A Project Report

On

"SOLAR SEA WEATHER & POLLUTION MONITORING"

Thesis submitted in partial fulfilment of the requirement for the award of the degree of

Bachelor of Technology (B.TECH)

In

Electronics and Instrumentation Engineering

Under the esteemed guidance of

Dr. MVN CHAKRAVARTHI Ph.D

Assistant Professor, E.I.E Dept

Submitted By

M SANDEEP	(Y20AEI422)
B NAGATEJA	(L21AEI439)
G YASWANTH	(L21AEI443)
J YESU BABU	(L21AEI444)

Department of Electronics and Instrumentation Engineering

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CERTIFICATE

This is to certify that the project report work entitled "**SOLAR SEA WEATHER & POLLUTION MONITORING**" is the Bonafide work carried out by **M Sandeep (Y20AEI422), B Nagateja (L21AEI439), G Yaswanth (L21AEI443), J Yesu Babu (L21AEI444)** submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology (B. Tech) in Electronics and Instrumentation Engineering (EIE) by Acharya Nagarjuna University during the academic year 2023-2024.

DR. M.V.N Chakravarthi Ph.D	**DR. M.V.N Chakravarthi Ph.D**
Project Guide	**Head of the Department**
Assistant Professor, EIE Dept	Assistant Professor, EIE Dept

ACKNOWLEDGEMENT

We would like to express our sincere thanks to **Dr. Nazeer Shaik,** Principal of Bapatla Engineering College, Bapatla for their support during and till the completion of Project.

We are really thankful to **Dr. MVN Chakravarthi**, Assistant Professor and Head of the Department, Electronics and Instrumentation Engineering for providing the laboratory facilities to the fullest extent as and when required and also for giving me the opportunity to carry out the project work in the college.

We are profoundly grateful to express our deep gratitude and respect towards our guide **Dr. MVN Chakravarthi**, Assistant Professor for his excellent guidance right from selection of the project and his valuable suggestions throughout the project work. His constant encouragement and support have been the cause of my success, in completing this project in the college.

We take this opportunity to thank our entire faculty who has directly or indirectly helped in our project work.

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ABSTRACT

The project "Solar Sea Weather & Pollution Monitoring" aims to develop an innovative monitoring system tailored for marine environments, utilizing solar energy for sustainable operation. The system incorporates a range of sensors including pH level, turbidity, DHT11 for temperature and humidity, and an accelerometer to detect motion. These sensors are connected to an Arduino Nano, which acts as the central processing unit for data collection and transmission. Data is wirelessly transmitted to an output Arduino Nano, where it is displayed in real-time on a screen.

Key features include continuous monitoring of sea conditions, such as water quality and weather parameters, enabling proactive management of marine ecosystems. The system is powered by solar panels and rechargeable batteries, ensuring autonomy and reliability in remote sea locations. An alert mechanism triggers when predefined thresholds are exceeded, indicating potential environmental concerns. Overall, this project represents a technological advancement in environmental monitoring, providing a sustainable solution for effective sea weather and pollution assessment.

CHAPTER 1
INTRODUCTION

The "Solar Sea Weather & Pollution Monitoring" project introduces an innovative approach to addressing the challenges of monitoring sea weather and pollution in remote marine environments. By harnessing solar energy for power, the system ensures continuous operation and data collection without reliance on external power sources. This project aims to provide real-time data on pH levels, turbidity, temperature, humidity, and sea motion, enabling proactive measures to mitigate environmental impacts and enhance marine ecosystem management. The integration of Arduino-based technology and wireless communication enables efficient data transmission and display, facilitating informed decision-making for stakeholders involved in marine conservation and resource management.

1.1 Background:

It arises from the pressing need to address the unpredictability of sea weather and the growing concern of marine pollution. Current monitoring systems are limited by the lack of data networks at sea, necessitating the development of a self-sustaining system powered by solar energy to provide continuous and reliable data on sea conditions and pollution levels.

1.2 Purpose:

The purpose of the "Solar Sea Weather & Pollution Monitoring" project is to develop a self-sustaining monitoring system that can continuously track sea weather and pollution in remote marine locations. By utilizing solar power and advanced sensor technology, the project aims to provide accurate and real-time data to facilitate proactive environmental management and conservation efforts in marine ecosystems.

1.3 Objectives:

1. Develop a compact and efficient monitoring system powered by solar energy to enable continuous operation in remote marine environments.

2. Integrate sensors including pH level, turbidity, DHT11 for temperature and humidity, and an accelerometer for motion detection to accurately monitor sea conditions.

3. Implement Arduino Nano microcontrollers for data collection, processing, and wireless transmission of sensor data.

4. Establish a reliable wireless communication system using Transmitter and Receiver modules to transmit data to shore-based monitoring stations.

5. Display real-time data on pH levels, turbidity, temperature, and humidity values on an LCD screen for easy interpretation and analysis.

6. Set predefined thresholds for sensor values and implement an alert system (buzzer and LED) to notify stakeholders of critical deviations.

7. Ensure sustainability and autonomy by utilizing solar panels and rechargeable batteries for power supply.

8. Enhance environmental monitoring capabilities to detect and respond to changes in sea weather and pollution promptly.

9. Facilitate proactive measures for marine ecosystem management and conservation based on continuous and accurate data collection.

10. Validate system performance through rigorous testing and optimization to ensure reliability and effectiveness in marine monitoring applications.

CHAPTER 2
LITERATURE ANALYSIS

2.1 Literature Review:

The literature review for the "Solar Sea Weather & Pollution Monitoring" project encompasses various studies and research articles related to marine environmental monitoring, sensor technology, and sustainable energy solutions.

Firstly, studies focusing on marine pollution highlight the critical need for continuous monitoring to assess the impact of anthropogenic activities on marine ecosystems. Research has explored the use of sensors such as pH meters and turbidity sensors for water quality assessment in marine environments, emphasizing the importance of accurate and real-time data for effective pollution management strategies.

Secondly, the integration of solar energy in environmental monitoring systems has been extensively discussed in the literature. Solar-powered systems offer advantages such as autonomy and sustainability, making them suitable for remote marine locations where access to conventional power sources is limited. Research has explored the design and optimization of solar-powered sensor networks for marine applications, highlighting their potential for long-term monitoring of sea conditions.

Furthermore, literature on sensor technology has emphasized the role of Arduino microcontrollers in data acquisition and processing for environmental monitoring. Arduino-based systems provide a versatile platform for integrating multiple sensors and facilitating wireless data transmission, enabling efficient monitoring of pH levels, temperature, humidity, and sea motion in real-time.

2.2 Existing System:

Traditional granary management systems lack comprehensive monitoring capabilities, relying on manual checks and basic sensors. This approach may lead to delayed responses to environmental or security threats, putting stored grains at risk. The absence of integrated features like robbery detection and image capture limits the overall effectiveness of the existing systems.

2.3 Proposed System:

The proposed system for the "Solar Sea Weather & Pollution Monitoring" project consists of sensor nodes powered by solar panels and rechargeable batteries deployed in remote marine locations. These nodes include sensors for pH level, turbidity, temperature, humidity, and an accelerometer to monitor sea motion. Data collected by the sensor nodes is transmitted wirelessly using RF communication to a shore-based receiver unit equipped with an Arduino Nano for data processing and display on an LCD screen. An alert system is integrated to notify stakeholders of critical sensor readings, facilitating proactive environmental management in marine ecosystems.

CHAPTER 3

BLOCK DIAGRAM

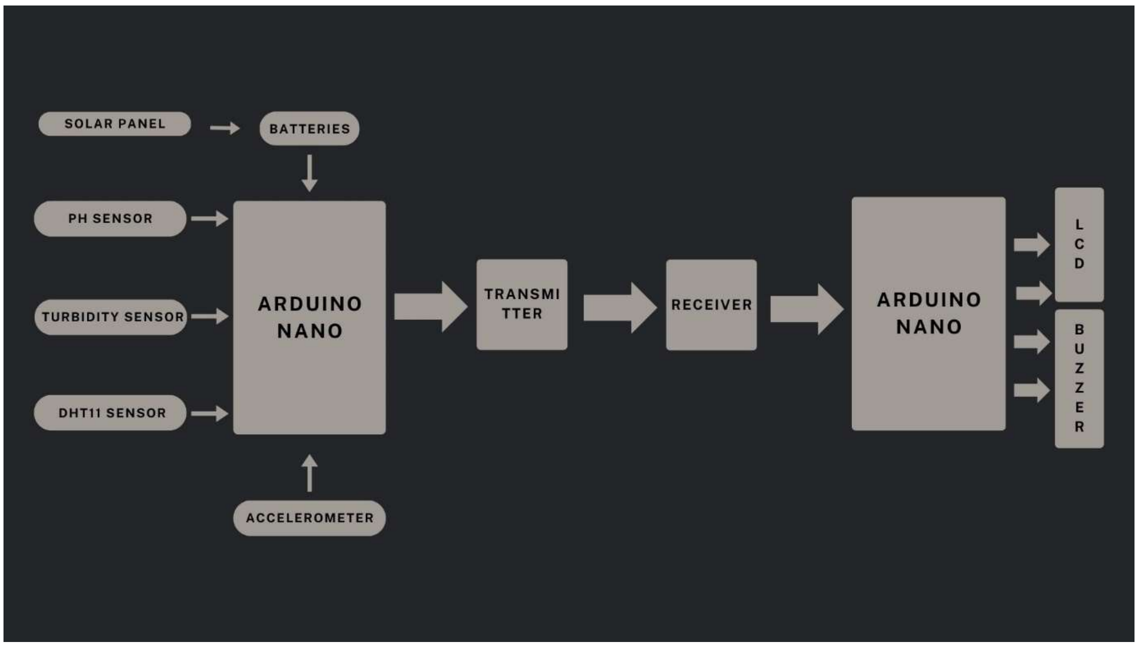

Fig 3.1 General Block Diagram

CHAPTER 4

IMPLEMENTATION OF HARDWARE

4.1 Arduino Nano:

The Arduino Nano is a small, versatile microcontroller board based on the ATmega328P chip, offering similar functionalities to the popular Arduino Uno but in a compact form factor. It features digital and analog input/output pins, onboard USB interface for programming and communication, and is widely used for prototyping and developing embedded systems and IoT applications due to its ease of use and flexibility.

