IoT-Based Environment Monitoring System

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Abstract- *IoT (Internet of Things) based environment monitoring refers to the use of IoT devices to monitor and collect data about environmental parameters such as temperature, humidity, air quality, and light levels. This data can be used to improve environmental control and energy efficiency and to gather information about the environment for scientific research or environmental protection purposes. IoT devices such as sensors, actuators, and smart devices can be connected to a network and used to monitor and control the environment. The collected data can be analyzed and processed to provide valuable insights and inform decision-making. IoT-based environment monitoring has the potential to revolutionize the way we monitor and protect the environment, enabling real-time monitoring and more efficient use of resources.*

Keywords- IoT, Node MCU ,Environmental monitoring Sensors, Rain sensor, Air quality sensors(DUST SENSOR),Temperature sensor, Humidity sensor, buzzers ,LDR sensors, Real-time monitoring ,Data analysis, Agriculture , Weather forecasting, Smart cities, Climate change, Pollution , Remote monitoring, Internet connectivity, Soil moisture ,Urban planning.

I. INTRODUCTION

Environment monitoring is crucial for various fields such as agriculture, healthcare, transportation, and urban planning. By monitoring the environment, we can better understand the impact of human activities on the environment and take proactive measures to mitigate negative effects. Additionally, environment monitoring can help us create a more sustainable and healthy environment for everyone.IoT-based environment monitoring involves using sensors, devices, and networks to collect and transmit data about various aspects of the environment, such as temperature, humidity, air quality, and noise levels. The data collected by these devices is then analyzed to gain insights into the environment and make informed decisions about how to manage it.The Internet of Things (IoT) has revolutionized the way we interact with the physical world by enabling the connection of everyday objects to the Internet. This connectivity has opened up a whole new world of possibilities for environmental monitoring, enabling us to collect and analyze data in real time and take proactive measures to manage our environment.IoT-based environment monitoring has a wide range of applications, from smart homes and buildings to agriculture, healthcare, and transportation. By leveraging the power of IoT, we can create a more sustainable, efficient, and healthy environment for everyone.

II. LITERATURE SURVEY

1.Building the Internet of Things using RFID

The RFID ecosystem experience" is a paper that discusses the use of Radio Frequency Identification (RFID) technology in building the Internet of Things (IoT). The paper describes the RFID ecosystem experience and how it can be used to create a comprehensive IoT system.The paper begins by discussing the basics of RFID technology and how it works. It then describes the different components of the RFID ecosystem, including tags, readers, middleware, and applications. The paper also discusses the challenges of building an RFID-based IoT system, such as data security and privacy concerns.The authors then describe several case studies where RFID technology has been used to create IoT systems, including asset tracking, supply chain management, and healthcare. They also discuss the benefits of using RFID technology in IoT systems, such as improved visibility, real-time data collection, and enhanced automation.Overall, the paper highlights the potential of RFID technology in building the Internet of Things and provides valuable insights for businesses and organizations looking to adopt IoT solutions.

2. “Enterprise information systems architecture analysis and evaluation,

Numerous software architecture proposals are available to industrial information engineers in developing their enterprise information systems. While those proposals and corresponding methodologies are helpful to engineers in determining appropriate architecture, the systematic methods for the evaluation of software architecture are scarce. To select appropriate software architecture from various alternatives appropriately, a scenario-based method has been proposed to assess how software architecture affects the fulfillment of business requirements. The empirical evaluation on the selection of a supply chain software tool has shown that the developed method offers remarkable insights of software development and can be incorporated into the industrial informatics practice of an organization with a moderate cost.

