

Solar Smart Air Pollution Monitoring Framework Using Arduino and Iot Applications

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Date of Submission: 25-03-2024

Date of Acceptance: 05-04-2024

Air pollution affects our day-to-day activities and quality of life. It poses a threat to the ecosystem and the quality of life on the planet. One major environmental problem that affects everyone's quality of life and offers serious health hazards is air pollution. A novel approach is suggested in the form of a Solar Smart Air Pollution Monitoring Framework to address this issue. This framework is a useful tool for raising environmental awareness and reducing pollution since it makes use of the Internet of Things (IoT) and Arduino to enable real-time air quality monitoring. Arduino microcontrollers process the data collected from the sensors and transmit it to a central server using IoT communication protocols. The use of solar power ensures the sustainability and autonomy of the system, making it suitable for deployment in remote or off-grid areas. The real-time data collected by the framework is then made accessible through a user-friendly interface, such as a web or mobile application. The Solar Smart Air Pollution Monitoring Framework offers several key advantages. Firstly, it provides instant and accurate information on air quality, allowing for prompt response and intervention in case of pollution spikes. Secondly, its solar-powered design makes it environmentally friendly and cost-effective, reducing the reliance on traditional energy sources. In order to monitor going to make an IOT Based Air Pollution Monitoring System in which we will monitor the Air Quality over a web server using internet and

will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like smoke, Temperature sensor etc. It will show the air quality as well as on webpage so that we can monitor it very easily. In this IOT method, you can monitor the pollution level from anywhere using your computer or mobile.

I. INTRODUCTION

Air pollution occurs when harmful or excessive quantities of substances including gases, particulates, and biological molecules are introduced into earth's atmosphere. It may cause diseases, allergies and also death of humans; it may also cause harm to other living organisms such as animals and food crops and may damage the natural environment. Human activity and natural processes can both generate air pollution. Basically, there are two types of air pollution exists; visible air pollution and invisible air pollution. The sustainment of all things living is due to a combination of gases that collectively form the atmosphere; the imbalance caused by the increase or decrease of the percentage of these gases can be harmful for survival. The ozone layer considered crucial for the existence of the ecosystems on the planet is depleting due to increased pollution. Global warming, a direct result of the increased imbalance of gases in the atmosphere is the biggest challenge that world has to overcome for better survival. Several divisions are made to understand the causes of air pollution.

The Solar Smart Air Pollution Monitoring system with Adafruit and IoT (Internet of Things) integration is designed to measure and analyze air quality using sensors, and then transmit this data to a cloud platform for further analysis and visualization. This project aims to create an efficient and sustainable solution for monitoring air pollution using solar power and Adafruit's hardware components. Adafruit provides a range of microcontrollers that are easy to use and well-supported in the maker community. These microcontrollers can interface with the air quality sensors and collect data. To make the system sustainable and independent of external power sources, a solar power system can be integrated. This includes a solar panel, a charge controller, and a battery for energy storage. The solar panel will harvest energy from the sun to power the monitoring system. Adafruit IO is a cloud-based IoT platform that can be used to store and visualize data from the air quality sensors. The microcontroller can be programmed to send data to Adafruit IO over Wi-Fi or cellular networks.

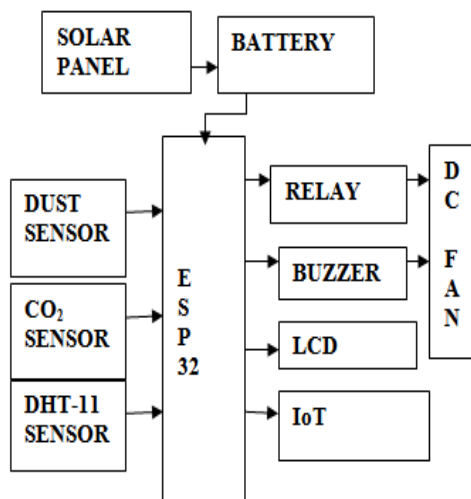
Banik,et.al.(1)The aim of this project is to develop such a device that can automatically detect and stop gas leakages in those permeable areas. The system detects the leakage of the LPG (Liquefied Petroleum Gas) using a gas sensor and uses the GSM to alert the person about the gas leakage via SMS. When the LPG concentration in the air exceeds a predetermined level, the gas sensor senses the gas leakage and the output of the sensor goes low. Zavorotnyi, V. F,et.al.(2)The proposed design is designed using PSoC based Integrated Development Environment (IDE). Programming is done using Kiel C that comes along with IDE.Jong-Hann Jean,et.al.(3)In the paper we tried to apply an MAV system equipped with various kinds of sensors to assist the patrol task of surveillance and security monitoring in campus, factories, or community buildings, which has the advantage that it can fly over obstacles such as barriers, fences, and ditches.Abu Hassan Abdullah,et.al.(4)Liquefied Petroleum Gas (LPG) is being used for heating in a wide range of domestic, industry and automobile applications. Ahmed Imteaj,et.al.(5)Energy is the most extensive need in today's world where we are wasting our energy deliberately or abstractedly. But we have to stop maltreatment to our energy.A. Devi, G. Gnanavel,et.al.(6)When we consider an industry of large area the monitoring, controlling of each section involved in the industry is a big task. It involves a large amount of man power and time consumption.Maurizio Rossi,et.al.(7). Even if the micro-machined gas sensors implementation is