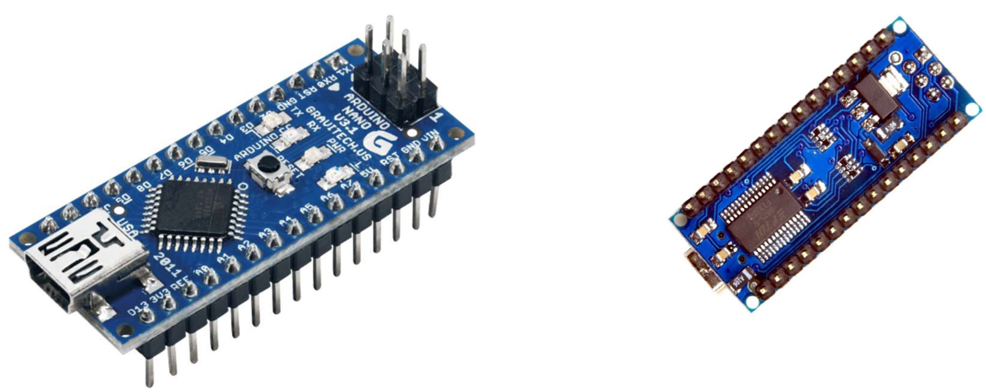

Fig 4.1.1 Arduino Nano:

Features:

The Arduino Nano offers the following key features:

1. Microcontroller: Based on the ATmega328P microcontroller, providing 32KB of flash memory (program space) and 2KB of SRAM.

2. Compact Size: Small form factor (approx. 18 x 45 mm) makes it suitable for projects with limited space requirements.

3. I/O Pins: 14 digital I/O pins (including 6 PWM outputs) and 8 analog inputs for interfacing with sensors, actuators, and other external components.

4. Integrated USB: Onboard USB interface for programming the board and serial communication with a computer.

5. Clock Speed: Operates at 16MHz clock frequency, supporting fast and responsive execution of program instructions.

6. Voltage Regulator: Built-in 5V voltage regulator, allowing the board to be powered via USB or an external power supply (7-12V DC).

7. Compatibility: Compatible with the Arduino IDE and supports various libraries and sketches available for the Arduino platform.

8. Peripheral Interfaces: Includes UART (serial), SPI, and I2C interfaces for communication with other devices and modules.

9. Reset Button: Integrated reset button for easy restarting and reprogramming of the board.

10. Cost-Effective: Relatively low-cost compared to other Arduino boards, making it ideal for hobbyists, students, and DIY projects.

Applications:

The Arduino Nano finds applications across various domains due to its compact size, versatility, and ease of use. Some common applications include:

1. Embedded Systems Prototyping: Arduino Nano is widely used for prototyping embedded systems and IoT devices due to its small form factor and extensive I/O capabilities.

2. Sensor Data Acquisition: It is used to interface with sensors (such as temperature, humidity, motion, etc.) to collect and process data for monitoring and control applications.

3. Robotics: Arduino Nano is popular for controlling and interfacing with motors, sensors, and actuators in robotic projects, ranging from small hobby robots to educational platforms.

4. Home Automation: It can be used to build DIY home automation systems for controlling lights, appliances, and security devices based on predefined conditions or user inputs.

5. Wearable Electronics: Arduino Nano's compact size makes it suitable for wearable electronics projects, enabling the development of smart clothing, health monitoring devices, and more.

6. Educational Projects: Arduino Nano is extensively used in educational settings for teaching electronics, programming, and robotics due to its simplicity and availability of learning resources.

7. Data Logging: It can be employed to create data logging systems for recording and analyzing environmental data (temperature, humidity, etc.) over time.

8. Remote Monitoring and Control: Arduino Nano-based systems can be used for remote monitoring and control applications, such as monitoring environmental conditions in remote locations or controlling devices over the internet.

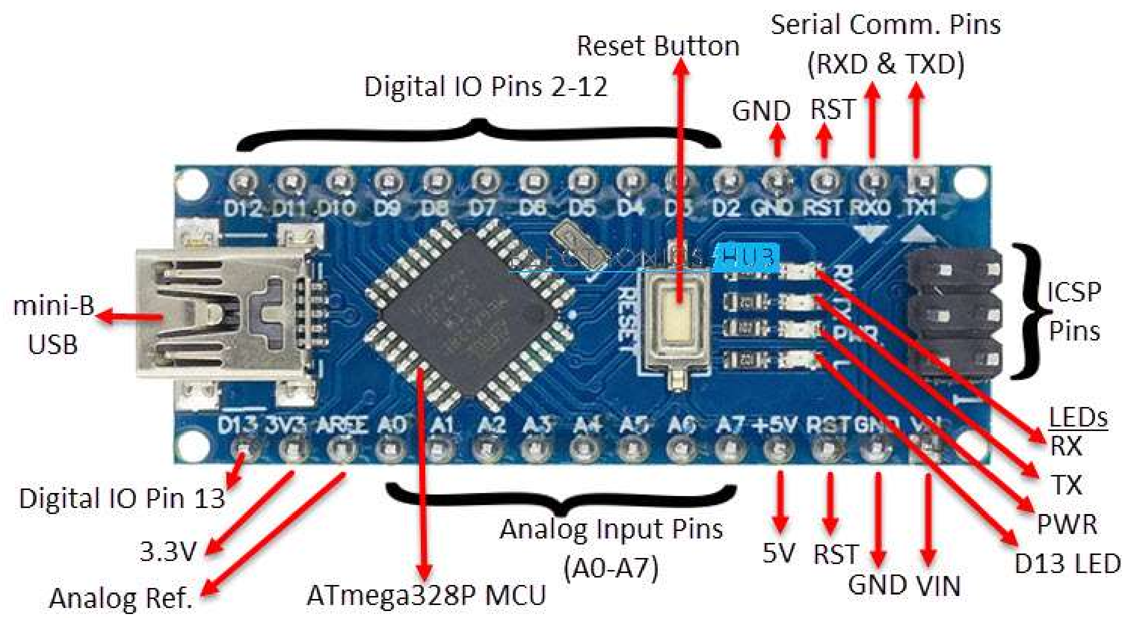

Fig 4.1.2 PIN Diagram

Conclusion:

The Arduino Nano features a pinout diagram that includes 14 digital I/O pins, 8 analog inputs, and multiple power and ground pins. These pins can be used to interface with sensors, actuators, displays, and other electronic components for versatile project development. The microcontroller at the heart of the Arduino Nano is the ATmega328P, which provides ample program memory, RAM, and various hardware interfaces like UART, SPI, and I2C, making it suitable for a wide range of embedded applications requiring compact size and flexibility. The combination of its pinout layout and powerful microcontroller makes the Arduino Nano an ideal choice for prototyping and building embedded systems and IoT devices.

4.2 RF Transmitter & Receiver:

For the "Solar Sea Weather & Pollution Monitoring" project, an RF (Radio Frequency) transmitter and receiver setup can be implemented using modules such as the NRF24L01. The RF transmitter module will be integrated with the Arduino Nano on the sensor unit to wirelessly transmit data to a shore-based receiver unit equipped with the RF receiver module. These modules communicate using a reliable and low-power RF protocol, enabling seamless transmission of sensor data over moderate distances in marine environments. The RF transmitter and receiver setup provides a robust and effective means of data communication for the monitoring system, enhancing the autonomy and flexibility.

Fig 4.2.1 RF Transmitter

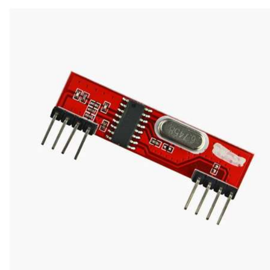

Fig 4.2.1.2 RF Receiver

Features:

The RF transmitter and receiver modules offer several features suitable for wireless communication applications:

Features of RF Transmitter:

1. Operating Frequency: Operates in the 2.4 GHz ISM band, providing good range and penetration capabilities.

4. Power Consumption: Low power consumption, suitable for battery-operated devices and IoT applications.

5. Transmission Range: Offers a typical line-of-sight range of up to 100 meters, extendable with external antennas.

6. Addressing: Supports multiple channels and addresses for point-to-point and multi-node communication setups.

7. SPI Interface: Interfaces with microcontrollers like Arduino via SPI (Serial Peripheral Interface) for data exchange.

8. Automatic Retransmission: Includes automatic packet retransmission and error detection features for reliable data delivery.

Features of RF Receiver:

1. Compatibility: Interoperable with NRF24L01 transmitters, enabling bidirectional communication between devices.

2. Fast Switching: Quick channel switching capability for enhanced communication flexibility and interference avoidance.

3. Payload Size: Supports variable payload sizes up to 32 bytes per packet, suitable for transmitting sensor data efficiently.

4. Interrupt Pin: Provides an interrupt pin for efficient data handling and event-driven programming.

5. Power Supply: Operates at 1.9V to 3.6V supply voltage, compatible with standard microcontroller power sources.

Applications of 433MHz RF Transmitter:

1. Wireless Remote Controls: Used in remote control systems for operating devices such as garage doors, lighting systems, and home appliances.

2. Wireless Data Transmission: Enables simple and cost-effective wireless data transfer between electronic devices over short to moderate distances.

3. Weather Monitoring Systems: Integrated into weather stations to transmit sensor data (e.g., temperature, humidity) wirelessly to a central display unit.

4. Security Systems: Employed in security alarms and surveillance systems for transmitting signals from sensors (e.g., door/window sensors, motion detectors) to a central control panel.

5. Keyless Entry Systems: Utilized in keyless entry systems for vehicles and buildings, allowing secure wireless access control.

6. Remote Sensing Applications: Used in IoT (Internet of Things) applications for remote monitoring and control of sensors and actuators.

7. Wireless Audio Transmission: Supports wireless audio streaming from audio sources to speakers or headphones.

Applications of 433MHz RF Receiver:

1. Wireless Sensor Networks: Integrated into wireless sensor networks (WSNs) for collecting data from distributed sensors in industrial and environmental monitoring applications.

2. Home Automation: Used in smart home systems to receive signals from remote controls or sensor nodes for controlling home devices.

3. Telemetry Systems: Employed in telemetry applications for collecting and transmitting data wirelessly from remote locations.

