IoT BASED WATER POLLUTION MONITORING SYSTEM

A PROJECT REPORT

Submitted by

DHANU SHREE P	(711119104021)
GUNASEKHAR C	(711119104026)
HARI PRAKASH P	(711119104028)
JAGADISH V	(711119104031)

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BONAFIDE CERTIFICATE

Certified that this project report **“IoT BASED WATER POLLUTION MONITORING SYSTEM”** is the bonafide work of **“DHANU SHREE P** (711119104021)**, GUNASEKHAR C (**711119104026)**, HARI PRAKASH P** (711119104028)**,** and **JAGADISH V** (711119104031)**”** who carried out the project work under my supervision.

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SIGNATURE	**SIGNATURE**
Dr. A. VELAYUDHAM M.E., Ph. D.,	**Ms. R. ASHWINI M.E.,**
HEAD OF THE DEPARTMENT	**SUPERVISOR**
Professor and Head,	Assistant Professor,
Department of CSE,	Department of CSE,
Jansons Institute of Technology,	Jansons Institute of Technology,
Karumathampatti,	Karumathampatti,
Coimbatore - 641659.	Coimbatore - 641659.

Submitted for the ANNA UNIVERSITY practical examination project work viva-voce held on ………………………

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INTERNAL EXAMINER	**EXTERNAL EXAMINER**

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ABSTRACT

Water pollution monitoring system is intended to continuously monitor the quality of water in a specific area. The sensors measure pH, TDS, turbidity, dust, MQ2, and water level, among other water quality parameters. If any of the water quality parameters exceedsthe safe levels, the system generates real-time alerts. The alerts can be delivered to the appropriate authorities and individuals via a mobile application. The system's goal is to provide a low-cost, high-efficiency solution for monitoring water quality and preventing water pollution. The system's effectiveness was tested in a real-world scenario, and the results showed that it has the potential to monitor water pollution and promptly notify authorities, which can help prevent disease spread and protect aquatic life. It’s inexpensive, scalable, and simple to implement, making it suitable for use in a variety of settings.

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LIST OF ABBREVIATIONS

ASCII	AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE
HF	HIGH FREQUENCY
IC	INTEGRATED CIRCUIT
I/O	INPUT/OUTPUT
IDE	INTEGRATED DEVELOPMENT ENVIRONMENT
LCD	LIQUID CRYSTAL DISPLAY
LF	LOW FREQUENCY
MHz	MEGA HERTZ
PWM	PULSE WIDTH MODULATION
RAM	RANDOM ACCESS MEMORY
TDS	TOTAL DISSOLVED SALTS

CHAPTER 1

INTRODUCTION

The Internet of Things (IoT) has transformed our interactions with the physical world by allowing us to collect and analyze data from a vast array of connected devices. Water pollution is one of the most pressing issues we face today, with far-reaching consequences for both the environment and human health. Water pollution monitoring systems based on IoT with alert capabilitiesprovide a powerful solution to this problem by providing real-time data on water quality and allowing for early detection of contamination events. These systems typically consist of a network of sensors deployed in bodies of water and linked via the internet to a central data processing unit. pH, TDS, turbidity,dust, MQ2, and water level are all measured by the sensors. The sensor data isthen transmitted to the central unit, which processes it and generates alerts if certain thresholds are exceeded.

The alerts can be sent to a variety of stakeholders, including water authorities, environmental organizations, and local communities, via SMS, email, or mobile apps. This allows for faster response times and faster action to mitigatethe effects of pollution events. Water pollution monitoring systems based on IoT with alert capabilities have the potential to revolutionize the way we monitor and manage water quality, allowing us to protect our water resources while also ensuring the health and the well being of the human beings and the environment.

1.1. Scope of the project

The system can collect various data points such as Ph, TDS, Turbidity, dust, water level and mq2 for gaseous state. The collected data is then transmitted in real-time to a cloud-based server where it can be analyzed and processed using machine learning algorithms to identify trends and patterns in the water quality. This information can be used to detect and alert on any potential water pollution incidents, and also to provide useful insights for water management and conservation efforts.

1.2. Objective

The main objective is the real time monitoring of data parameters of various sensors. By providing real-time monitoring and detection of water pollution incidents, the system aims to protect the environment, public health, and water resources. Additionally, the data collected by the system can be used for data-driven decision-making to improve water resource management and conservation efforts. Improve the overall quality of water resources through continuous monitoring and early detection of potential pollution incidents.

1.3. Problem Definition

The system should be capable of detecting and alerting any abnormal changes in water quality that may indicate the presence of pollutants or contaminants.

They should be capable of:

- Choosing the right type of sensors that can accurately measure the water quality parameters and withstand harsh environmental conditions such as extreme temperatures, humidity, and corrosion.
- Establishing a reliable and secure communication network between the sensors and the cloud-based server for real-time data transmission.
- Developing an efficient data processing algorithm to filter, analyze, and visualize the collected data to identify any abnormal changes inwater quality.
- Implementing an alerting mechanism that can notify the relevant authorities or stakeholders in case of any significant changes in water quality beyond the acceptable limits.
- Designing a system that is cost-effective and scalable to deploy in various water bodies, including remote and hard-to-reach area.

CHAPTER 2

LITERATURE SURVEY

1. **"IoT-Based Water Quality Monitoring System using Raspberry Pi" by S. S. Shinde and S. K. Shukla. This paper presents an IoT-based water quality monitoring system using Raspberry Pi that measures different water quality parameters such as pH, temperature, and turbidity.**

Various sensors are used to measure the water quality parameters, including pH sensor, temperature sensor, turbidity sensor, and water level sensor. The collected data is then transmitted to the Raspberry Pi, which acts as a central processing unit, through a wireless communication module. The system also uses a web-based interface to display the real-time data of the water quality parameters, which can be accessed remotely by the users. The users can monitor the water quality parameters and take necessary actions if any parameter is found to be beyond the acceptable limit.

Data analysis algorithm that uses machine learning techniques to predict the water quality parameters based on the collected data. It can help in predicting the water quality parameters in real-time, which can be helpful in detecting any water pollution at an early stage.

Overall, presents a cost-effective and efficient IoT-based water quality monitoring system using Raspberry Pi, which can help in ensuring the safety of water resources and detecting any water pollution at an early stage.

2. "Wireless Sensor Network-Based Water Quality Monitoring System" by M. A. Hoque and M. A. Rahman. This paper presents a wireless sensor network-based water quality monitoring system that uses multiple sensors to monitor different water quality parameters.

Various sensors to measure the water quality parameters, including pH, dissolved oxygen, temperature, and conductivity. These sensors are placed at different locations in the water body, and the data collected by these sensors is transmitted wirelessly to a central data collection unit using ZigBee communication protocol. The collected data is then processed and analyzed using a microcontroller-based system.

This monitor the water quality parameters and send alerts to the concerned authorities if any parameter is found to be beyond the acceptable limit. The system also has a web-based interface that displays the real-time data of the water quality parameters, which can be accessed remotely by the users.

The effective monitoring water quality parameters and send alerts in real-time if any parameter is found to be beyond the acceptable limit. Overall, it presents a wireless sensor network-based water quality monitoring system that can help in ensuring the safety of water resources and detecting any water pollution at an early stage. The proposed system is cost-effective, efficient, and can be easily deployed in remote areas with limited infrastructure.

3. **"Design and implementation of an IoT-based water pollution monitoring system using LoRa" by H. Kim, D. Kim, and H. Lee. This paper presents an IoT-based water pollution monitoring system that uses LoRa (Long Range) technology to transmit water quality data to a remote server.**

Various sensors to measure water quality parameters, including pH, temperature, dissolved oxygen, and turbidity. The collected data is processed and transmitted wirelessly using LoRa technology, which allows for long-range communication and low power consumption. The system consists of three main components: sensor nodes, a gateway, and a remote server. The sensor nodes are responsible for collecting the water quality data, which is then transmitted to the gateway. The gateway acts as a bridge between the sensor nodes and the remote server and is responsible for transmitting the data to the server.

The remote server is responsible for storing and processing the collected data, which can be accessed by the users using a web-based interface. The system alsohas an alert mechanism that sends notifications to the concerned authorities if anywater quality parameter is found to be beyond the acceptable limit.

The results showed the effective monitoring water quality parameters and transmit the data over a long range with low power consumption. Overall, an efficient and cost-effective IoT-based water pollution monitoring system using LoRa technology. The proposed system can help in ensuring the safety of water resources and detecting any water pollution at an early stage, especially in remote areas with limited infrastructure.

4. **"Development of a low-cost IoT-based water quality monitoring system using Arduino" by S. S. Suresh and S. M. N. Rao. This paper presents a low-cost IoT-based water quality monitoring system using Arduino that measures various water quality parameters such as pH, temperature, and dissolved oxygen.**

Various sensors, including a pH sensor, a temperature sensor, and a dissolved oxygen sensor, to measure the water quality parameters. The collected data is then transmitted wirelessly using Wi-Fi technology to a remote server. The remote server is responsible for storing and processing the collected data, which can be accessed by the users using a web-based interface. The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit.