supported by several examples, reports on airborne applications of these sensors are very limited. Ronik Dhakar,(8) Especially, the ZigBee, one of the important wireless technologies, has become attractable in both of commercial and research areas, because of open standard, low-cost, and low-power characteristics.Perumal, S,et.al.(9)In this article, studies on different characteristics of nanofluids like Thermal conductivity, viscosity, density, specific heat and heat transfer performances of concentric tube heat exchanger with nano fluids for enhancing the heat transfer. K.Senthilkumar, et.al.(10)The heat exchanger device such as concentric tube heat exchanger faces challenges to obtain the best thermal performance of heat exchanger devices plays important role in the performance of cooling system. The conventional coolant offer low thermal conductivity.Perumal saravananand Mohan raman,(11)Today, for many engineering applications, heat extracted from exhaust waste gas is used. Because of their capabilities and benefits, heavy-duty Diesel engines are widely installed and operated in industries for electrical energy production, transportation, etc., but about 30% of the input energy is wasted by exhaust gas emissions and water cooling.De Albornoz,et.al.(12)This research requires the development and evaluation of a robust mobile robotic platform which supports an odor sensory unit, as well as some development tools like PC communication, data saving and the odor delivery system. Vishakha D,et.al.(13)Main focus in automation is to control light ON/OFF status, fan speed and other home appliances remotely. Home security includes services like gas leakage and trace pass protection. This system is very beneficial for old ages and handicapped people as well for working people, it is a blessing as it alert the person if any nasty situation raised at home in their absence.

II. BLOCK DIAGRAM OF PROPOSED SYSTEM

By integrating these components, a solar and battery-powered air pollution monitoring system can contribute to environmental sustainability and public health. It's important to work with relevant stakeholders, including local authorities and environmental agencies, to ensure the system aligns with regional requirements and contributes to improving air quality. The system consists of MQ6 sensor, DHT-11 sensor,dust sensor, relay, fan and Lcd. The MQ6 sensor detects the CO2 gas in environment to transmit the data to controller. DHT 11 sensor to sense the temperature and humidity. Dust sensor recognized the dust

particle. The gas sensor senses the gas in environment the DC fan ON trigger by relay. Sensor is giving us value of 90 when there is no gas near it and the air quality safe level is 350 PPM and it should not exceed 1000 PPM. When it will exceed the limit of 1000 PPM, it will cause Headaches, sleepiness and stagnant, stuffy air. It will contain temperature and humidity so it will possibly show the current temperature and humidity of the air. According to the model the 4 sensors works as input data, they transmit data for knowing which gas it is, what is the temperature and humidity. LCD shows the data of the gases in ppm (parts per million). IoT includes the values of temperature, gas and humidity which indicates for certain limit



III. DESIGN OF SOLAR SMART AIR POLLUTION MONITORING FRAMEWORK USING ARDUINO AND IoT APPLICATIONS

Another direct effect is the immediate alterations that the world is witnessing due to global warming. With increased temperatures worldwide, increase in sea levels and melting of ice from colder regions and icebergs, displacement and loss of habitat have already signalled an impending disaster if actions for preservation and normalization are not undertaken timely. Harmful gases like nitrogen oxides and oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to human, animals and crops. Eutrophication is a condition where high amount of nitrogen present in some pollutants gets developed on sea's surface and turns itself into algae and adversely affects fish, plants and animal

species. This scalable and environmentally friendly smart air pollution monitoring system makes use of Adafruit's hardware in conjunction with solar power and Internet of Things connectivity to monitor and control air quality in a variety of settings. It can be used in industrial zones, urban areas, or even isolated places with sporadic access to power sources.

IV. HARDWARE DESCRIPTION POWER SUPPLY

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters.