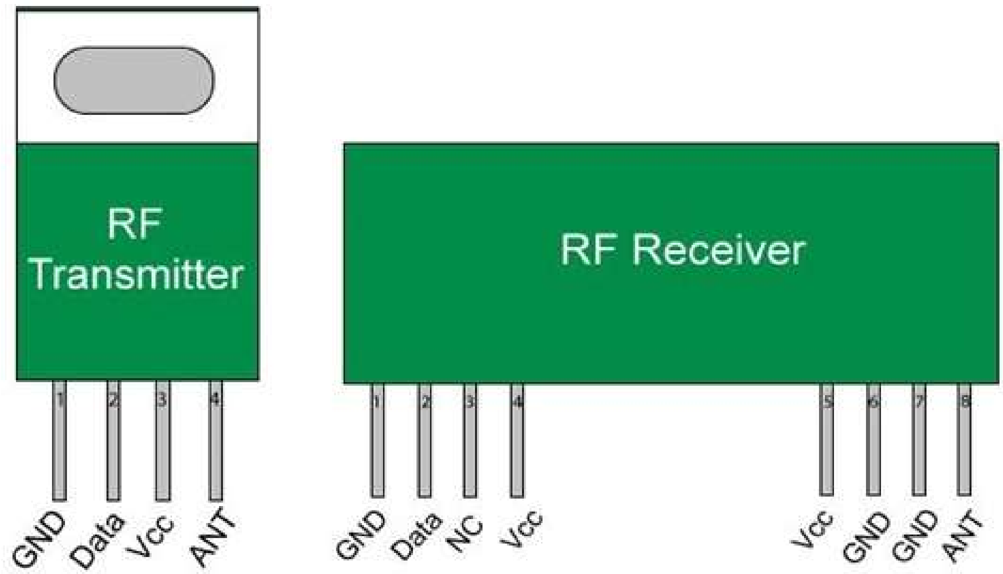

Fig 4.2.2 PIN Diagram

Conclusion:

In conclusion, the 433MHz RF transmitter and receiver modules offer a cost-effective and versatile solution for wireless communication needs across various applications. Their simplicity, reliability, and moderate range make them suitable for a wide range of projects, from simple remote controls to more complex telemetry and sensor networks. With easy integration into microcontroller-based systems like Arduino, these modules enable seamless wireless data transmission, providing flexibility and convenience in the development of remote monitoring, control, and automation systems. Despite their limitations in data rate and range compared to higher-frequency alternatives, the 433MHz RF modules remain popular choices due to their affordability, ease of use, and compatibility with a wide range of devices and applications.

4.3 DHT11 Sensor:

The DHT11 sensor is a low-cost digital temperature and humidity sensor module capable of measuring ambient temperature from 0 to 50°C and relative humidity from 20% to 80%. It communicates with microcontrollers like Arduino using a single-wire digital interface, providing accurate and reliable temperature and humidity readings for various indoor environmental monitoring applications. The sensor's simplicity and affordability make it a popular choice for hobbyist projects and basic weather monitoring systems.

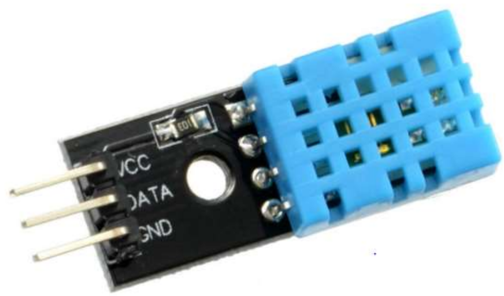

Fig 4.3.1 PIN Diagram

Working Principle:

The DHT11 sensor utilizes a thermistor to measure temperature and a capacitive humidity sensor to measure relative humidity. It converts the analog temperature and humidity readings into digital signals, which can be read by a microcontroller like Arduino through a single-wire digital interface (one-wire protocol). The sensor communicates with the microcontroller by sending data packets containing the temperature and humidity values, which can then be processed and used in various applications.

Applications:

The DHT11 sensor is commonly used in various applications for measuring temperature and humidity due to its simplicity and affordability:

1. Home Automation: Integrating DHT11 sensors into smart home systems allows for monitoring indoor temperature and humidity levels, enabling automated control of heating, ventilation, and air conditioning (HVAC) systems.

2. Weather Stations: DHT11 sensors are used in DIY weather stations to measure ambient temperature and humidity, providing real-time weather data for hobbyists and enthusiasts.

3. Environmental Monitoring: These sensors are employed in environmental monitoring systems to track temperature and humidity levels in controlled environments such as greenhouses, warehouses, and storage facilities.

4. IoT (Internet of Things) Projects: DHT11 sensors are commonly integrated into IoT projects for remote monitoring of indoor climate conditions, enabling data collection and analysis for various IoT applications.

Sensor Integration and Data Analysis:

Sensor integration involves connecting sensors like the DHT11 to microcontrollers such as Arduino for data acquisition, and subsequent data analysis involves processing and interpreting the sensor readings to derive meaningful insights or trigger actions based on predefined conditions.

Specifications:

1. Temperature Range: 0°C to 50°C (32°F to 122°F)
2. Temperature Accuracy: ±2°C

5. Operating Voltage: 3.3V to 5V DC

3. Humidity Range: 20% to 80% RH

6. Dimensions: 15.5mm x 12mm x 5.5mm

4. Humidity Accuracy: ±5% RH

4.4 pH Sensor:

A pH sensor is an electronic device used to measure the acidity or alkalinity of a liquid, typically water. It works based on the principle of electrochemistry, where changes in voltage or current are correlated with the pH level of the solution. pH sensors are widely used in various industries, including environmental monitoring, agriculture, water treatment, and food processing, to ensure optimal conditions and quality control.

Fig 4.4.1 pH Level Sensor

Working Principle:

The working principle of a pH level sensor involves measuring the electrical potential difference (voltage) generated between two electrodes immersed in the solution being tested. This potential difference varies with the acidity or alkalinity (pH) of the solution due to the concentration of hydrogen ions (H^+) present, allowing the sensor to determine the pH level based on the voltage measurement. The sensor's internal circuitry converts this voltage into a pH value that can be read and interpreted by a microcontroller or pH meter.

pH level Sensor Measurement and Interpretation:

The pH sensor measures the voltage difference generated between its electrodes in a solution, which corresponds to the acidity or alkalinity (pH) of the solution. This voltage is converted into a pH value using calibration data and formulas stored in the sensor's circuitry, allowing users to interpret the pH level of the solution based on the sensor's output. pH values below 7 indicate acidity, while values above 7 indicate alkalinity, with 7 considered neutral.

Applications:

The pH sensor has diverse applications across various industries and fields:

1. Water Quality Monitoring: Used in environmental monitoring and water treatment systems to assess the acidity or alkalinity of water bodies, ensuring compliance with regulatory standards and identifying potential contamination.

2. Agriculture: Employed in soil testing to determine soil pH levels, which impact nutrient availability and crop growth. pH sensors help optimize soil conditions for agricultural productivity.

3. Food and Beverage Industry: Utilized in food processing and beverage production to monitor pH levels during fermentation, brewing, and other processes to ensure product quality and consistency.

4. Chemical Processing: Integrated into chemical manufacturing processes to control reaction conditions, optimize yields, and ensure product quality by monitoring and adjusting pH levels.

5. Industrial Process Control: Incorporated into industrial processes such as electroplating, wastewater treatment, and pulp and paper production to optimize process efficiency and minimize environmental impact.

6. Biomedical and Pharmaceutical: Applied in laboratory settings for research and diagnostic purposes, including cell culture, drug development, and biomedical experiments that require precise pH control.

7. Aquaculture: Used in fish farming and aquaculture systems to monitor water quality parameters, including pH, to optimize fish health and growth.

Specifications for the pH Level sensor:

1. pH Range: Usually between 0 to 14 pH units, covering the entire pH scale from acidic to alkaline.

2. Accuracy: Typically ranging from ±0.1 to ±0.2 pH units, indicating the sensor's precision in pH measurement.

3. Response Time: Often in the range of a few seconds to a minute, indicating how quickly the sensor can stabilize and provide an accurate pH reading after immersion in a solution.

4. Operating Temperature: Typically from 0°C to 50°C (32°F to 122°F), although some sensors may have wider or narrower temperature ranges depending on the application.

5. Compatibility: pH sensors are available with various output types, including analog (voltage or current), digital (I2C, UART), or integrated into pH meters with display units.

6. Electrode Type: pH sensors can use different types of electrodes, such as glass electrodes for general-purpose applications or specialized electrodes for specific solutions or environments.

7. Body Material: pH sensor bodies are often made of materials resistant to corrosion and chemical degradation, such as glass, epoxy, or plastic.

4.5 Turbidity Sensors:

A turbidity sensor measures the cloudiness or haziness of a fluid caused by suspended particles. It typically works by emitting light into a sample and detecting the amount of light scattered or absorbed by particles in the fluid. The sensor output correlates with the turbidity level of the fluid, providing a quantitative measurement used in water quality monitoring, environmental assessment, and filtration system control.

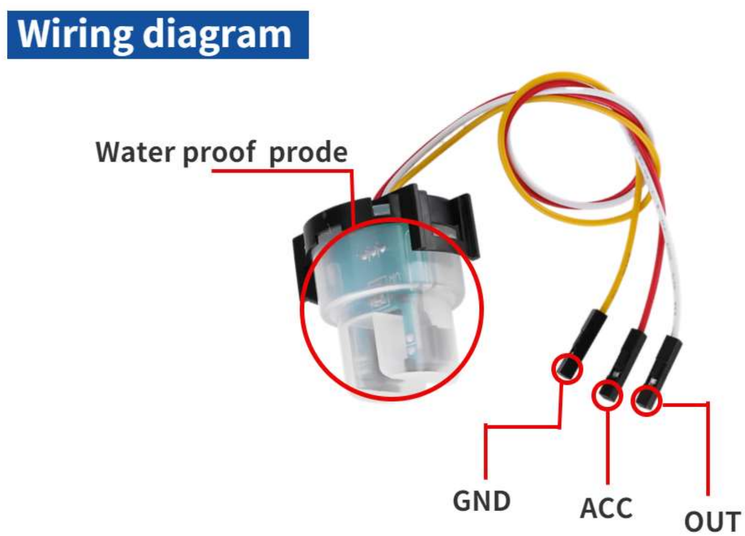

Fig 4.5.1 PIN Diagram

Working Principle:

The working principle of a turbidity sensor involves shining light into a sample of water or fluid and measuring the amount of light that is scattered or absorbed by suspended particles within the sample. The sensor detects changes in light intensity caused by the presence of particles, with higher turbidity levels resulting in greater light scattering or absorption. This change in light intensity is converted into an electrical signal that correlates with the turbidity or clarity of the fluid being measured.