The results showed the effective monitoring water quality parameters and transmit the data over Wi-Fi with low power consumption.

IoT-based water quality monitoring system using Arduino that can help in ensuring the safety of water resources and detecting any water pollution at an early stage. It is cost-effective, efficient, and can be easily deployed in remote areas with limited infrastructure.

5. **"IoT-based water quality monitoring system for smart cities" by S. K. Lim and K. H. Kim. This paper presents an IoT-based water quality monitoring system for smart cities that integrates water quality data withother smart city systems such as traffic management and waste management.**

Various sensors to measure water quality parameters such as pH, temperature, and dissolved oxygen. The collected data is then transmitted wirelessly using Wi-Fi technology to a cloud server, where it is processed and integrated with other smart city systems. The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit. The integrated system allows the authorities to make informed decisions and take necessary actions based on the collected data.

The results showed the effective monitoring water quality parameters and integrate the data with other smart city systems. Overall, presents an innovative approach to water quality monitoring that integrates water quality data with other smart city systems. The proposed system can help in ensuring the safety of water resources and improving the overall quality of life in smart cities.

CHAPTER 3

SYSTEM ANALYSIS

3.1. EXISTING SYSTEM

The accuracy of the data collected by IoT devices can be affected by several factors such as calibration, sensor accuracy, and environmental conditions.

It is important to ensure that the data collected is accurate and reliable. IoT devices require a power supply to operate. In remote or hard-to-reach locations, providing a reliable power supply can be a challenge. The use of renewable energy sources such as solar power can be a solution to this problem. Therefore, there is a need to develop the efficiency of accurate data parameters and to enhance the system of continuous power supply to the objective.

3.1.1. DRAWBACKS

- Requires a stable power supply to run its functionality
- Limited coverage, as the system may only monitor a specific area
- Vulnerable to security risks, such as hacking and data breaches
- Requires regular maintenance and calibration to ensure accuratereadings
- Requires technical expertise for installation, maintenance, and monitoring

3.2. PROPOSED SYSTEM

The objective of a water polluted ion management system in IoT is to monitor and manage water quality in real-time to prevent or minimize pollution. Real-time water quality monitoring, IoT systems can continuously monitor the water quality in real-time, providing accurate and up-to-date information.

IoT systems can use intelligent algorithms to detect and identify pollutants in the water, enabling quick response to pollution events. To improve the quality of water resources, protect human health, and promote sustainable water management practices.

3.2.1 MERITS

- Real-time data collection on water quality parameters
- Remote monitoring of water quality parameters
- IoT based systems are cost effective
- Early warning system allowing for quick intervention andprevention from pollution
- Efficient data management that analyzes large amount of data efficiently

3.3. SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS

- Arduino uno
- Power Supply
- Water Level Sensor
- pH Sensor
- Dust Sensor
- TDS Sensor
- Turbidity Sensor
- MQ2 Sensor
- LCD Display
- WIFI Module

SOFTWARE REQUIREMENTS

- SOFTWARE = Arduino IDE
- LANGUAGE = Embedded C

CHAPTER 4

SYSTEM DESIGN

4.1. BLOCK DIAGRAM

The figure mentioned below depicts the visual representation of a system that uses simple, labeled blocks that represent single or multiple items, connected by lines to show relationships between them.