3. Decision &risk based design structures; decision support needs for conceptual, concurrent design

In this paper, we elaborate on the decision support needs during conceptual, concurrent design. For this purpose, we consider the type of decision aids that might be helpful to the designers during design, and the information needed by the applications of the products of the design that could be captured and structured by these decision aid tools and processes. We explain our current thoughts and recommendations with respect to the research challenges in this area based on our experience with conceptual, concurrent design teams, as well as our synthesis of the first NASA sponsored workshop on “Decision Based Design Structures” that was held on October 6, 7, &8th 2004 to address some of the same issues. The design context under consideration is Space Missions

4. FC-PACO-RM: A Parallel Method for Service Composition Optimal-Selection in Cloud Manufacturing System

In order to realize the full-scale sharing, free circulation and transaction, and on-demand-use of manufacturing resource and capabilities in modern enterprise systems (ES), Cloud manufacturing (CMfg) as a new service-oriented manufacturing paradigm has been proposed recently. Compared with cloud computing, the services that are managed in CMfg include not only computational and software resource and capability service, but also various manufacturing resources and capability service. These various dynamic services make ES more powerful and to be a higher-level extension of traditional services. Thus, as a key issue for the implementation of CMfg-based ES, service composition optimal-selection (SCOS) is becoming very important. SCOS is a typical NP-hard problem with the characteristics of dynamic and uncertainty. Solving large scale SCOS problem with numerous constraints in CMfg by using the traditional methods might be inefficient. To overcome this shortcoming, the formulation of SCOS in CMfg with multiple objectives and constraints is investigated first, and then a novel parallel intelligent algorithm, namely full connection based parallel adaptive chaos optimization with reflex migration (FC-PACO-RM) is developed. In the algorithm, roulette wheel selection and adaptive chaos optimization are introduced for search purpose, while full-connection parallelization in island model and new reflex migration way are also developed for efficient decision. To validate the performance of FC-PACO-RM, comparisons with 3 serial algorithms and 7 typical parallel methods are conducted in three typical cases. The results demonstrate the effectiveness of the proposed method for addressing complex SCOS in CMfg.

5. Enterprise Systems: State-of-the-Art and Future Trend

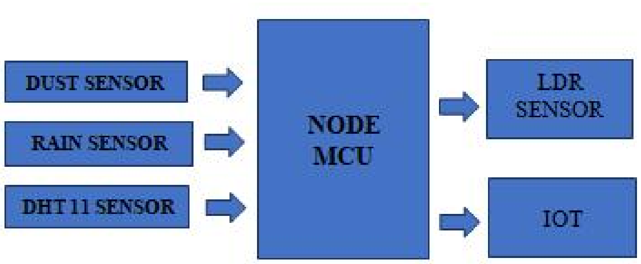
Rapid advances in industrial information integration methods have spurred tremendous growth in the use of enterprise systems. Consequently, a variety of techniques have been used for probing enterprise systems. These techniques include business process management, workflow management, Enterprise Application Integration (EAI), Service-Oriented Architecture (SOA), grid computing, and others. Many applications require a combination of these techniques, which is giving rise to the emergence of enterprise systems. Development of the techniques has originated from different disciplines and has the potential to significantly improve the performance of enterprise systems. However, the lack of powerful tools still poses a major hindrance to exploiting the full potential of enterprise systems. In particular, formal methods and systems methods are crucial for modeling complex enterprise systems, which poses unique challenges. In this paper, we briefly survey the state of the art in the area of enterprise systems as they relate to industrial informatics.

III. PROPOSED SYSTEM

1. **NodeMCU:** The system could use a NodeMCU development board as the primary microcontroller to collect and transmit data from the various sensors.
2. **Rain Sensor:** A rain sensor could be used to detect rainfall and collect data on precipitation levels.
3. **Air Quality Sensor:** An air quality sensor could be used to monitor the level of pollutants in the air, including carbon monoxide, nitrogen dioxide, and particulate matter.
4. **Temperature Sensor and Humidity Sensor:** These sensors could be used to monitor the temperature and humidity levels in the environment.
5. **LDR Sensor:** A light-dependent resistor (LDR) sensor could be used to detect changes in light levels and provide data on the intensity of sunlight.
6. **IoT Connectivity:** The system could be connected to the internet, allowing data to be transmitted and accessed remotely using a web or mobile application.
7. **Data Analytics:** Data collected from the various sensors could be analyzed using machine learning algorithms and statistical models to identify patterns and trends in environmental data.
8. **Alerts and Notifications:** The system could be programmed to send alerts and notifications to users when certain environmental conditions are met, such as when

the air quality reaches a dangerous level or when rainfall levels exceed a certain threshold.