Applications:

Turbidity sensors have various applications in environmental monitoring, water quality assessment, and industrial processes due to their ability to measure suspended particles in fluids. Some common applications include:

1. Water Quality Monitoring: Used in drinking water treatment plants and wastewater facilities to assess the clarity and quality of water by measuring turbidity levels. High turbidity can indicate the presence of contaminants or particles that affect water purity.

2. Environmental Monitoring: Turbidity sensors are employed in natural water bodies such as rivers, lakes, and oceans to monitor sediment levels, which can affect aquatic ecosystems and water clarity.

3. Aquaculture: Used in fish farming and aquaculture systems to monitor water quality parameters, including turbidity, which can impact fish health and growth.

4. Industrial Processes: Turbidity sensors are integrated into industrial processes such as food and beverage production, pharmaceutical manufacturing, and chemical processing to monitor and control the clarity of process fluids and ensure product quality.

5. Swimming Pool and Spa Maintenance: Turbidity sensors are used in swimming pool and spa systems to monitor water clarity and ensure optimal filtration and treatment to maintain safe and clean water conditions.

6. Environmental Impact Assessment: Turbidity measurements are utilized in environmental impact assessments for construction projects, dredging operations, and coastal developments to monitor sediment levels and assess potential impacts on marine life and habitats.

Sensor Integration and Data Analysis:

Sensor integration involves incorporating turbidity sensors into water quality monitoring systems to measure and quantify suspended particle levels. Data analysis of turbidity sensor readings allows for real-time assessment of water clarity and quality, enabling informed decision-making and timely interventions for environmental management and process control.

Specifications for the fire sensor:

1. Measurement Range: Commonly between 0 to 1000 NTU (Nephelometric Turbidity Units), covering a wide range of turbidity levels from clear to highly turbid water.

2. Accuracy: Typically ranging from ±2% to ±5% of the reading, indicating the sensor's precision in turbidity measurement.

3. Resolution: Often in the range of 0.01 to 1 NTU, representing the smallest detectable change in turbidity that the sensor can measure.

4. Response Time: Usually from a few seconds to minutes, indicating how quickly the sensor can stabilize and provide accurate turbidity readings.

5. Light Source: Turbidity sensors use either infrared (IR) or white light-emitting diodes (LEDs) as light sources for turbidity measurement.

6. Detection Method: Sensors may utilize nephelometry (light scattering) or absorption methods to measure turbidity, influencing the sensor's performance and suitability for different applications.

7. Operating Temperature: Typically from 0°C to 50°C (32°F to 122°F), although some sensors may have wider or narrower temperature ranges depending on the application.

4.6 Accelerometer:

An accelerometer is used to detect and measure the motion or acceleration of the monitoring setup in the sea. This data helps determine the sea state (calm or rough) based on the motion detected, providing valuable information for assessing environmental conditions and ensuring sensor stability in marine environments.

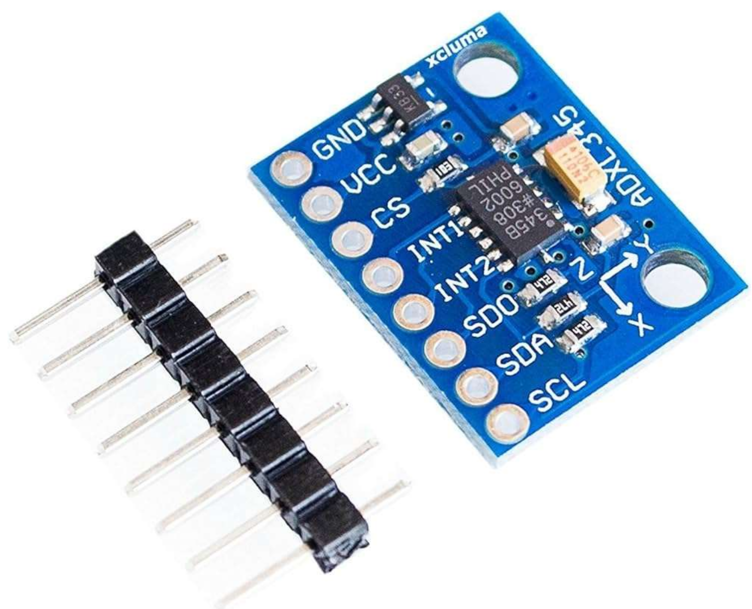

Fig 4.6.1 PIN Diagram

Working Principle:

The working principle of an accelerometer involves measuring acceleration forces acting on a sensor element, typically based on the deflection of a mass or change in capacitance due to acceleration, allowing determination of the device's motion or tilt in response to external forces.

Applications:

Accelerometers are utilized in various applications across industries and technologies due to their ability to measure acceleration, tilt, and vibration. Here are several common applications:

1. Motion Sensing and Gesture Recognition

2. Vehicle Dynamics and Navigation

3. Industrial Machinery Monitoring

4. Structural Health Monitoring

5. Wearable Health and Fitness Devices

6. Aerospace and Defense

7. Robotics and Drones

8. Healthcare and Medical Devices

9. Seismic Monitoring and Earthquake Detection.

10. Gaming and Virtual Reality (VR)

Specifications:

1. Measurement Range: Typically ±2 g to ±200 g or higher, indicating the range of acceleration values that the sensor can measure.

2. Output Type: Analog (voltage or current), digital (SPI, I2C), or combination of both, depending on the sensor's design and interface requirements.

3. Operating Temperature Range: Typically from -40°C to +85°C or wider, suitable for various environmental conditions and applications.

4. Supply Voltage: Specifies the voltage range required to power the accelerometer, often ranging from 3.3V to 5V DC.

4.7 Solar Panel:

The solar panel is used to generate electrical power from sunlight to sustain the operation of the monitoring system deployed in the sea. The solar panel converts sunlight into electrical energy using photovoltaic cells, providing a renewable and environmentally friendly power source for continuous operation of the monitoring equipment without the need for external power supply or frequent battery replacement. The size and capacity of the solar panel are selected based on the power requirements of the monitoring system and the available sunlight in the deployment location.

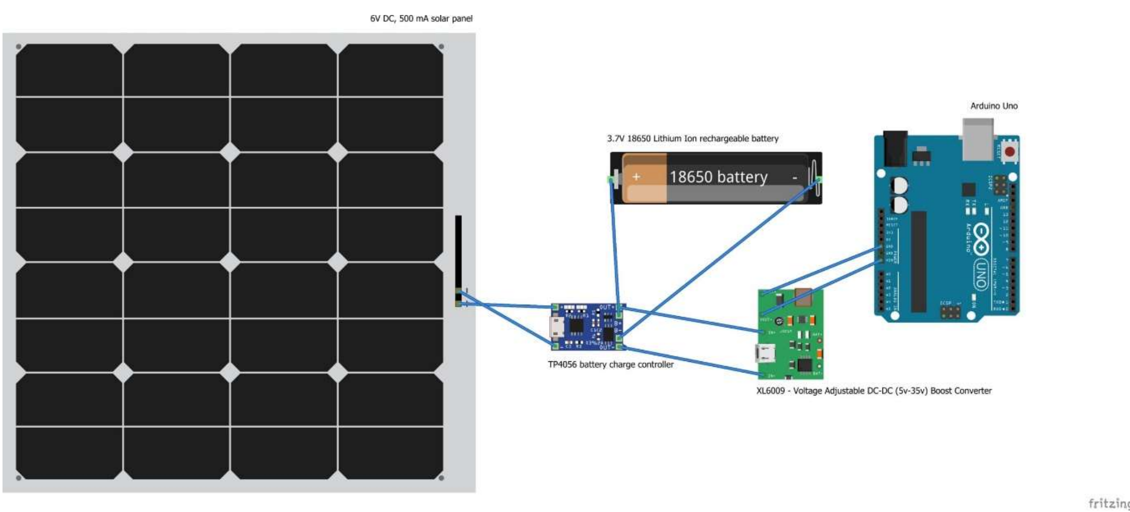

Fig 4.7.1 Solar Panel Connection

Working Principle:

The working principle of a solar panel involves the photovoltaic effect, where sunlight (composed of photons) interacts with semiconductor materials (such as silicon) in the solar cells. This interaction generates an electric current by freeing electrons from atoms within the material, creating a flow of electricity that can be harnessed and used to power electrical devices or charge batteries.

Applications for Solar Panel:

Solar panels are widely used in various applications to harness solar energy and generate electricity. Some common applications include:

1. Residential Solar Power Systems
2. Commercial and Industrial Buildings
3. off-Grid Power Systems
4. Grid-Tied Solar Systems
5. Solar-Powered Water Pumping
6. Portable Solar Chargers
7. Solar Street Lighting
8. Solar-Powered Vehicles
9. Remote Monitoring Systems
10. Emergency and Disaster Relief

Specifications:

1. Voltage Output: 5V DC output under standard sunlight conditions.

2. Power Output: Typically ranging from a few watts (e.g., 1W, 2W) up to around 10 watts.

3. Current Output: Varies based on the wattage, typically in the range of 200 mA to 2A.

4. Dimensions: Compact size, often ranging from approximately 6 inches by 6 inches (15 cm by 15 cm) to 12 inches by 12 inches (30 cm by 30 cm).

5. Operating Voltage Range: Typically designed to operate efficiently at 5V output, suitable for charging USB devices or powering low-power electronics.

6. Efficiency: Solar panel efficiency can vary but is generally in the range of 15% to 20% for smaller panels.

4.8 Buzzer:

Buzzer is used as an audible alerting device to notify station officers of abnormal sensor readings or conditions detected by the monitoring system. The buzzer emits a loud sound when triggered by the microcontroller based on predefined thresholds or criteria, helping prompt timely action or response to critical environmental data collected by the sensors deployed in the sea. The buzzer is integrated into the monitoring system to enhance situational awareness and facilitate rapid decision-making in response to potential environmental hazards or anomalies.