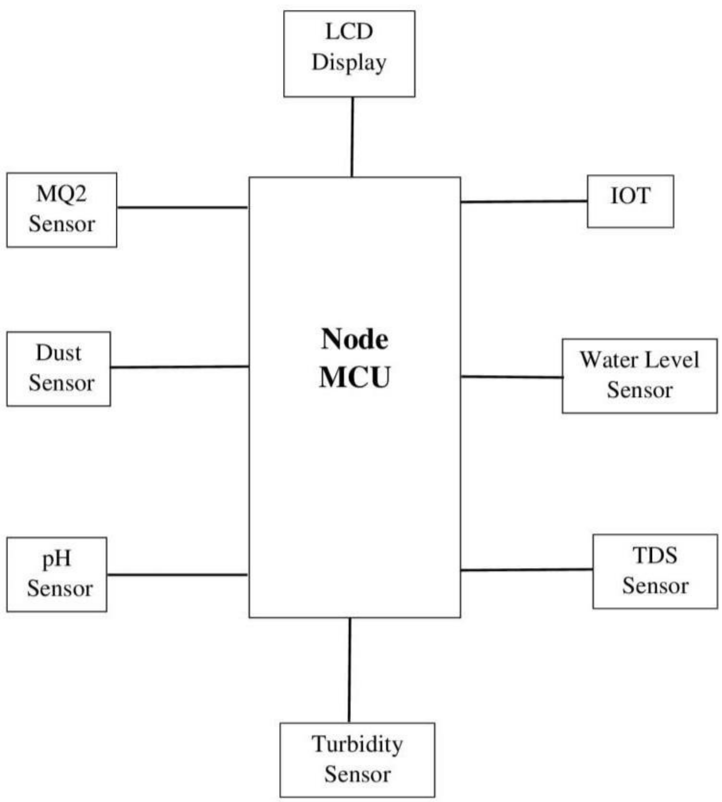


Fig. 4.1. Block Diagram

4.2. CIRCUIT DIAGRAM

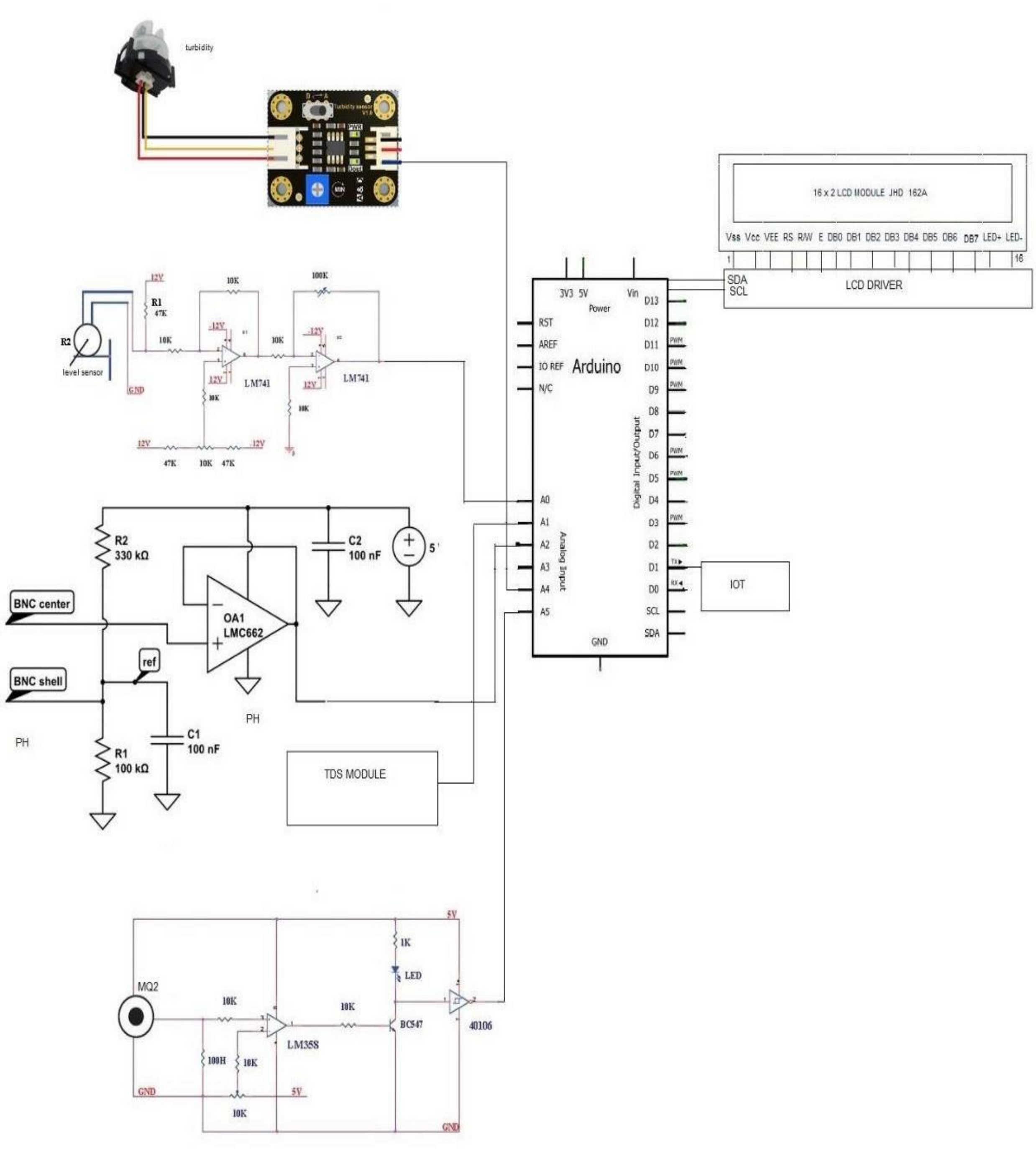


Fig.4.2. Circuit Diagram

4.3. ARDUINO UNO

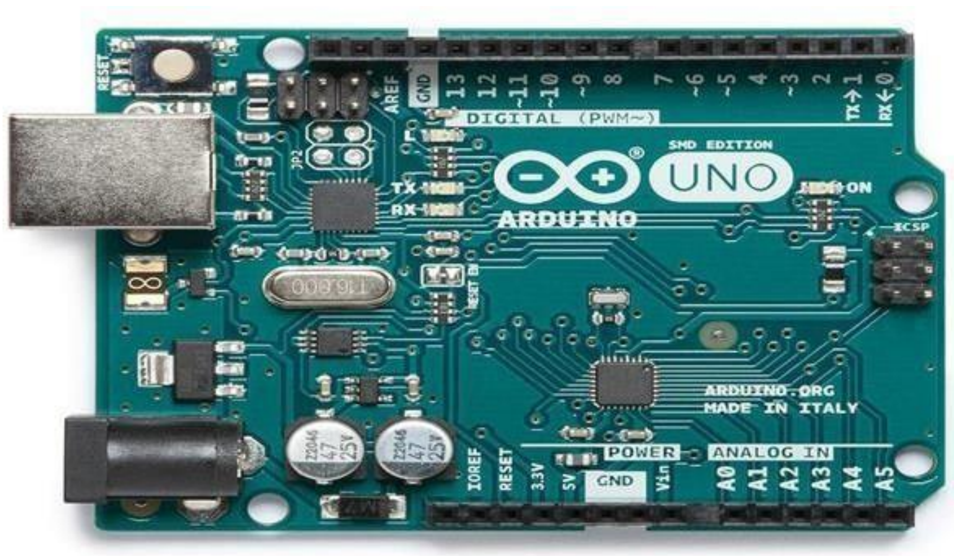


Fig 4.3. Arduino UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online. Message can be sent to the board what to do by sending a set of instructions to the microcontroller on the board. To do so the Arduino programming language and the Arduino Software (IDE) are used. Our whole project lies on this board.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming.

As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IOT applications, wearable, 3D printing, and embedded environments.

➢ CONFIGURATION

- Microcontroller
- ATmega328
- Operating Voltage 5V
- Input Voltage(recommended) 7-12V
- Input Voltage(limits) 6-20V
- Digital I/O Pins 14(of which 6 provide PWM Output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V pin 50 mA
- Flash Memory 32 KB(ATmega328) of which 0.5 KB used by boot loader
- SRAM 2 KB (ATmega328)
- EEPROM 1 KB (ATmega328)
- Clock Speed 16 MHZ

➢ ATMEGA 328P – MICROCONTROLLER

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards.

As said, first we need to program the controller and that is done by writing the appropriate program file in the ATMEGA328P FLASH memory. After dumping this program code, the controller executes this code and provides appropriate response.

With program memory of 32 Kbytes ATMEGA328P applications are many. With various POWER SAVING modes, it can work on MOBILE EMBEDDED SYSTEMS. With Watchdog timer to reset under error it can be used on systems with minimal human interference. With advanced RISC architecture, the controller executes programs quickly. Also, with in chip temperature sensor the controller canbe used at extreme temperatures**.**

- **PIN DIAGRAM**

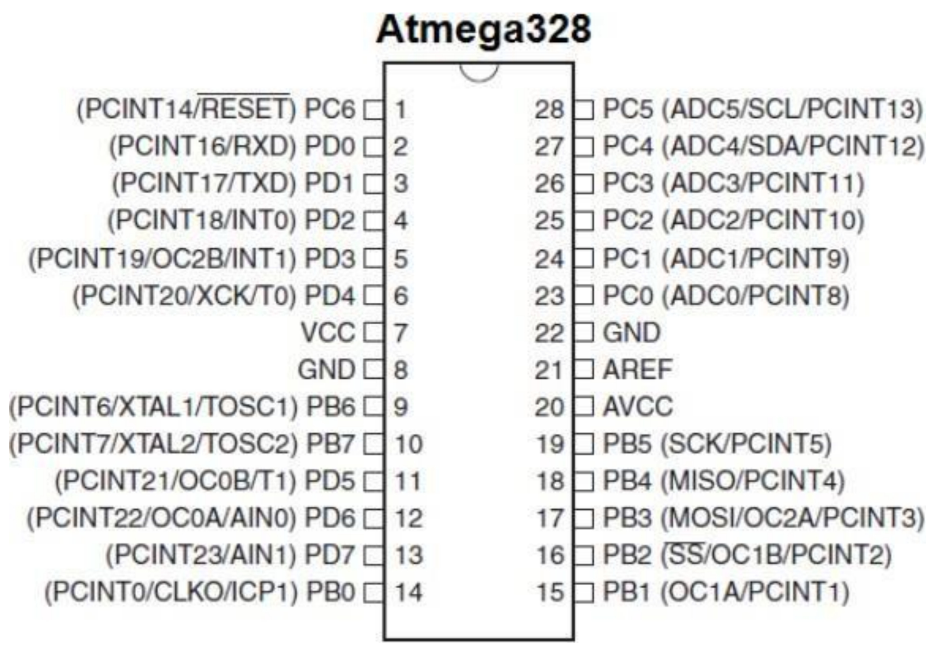


Fig 4.4. Pin Diagram Atmega328

VCC - Digital supply voltage for MCU,
GND - Ground for MCU.

Port B (PB7:0) - XTAL1/XTAL2/TOSC1/TOSC2 Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port B pins that are externally pulled low will source current if the pull- up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port C (PC5:0) - Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC-5.0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

PC6/RESET - If the RSTDISBL fuse is programmed, PC6 is used as an input pin. If the RSTDISBL fuse is unprogrammed, PC6 is used as a reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

Port D (PD7:0) - Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The port D output buffers have symmetrical drive characteristics with both high sink and source capability

AVCC - AVCC is the supply voltage pin for the A/D converter, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF - AREF is the analog reference pin for the A/D converter.

By combining an 8-bit RISC CPU with in-system self-programmable flash on a monolithic chip, the Atmel ATmega328P is a powerful microcontroller that provides a highly flexible and cost-effective solution to many embedded control applications. The ATmega328P AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

- **ARCHITECTURE DESIGN**

The AT-mega 328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48P/88P/168P/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

Since ATmega328P is used in Arduino Uno and Arduino nano boards, you can directly replace the arduino board with ATmega328 chip. For that first you need to install the arduino bootloader into the chip (Or you can also buy a chip with bootloader – ATMega328P-PU). This IC with bootloader can be placed on Arduino Uno board and burn the program into it.

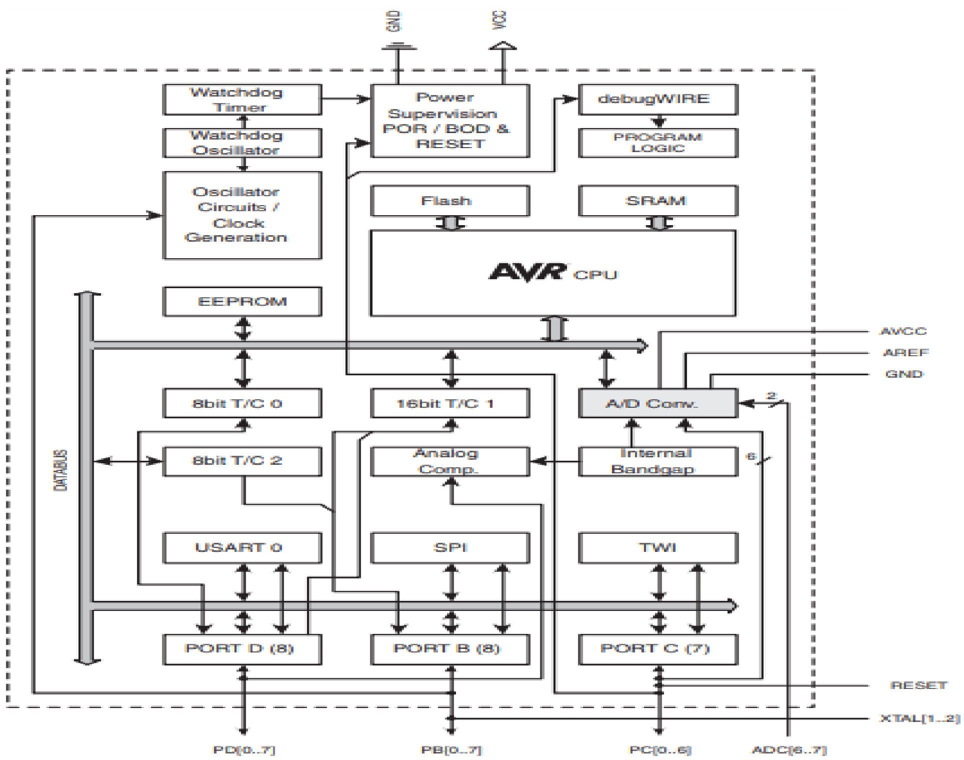


Fig 4.5. Architecture Design of AVR MCU - ATmega328P

Once Arduino program is burnt into the IC, it can be removed and used in place of Arduino board, along with a Crystal oscillator and other components as required for the project. The fast-access register file contains 8-bit general purpose working registers with a single clock cycle access time. This allows single-cycle arithmetic logic unit (ALU) operation.

