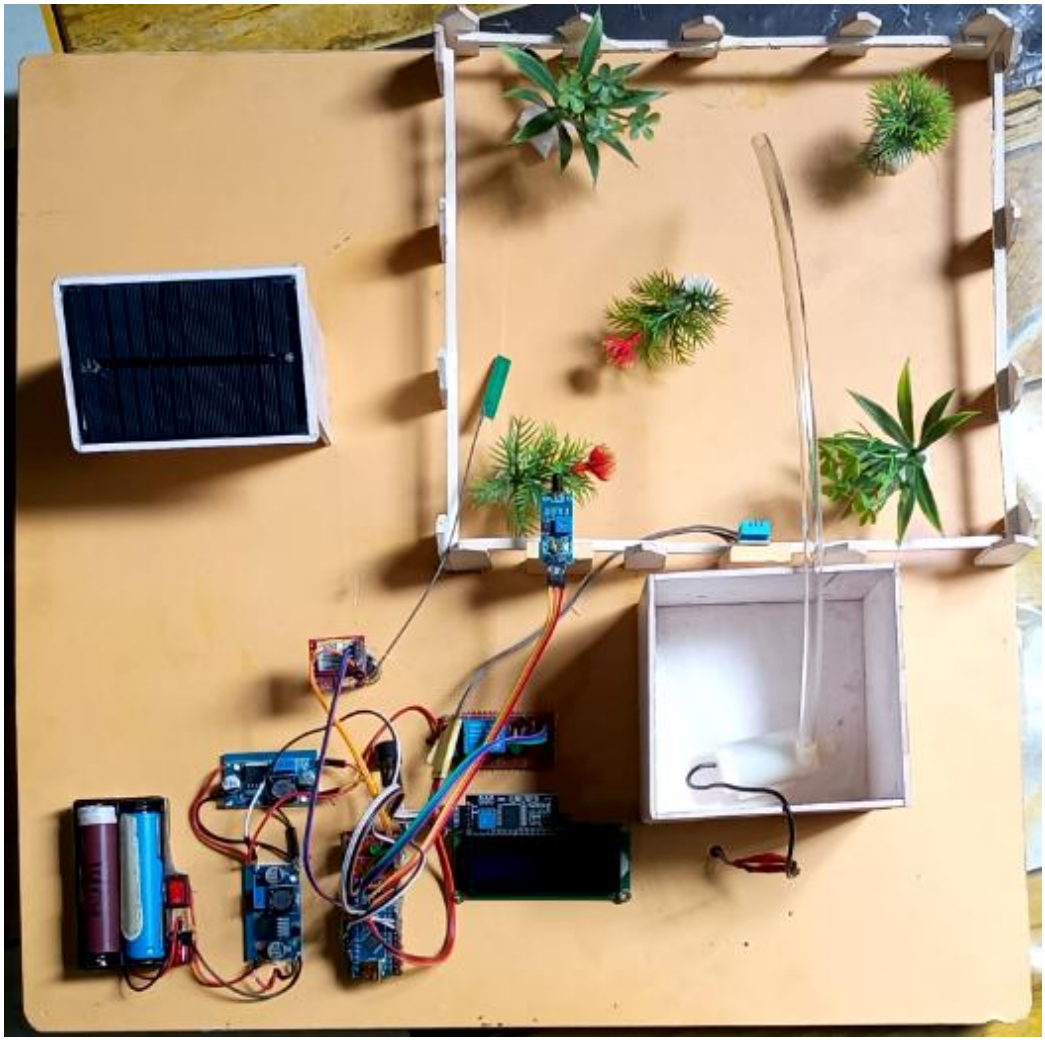


Figure 6.1: Our Complete Project Prototype Image

6.2 Result

After finally completing this project, we ran it & we observed the output of this project. We can see that it is working well as expected. After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- Finally, we have completed our project successfully & check our project its run accurately according to our objective.
- At first, we start our system.
- Solar panel and battery setup ensures uninterrupted operation even in remote, off-grid forest areas.
- Flame and temperature sensors successfully detect abnormal heat and fire presence in early stages.
- Buzzer alerts locally and GSM module sends SMS notifications promptly to authorities for fast response.
- Pump motor activation via relay delivers immediate fire control, minimizing potential damage.
- LCD display provides live updates of temperature and flame status for on-site awareness.
- GSM-based communication allows the system to function without internet or Wi-Fi, making it ideal for remote forests.