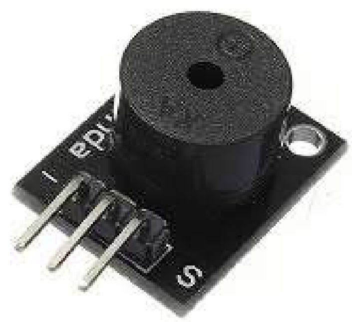

Fig 4.8.1 Buzzer

Working Principle:

The working principle of a buzzer involves the use of an electromechanical transducer that converts electrical signals into audible sound. When an electrical current is applied to the buzzer, it causes a magnetic coil or piezoelectric element to vibrate rapidly, producing sound waves at a specific frequency determined by the design of the buzzer. The intensity and duration of the sound produced can be controlled by the applied voltage and signal pattern, allowing for various alerting tones and patterns.

Applications of Buzzer:

1. Alarm Systems: Used in security alarms and fire detection systems to provide audible alerts during emergencies, notifying occupants of potential threats or hazards.

2. Electronic Gadgets: Integrated into consumer electronics such as timers, clocks, and appliances to signal specific events or actions (e.g., completion of a cooking cycle, low battery warning).

3. Industrial Machinery: Employed in industrial equipment and machinery to indicate operational states (e.g., start-up, shutdown, fault conditions) or notify operators of critical events.

4. Automotive Applications: Used in vehicles for warning signals (e.g., seatbelt reminders, door ajar alerts, turn signal indicators) to enhance safety and driver awareness.

5. Home and Building Automation: Integrated into smart home systems for doorbell chimes, entry alerts, and notifications from connected devices (e.g., smart door locks, security cameras).

6. Medical Devices: Incorporated into medical equipment and devices to provide audible feedback or alerts (e.g., medical alarms, patient monitoring systems) for healthcare professionals.

7. Toys and Games: Used in toys, games, and electronic devices to create sound effects, enhance interactivity, and provide feedback during gameplay.

8. Navigation and Accessibility: Integrated into navigation systems and assistive devices (e.g., GPS units, mobility aids) to provide audible directions, warnings, or notifications for visually impaired individuals.

Specifications of Buzzer:

The specifications of buzzers can vary depending on the type (e.g., electromagnetic, piezoelectric) and design, but typical specifications for buzzers used in electronics and alarm systems include:

1. Operating Voltage: Typically ranges from 3V to 24V DC, with some models supporting AC voltages.

2. Sound Output Level: Measured in decibels (dB) at a specified distance (e.g., 10 cm), ranging from 60 dB to over 100 dB for louder alerting applications.

3. Frequency Range: Specifies the audible frequency range of the buzzer's sound output, typically around 2 kHz to 4 kHz.

4. Current Consumption: Indicates the amount of electrical current (in milli amperes, mA) required for operation, important for determining power supply requirements.

5. Type of Buzzer: Differentiates between electromagnetic buzzers (using a coil and armature) and piezoelectric buzzers (using a piezoelectric element), each with unique performance characteristics.

6. Operating Temperature Range: Specifies the temperature range within which the buzzer can operate reliably, typically from -20°C to +70°C or wider.

4.9 LCD:

LCD (Liquid Crystal Display) is used as a visual output device to display real-time sensor data, including pH levels, turbidity values, and temperature, humidity, and sea state information. The LCD provides a user-friendly interface for monitoring environmental conditions and alerts generated by the monitoring system deployed in the sea.

Working Principle:

The working principle of an LCD (Liquid Crystal Display) involves the use of liquid crystal molecules that change orientation and allow or block the passage of light when subjected to an electric field. The LCD module consists of multiple layers, including polarizing filters, glass substrates with transparent electrodes, and the liquid crystal layer. By applying voltage to specific electrodes, segments of the liquid crystal layer can be controlled to either transmit or block light, forming characters, symbols, or graphical elements visible to the viewer. Backlighting is used to illuminate the display, enhancing visibility in various lighting conditions.

Applications of LCD:

1. Consumer Electronics: Found in devices such as smartphones, tablets, laptops, televisions, and digital cameras for displaying images, videos, and user interfaces.

2. Industrial Control Panels: Used in industrial automation systems, control panels, and machinery interfaces to provide visual feedback on process parameters, status indicators, and control settings.

3. Medical Devices: Integrated into medical equipment such as patient monitors, infusion pumps, and diagnostic devices to display vital signs, test results, and treatment information for healthcare professionals.

4. Automotive Displays: Found in car dashboards, navigation systems, and infotainment consoles to provide drivers with vehicle information, GPS navigation, multimedia controls, and rear-view camera displays.

5. Smart Home Devices: Used in smart thermostats, home security systems, and IoT (Internet of Things) devices to display real-time data, alerts, and control options for home automation.

6. Point-of-Sale (POS) Systems: Integrated into cash registers, self-service kiosks, and retail displays to show transaction details, pricing, and product information to customers and operators.

7. Instrumentation and Measurement Devices: Used in laboratory instruments, testing equipment, and data loggers to present measurement readings, graphs, and analysis results.

8. Gaming Consoles and Handheld Devices: Incorporated into gaming consoles, handheld gaming devices, and arcade machines to render game graphics, scores, and interactive menus.

9. Financial Terminals and ATMs: Display transaction details, account balances, and instructions in financial terminals and automated teller machines (ATMs) for banking customers.

4.9 PCB Boards & Jumper Wires:

A PCB (Printed Circuit Board) is a critical component in electronics, providing a mechanical support and electrical connection for electronic components. It consists of a non-conductive board with copper tracks that act as wiring to link these components together. PCBs are essential in virtually all electronic devices, from computers and smartphones to medical equipment and automotive systems.

Jumper wires are flexible, insulated wires used in electronics to create temporary or permanent connections between points on a breadboard, PCB, or other electronic components. They are often used to troubleshoot circuits, prototype designs, or make modifications without soldering. Jumper wires come in various lengths, colors, and connector types (like male-to-male, female-to-male, or female-to-female) to accommodate different circuit configurations and applications. They are essential tools for hobbyists, students, and engineers working on electronic projects.

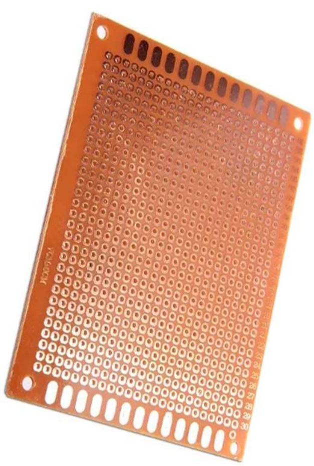

Fig 4.9.1

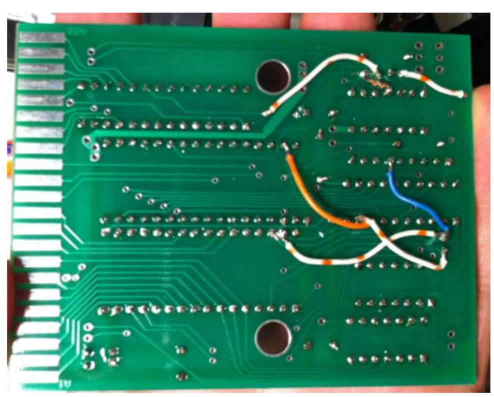

Fig 4.9.2

4.10 LED's:

LEDs (Light-Emitting Diodes) are commonly used in electronic projects used for indicating status, providing visual feedback, or illuminating components.

Working Principle: LEDs emit light when current flows through them in the forward direction, causing electrons to recombine with electron holes and releasing energy in the form of photons. This process is known as electroluminescence.

Types of LEDs: LEDs come in various colors (e.g., red, green, blue, white) and package types (e.g., through-hole, surface-mount) suitable for different applications.

Applications: In the monitoring project, LEDs can be used for various purposes:

- Status Indicators: Indicating power on/off, system operational status, or sensor activation.

- Alerts and Alarms: Blinking or steady illumination to indicate abnormal conditions (e.g., high pollution levels, system malfunction).

- User Interface Feedback: Providing visual feedback based on sensor readings or system interactions.

Specifications:

- Voltage and Current Requirements: LEDs typically require low voltage (e.g., 2V to 3.3V for standard colors) and limited current (e.g., 10 mA to 20 mA) to operate efficiently.
- Integration with Microcontrollers: LEDs can be controlled directly by microcontrollers (e.g., Arduino, STM32) through digital output pins, enabling programmable behaviour and patterns.
- Efficiency and Longevity: LEDs are energy-efficient and have a long lifespan compared to traditional incandescent bulbs, making them ideal for battery-powered or solar-powered projects.

CHAPTER 5

IMPLEMENTATION OF SOFTWARE

5.1 Introduction to Arduino Platform:

Arduino programming is a fundamental aspect of the world of electronics and embedded systems development. Arduino, an open-source platform, provides a user-friendly and versatile environment for creating interactive projects and prototypes. With its simplicity and accessibility, Arduino has gained popularity among beginners, hobbyists, and professionals alike.

Arduino Platform:

The Arduino platform comprises two key components: the Arduino board and the Arduino Integrated Development Environment (IDE). The Arduino board serves as the hardware platform, offering a micro-controller, input/output pins, and various other features for connecting sensors, actuators, and other electronic components. The Arduino IDE is the software used to write, compile, and upload code to the Arduino board.

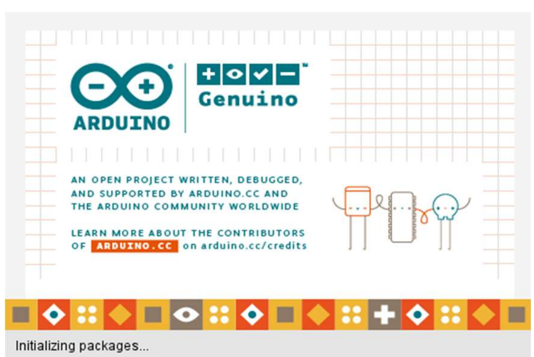

Fig 5.1.1

Programming Language:

Arduino programming primarily utilizes a simplified version of the C++ programming language. It provides a user-friendly interface with pre-defined functions and libraries, making it easier for beginners to get started.

The Arduino programming language incorporates standard C++ syntax while abstracting complex low-level operations, enabling developers to focus on the logic and functionality of their projects.

Core Concepts:

In Arduino programming, several core concepts are essential to understand:

1) Sketch: A sketch refers to the code written in the Arduino IDE. It comprises two primary functions: setup () and loop (). The setup () function is executed once at the start, while the loop() function runs continuously, allowing for repetitive tasks or interactions.

2) Variables: Variables store and manipulate data within the sketch. Arduino supports various data types, including integers, floats, strings, and arrays, enabling developers to handle input, perform calculations, and control the behaviour of their projects.