In a typical ALU operation, two operands are output from the register file, the operation is executed, and the result is stored back in the register file – in one clock cycle.

Six of the 32 registers can be used as three 16-bit indirect address register pointers for data space addressing – enabling efficient address calculations. One of the these address pointers can also be used as an address pointer for look up tables in flash program memory. These added function registers are the 16-bit X-, Y-, and Z-register, described later in this section. The ALU supports arithmetic and logic operations between registers or between a constant and a register.

Single register operations can also/ be executed in the ALU. After an arithmetic operation, the status register is updated to reflect information about the result of the operation.

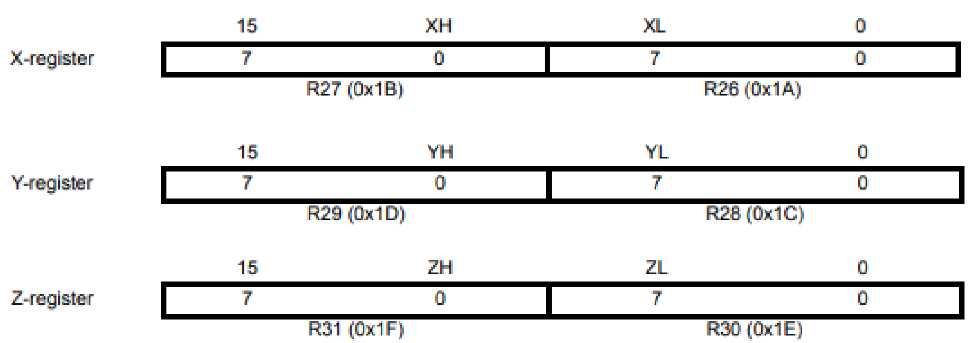


Fig.4.6. Arithmetic Operation

Program flow is provided by conditional and unconditional jump and call instructions, able to directly address the whole address space. Most AVR instructions have a single 16-bit word format. Every program memory address contains a 16- or 32-bit instruction.

Program flash memory space is divided in two sections, the boot program section and the application program section. Both sections have dedicated lock bits for write and read/write protection.

The SPM instruction that writes into the application flash memory section must reside in the boot program section. During interrupts and subroutine calls, the return address program counter (PC) is stored on the stack.

The stack is mainly used for storing temporary data, for storing local variables and for storing return addresses after interrupts and subroutine calls. Note that the stack is implemented as growing from higher to lower memory locations. The stack pointer register always points to the top of the stack. The stack pointer points to the data SRAM stack area where the subroutine and interrupt stacks are located.

A flexible interrupt module has its control registers in the I/O space with an additional global interrupt enable bit in the status register. All interrupts have a separate interrupt vector in the interrupt vector table. The interrupts have priority in accordance with their interrupt vector position.

The lower the interrupt vector address, the higher the priority. The I/O memory space contains 64 addresses for CPU peripheral functions as control registers, SPI, and other I/O functions. The I/O memory can be accessed directly, or as the data space locations following those of the register file, 0x20 - 0x5F.

In addition, the ATmega328P has extended I/O space from 0x60 - 0xFF in SRAM where only the ST/STS/STD and LD/LDS/LDD instructions can be used.

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery.

The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts.

If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through thispin.
- 5V Regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5Vsupply.

- A 3.3-volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND Ground pins.
- Sleep modes enable the application to shut down unused modules inthe MCU, thereby saving power.
- The AVR provides various sleep modes allowing the user to tailorthe power consumption to the application’s requirements.
- When enabled, the Brown-out Detector (BOD) actively monitors thepower supply voltage during the sleep periods.

➢ CIRCUIT DIAGRAM

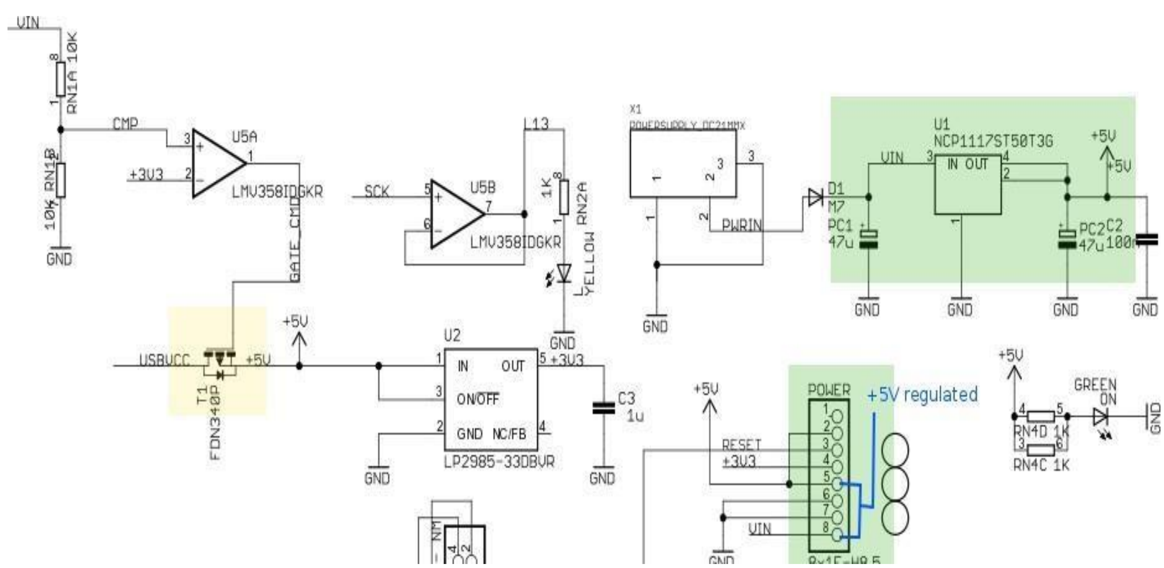


Fig.4.7. Circuit Diagram of Power Supply Design – Arduino UNO

➢ MEMORY

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the boot loader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library). It is organized as a separate data space, in which single bytes can be read and written.

The EEPROM has an endurance of at least 100,000 write/erase cycles. All ATmega48P/88P/168P/328P I/Os and peripherals are placed in the I/O space. All I/O locations may be accessed by the LD/LDS/LDD and ST/STS/STD instructions, transferring data between the 32 general purpose working registers and the I/O space. I/O Registers within the address range 0x00 - 0x1F are directly bit-accessible using the SBI and CBI instructions. In these registers, the value of single bits can be checked by using the SBIS and SBIC instructions.

Refer to the instruction set section for more details. When using the I/O specific commands IN and OUT, the I/O addresses 0x00 - 0x3F must be used.

➢ GENERAL PURPOSE INPUT AND OUTPUT

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode (), digital Write (), and digital Read () functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 KOhms. In addition, some pins have specialized functions

- Serial 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB- to-TTL Serial chip.

- External Interrupts 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.
- PWM 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.
- SPI 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).

These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. LED 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provides 10 bits of resolution (i.e.,1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function. Additionally, some pins have specialized functionality I 2C 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library.

- **FEATURES**
  - Microcontroller ATmega328.
  - Operating Voltage 5V.
  - Input Voltage (recommended) 7-12V.
  - Input Voltage (limits) 6-20V.
  - Digital I/O Pins 14 (of which 6 provide PWM output)
  - Analog Input Pins 6.
  - DC Current per I/O Pin 40 mA.

- DC Current for 3.3V Pin 50 mA.
- Protocol: USART, SPI & I2C.
- Low Power Consumption 0.3mA/MHz
- Operating Frequency: 20 MHz

➢ LAYOUT CONNECTION

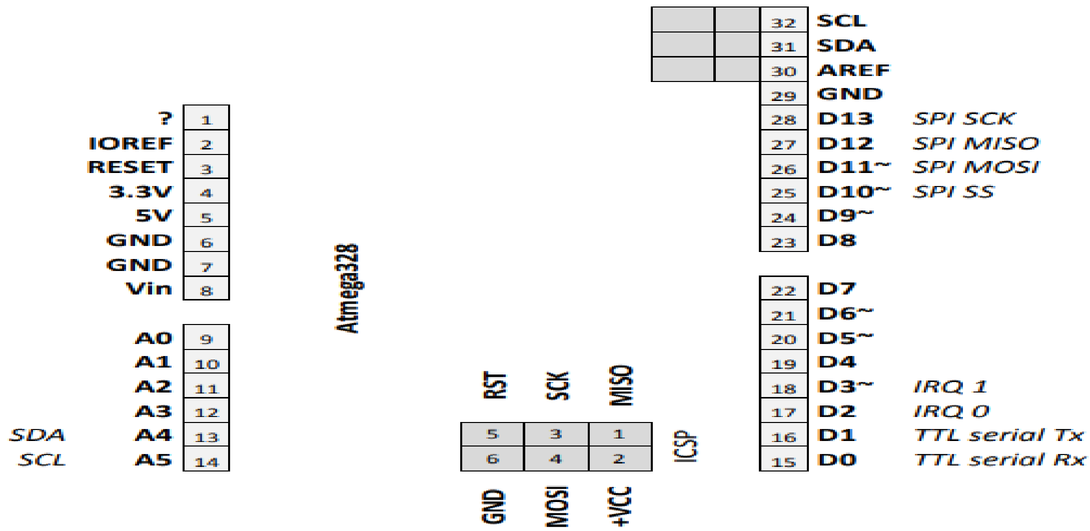


Fig.4.8 Layout diagram

➢ BENEFITS

- Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms.
- Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- Simple, clear programming environment - The Arduino programming environment is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well.

- Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers.
- Open source and extensible hardware - The Arduino is based on Atmel's ATMEGA8 and ATMEGA168 microcontroller.

➢ INTEGRATED DEVELOPMENT ENVIRONMENT

The Integrated Development Environment (IDE)is a combination of editor, linker and a compiler which helps the developer to make their Firmware for their Innovative Projects. Arduino IDE play a major role in open source platform for fast prototyping and easy to access of library.

It is user friendly tool for beginners and it supports programming language like embedded C, Luna etc. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. Its supports all the variant of Arduino boards like Arduino Uno, Nano and Mega etc. As soon as it reaches a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments

➢ ARDUINO IDE SOFTWARE

With this Arduino Integrated Development Environment you can edit, compile and upload Arduino sketches to the Arduino boards.

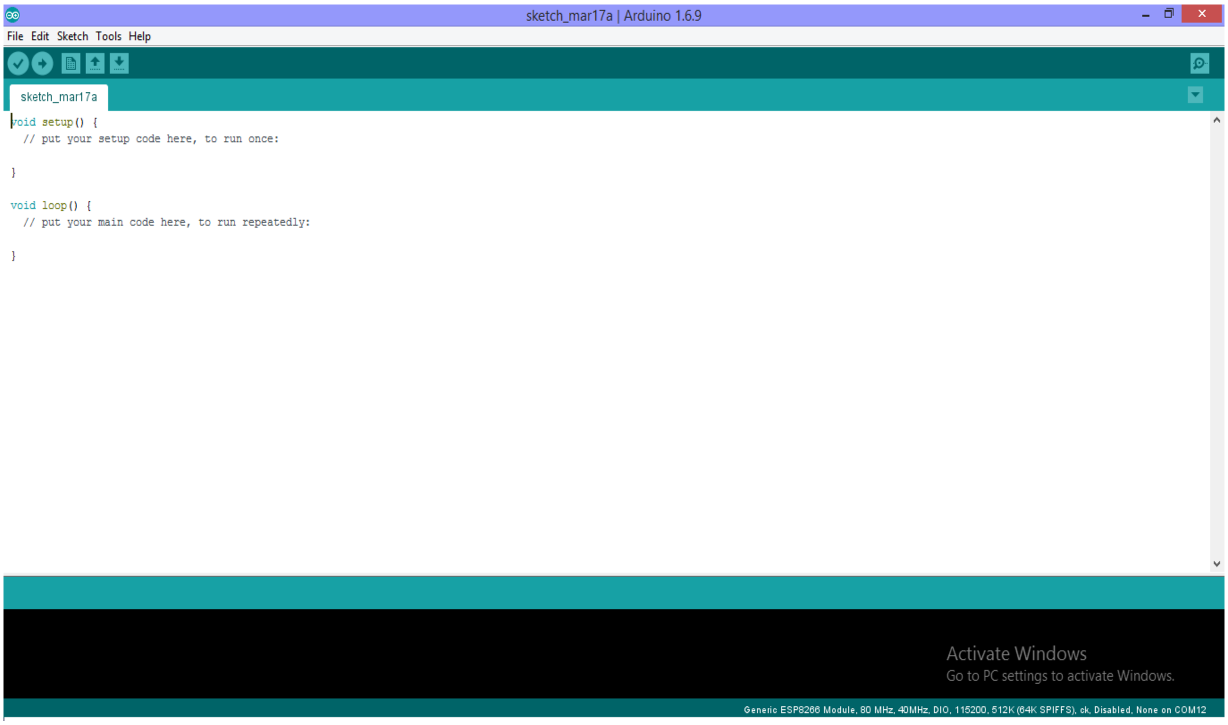


Fig.4.9. Arduino IDE Software

4.3.POWER SUPPLY

This is a simple approach to obtain a 12V and 5V DC power supply using a single circuit. The circuit uses two ICs 7812 and 7805 for obtaining the required voltages. The AC mains voltage will be stepped down by the transformer, rectified by bridge and filtered by capacitor to obtain a steady DC level. The 7812 regulates this voltage to obtain a steady 12V DC.

The output of the IC1 will be regulated by the 7805 to obtain a steady 5V DC at its output. In this way both 12V and 5V DC are obtained.

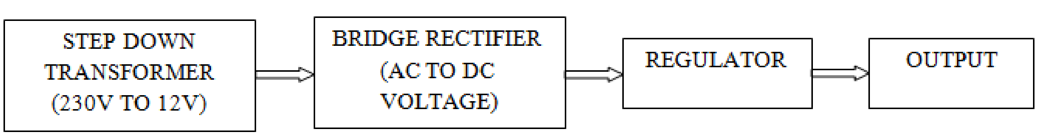


Fig.4.10. Power Supply Block Diagram

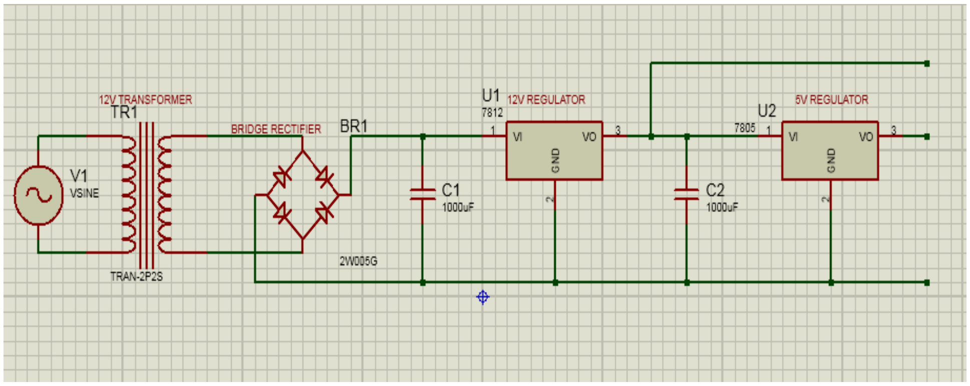


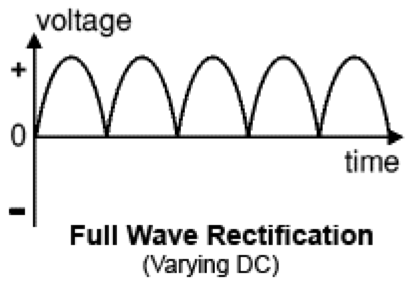
Fig.4.11. Circuit Diagram of Power Supply

- **Transformer**

The potential transformer will step down the power supply voltage (0-230V) to (0-15V and 0-9V) a level. If the secondary has less turns in the coil then the primary, the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge.

This is called a STEP-DOWN transformer. Then the secondary of the potential transformer will be connected to the rectifier.

- **Bridge rectifier**



When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

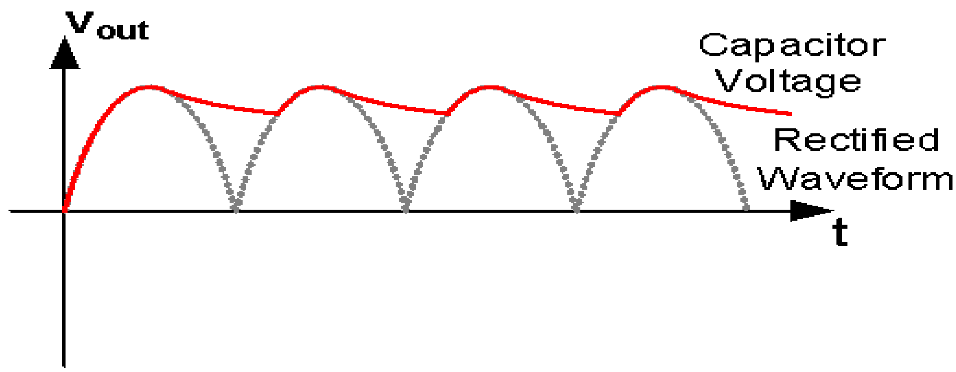
The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through Load,through D3, through the secondary of the transformer back to point B.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 andD3. Current flow will now be from point A through D4, up through Load, through D2, through the secondary of transformer, and back to point A. Across D2 and D4. The current flow through Load is always in the same direction. In flowing through Load this current develops a voltage corresponding to that. Since current flows through the load during both halfcycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional half-wave circuit. This bridge rectifier always drops 1.4Volt of the input voltage because of the diode.