SOLAR PANEL

These power plants can be grid-connected, feeding electricity directly into the electrical grid, or off-grid, providing power to remote areas or standalone applications. A solar power plant creates the energy from the sun to produce electricity in an environmentally friendly way. It uses various technologies to capture solar radiation and convert it into usable energy, making it a clean and sustainable alternative to traditional fossil fuels. Solar power plants come in different forms, but the most common types are solar thermal power plants and solar photovoltaic plants. Solar thermal power plants use mirrors or lenses to concentrate sunlight and generate steam, which drives turbines to produce electricity. On the other hand, solar photovoltaic plants use solar panels made of semiconductor materials to directly convert sunlight into electricity. The electricity generated by solar power plants can be fed into the power grid to supply homes, businesses, and industries with clean energy. One of the significant advantages of solar power is its eco-friendliness, as it does not release harmful pollutants or greenhouse gases, reducing the impact on climate change and the environment. Solar power plants play a crucial role in the transition to sustainable energy production. As technology continues to improve and costs decrease, solar power is becoming more accessible and widespread.

WORKING PRINCIPLE SOLAR PANEL

A solar power plant, also known as a solar farm or solar energy facility, is a large-scale installation that harnesses sunlight to generate electricity. It consists of numerous solar panels or photovoltaic (PV) modules arranged in an

organized manner to capture solar energy efficiently.

BATTERY

A lead acid battery is a rechargeable battery that uses lead and sulphuric acid to function. The lead is submerged into the sulphuric acid to allow a controlled chemical reaction. This chemical reaction is what causes the battery to produce electricity. Then, this reaction is reversed to recharge the battery. To put it simply, the battery's electrical charge is generated when the sulphate in the sulphuric acid becomes bonded to the lead. The electrical charge is replenished by reversing this reaction. That is, the sulphate goes back into the sulphuric acid and, thus, the battery is recharged. Now, obviously, there's a finite amount of sulphate ions in the acid. And the available surface area of the lead it bonds to is limited, too. So, as the sulphate is depleted, the charge becomes weaker. For this reason, lead-acid batteries are not ideal for powering devices for a long period of time. Instead, they're best for applications that need a short, powerful burst of energy.

FILTER

The purpose of power supply filters is to smooth out the ripple contained in the pulses of DC obtained from the rectifier circuit while increasing the average output voltage or current

VOLTAGE REGULATOR

A voltage regulator is a system designed to automatically maintain a constant voltage. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.



Voltage regulator

Advantages of voltage regulator

- Output voltage regulation is good (tap switching) to very good (double conversion)
- Ultrafast voltage correction speed.
- No restrictions on the number of correction cycles.
- Versatility of kVA rating, voltage and configuration.
- Very low or no regular maintenance.

- Good line isolation

DHT 11 SENSOR

The quantity of water vapor in the air is measured as humidity. The amount of humidity in the air has an impact on a number of chemical, biological, and physical processes. Humidity can have an impact on staff health and safety, company costs associated with the products, and employee safety. So, measuring humidity is crucial in the semiconductor and control system sectors. The quantity of moisture in a gas which might be a combination of water vapor, nitrogen, argon, or pure gas, for example is determined by its relative humidity. Based on their measuring units, humidity sensors may be divided into two categories. A relative humidity sensor and an absolute humidity sensor are what they are. A digital temperature and humidity sensor is the DHT11.

A cheap digital sensor for detecting humidity and temperature is the DHT11. To instantly detect humidity and temperature, this sensor may be simply interfaced with any micro-controller, including Arduino, Raspberry Pi, etc. Both a sensor and a module are available for the DHT11 humidity and temperature sensor. The pull-up resistor and a power-on LED distinguish this sensor from the module. A relative humidity sensor is the DHT11. This sensor employs a capacitive humidity sensor and a thermistor to detect the ambient air.



DHT 11 Sensor

Working Principle of DHT11 Sensor

The DHT11 sensor comprises of a thermistor for measuring temperature and a capacitive humidity detecting device. The humidity detecting capacitor consists of two electrodes separated by a substrate that may store moisture as a dielectric. The capacitance value changes as the humidity levels fluctuate. The IC calculates, interprets, and converts the modified resistance values into digital form. This sensor employs a negative temperature coefficient thermistor to measure temperature, which results in a drop in resistance value as temperature rises.

The DHT11 has a temperature range of 0 to 50 degrees Celsius with a 2-degree precision. This sensor has a 20 to 80% humidity range with a 5% accuracy. This sensor's samplingrate is 1Hz. In

other words, it provides one reading per second. The DHT11 is a tiny device with a 3-to-5-volt operational range. 2.5mA is the maximum current that may be used for measuring.

Applications

This sensor is employed in a number of applications, including the measurement of temperature and humidity levels in HVAC systems.

These sensors are also used by weather stations to forecast the weather. In houses where residents are susceptible to the effects of humidity, the humidity sensor is employed as a preventative measure.

This sensor is used in offices, vehicles, museums, greenhouses, and businesses to detect humidity levels and as a safety precaution

MQ6 SENSOR

The MQ6 gas sensor is a device that has a fast response to Liquid petroleum gas, generally used in equipment to detect gas leaks in industrial and other works. This is a simple sensor suitable for detecting LPG in the air that mostly contains butane and propane. The sensor allows us to detect if there are gas concentrations anywhere and we can hence use it in various industrial and commercial projects. The Digital Pin of this sensor allows it to operate even without a microcontroller and that is manageable when you are trying to catch one specific gas. The sensor can also detect different combustible gas.