IV. BLOCK DIAGRAM



BLOCK DIAGRAM EXPLANATION

NODE MCU ESP82266

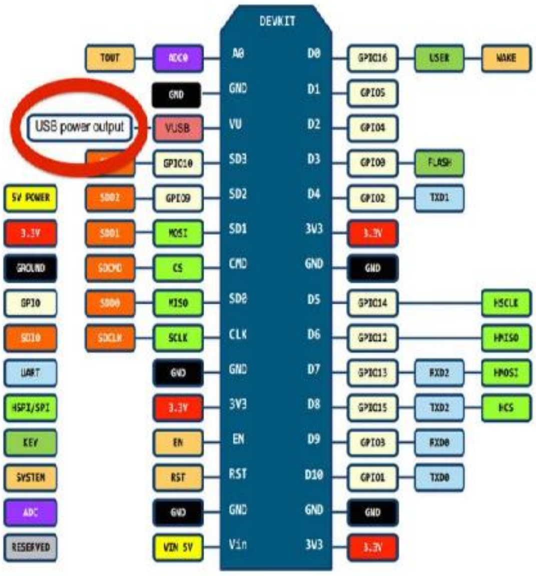
The ESP8266 itself is a self-contained WiFi networking solution offering as a bridge from existing micro controller to WiFi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Specification:

- Voltage:3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption: 10uA~170mA.
- Flash memory attachable: 16MB max (512K normal).
- Integrated TCP/IP protocol stack.
- Processor: Tensilica L106 32-bit.
- Processor speed: 80~160MHz.
- RAM: 32K + 80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode
- 802.11 support: b/g/n.
- Maximum concurrent TCP connections: 5.
- GPIO pin re-mapped, use the index to access gpio, i2c, pwm.
- Both Integer version(less memory usage) and Float version(Default) firmware provided

New Wireless module with CH340 USB-UART, NodeMcu is WIFI IoT (Internet of Things) development board based on ESP8266.

NodeMcu is a tiny board, based on ESP8266, integates GPIO, PWM, IIC, 1-Wire and ADC all in one board. It's a Lua based firmware for WiFi-SOC (Systems-On-Chop) ESP8266 WiFi module.



- NodeMCU V3 is an open-source firmware and development kit that plays a vital role in designing your own IoT product using a few Lua script lines.
- Multiple GPIO pins on the board allow you to connect the board with other peripherals and are capable of generating PWM, I2C, SPI, and UART serial communications.
- The interface of the module is mainly divided into two parts including both Firmware and Hardware where former runs on the ESP8266 Wi-Fi SoC and later is based on the ESP-12 module.
- The firmware is based on Lua – A scripting language that is easy to learn, giving a simple programming environment layered with a fast scripting language that connects you with a well-known developer community.
- And open source firmware gives you the flexibility to edit, modify and rebuilt the existing module and keep

changing the entire interface until you succeed in optimizing the module as per your requirements.
- USB to UART converter is added on the module that helps in converting USB data to UART data which mainly understands the language of serial communication.
- Instead of the regular USB port, MicroUSB port is included in the module that connects it with the computer for dual purposes: programming and powering up the board.
- The board incorporates status LED that blinks and turns off immediately, giving you the current status of the module if it is running properly when connected with the computer.
- The ability of module to establish a flawless WiFi connection between two channels makes it an ideal choice for incorporating it with other embedded devices like Raspberry Pi.