➢ Filter

If a Capacitor is added in parallel with the load resistor of a Rectifier to form a simple Filter Circuit, the output of the Rectifier will be transformed into a more stable DC Voltage. At first, the capacitor is charged to the peak value of the rectified Waveform. Beyond the peak, the capacitor is discharged through the load until the time at which the rectified voltage exceeds the capacitor voltage. Then the capacitor is charged again and the process repeats itself.



➢ IC voltage regulators

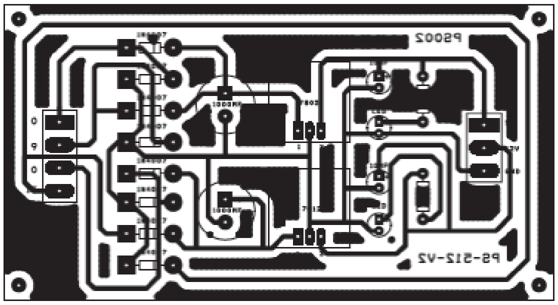
Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, it is applied to one input terminal, a regulated dc output voltage from a third terminal, with the second terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

This is a regulated power supply circuit using the 78xx IC series. These regulators can deliver current around 1A to 1.5A at a fix voltage level. The common regulated voltages are 5V, 6V, 8V, 9V, 10V, 12V, 15V,18V, and 24V. It is important to add capacitors across the input and output of the regulator IC to improve the regulation.

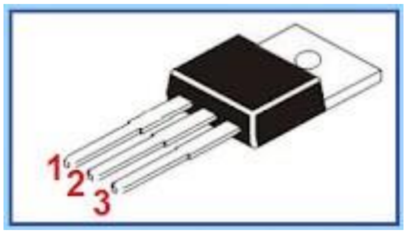
In this circuit we are using 7805 and 7812 regulators so it converts variable dc into constant positive 5V and 12V power supply respectively.

PCB LAYOUT:



Component description:

1) Input
2) Ground
3) Output



Types of Positive voltage regulator:

78xx Regulator		
IC Part	Minimum Input Voltage	Regulated Output
7805	7.3V	5V
7806	8.4V	6V
7808	10.5V	8V
7809	11.5V	9V
7810	12.5V	10V
7812	14.6V	12V
7815	17.7V	15V
7818	21.0V	18V
7824	27.1V	24V

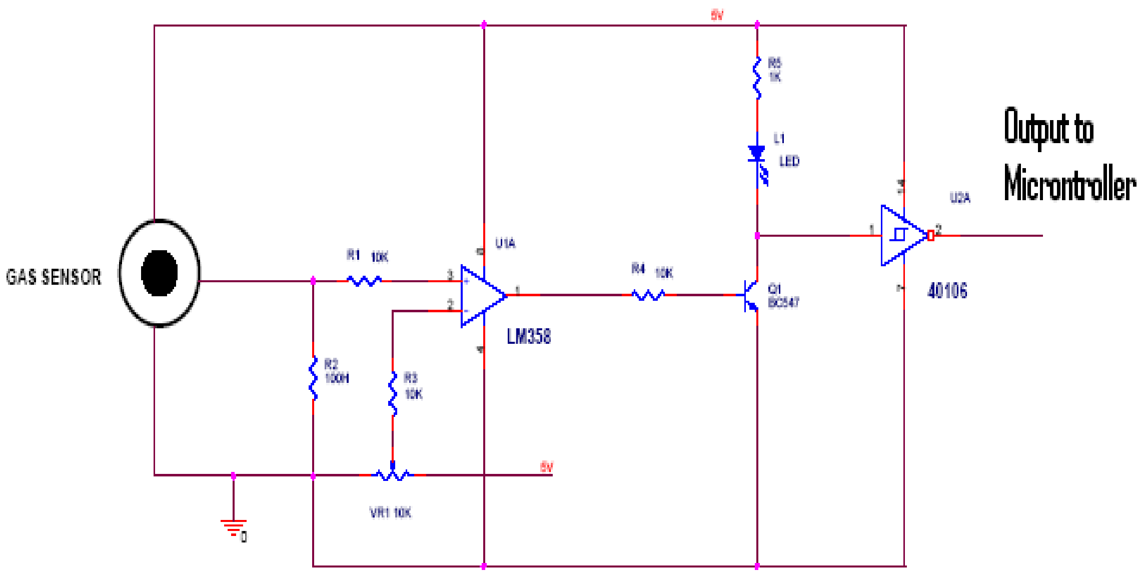
4.4. GAS SENSOR

Ideal sensor for use to detect the presence of a dangerous LPG leak in your car or in a service station, storage tank environment. This unit can be easily incorporated into an alarm unit, to sound an alarm or give a visual indication of the LPG concentration. The sensor has excellent sensitivity combined with a quick response time. The sensor can also sense iso-butane, propane. The unit will work with a simple drive circuit and offers excellent stability with long life. This circuitis mainly designed to sense the present LPG GAS in the atmosphere.

The LPG GAS (Propane) is sensed by the gas sensor. The gas sensor is the one type of transducer which produces the voltage signal depends on the gas level. Then the voltage signal is given to inverting input terminal of the comparator. The comparator is constructed by the operational amplifier LM 741. The reference voltage is given to non inverting input terminal. Then the output voltage is given to microcontroller in order to determine the presence of a dangerous LPG leak.

Fig.4.12.Gas Sensor

Schematic Circuit:



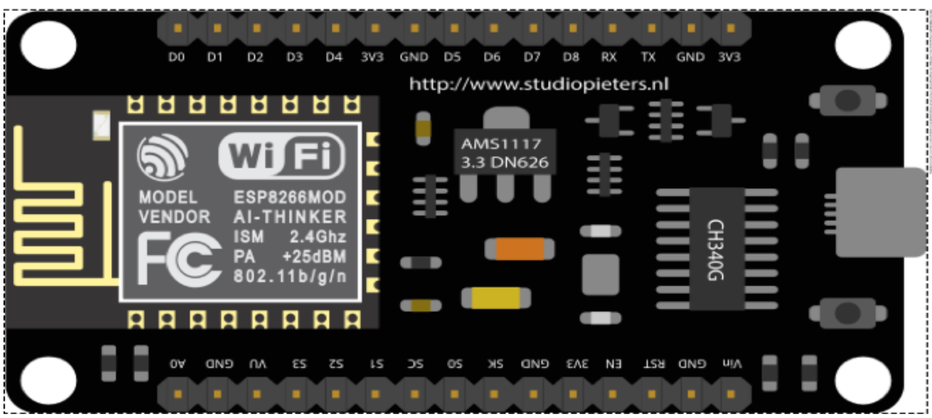
Specification:

- Working voltage: DC 5V
- Working Current: 150mA
- DOUT: TTL output
- AOUT: Analog output

Features:

- High Sensitivity
- High sensitivity to Ammonia, Sulfide and Benze
- Stable and Long Life
- Detection Range: 10 - 300 ppm NH3, 10 - 1000 ppmBenzene, 10 - 300 Alcohol
- Heater Voltage: 5.0V
- Dimensions: 18mm Diameter, 17mm High excluding pins,Pins - 6mm High

4.5. Node MCU V3 For Fast IoT Application Development

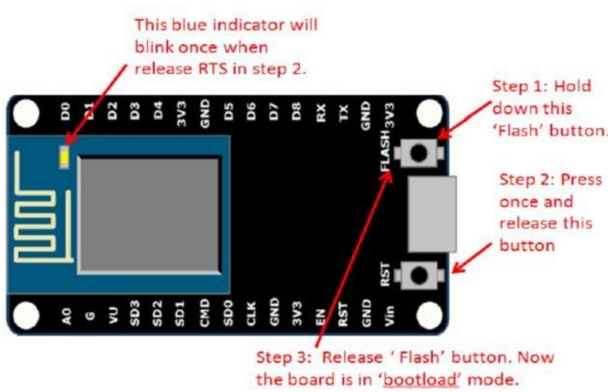


The best way to develop quickly an IoT application with less Integrated circuits to add is to choose this circuit “Node MCU”. Today, we will give a detailed Introduction on Node-MCU V3. It is an open-source firmware and development kit that plays a vital role in designing a proper IoT product using a few script lines.

The module is mainly based on ESP8266 that is a low-cost Wi-Fi microchip incorporating both a full TCP/IP stack and microcontroller capability. It is introduced by manufacturer Espress if Systems. The ESP8266 Node-MCU is a complex device, which combines some features of the ordinary Arduino board with the possibility of connecting to the internet.

Arduino Modules and Microcontrollers have always been a great choice to incorporate automation into the relevant project. But these modules come with a little drawback as they don't feature a built-in WiFi capability, subsequently, we need to add external WiFi protocol into these devices to make them compatible with the internet channel.