MQ6 sensor

Pinout of MQ6 sensor

S.No	Pin name	Description
1.	Vcc	Power Pin requires an operating voltage of 5V.
2.	GND	Ground pin.
3.	DO	Digital out the pin, to get the digital output from the sensor, need to set the threshold value using Pot.
4.	AO	Analog out the pin. It based the output of this pin on the intensity of the LPG or other gas.

Features

- High sensitivity to LPG, iso-butane, propane
- Small sensitivity to alcohol, smoke.
- Fast response
- Stable and long life
- Simple drive circuit
- Preheat duration 20 seconds
- Can be used as a Digital or analog sensor

Specifications

- Detecting Concentration: 300 to 10000 ppm
- Input Voltage: 5 VDC
- Power: 150 mA
- Digital Output Voltage: TTL digital 0 and 1 (0.1 V and 5 V)
- Analog Output Voltage (relatively clean): 0.1 V to 0.3 V
- Analog Output Voltage (highest concentration): 4 V
- PCB Size: 32 x 20 x 22 mm

DUST SENSOR

The photo-sensor detects the reflected IR LED light by dust particles in air. The SMART Dust Sensor can detect the small particles like cigarette smoke and it can distinguish small particles like smoke from large house dust by pulse pattern of signal output.



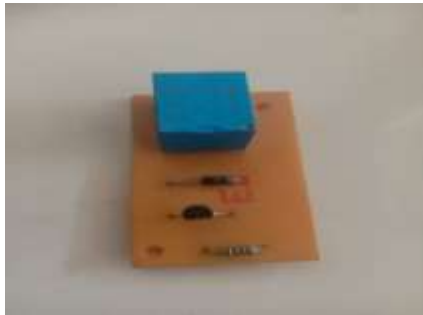
Dust sensor

Features and specifications

- Low Current Consumption: 20mA max
- Typical Operating Voltage: 4.5V to 5.5V
- Minimum Detectable Dust Size: 0.5µm
- Dust Density Sensing Range: Up to 580 µg/m3
- Sensing Time: Less than 1 Second
- Sensitivity: 0.5 V/(100 µg/m3)
- Operating Temperature: -10 C to +65 C
- Dimensions: 1.81 x 1.18 x 0.69" (46.0 x 30.0 x 17.6 mm)
- The presence of dust can be detected by the photometry of only one pulse
- Enable to distinguish smoke from house dust
- Lead-free and RoHS directive compliant

RELAY MODULE

A relay is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal. The input voltage of the relay signal ranges from 0 to 5V.



Relay module

Pin configuration

Pin1 (End 1): It is used to activate the relay; usually this pin one end is connected to 5Volts whereas another end is connected to the ground.

Pin2 (End 2): This pin is used to activate the Relay.

Pin3 (Common (COM)): This pin is connected to the main terminal of the Load to make it active.

Pin4 (Normally Closed (NC)): This second terminal of the load is connected to either NC/ NO pins. If this pin is connected to the load, then it will be ON before the switch.

Pin5 (Normally Open (NO)): If the second terminal of the load is allied to the NO pin, then the load will be turned off before the switch.

Working

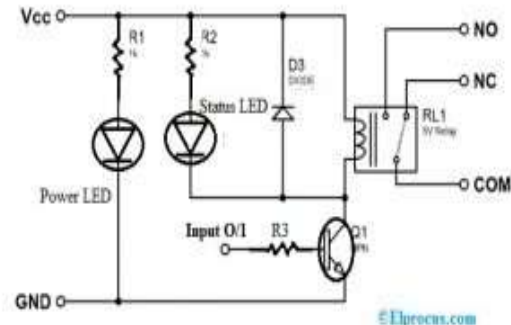
The relay uses the current supply for opening or closing switch contacts. Usually, this can be done through a coil to magnetize the switch contacts & drags them jointly once activated. A spring drives them separately once the coil is not strengthened.

By using this system, there are mainly two benefits, the first one is, the required current for activating the relay is less as compared to the current used by relay contacts for switching. The other benefit is, both the contacts & the coil are isolated galvanically, which means there is no electrical connection among them.

RELAY MODULE CIRCUIT DIAGRAM

The circuit diagram of the single-channel relay module circuit is shown below. In this circuit, we can observe that how the relay module is activated and deactivated through a digital signal. This signal is applied to a control pin of the relay

module.



Circuit diagram of relay module

The circuit diagram of relay module of the single-channel relay module includes resistors-2, transistors, LEDs-2 & a 5V relay. Relay modules are available in two types based on the control signal type used for activation of the relay.