6.3 Cost Sheet

Table 2: Project Cost Analysis

SI No	Component Name	Specification	Qty	Unit Price	Total Price
01	Battery	3.7V	2	150	300
02	Arduino Nano	IC ATmega328p	1	600	600
03	Solar panel	mini	1	300	300
04	Pump Motor	DC 5V	1	250	250
05	Relay Module	5V	1	250	250
06	Flame Sensor		1	350	350
07	Temperature Sensor	DHT 11	1	300	300
08	LCD Display	16*2	1	400	400
09	GSM Module	SIM800L	1	450	450
10	Buck Converter	LM2596	2	150	300
11	Buzzer		1	50	50
12	Other			800	800
					4350/=

6.4 Advantages

There are many advantages of the project. Some of these are given below:

- The whole system is automatic system.
- Easy to use.
- Real-Time Data give
- Lowered Operation Costs
- Early fire detection
- Temperature monitoring
- Environment Friendly
- Wireless Communication

6.5 Application

This project has applications in many fields due its necessity. We have selected a few of them and they are given below:

- Forest fire detection
- National Parks and Reserves
- Eco-Tourism Zones
- Environmental monitoring

6.6 Limitation

Through the project has many advantages it has also some limitation, they are given below:

- This project can now be only used for small scale purposes
- Used cheap Chinese products for the prototype so there's some processing delay present in the circuit.
- No energy backup.

6.7 Future Works

There are some scopes for further work in improving the IoT online Irrigtion System**:**

- In the future we are looking forward to improved of our whole system design to make it more efficient.
- In future development this project can be develop by alarm System .
- In future, I will try it to apply in real field.

- In Future we will add extra power system.
- In future develop Control on IoT System

6.8 Conclusion

The GSM-Based Solar Power Forest Fire Detection and Prevention System presents an efficient, eco-friendly solution for early forest fire detection and response. By utilizing an Arduino Nano as the central controller, the system integrates flame and temperature sensors to monitor fire-prone areas in real-time. Its solar-powered design ensures continuous operation in remote locations, while the GSM module enables instant alerts to authorities via SMS, enhancing response speed. The inclusion of an automatic fire suppression mechanism using a pump motor and local alerts through a buzzer further strengthens the system's effectiveness. The LCD display provides clear on-site data visibility. Although limitations exist—such as dependency on GSM signals and limited sensor range—the system remains highly valuable for forest conservation. It offers a reliable, autonomous, and scalable solution that can significantly reduce forest fire damage and support environmental protection efforts. This project emphasizes the importance of integrating renewable energy and smart technology for sustainable forest management.

REFERENCE

[1] J. Papán, M. Jure_x0005_cka, J. Púchyová, “WSN for Forest Monitoring to Prevent Illegal Logging”, Proceedings of the Federated Cinference on Computer Science and Information Systems, pp. 809-812, 2012.

[2] RAINFOREST CONNECTION: Saving rainforests https://rfcx.org/our_work.html, accessed 15 February 2019

[3] H. Zhou, et al. "Dynamic Real-Time Infrastructure Planning and Deployment for Disaster Early Warning Systems." In International Conference on Computational Science, pp. 644-654, 2018

[4] D. T. Bui et al, “A hybrid artificial intelligence approach using GISbased neural-fuzzy inference system and particle swarm optimization for forest fire susceptibility modeling at a tropical area”, Agricultural and forest meteorology, 233, pp.32-44, 2017.

[5] Arasvathi, Nahalingham and Chelsea, Ferdyanti Kosasih “Study and Implementation of Internet of Things (IoT) Based Forest Fire Automation System to Detect and Prevent Wildfire”. INTI Journal, 1 (15), pp. 1-5, 2018.

[6] O. Raso et al. “Implementation of elliptic curve diffie hellman in ultralow power microcontroller” In: 2015 38th International Conference on Telecommunications and Signal Processing (TSP). pp. 662-666, 2015.

[7] Kosmas Dimitropoulos, Panagiotis Barmpoutis, and Nikos Grammalidis (2015). *Spatio Temporal Flame Modeling and Dynamic Texture Analysis for automatic video-based fire detection*, IEEE transactions on circuits and systems for video echnology, vol. 25, no. 2.