This is the famous Node-MCU which is based on ESP8266 WiFi SoC. This is version 3 and it is based on ESP-12E (An ESP8266 based WiFi module). In this article, we will try present useful details related to this WiFi Development Kit, its main features, pinout and everything we need to know about this module and the application domain.



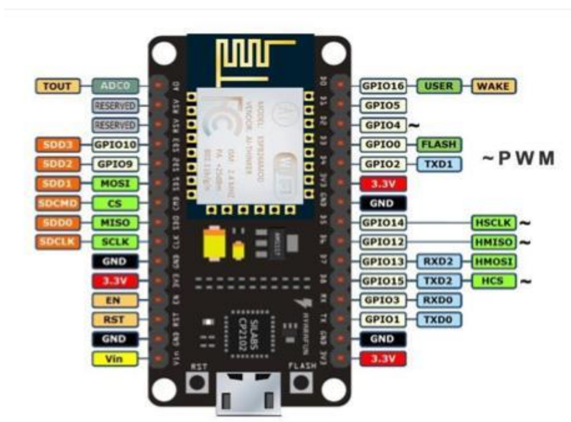
And open source firmware gives you the flexibility to edit, modify and rebuilt the existing module and keep changing the entire interface until you succeed in optimizing the module as per your requirements. USB to UART converter is added on the module that helps in converting USB data to UART data which mainly understands the language of serial communication. The board incorporates status LED that blinks and turns off immediately, giving you the current status of the module if it is runningproperly when connected with the computer.

Instead of the regular USB port, Micro USB port is included in the module that connects it with the computer for dual purposes: programming and powering up the board.

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.

Node MCU V3 Pinout

Node MCU V3 comes with a number of GPIO Pins. Following figure shows the Pinout of the board.



Features:

- Low cost, compact and powerful Wi-Fi Module
- Power Supply: +3.3V only
- Current Consumption: 100mA
- I/O Voltage: 3.6V (max)
- I/O source current: 12mA (max)
- Built-in low power 32-bit MCU @ 80MHz
- 512kB Flash Memory
- Can be used as Station or Access Point or both combine
- Supports Deep sleep (<10uA)
- Supports serial communication hence compatible with many development platform like Arduino

Applications :

- IOT Projects
- Access Point Portals
- Wireless Data logging
- Smart Home Automation
- Learn basics of networking
- Portable Electronics
- Smart bulbs and Sockets

4.6.Water Level Sensor

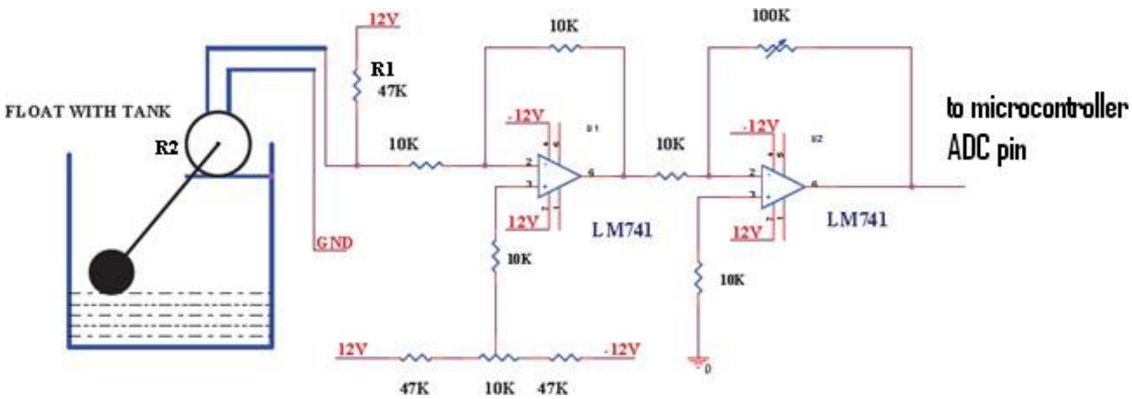


Fig.4.13.Water Level Sensor

Schematic explanation:

Float is the one type of transducer which is used to measure the water levelin the tank. The float changes the resistance value depending on the water level. This method is working with the principle of potential divider form.

Potential divider form:

$$V_{out} = V_{in} \frac{R_2}{(R_1 + R_2)}$$

If the R1 and R2 value is equal means the output is half of the Vcc supply. In this circuit output is a variable one. So, the output is depending upon the R2 resistance value.

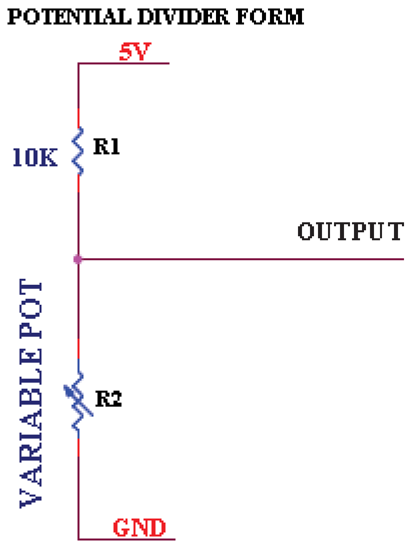


Fig.4.13.1.Potential Divider

4.7.Turbidity Sensor

Fig.4.14.Turbidity Sensor

Introduction

The turbidity sensor detects water quality by measuring the levels of turbidity. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases.

Turbidity sensors are used to measure water quality in rivers and streams, wastewater and effluent measurements, control instrumentation for settling ponds, sediment transport research and laboratory measurements. This sensor provides analog and digital signal output modes. The threshold is adjustable when in digital signal mode. You can select the mode according to your MCU.

Specification:

- Operating Voltage: 5V DC
- Operating Current: 40mA (MAX)
- Response Time : <500ms
- Insulation Resistance: 100M (Min)
- Output Method:
  Analog output: 0-4.5V
  Digital Output: High/Low level signal (you can adjust the threshold value by adjusting the potentiometer)
- Operating Temperature: 5~90
- Storage Temperature: -10~90
- Weight: 30g
- Adapter Dimensions: 38mm*28mm*10mm/1.5inches *1.1inches*0.4inches

Connection Diagram

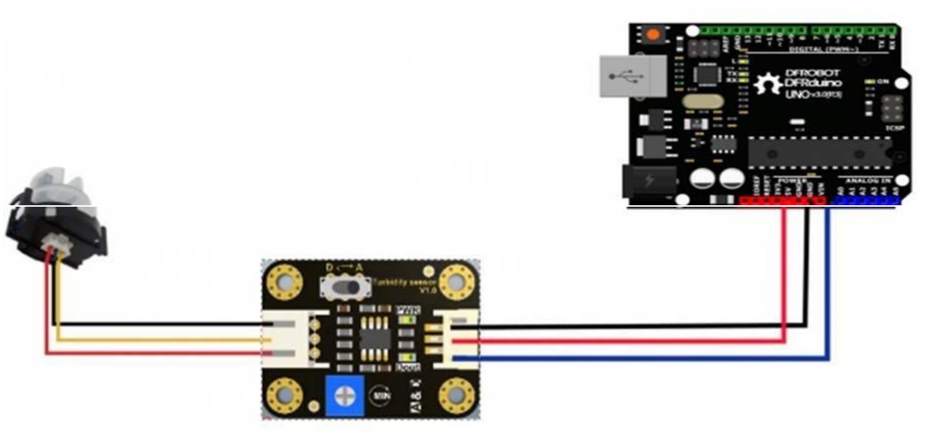


Fig.4.14.1.Connection Diagram

Interface Description:

1. "D/A" Output Signal Switch

- "A": Analog Signal Output, the output value will decrease when in liquids with a high turbidity
- "D": Digital Signal Output, high and low levels, which can be adjusted by the threshold potentiometer

2. Threshold Potentiometer: you can change the trigger condition by adjusting the threshold potentiometer in digital signal mode.

4.8.Analog TDS Sensor/Meter for Arduino

This is an Arduino-compatible TDS Meter Kit for measuring TDS value of the water, to reflect the cleanliness of the water. It can be applied to domestic water, hydroponic and other fields of water quality testing.

You may also check Liquid Senser Selection Guide to get better familiar withour liquid senser series.

TDS (Total Dissolved Solids), indicates how many milligrams of dissolvedsolids are dissolved in 1 liter of water. Generally, the higher the TDS value, the more dissolved substances contained in the water and the less clean the water. Therefore, the value of TDS can be used as one of the basis for reflecting the cleanliness of water.

The commonly used TDS testing equipment is a TDS pen. Although it is cheap and easy to use, it cannot transmit data to the control system for long- Term online monitoring and water quality analysis. Using a special instrument, although it can transmit data and has high accuracy, it is very expensive.