No:	Pin Name	Description
For DHT11 Sensor		
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	NC	No Connection and hence not used
4	Ground	Connected to the ground of the circuit
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1	Vcc	Power supply 3.5V to 5.5V
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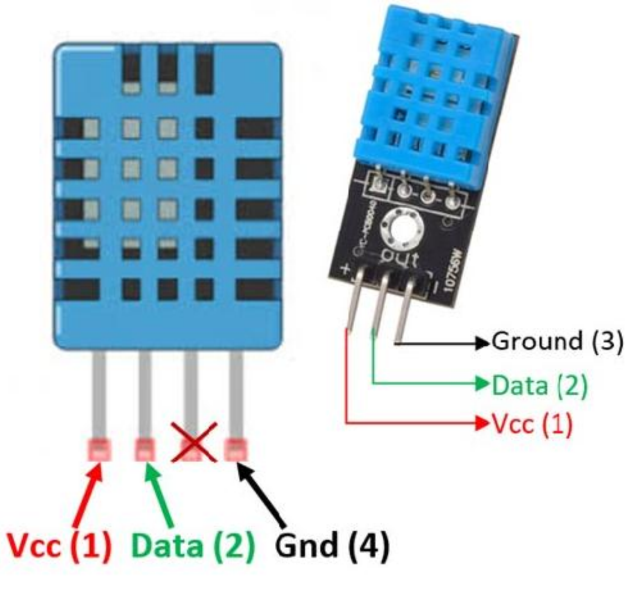
Features:

- Open-source
- Arduino-like hardware
- Status LED
- MicroUSB port
- Reset/Flash buttons
- Interactive and Programmable
- Low cost
- ESP8266 with inbuilt wifi
- USB to UART converter
- GPIO pins

As mentioned above, a cable supporting micro USB port is used to connect the board. As you connect the board with a computer, LED will flash. You may need some drivers to be installed on your computer if it fails to detect the NodeMCU board.

Temperature and humidity (DHT 11):

- ❖ 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).
- ❖ Its fairly simple to use, but requires careful timing to grab data. The **DHT11** calculates relative humidity by measuring the electrical resistance between two electrodes. The humidity **sensing** component of the **DHT11 is** a moisture holding substrate with the electrodes applied to the surface.



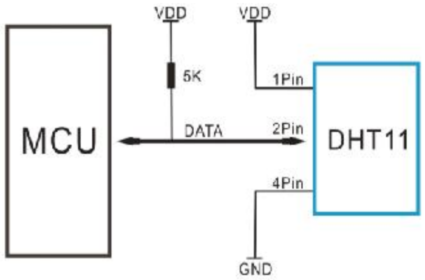
PinIdentification and Configuration:

DHT11 Specifications:

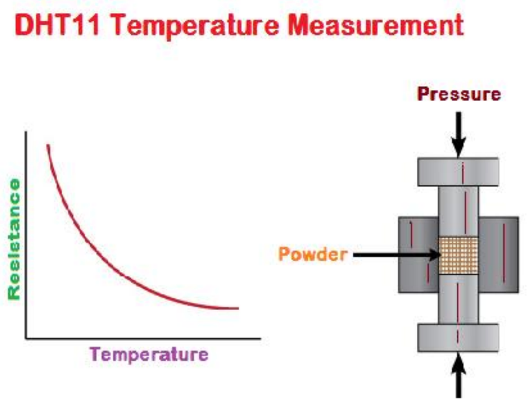
- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)

- 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%

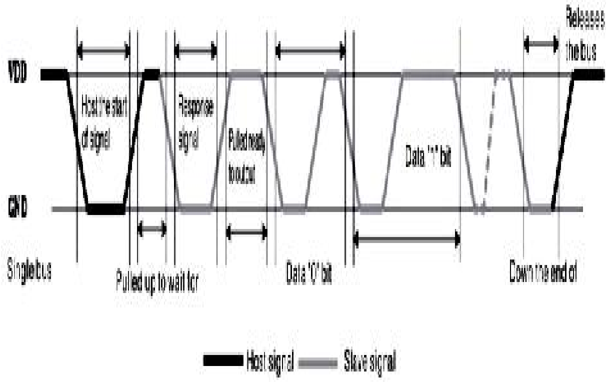
The DHT11 Sensor is factory calibrated and outputs serial data and hence it is highly easy to set it up. The connection diagram for this sensor is shown below.



As you can see the data pin is connected to an I/O pin of the MCU and a 5K pull-up resistor is used. This data pin outputs the value of both temperature and humidity as serial data. If you are trying to interface DHT11 with Arduino then there are ready-made libraries for it which will give you a quick start.