One relay module comes with an NPN transistor whereas another module comes with a PNP transistor. If the relay module uses an NPN Transistor, then it will activate the relay by applying an active high signal to the control pin. Alternatively, if a PNP is used then the relay will be activated through an active low signal on the control pin.

COMPONENTS OF RELAY MODULE

Output Terminal

The output terminal of the relay module is located at the left-hand side, used to fix an AC/DC load & AC/DC i/p power source. Every o/p connector's terminal is connected through NC, COM pins & NO of the relay.

The relay module consists of screws that are used to connect wires & cables. The max current supported by this module is 10A & the max contact voltage is 250V AC & 30V DC. Thick main cables are mainly used whenever high voltage & current load is used.

Status LED

Status LED is connected by using a current limiting resistor that is located on the top right side of the relay module. So, this LED illustrates the relay status by activating the relay & coil through a signal pin. The DC supplies throughout a relay coil.

Freewheeling Diode

The connection of this diode can be done across the coil to keep away from the back EMF effect, so-called a flyback diode. The type of coil

used in the relay is the inductive type. Once the current supplies throughout an inductive load, then it generates a back EMF voltage, which may harm the circuit. So, this diode is mainly used to keep away from this effect.

Input Connector

The input connector is located on the right side of the module. This connector is mainly used to supply a 5V power supply & input signal. In addition, it also supplies power supply toward the power LED, relay coil & status LED.

Switching Transistor

Generally, the input signal which is given to a relay is from the I/O pins of microcontrollers like ESP32, TM4C123, Arduino, etc. However, the highest current sourcing capacity of GPIO pins is usually below 20mA.

Therefore, a switching transistor is used in this module is to strengthen the current to the requirement of the minimum current level of the relay coil. A switching transistor is used to control the 5V relay from the microcontroller's GPIO pin.

Features

- Normal Voltage is 5V DC
- Normal Current is 70mA
- AC load current Max is 10A at 250VAC or 125V AC
- DC load current Max is 10A at 30V DC or 28V DC
- It includes 5-pins and is designed with plastic material
- Operating time is 10msec
- Release time is 5msec
- Maximum switching is 300 operating per minute
- Specifications
- Voltage supply ranges from 3.75V – 6V
- Quiescent current is 2mA
- Once the relay is active then the current is ~70mA
- The highest contact voltage of a relay is 250VAC/30VDC

Advantages

- A remote device can be controlled easily
- It is triggered with less current but it can also trigger high power machines
- Easily contacts can be changed
- At a time, several contacts can be controlled using a single signal
- Activating part can be isolated
- It can switch AC or DC
- At high temperatures, it works very well

Applications

- Used in over voltage/under voltage protection system
- Mains Switching
- Speed control of motors through start-delta converters
- Automatic electrical appliances
- Electrical isolation in between high & low power sources
- Lights
- AC voltage load switching using less voltage DC
- Delivery of Isolated power
- Home automation projects
- Switching with High Current

DC FANS

The direct current fans, or DC fans, are powered with a potential of fixed value such as the voltage of a battery. Typical voltage values for DC fans are, 5V, 12V, 24V and 48V. In contrast, the alternating current fans, or AC fans, are powered with a changing voltage of positive and of equal negative value.



DC fan

Features

- Perfectly fit on the extruder
- Noiseless Performance
- Very low Current consumption

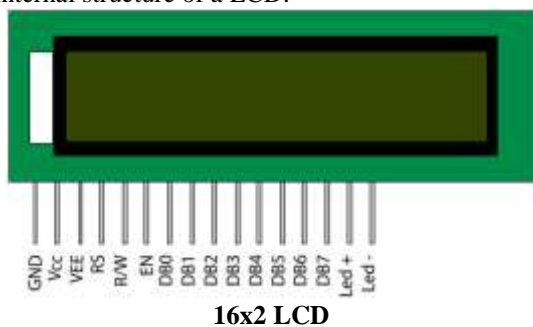
Specifications

- Operating Voltage: 12V DC
- Type: DC
- Operating Current: 0.2Amp±10%
- Rated speed: 2600RPM ±10%
- Air Flow: 30.7CFM
- Noise: 30.7dBA
- Length: 80mm
- Width: 80mm
- Height: 25mm
- Weight: 85gm

LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of

applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.



16x2 LCD

INTERNET OF THINGS (IoT) INTRODUCTION

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Working of IoT

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments.

IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another.

The devices do most of the work without human intervention, although people can interact with the devices for instance, to set them up, give them instructions or access the data.

2 Important of IoT

The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business.

IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations

Benefits of IoT

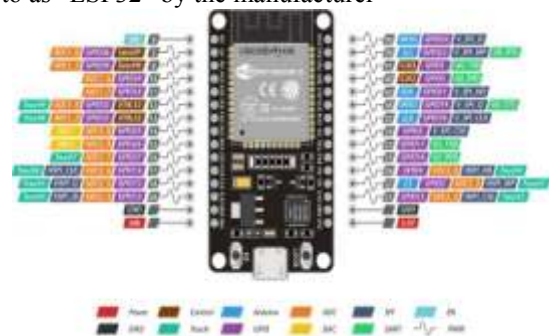
- Save time and money
- Information can access from anywhere any time
- Improved communication
- Transferring the data packets
- Improve the quality of business service

Application of IoT

- Connected vehicles
- Traffic managements
- Smart grids
- Environmental monitoring
- Smart homes/smart buildings
- Smart cities
- Industrial, agricultural and commercial management

ESP32 MICROCONTROLLER

ESP32 is the name of the chip that was developed by Expressive Systems. This provides Wi-Fi (and in some models) dual-mode Bluetooth connectivity to embedded devices. While ESP32 is technically just the chip, modules and development boards that contain this chip are often also referred to as “ESP32” by the manufacturer



Pinout Configuration

ESP32 Peripheral features

- 18 Analog-to-Digital Converter (ADC) channels
- 10 Capacitive sensing GPIOs
- 3 UART interfaces
- 3 SPI interfaces
- 2 I2C interfaces
- PWM output channels
- 2 Digital-to-Analog Converters (DAC)
- 2 I2S interfaces

GPIO pins

ESP32 Wroom32 Devkit has total 25 GPIOs out of that few pins are Input only Pins,

Input Only Pins

GPIO 34, GPIO 35, GPIO 36, GPIO 39

Not all pins have input pullup, you need external pullup on these pins when using as input pullup.

Pins with internal pull up INPUT_PULLUP

GPIO14, GPIO16, GPIO17, GPIO18, GPIO19, GPIO21, GPIO22, GPIO23

Pins without internal pull up

GPIO13, GPIO25, GPIO26, GPIO27, GPIO32, GPIO33

Analog Input Pins

Analog to digital conversion is the ability to read a voltage level found on a pin between 0 and some maximum value and convert that analog value into a digital representation. Varying the voltage applied to the pin will change the value read. The ESP32 has an analog to digital converter built into it with a resolution of up to 12 bits which is 4096 distinct values.

- ADC1_CH0
- ADC1_CH3
- ADC1_CH4
- ADC1_CH5

Capacitive touch pins

The ESP32 has 10 internal capacitive touch sensors.

- T0 (GPIO 4)
- T1 (GPIO 0)
- T2 (GPIO 2)
- T3 (GPIO 15)
- T4 (GPIO 13)
- T5 (GPIO 12)
- T6 (GPIO 14)
- T7 (GPIO 27)
- T8 (GPIO 33)

- T9 (GPIO 32)

Digital to Analog Converter (DAC)

There are 2 x 8 bits DAC channels on the ESP32 to convert digital signals into analog voltage **signal outputs**.

- DAC1 (GPIO25)
- DAC2 (GPIO26)

RTC GPIOs

There is RTC GPIO support on the ESP32. The GPIOs routed to the RTC low-power subsystem can be used when the ESP32 is in deep sleep. These RTC GPIOs can be used to wake up the ESP32 from deep sleep when the Ultra-Low Power (ULP) co-processor is running. The following GPIOs can be used as an external wake up source.

- RTC_GPIO0 (GPIO36)
- RTC_GPIO3 (GPIO39)
- RTC_GPIO4 (GPIO34)
- RTC_GPIO5 (GPIO35)
- RTC_GPIO6 (GPIO25)
- RTC_GPIO7 (GPIO26)
- RTC_GPIO8 (GPIO33)
- RTC_GPIO9 (GPIO32)
- RTC_GPIO10 (GPIO4)
- RTC_GPIO11 (GPIO0)
- RTC_GPIO12 (GPIO2)
- RTC_GPIO13 (GPIO15)
- RTC_GPIO14 (GPIO13)
- RTC_GPIO15 (GPIO12)
- RTC_GPIO16 (GPIO14)
- RTC_GPIO17 (GPIO27)
- PWM

The ESP32 LED PWM controller has 16 independent channels that can be configured to generate PWM signals with different properties. All pins that can act as outputs can be used as PWM pins (Input only pin GPIOs 34 to 39 can't generate PWM).

Serial

ESP32 has three serial ports

First Serial RX0, TX0 is used for programming,

- GPIO3 (U0RXD)
- GPIO1(U0TXD)

Another Serial port is available on

- GPIO16 (U2RXD).
- GPIO17 (U2TXD).

When programming it is named as Serial2.

I2C

When using the ESP32 with the Arduino IDE, you should use the ESP32 I2C default pins (supported

by the Wire library):

- GPIO 21 (SDA)
- GPIO 22 (SCL)

Interrupts

All GPIOs can be configured as interrupts.