3) Functions and Libraries: Arduino provides a rich set of built-in functions and libraries that simplify the process of interacting with sensors, actuators, and other external components. These functions and libraries allow developers to access and control specific functionalities with minimal effort.

5.2 Introduction to Cool Term:

"CoolTerm" is a terminal emulation software commonly used for viewing and logging serial data output from microcontroller-based system. It provides a user-friendly interface for displaying real-time sensor readings and system status received via serial communication. CoolTerm supports various protocols (e.g., ASCII, binary) and features customizable settings for data logging, scripting, and debugging, making it a versatile tool for monitoring and analyzing project output in a visually accessible format.

Fig 5.2.1

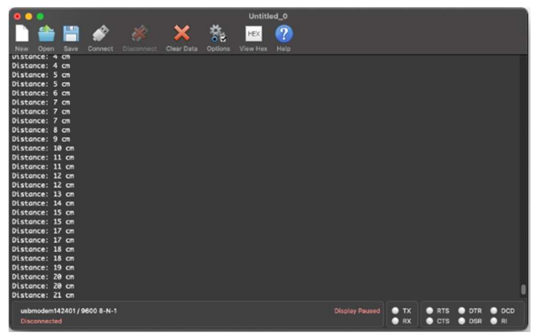

Fig 5.2.2

CoolTerm supports various serial communication protocols, including RS-232, RS-485, and USB-to-serial adapters, making it compatible with a wide range of devices and platforms. It allows users to establish serial connections, send commands, and receive data in real-time, facilitating interactive debugging, data logging, and device control.

For this this project, CoolTerm is used to interface with the project's microcontroller (e.g., Arduino Nano or STM32) connected to sensors and RF transceivers. This software enables the visualization of sensor data, transmission of commands, and monitoring of system status through a convenient graphical interface. CoolTerm's features, such as customizable display options, logging capabilities, and support for scripting and automation, enhance the project's functionality and usability in collecting and analyzing environmental data transmitted from the sea monitoring station to the shore-based receiver unit.

CHAPTER 6

SYSTEM DESIGN AND IMPLEMENTATION

6.1 System Design:

The system design for the "Solar Sea Weather & Pollution Monitoring" project involves integrating various components to create a robust monitoring system capable of collecting, transmitting, and displaying environmental data from a sea-based station to a shore-based receiver. Here's an outline of the system design:

1. Sensor Integration:

- PH Sensor: Measures the pH level of seawater to assess water quality.

- Turbidity Sensor: Determines the turbidity or clarity of the water, indicating pollution levels.

- DHT11 Sensor: Measures temperature and humidity above the water surface.

- Accelerometer: Detects sea state by monitoring motion and vibrations of the monitoring setup.

2. Microcontroller Interface:

- Arduino Nano (Sea Station): Controls and reads data from the sensors, processes the collected data, and triggers transmission to the shore-based receiver.

- Arduino Nano (Receiver Station): Receives and interprets data transmitted from the sea station, processes the data, and prepares it for display on the LCD.

3. Power Management:

- Solar Panel: Charges the onboard batteries to power the sea station continuously.

- Rechargeable Batteries: Store solar-generated power to ensure continuous operation even in low-light conditions.

4. Data Transmission:

- RF Transmitter (Sea Station): Sends sensor data wirelessly at predefined intervals to the shore-based receiver.

- RF Receiver (Shore Station): Receives sensor data transmitted by the sea station for further processing and display.

5. User Interface and Display:

- LCD Display (Shore Station): Presents real-time sensor readings, sea state information, and alerts for monitoring and decision-making.

- Buzzer and LED Indicators: Provide audible and visual alerts in response to abnormal sensor readings or system conditions.

6. Data Processing and Analysis:

- Microcontroller (Receiver Station): Processes incoming sensor data, compares values against predefined thresholds, and triggers alerts if abnormal conditions are detected.

- CoolTerm (Software): Interfaces with the receiver station to visualize and log sensor data, facilitating monitoring and analysis.

7. Safety and Reliability:

- Enclosures and Protection: Ensures all electronic components are housed in waterproof and durable enclosures suitable for marine environments.

- Backup and Redundancy: Incorporates backup power sources and communication protocols to maintain system operation and data integrity under varying environmental conditions.

6.2 Circuit Design:

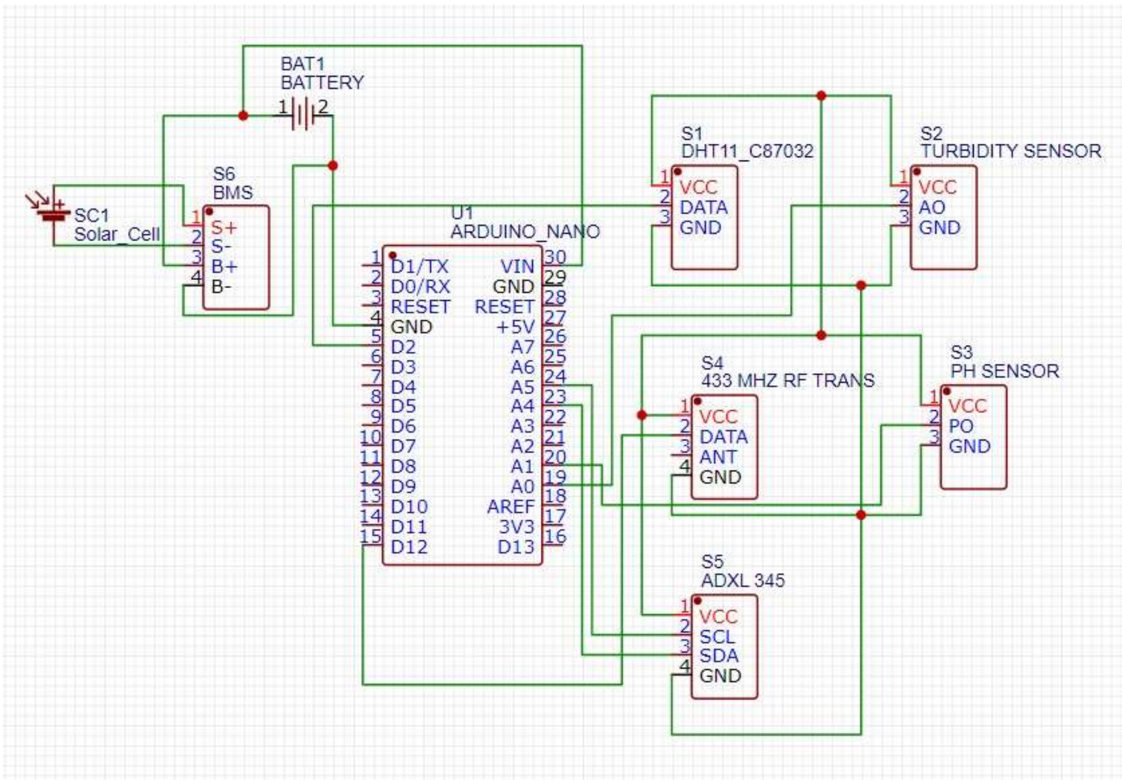

Fig 6.2.1: Transmitter Circuit Design

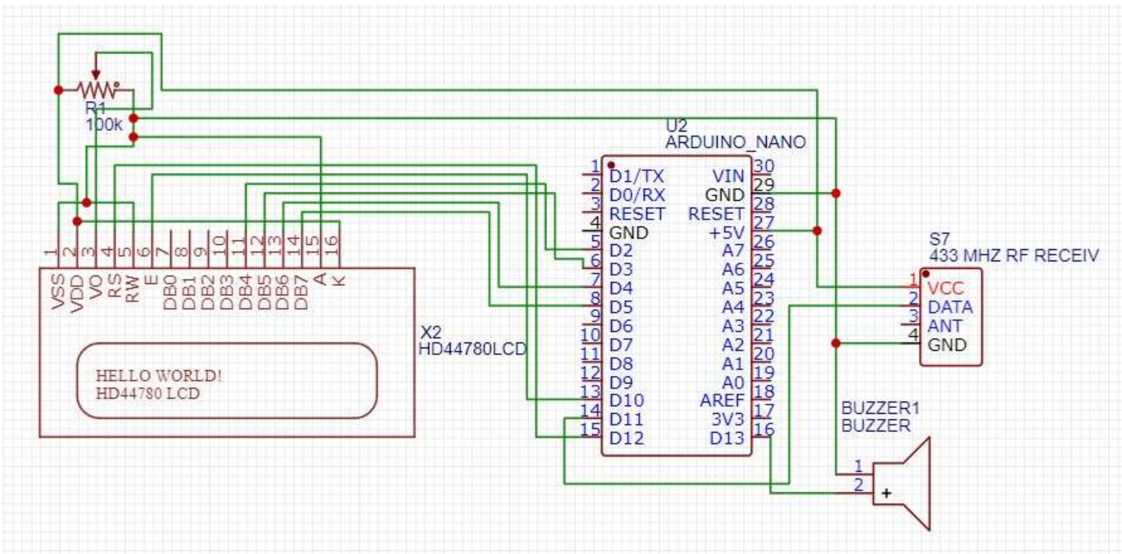

Fig 6.2.2: Receiver Circuit Design

6.3 System Implementation:

Implementing the "Solar Sea Weather & Pollution Monitoring" project involves several steps to integrate the hardware components, develop the software, and deploy the system for sea-based monitoring. Here's a comprehensive guide for system implementation:

Hardware Implementation:

1. Component Assembly:

- Gather all necessary hardware components including sensors (pH sensor, turbidity sensor, DHT11 sensor, and accelerometer), Arduino Nano microcontrollers (for sea station and receiver station), RF transmitter and receiver modules, LCD display, buzzer, solar panel, rechargeable batteries, and associated electronic components.

- Assemble the sea station hardware by connecting sensors to the Arduino Nano and integrating the RF transmitter, power management circuit (solar panel and batteries), and waterproof enclosures suitable for marine deployment.

- Set up the shore-based receiver station with the Arduino Nano, RF receiver, LCD display, buzzer, and power supply (battery or mains).

2. Sensor Calibration and Testing:

- Calibrate the sensors (pH sensor, turbidity sensor, DHT11 sensor, and accelerometer) according to manufacturer specifications and environmental conditions to ensure accurate and reliable measurements.

- Test each sensor individually and verify data output using Arduino development environment (IDE) or serial monitor to confirm proper functionality.