If you are trying to interface it with some other MCU then the datasheet given below will come in handy. The output given out by the data pin will be in the order of 8bit humidity integer data + 8bit the Humidity decimal data +8 bit temperature integer data + 8bit fractional temperature data +8 bit parity bit. To request the DHT11 module to send these data the I/O pin has to be momentarily made low and then held high as shown in the timing diagram .



Operating specifications:

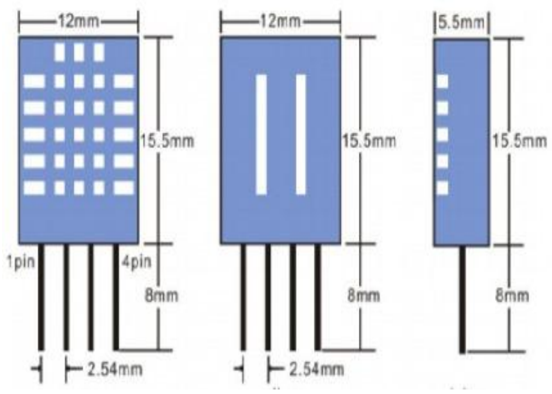
(1) Power and Pins:

Power's voltage should be 3-5.5V DC. When power is supplied to sensor, don't send anyinstruction to the sensor within one second to pass unstable status. One capacitor valued 100nFcan be added between VDD and GND for power filtering.

(2) Communication and signal:

Single-bus data is used for communication between MCU and DHT11

2D–model of the sensor:



Applications:

- Measure temperature and humidity
- Local Weather station
- Automatic climate control
- Environment monitoring

RAIN SENSOR

A rain sensor or rain switch is a switching device activated by rainfall. There are two main applications for rain sensors. The first isa water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall. The second is a device used to protect the interior of an automobile from rain and to support the automatic mode of windscreen wipers.

TYPES OF RAINS SENSORS

Depending on the type of yard you have, where you live, and how often it rains, you will want to determine the type of sensor to use. Here are some of the different rain sensors:

- Rainfall collection cup - This sensor stops the sprinklers from turning on when the rainfall cup fills to a certain level. An issue to be aware of with this kind of sensor is a false fill up. Leaves, debris, and even bugs or pests can fill up the collection cup causing the sprinklers to shut off. They often work through wireless communication.
- Expansion disk - This type of rain sensor is becoming more and more popular all the time. This particular sensor uses a cork disk that expands when there is rainfall to measure the level of precipitation. A pressure switch is then used to break the electrical connection which causes the sprinklers to turn on and off.

HOW DO THIS OPERATE?

The rain sensor works on the principle of total internal reflection. ... An infrared light beams at a 45-degree angle on a clear area of the windshield from the sensor- inside the car. When it rains, the wet glass causes the light to scatter and lesser amount of light gets reflected back to the sensor

An additional application in professional satellite communications antennas is to trigger a rain blower on the aperture of the antenna feed, to remove water droplets from the mylar cover that keeps pressurized and dry air inside the wave-guides.

LDR:

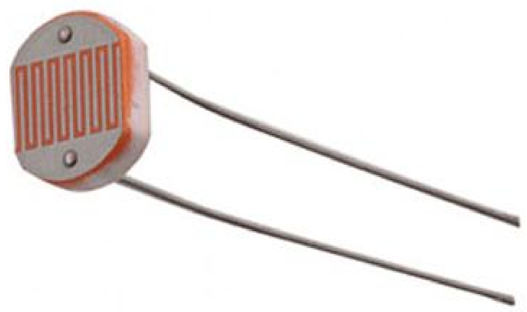
The **Light Dependent Resistor** (**LDR**) is just another special type of Resistor and hence has no polarity. Meaning they can be connected in any direction. They are breadboard friendly and can be easily used on a perf board also. The symbol for LDR is just as similar to Resistor but adds to inward arrows .The arrows indicate the light signals.