Enable (EN)

Enable (EN) is the 3.3V regulator's enable pin. It's pulled up, so connect to ground to disable the 3.3V regulator. This means that you can use this pin connected to a pushbutton to restart your ESP32.

ESP 32 functions

ESP32 has many applications when it comes to the Internet of Things (IoT). Here are just some of the IoT functions the chip is used for:

Networking: The module's Wi-Fi Antenna and dual-core enables embedded devices to connect to routers and transmit data.

Data Processing: Includes processing basic inputs from Analog and Digital sensors to far more complex calculations with an RTOS or Non-OS SDK.

P2P Connectivity: Creates direct communication between different ESPs and other devices using IoT P2P connectivity.

Web Server: Access pages written in HTML or development languages.

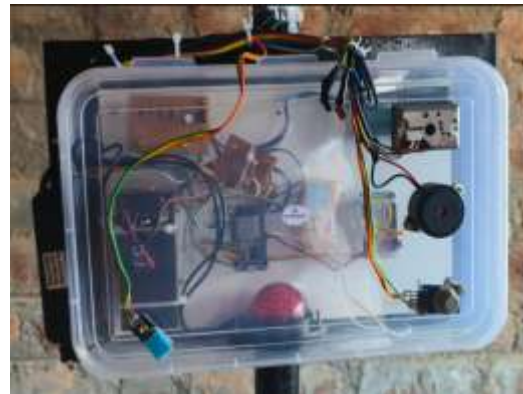
ESP 32 APPLICATIONS

- Programmable Logic Controllers (Plcs)
- Including Wearable Health Monitors
- Including HVAC And Thermostats
- Including Surveillance Cameras And Smart Locks Applications
- Prototyping Of Iot Devices
- Low Power Battery Operated Applications

V. RESULT AND DISCUSSION

The following figures represents the Smart Air Pollution Monitoring System prototype model that is functioned using solar energy. The air-handling unit (AHU) have been mounted over the top end of tower framework. The AHU consists of DC suction fan at lateral side of chamber and the section of filter paper with steel mesh is arranged normal to the air intake. The sensor unit has fixed below the AHU in tower, which contains temperature sensor, humidity sensor, dust sensor and gas sensor. the going to make an IOT Based Air Pollution Monitoring System in which we will (Dust=2.00mg/m³), (Gas=20.00cf), (Tem=100°C),

(Hum=20.00g.m³). to be monitored using this sensor and recycle the polluted air in AHU. The entire mentoring system was processed using solar energy and the observed air quality data have maintained and transferred to the ad fruit software (IoT).



Overall Assembling Of Air Pollution Monitoring System



Overall assembling of air pollution monitoring system

The below figures are the working output of "Solar Air Pollution Monitoring System". The

air quality of dust level (DT), carbon gas level (GS), and atmospheric humidity range (HM) and air temperature (TP) has displayed in LCD indicator.



2024/03/30 11:23:54AM	35.00	×
2024/03/30 11:23:04AM	35.00	×
2024/03/30 11:22:14AM	35.00	×
2024/03/30 11:21:24AM	35.00	×
2024/03/30 11:20:34AM	35.00	×
2024/03/30 11:18:59AM	35.00	×
2024/03/28 10:54:00AM	37.00	×
2024/03/28 10:53:36AM	37.00	×
2024/03/28 09:57:59AM	35.00	×
2024/03/28 09:56:29AM	34.00	×
2024/03/27 06:14:03PM	36.90	×
2024/03/27 10:09:19AM	34.20	×

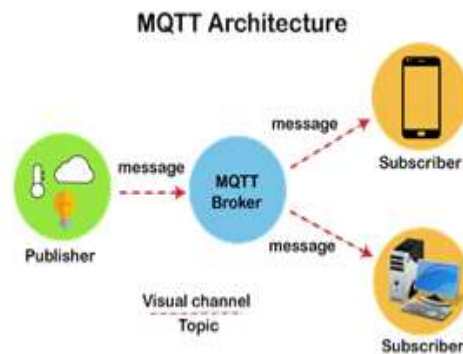
Record 1 through 12 of 12 (100.00% loaded)

Appears on Dashboards

- POLLUTION_MONITORING_SYSTEM

3.MQTT (MQ TELEMETRY TRANSPORT)

MQTT (MQ Telemetry Transport) is a lightweight open messaging protocol that provides resource-constrained network clients with a simple way to distribute telemetry information in low-bandwidth environments. The protocol, which employs a publish/subscribe communication pattern, is used for machine-to-machine (M2M) communication.



Created as a low-overhead protocol to accommodate bandwidth and CPU limitations, MQTT was designed to run in an embedded environment where it could provide a reliable, effective path for communication. Suitable for connecting devices with a small code footprint, MQTT is a good choice for wireless networks that experience varying levels of latency due to occasional bandwidth constraints or unreliable connections. The protocol has applications in industries ranging from automotive to energy to telecommunications.