[8] Osman Gunay, A. Enis C ， Etin, Yusuf Hakan, Habiboglu. *Flame Detection method in video using Covariance descriptors*, IEEE transactions, 1817-1820.

[9] Yusuf Hakan Habibo˘glu, Osman Günay, A. Enis Çetin (2011). *Covariance matrix-based fire and flame detection method in video*", Springer-Verlag, 17.

[10] CHENG Caixia, SUN Fuchun, ZHOU Xinquan (2011). *One Fire Detection Method Using* Neural *Networks*, Tsinghua Science and Technology, ISSN 1007-0214 05/17 31-35Volume 16, Number 1.

[11] Hamed Adab, Kasturi Devi Kanniah, Karim Solaimani. *Modeling forest fire risk in the northeast of Iran using remote sensing and GIS techniques*, Springer Science+Business Media Dordrecht 2012.

[12] S. A. Christopher, M. Wang, T. A. Berendes, and R. M. Welch (1998). *The 1985 biomass burning season in South America: Satellite remote sensing of fires, smoke, and regional radiative energy budgets*, vol. 37, 661– 678.

[13] Surya.T.S, Suchithra.M.S. Survey on Different Smoke Detection Techniques Using Image Processing. *International Journal of Research in Computer and Communication Technology*, 16-19.

[14] Surapong Surit, Watchara Chatwiriya. *Forest Fire Smoke Detection in Video Based on Digital Image Processing Approach*.

[15] Paulo Vinicius Koerich Borges (2010). *A Probabilistic Approach for VisionBased Fire Detection in Videos*, IEEE transactions on circuits and systems for video technology, vol. 20, no. 5.

APPENDIX

Programme Code

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>   // scl=d1 & sda=d2
LiquidCrystal_I2C lcd(0x27, 16, 2);  // I2C address 0x27, 16 columns and 2 rows

#include <SoftwareSerial.h>
SoftwareSerial SIM900(7, 8);

// DHT11 setup
#include <DHT.h>
#define DHTPIN 3          // DHT11 data pin connected to digital pin 3
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

String textMessage;
char msg;
char phone_no[] = "+01794673920";
String message;
char str[15];

int fire_sensor = 2;
int pump = 4;
int buzzer =5;

void setup() {
  Serial.begin(9600);
  pinMode(fire_sensor, INPUT);
  pinMode(pump, OUTPUT);
  pinMode(buzzer, OUTPUT);

  lcd.init();
  lcd.backlight();

  SIM900.begin(9600);
  delay(200);
  SIM900.print("AT+CMGF=1\r");
  delay(100);
  SIM900.print("AT+CNMI=2,2,0,0,0\r");
  delay(100);
  SIM900.println("AT+CNMI=2,2,0,0,0");
  Serial.println("SIM900 ready...");

  dht.begin();  // Initialize DHT sensor
}

void loop() {
```

```
  int flame = digitalRead(fire_sensor);
  float temp = dht.readTemperature();    // Read temperature in Celsius
  int hum = dht.readHumidity();        // Read humidity

  // Display Temperature and Humidity
  lcd.setCursor(0, 1);
  lcd.print("T:");
  lcd.print(temp);
  lcd.print((char)223); // Degree symbol
  lcd.print("C ");
  lcd.print("H:");
  lcd.print(hum);
  lcd.print("%");

  if (SIM900.available() > 0) {
    textMessage = SIM900.readString();
    Serial.print(textMessage);
    delay(10);
  }

  Serial.println(flame);
  if (flame == 0) {
    lcd.setCursor(0, 0);
    lcd.print("Fire detected!   ");
    digitalWrite(pump, HIGH);
    digitalWrite(buzzer, HIGH);

    sendSMS("Fire Detected!!!!! Take necessary steps");
    delay(5000);
  } else {
    lcd.setCursor(0, 0);
    lcd.print("No Fire         ");
    digitalWrite(pump, LOW);
    digitalWrite(buzzer, LOW);
  }

  delay(2000); // Delay for DHT reading stability
}

void sendSMS(String message) {
  SIM900.println("AT+CMGF=1");
  delay(100);
  SIM900.print("AT+CMGS=\"+01794673920\"");
  SIM900.write(0x0D);
  delay(100);
  SIM900.println(message);
  delay(100);
  SIM900.write(0x1A);
  delay(100);
}
```