LDR Features

- Can be used to sense Light
- Easy to use on Breadboard or Perf Board
- Easy to use with Microcontrollers or even with normal Digital/Analog IC
- Small, cheap and easily available
- Available in PG5 ,PG5-MP, PG12, PG12-MP, PG20 and PG20-MP series

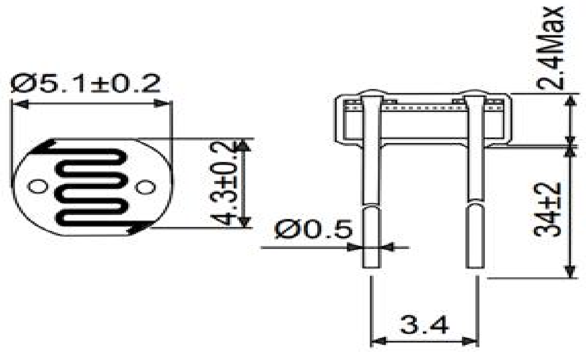
A **photoresistor** or **LDR** (Light Dependent Resistor), as the name suggests will change it resistance based on the light around it. That is when the resistor is placed in a dark room it will have a resistance of few Mega ohms and as we gradually impose light over the sensor its resistance will start to decrease from Mega Ohms to few Ohms.

This property helps the LDR to be used as a **Light Sensor**. It can detect the amount of light falling on it and thus can predict days and nights.



Applications

- Automatic Street Light
- Detect Day or Night
- Automatic Head Light Dimmer
- Position sensor
- Used along with LED as obstacle detector
- Automatic bedroom Lights
- Automatic Rear view mirror



DUST SENSOR

GP2Y1010AU0F Module is used to Sense Dust Particles in air and also called as an optical air quality sensor. It is very much Smaller in size. It detects the reflected light of dust in air. Especially, it is effective to detect very fine particle like the cigarette smoke. In addition it can distinguish smoke from house dust by pulse pattern of output voltage and is commonly used in air purifier systems.

The sensor has a very low current consumption (20mA max, 11mA typical), and can be powered with up to 7VDC. The output of the sensor is an analog voltage proportional to the measured dust density, with a sensitivity of 0.5V/0.1mg/m3.

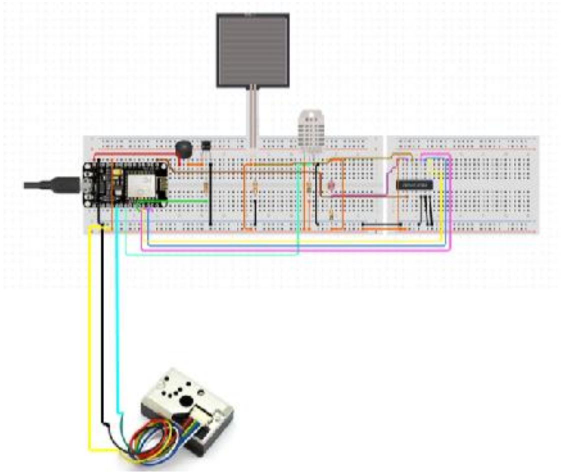
Features:-

- Compact, thin package (46.0 ×30.0×17.6 mm)
- Low consumption current (Icc: MAX. 20 mA)
- The presence of dust can be detected.
- Photometry of only one pulse
- Enable to distinguish smoke from house dust
- Lead-free and RoHS directive compliant

V. CONCLUSION

In conclusion, IoT-based environment monitoring using NodeMCU and various sensors such as rain, DHT11, LDR, dust, and buzzer is an essential need in today's world. The proposed system provides real-time data on critical environmental factors that impact our health and well-being, such as air quality, temperature, humidity, rainfall, and particulate matter concentration. With this system, users can monitor environmental conditions in real-time and identify potential health risks or other hazards. The system can also help organizations and governments make informed decisions about resource management and planning. By analyzing data collected from the sensors, the system can identify long-term trends and patterns, helping to inform policies and actions that promote sustainability and environmental protection. The proposed system is cost-effective, easy to implement, and highly customizable, making it accessible to a wide range of users. With further enhancements such as machine learning algorithms and integration with other systems, the system can provide even more advanced insights and capabilities. IoT-based environment monitoring is a vital tool in promoting a healthier and more sustainable future. With the help of IoT technology and innovative solutions such as this proposed system, we can make informed decisions to protect our environment and improve our quality of life.

CIRCUIT DIAGRAM



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