MQTT MESSAGES

When a client wants to send data to the broker, this is known as a “publish.” When a client wants to receive data from the broker, it will “subscribe” to a topic or topic. When a client subscribes to a certain topic, it will receive all messages published on that topic going forward.

Along with the message itself, the publisher also sends a QoS (Quality of Service) level. This level defines the guarantee of delivery for the message.

These levels are as follows:

At most once: When the message is published, the broker will only receive the message “at most once.” This level should not be used for mission-critical information since it carries the risk that the subscribers will not receive the message.

At least once: The publisher continues to resend the message until it receives an acknowledgment from the broker regarding the particular message. In other words, it’s more important that the message is received than it is to ensure it is only received once. This is probably the most commonly used QoS level.

Exactly once: The publisher and broker work together to ensure the broker will receive and act on a message exactly once. This requires some additional overhead in the form of a four-part

handshake. Although this is the safest QoS level, it is also the slowest and therefore only used when necessary.

Benefits of MQTT

- Efficient data transmission and quick to implement, due to its being a lightweight protocol;
- Low network usage, due to minimized data packets;
- Efficient distribution of data;
- Successful implementation of remote sensing and control;
- Fast, efficient message delivery;

Applications of MQTT

- Synchronization of sensors, such as fire detectors or motion sensors for theft detection, to determine if a hazard is valid
- Monitoring health parameters using sensors for patients leaving a hospital
- Sensors alerting people of danger

ADAFRUIT IO

Adafruit io is a platform designed by ADAFRUIT IO to display, respond, and interact with your project's data. Adafruit also keep your data private (data feeds are private by default) and secure (ADAFRUIT will never sell or give this data away to another company)

Install libraries

In the Arduino ide, navigate to sketch -> include library->manage libraries. Enter Adafruit io Arduino into the search box, and click install on the Adafruit io Arduino library option to install version 4.0.0 or higher.

ADAFRUIT IO SETUP

If you do not already have an Adafruit io account, create one now. Next, navigate to the Adafruit io dashboards page.

We'll create a dashboard to visualize and interact with the data being sent between your esp32-s2 board and

Adafruit io

- Click the new dashboard button.
- Name your dashboard my esp32-s2.
- Your new dashboard should appear in the list.
- Click the link to be brought to your new dashboard.
- We'll want to turn the board's led on or off from Adafruit io. To do this, we'll need to add a toggle button to our dashboard.

- Click the cog at the top right-hand corner of your dashboard.
- In the dashboard settings dropdown, click create new block.
- Select the toggle block.
- Under my feeds, enter led as a feed name. Click create.
- Choose the led feed to connect it to the toggle block. Click next step

UNDER BLOCK SETTINGS,

Change button on text to 1

Change button off text to 0

Click create block

USAGE WITH ADAFRUIT IO

The esp32-s2 is an affordable, all-in-one, option for connecting your projects to the internet using our IOT platform, ADAFRUIT IO.

For more information and guides about ADAFRUIT IO, check out the ADAFRUIT IO basics series

VI. CONCLUSION

The system to monitor the air of environment using, IOT Technology is proposed to improve quality of air. With the use of IOT technology enhances the process of monitoring various aspects of environment such as air quality monitoring issue proposed in this method. Here the using of sensor gives the sense of different type of dangerous gas and controller is the heart of this project which controls the entire process. Whole process to internet and LCD is used for the visual Output. The Automatic Air & monitoring management system is a step forward to contribute a solution to the biggest threat. This scalable and environmentally friendly smart air pollution monitoring system makes use of Adafruit's hardware in conjunction with solar power and Internet of Things connectivity to monitor and control air quality in a variety of settings. The environmental impact of conventional energy sources is lessened by solar power, which offers a clean and sustainable energy source. This contributes to the development of an environmentally responsible and sustainable method of powering air pollution monitoring equipment. It can be used in industrial zones, urban areas, or even isolated places with sporadic access to power sources. OSHA proposed a 1 mg/m³ 8-hour TWA for hardwood dust and a 5 mg/m³ 8-hour TWA for softwood dust. The ideal relative humidity for health and comfort is about 40–50%. In the winter months, it may have to be lower than 40% RH to avoid condensation on the windows.

There were 130 CFM of atmospheric air have passed through suction fan and gets purified by filter paper and honeycomb mesh. There is zero level of dust and carbon gas observed in air whereas average humidity 57% and the air temperature 37°C. In general, range of 350 to 400 PPM of CO₂ gas is normally contained in atmospheric air. If it raised beyond 1000 PPM, air AHU gets actuated automatically and air recirculated to atmosphere about 110 CFM approximately.

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