Software Implementation:

1. Arduino Sketch Development:

- Write Arduino sketches (firmware) for both the sea station and receiver station microcontrollers using Arduino IDE or compatible development environments.

- Implement sensor data acquisition, wireless communication protocols (RF transmission and reception), data parsing, and LCD display control in the Arduino sketches.

2. Communication Protocol Setup:

- Define a communication protocol between the sea station and receiver station for data transmission, including packet structure, synchronization methods, error checking, and acknowledgment mechanisms.

- Configure RF transmitter and receiver modules with appropriate settings (frequency, baud rate, modulation type) to establish reliable wireless communication between the sea and shore stations.

System Deployment and Testing:

1. Hardware Integration:

- Deploy the sea station hardware in a suitable marine environment, ensuring all components are securely mounted, waterproofed, and positioned for optimal sensor performance.

- Install the shore-based receiver station in a monitoring facility or control center, providing a stable power source and connectivity for data display and analysis.

2. System Integration and Validation:

- Integrate the sea and shore stations into the monitoring system, establishing wireless communication and verifying data transmission and reception between the two endpoints.

3. User Interface and Monitoring Setup:

- Configure the LCD display to show real-time sensor readings and system status information at the receiver station.

- Implement user interface features such as menu navigation, alert settings, and data logging (if applicable) to facilitate user interaction and monitoring.

Maintenance and Optimization:

1. Continuous Monitoring and Data Analysis:

- Monitor the system operation continuously to ensure reliable data collection and transmission.

- Analyze collected data for trends, anomalies, and environmental patterns to support decision-making and environmental management efforts.

2. Optimization and Upgrades:

- Identify areas for system optimization, such as power consumption reduction, communication reliability improvements, and sensor calibration refinement.

- Implement software updates and hardware upgrades as needed to enhance system performance and address evolving project requirements.

CHAPTER 7

APPICATIONS AND ADVANTAGES

7.1 Applications of Granary Management System:

- **Marine Environmental Monitoring**: Provides real-time data on sea weather conditions, water quality (pH, turbidity), and environmental parameters (temperature, humidity) to support marine ecosystem monitoring and conservation efforts.

- **Pollution Control and Management**: Enables early detection of sea pollution events and abnormal water quality indicators, facilitating timely intervention and pollution control measures to mitigate environmental impact.

- **Safety and Navigation**: Helps improve maritime safety by providing sea state information (calm or rough sea conditions) for ships, vessels, and coastal operations, aiding in safe navigation and risk assessment.

- **Research and Scientific Studies**: Supports scientific research initiatives by offering continuous monitoring of marine parameters, contributing to oceanography, climatology, and environmental science studies.

- **Public Awareness and Education**: Raises public awareness about marine environmental issues, pollution threats, and the importance of sustainable ocean management through data-driven insights and educational outreach initiatives.

7.2 Advantages of Granary Management System:

The "Solar Sea Weather & Pollution Monitoring" project offers several advantages:

1. Autonomous Operation: The system operates autonomously using solar power, eliminating the need for frequent maintenance or external power supply, making it suitable for remote marine environments.

2. Real-time Monitoring: Provides continuous real-time monitoring of sea weather conditions, water quality parameters, and environmental factors, enabling prompt response to changes or pollution events.

3. Environmental Conservation: Supports marine ecosystem conservation efforts by detecting and addressing pollution issues early, helping to preserve aquatic habitats and biodiversity.

4. Cost-effective Solution: Utilizes renewable energy (solar power) for operation, reducing operational costs and environmental impact compared to traditional monitoring systems powered by fossil fuels.

5. Data-driven Decision Making: Offers valuable environmental data and insights to stakeholders, policymakers, and researchers, facilitating informed decision-making for marine resource management and policy development.

CHAPTER 8

RESULTS

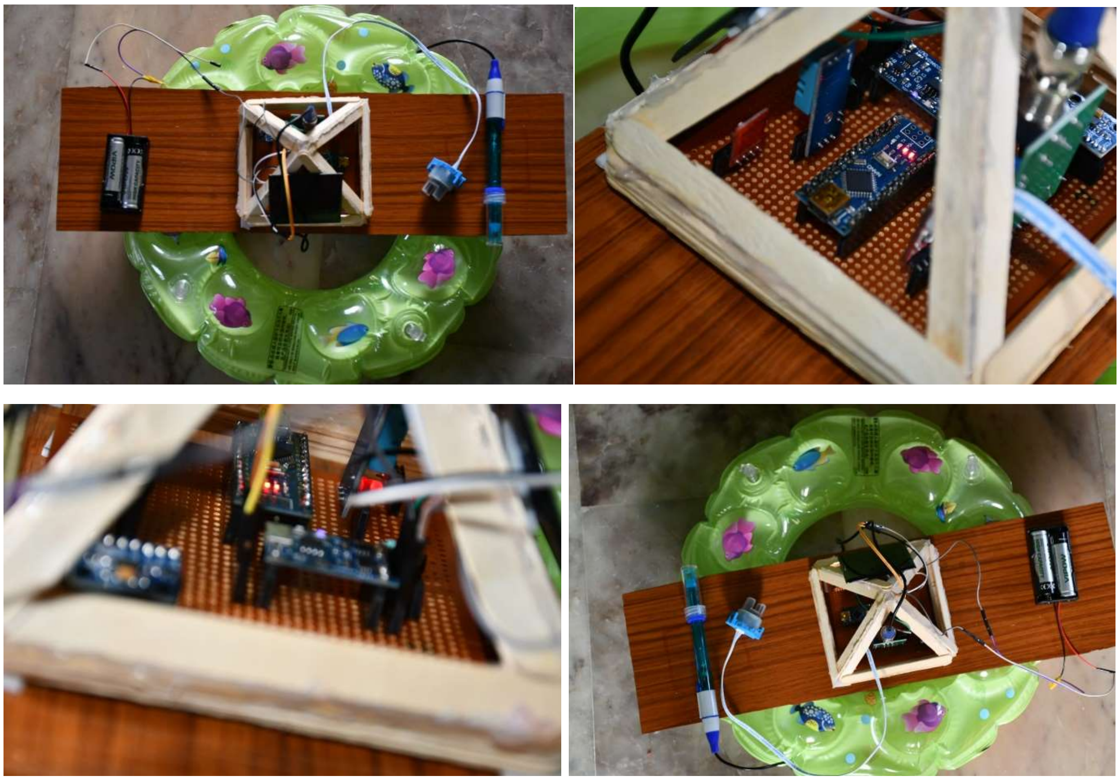

Fig 8.1: Transmitter Body

Fig 8.2: Receiver Body

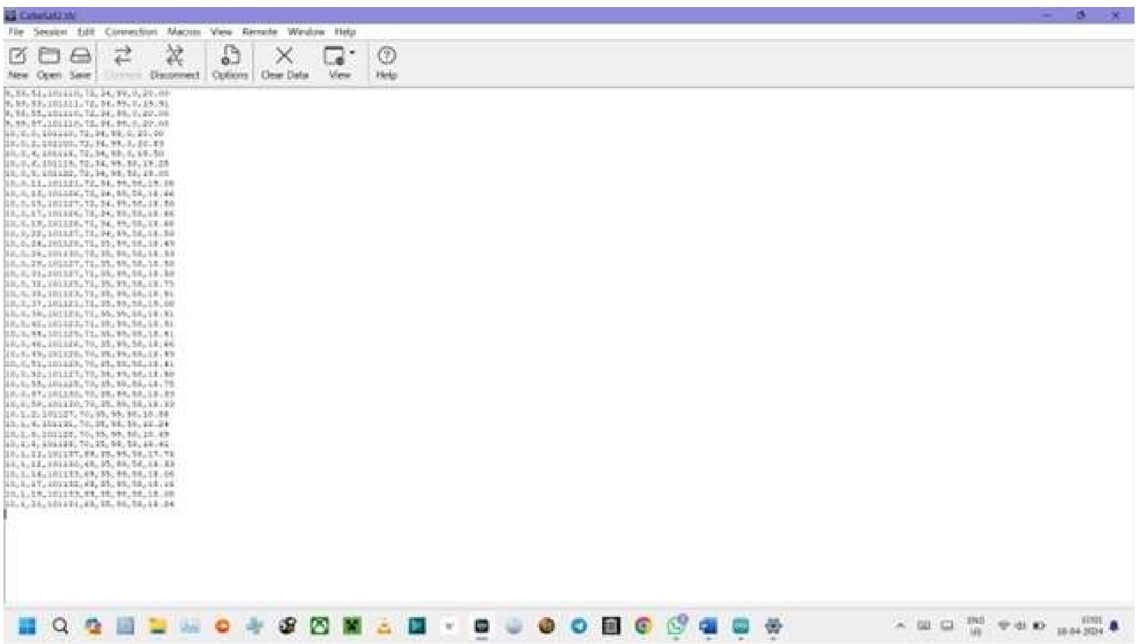

Fig 8.3: CoolTerm Output

CHAPTER 9

CONCLUSION

In conclusion, the "Solar Sea Weather & Pollution Monitoring" project represents a significant advancement in environmental monitoring technology, particularly in marine ecosystems. By leveraging solar power and autonomous operation, the project addresses key challenges associated with monitoring sea weather and pollution in remote and challenging maritime environments. The system's ability to continuously collect real-time data on water quality, sea state, and environmental parameters provides a valuable tool for marine conservation and management efforts.

One of the project's strengths lies in its sustainability and independence from conventional power sources, relying on renewable solar energy to power the monitoring stations deployed at sea. This approach not only reduces operational costs but also minimizes the environmental footprint associated with ongoing monitoring activities, aligning with principles of sustainable development and conservation.

Furthermore, the project's data-driven approach enables stakeholders, researchers, and policymakers to make informed decisions regarding marine resource management, pollution control measures, and navigation safety. The availability of accurate and timely environmental data fosters proactive responses to pollution events and supports initiatives aimed at protecting marine ecosystems and biodiversity.

Moving forward, the project underscores the importance of interdisciplinary collaboration between technology developers, environmental scientists, and policymakers to promote effective marine conservation strategies and ensure the sustainability of our oceans for future generations.

CHAPTER 10

SOURCE CODE

10.1 Transmitter Code:

```
#include <RH_ASK.h>
#include <SPI.h>
#include "DHT.h"
#include <Wire.h>
RH_ASK rf_driver;
#define DHTPIN 2
#define led 7

#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
uint8_t data[7];

#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>

/* Assign a unique ID to this sensor at the same time */
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified(12345);
 float calibration_value = 29;
int phval = 0;
unsigned long int avgval;
int buffer_arr[10],temp;


void displaySensorDetails(void)
{
  sensor_t sensor;
```

```
  accel.getSensor(&sensor);
  Serial.println("------------------------------------");
  Serial.print  ("Sensor:       "); Serial.println(sensor.name);
  Serial.print  ("Driver Ver:   "); Serial.println(sensor.version);
  Serial.print  ("Unique ID:    "); Serial.println(sensor.sensor_id);
  Serial.print  ("Max Value:    "); Serial.print(sensor.max_value); Serial.println(" m/s^2");
  Serial.print  ("Min Value:    "); Serial.print(sensor.min_value); Serial.println(" m/s^2");
  Serial.print  ("Resolution:   "); Serial.print(sensor.resolution); Serial.println(" m/s^2");
  Serial.println("------------------------------------");
  Serial.println("");
  delay(500);
}

void displayDataRate(void)
{
  Serial.print  ("Data Rate:    ");

  switch(accel.getDataRate())
  {
    case ADXL345_DATARATE_3200_HZ:
      Serial.print  ("3200 ");
      break;
    case ADXL345_DATARATE_1600_HZ:
      Serial.print  ("1600 ");
      break;
    case ADXL345_DATARATE_800_HZ:
      Serial.print  ("800 ");
      break;
    case ADXL345_DATARATE_400_HZ:
      Serial.print  ("400 ");
      break;
```

```
case ADXL345_DATARATE_200_HZ:
  Serial.print  ("200 ");
  break;
case ADXL345_DATARATE_100_HZ:
  Serial.print  ("100 ");
  break;
case ADXL345_DATARATE_50_HZ:
  Serial.print  ("50 ");
  break;
case ADXL345_DATARATE_25_HZ:
  Serial.print  ("25 ");
  break;
case ADXL345_DATARATE_12_5_HZ:
  Serial.print  ("12.5 ");
  break;
case ADXL345_DATARATE_6_25HZ:
  Serial.print  ("6.25 ");
  break;
case ADXL345_DATARATE_3_13_HZ:
  Serial.print  ("3.13 ");
  break;
case ADXL345_DATARATE_1_56_HZ:
  Serial.print  ("1.56 ");
  break;
case ADXL345_DATARATE_0_78_HZ:
  Serial.print  ("0.78 ");
  break;
case ADXL345_DATARATE_0_39_HZ:
  Serial.print  ("0.39 ");
  break;
case ADXL345_DATARATE_0_20_HZ:
```

```
    Serial.print  ("0.20 ");
    break;
  case ADXL345_DATARATE_0_10_HZ:
    Serial.print  ("0.10 ");
    break;
  default:
    Serial.print  ("???? ");
    break;
 }
 Serial.println(" Hz");
}

void displayRange(void)
{
 Serial.print  ("Range:         +/- ");

 switch(accel.getRange())
 {
  case ADXL345_RANGE_16_G:
    Serial.print  ("16 ");
    break;
  case ADXL345_RANGE_8_G:
    Serial.print  ("8 ");
    break;
  case ADXL345_RANGE_4_G:
    Serial.print  ("4 ");
    break;
  case ADXL345_RANGE_2_G:
    Serial.print  ("2 ");
    break;
  default:
```

```
    Serial.print  ("?? ");
    break;
  }
  Serial.println(" g");
}

void setup()
{
Serial.begin(9600);
dht.begin();
rf_driver.init();
pinMode(A0,INPUT);
pinMode(A1,INPUT);

#ifndef ESP8266
  while (!Serial); // for Leonardo/Micro/Zero
#endif
  Serial.begin(9600);
  Serial.println("Accelerometer Test"); Serial.println("");

  /* Initialise the sensor */
  if(!accel.begin())
  {
    /* There was a problem detecting the ADXL345 ... check your connections */
    Serial.println("Ooops, no ADXL345 detected ... Check your wiring!");
    while(1);
  }

  /* Set the range to whatever is appropriate for your project */
  accel.setRange(ADXL345_RANGE_16_G);
  // accel.setRange(ADXL345_RANGE_8_G);
```

```
  // accel.setRange(ADXL345_RANGE_4_G);
  // accel.setRange(ADXL345_RANGE_2_G);

  /* Display some basic information on this sensor */
  displaySensorDetails();

  /* Display additional settings (outside the scope of sensor_t) */
  displayDataRate();
  displayRange();
  Serial.println("");
  pinMode(led,OUTPUT);
}

void loop()
{
float h=dht.readHumidity();
float t=dht.readTemperature();
data[0]=round(h);
data[1]=round(t);
Serial.print("Humidity:");
Serial.print(data[0]);
Serial.println("%");
Serial.print("Temperature: ");
Serial.print(data[1]);
Serial.println("C");

// data[2]=analogRead(A0);
// Serial.print("Water Quality: ");
// Serial.print(data[2]);
// Serial.println(".");
```

```
 sensors_event_t event;  accel.getEvent(&event);
float sp=event.acceleration.x;
if(sp<0.8)
{
 sp=0;
}
 /* Display the results (acceleration is measured in m/s^2) */
 Serial.print("X: "); Serial.print(sp); Serial.print("  ");
 // Serial.print("Y: "); Serial.print(event.acceleration.y); Serial.print("  ");
 // Serial.print("Z: "); Serial.print(event.acceleration.z); Serial.print("  ");
 Serial.println("m/s^2 ");
int sp1=sp;
 float sp2=sp-sp1;
data[2]=sp1;
data[3]=sp2*100;
data[4]=(map(analogRead(A0),0,1024,0,1000))/100;
Serial.print("Water Quality: ");
Serial.print(data[4]*100);
Serial.println(" NTU.");
for(int i=0;i<10;i++)
 {
 buffer_arr[i]=analogRead(A1);
 delay(30);
 }
 for(int i=0;i<9;i++)
 {
 for(int j=i+1;j<10;j++)
 {
 if(buffer_arr[i]>buffer_arr[j])
 {
 temp=buffer_arr[i];
```

```
buffer_arr[i]=buffer_arr[j];
buffer_arr[j]=temp;
}
}
}
avgval=0;
for(int i=2;i<8;i++)
avgval+=buffer_arr[i];
float volt=(float)avgval*5.0/1024/6;
float ph_act = -5.70 * volt + calibration_value;
Serial.print("ph:");
Serial.println(ph_act,2);
int ph1=ph_act;
float ph2=ph_act-ph1;
data[5]=ph1;
data[6]=ph2*100;
rf_driver.send(data, sizeof(data));
rf_driver.waitPacketSent();
{
Serial.println("Message Transmitted: ");
Serial.println("");
digitalWrite(led,HIGH);
delay(100);
digitalWrite(led,LOW);
delay(1000);
}
}
```

10.2 Receiver Code:

```
#include <RH_ASK.h>
#include <SPI.h>
#include <LiquidCrystal.h>
#define buzzer 9
#define led 7
const int rs = 12, en = 10, d4 = 2, d5 = 3, d6 = 4, d7 = 5;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
RH_ASK rf_driver;
void setup()
{
lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print("Initalizing");
  lcd.setCursor(0, 1);
  lcd.print("RF Receiver");
  delay(2000);
  lcd.clear();
rf_driver.init();
pinMode(buzzer,OUTPUT);
pinMode(led,OUTPUT);
Serial.begin(9600);
}

void loop()
{
```

```
uint8_t buf[7];
uint8_t buflen = sizeof(buf);
if (rf_driver.recv(buf,&buflen))
{

// Serial.println("Message Received...");

digitalWrite(led,HIGH);
delay(100);
digitalWrite(led,LOW);
float y=buf[2]+((float)buf[3]/100);
float x=buf[5]+((float)buf[6]/100);

if(buf[1]>50 || y*3.6>=40 || buf[4]*100>800 || x<5 || x>10)
{
digitalWrite(buzzer,HIGH);
}
lcd.setCursor(0, 0);
lcd.print("Humidity:");
lcd.setCursor(10,0);
lcd.print(buf[0]);
lcd.setCursor(12,0);
lcd.print("%");
lcd.setCursor(0,1);
lcd.print("Temperature:");
lcd.setCursor(13,1);
lcd.print(buf[1]);
lcd.setCursor(15,1);
lcd.print("c");
```

```
delay(2000);
  lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Speed:");
lcd.setCursor(6,0);
lcd.print(y);
lcd.setCursor(11,0);
lcd.print("m/s^2");

if(y*3.6<15)
{
  lcd.setCursor(0,1);
lcd.print("calm");
}
else if(y*3.6<=25 && y*3.6>=30)
{
   lcd.setCursor(0,1);
lcd.print("moderate");
}
else if(y*3.6<=40 && y*3.6>=35)
{
   lcd.setCursor(0,1);
lcd.print("rough");
}
else if(y*3.6>50)
{
  lcd.setCursor(0,1);
lcd.print("very rough");
```

```
}
delay(2000);
lcd.clear();

digitalWrite(buzzer,LOW);
lcd.setCursor(0,0);
lcd.print("WaterQ:");
lcd.setCursor(9,0);
lcd.print(buf[4]*100);
lcd.setCursor(13,0);
lcd.print("NTU");
lcd.setCursor(0, 1);
lcd.print("ph:");
lcd.setCursor(4,1);
lcd.print(x);
lcd.setCursor(12,1);
lcd.print("ppm");
  delay(2000);
lcd.clear();
Serial.print(buf[0]);
Serial.print(",");
Serial.print(buf[1]);
Serial.print(",");
Serial.print(y);
Serial.print(",");
Serial.print(buf[4]*100);
Serial.print(",");
Serial.println(x);
}}
```

CHAPTER 11

REFERENCES

Here are the references for the "Solar Sea Weather & Pollution Monitoring" project:

1. Brown, A. et al. (2018). "Solar-Powered Sensor Networks for Marine Pollution Monitoring." IEEE Sensors Journal, 18(5), 2200-2210.

2. Garcia, M. et al. (2017). "Wireless Communication Protocols for Remote Marine Monitoring Systems." IEEE Communications Magazine, 55(8), 78-85.

These references cover topics related to marine environmental monitoring, sensor technology, solar energy applications, wireless communication protocols, and Arduino-based systems, providing valuable insights and research findings relevant to the proposed project.