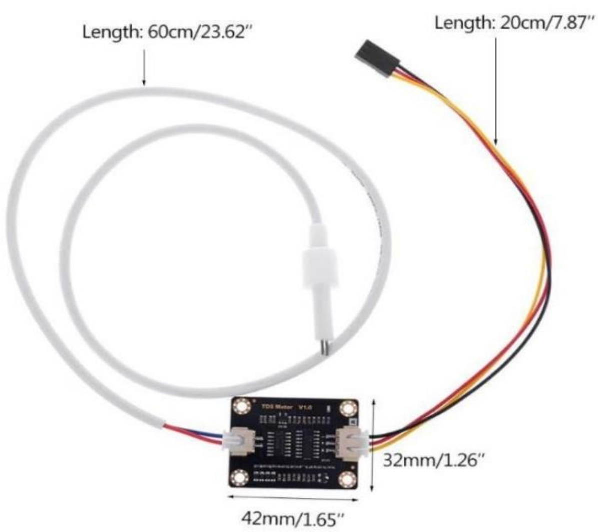


Fig.4.15.TDS Sensor

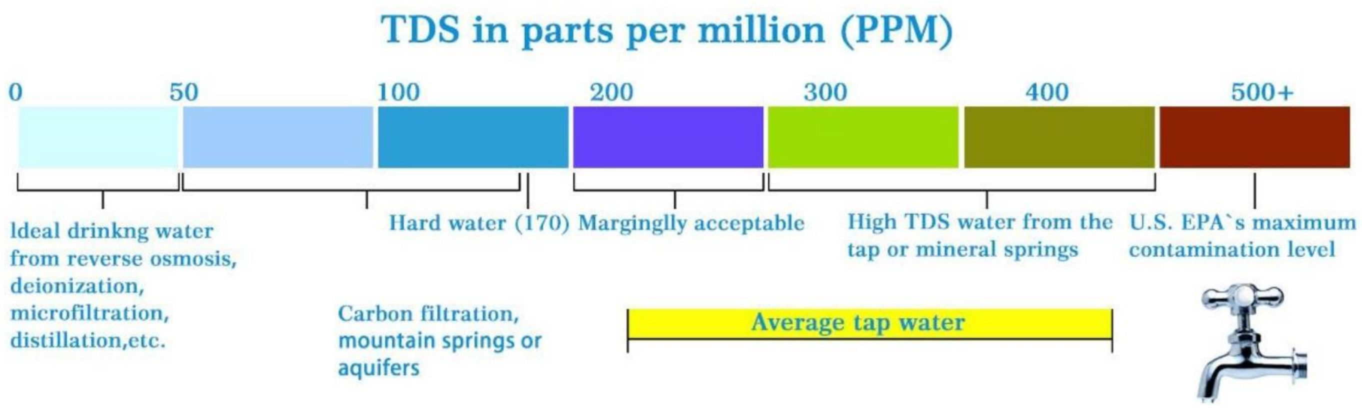


Fig.4.15.1.Parameters of TDS

This product can be used in water quality application, such as domestic water analysis and hydroponics. With this product, you can easily DIY a TDS detector to reflect the cleanliness of water to protect your health !

Specification:

• **Signal Transmitter Board**

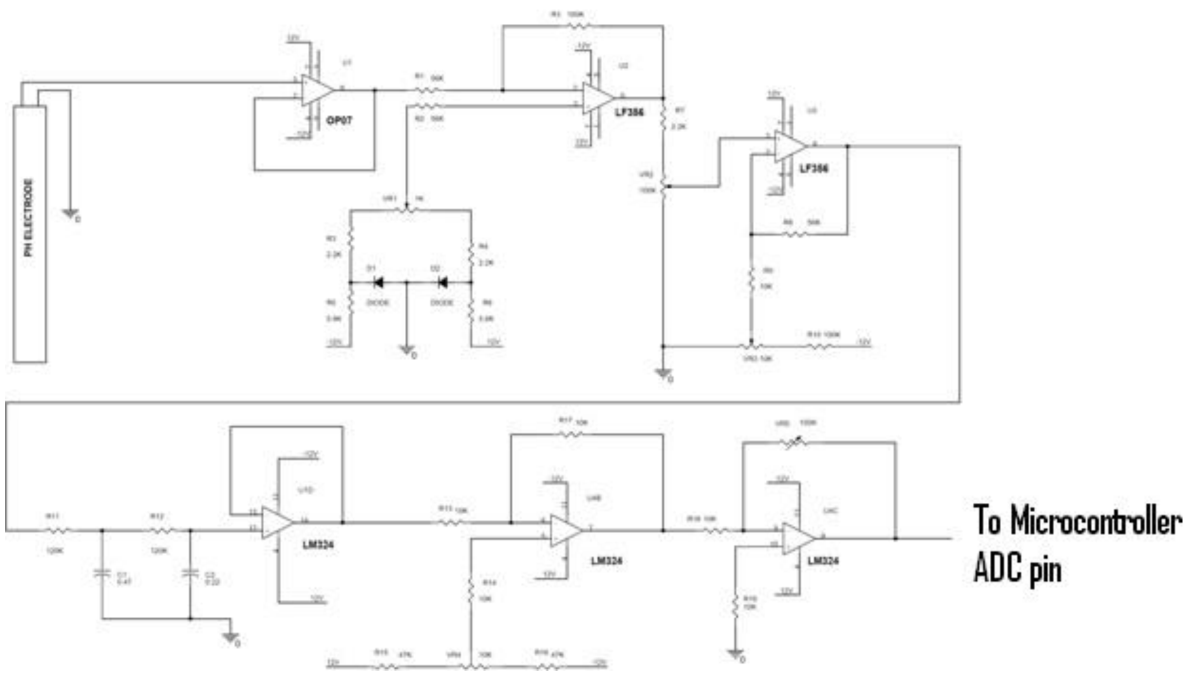
- o Input Voltage: 3.3 ~ 5.5V
- o Output Voltage: 0 ~ 2.3V
- o Working Current: 3 ~ 6mA
- o TDS Measurement Range: 0 ~ 1000ppm
- o TDS Measurement Accuracy: ±10% F.S. (25 °C)

• **TDS probe**

- o Number of Needle: 2
- o Total Length: 83cm
- o Connection Interface: XH2.54-2P o Color: White
- o Other: Waterproof Probe

4.9. pH-value Measurement

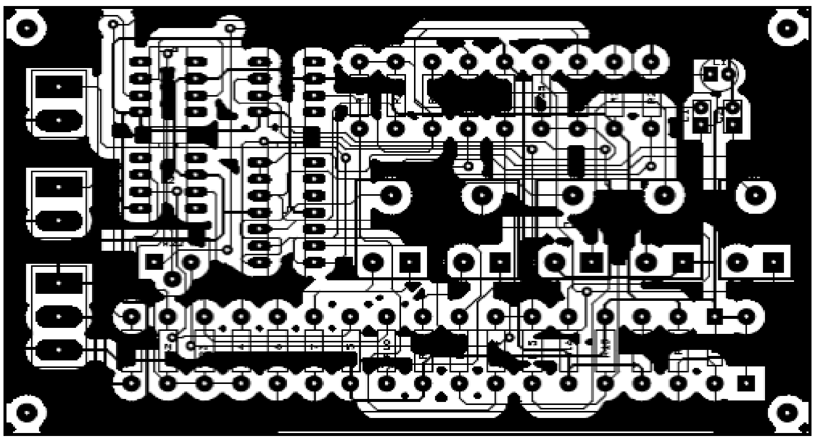
Schematic Diagram:



Schematic Explanation:

This circuit is designed to measure the PH level in the water. The PH electrode is used to measure the PH level. Depending on the PH level in the water it generates the corresponding voltage signal. This voltage signal is in the range of mV so it is amplified by the operational amplifier. The amplifier is constructed by the OP07 operational amplifier. Then the amplified signal is given to inverting input terminal of the operational amplifier. The amplifier is constructed by LF356 operational amplifier. Then the +12v to -12v reference signal is generated by the pair diodes D1 and D2 which is given to non inverting input terminal. Then the output signal is given to filter section in which the noise signal in the output is filtered. The filter section is constructed by the LM324 operational amplifier and the capacitor C1 and C2. Then the noise free signal is given to comparator in which the PH level is compared with reference level then the final voltage given to gain amplifier in which the variable resistor is connected in the feedback path. Then final gain voltage is given to related circuit in order to find the PH level in the water.

PCB LAYOUT :



4.10.Dust sensor

This dust sensor “GP2Y1010AU0F” is the device to detect house dust, cigarette smoke, etc. and designed as a sensor for automatic running of application like air purifier and air conditioner with air purifier function.

Light from the light emitter (Light Emitting Diode) is spotted with a lens and a slit as shown on the chart-A. Also for the light detector (Photodiode), a lens and a slit is positioned in front of it to cut disturbance light and to detect light reflection (when detecting dust) efficiently. Area where those two optical axis cross is detection area of the device.

Chart-B shows what is ongoing inside of the device when no dust exists and Chart-C shows that when dust exists. The device makes voltage output even when dust is not being detected. This output voltage at no dust condition is specified as Voc on the specification. This is because light emitted from the LED reflects at case of the device & some part of it gets to the detector.

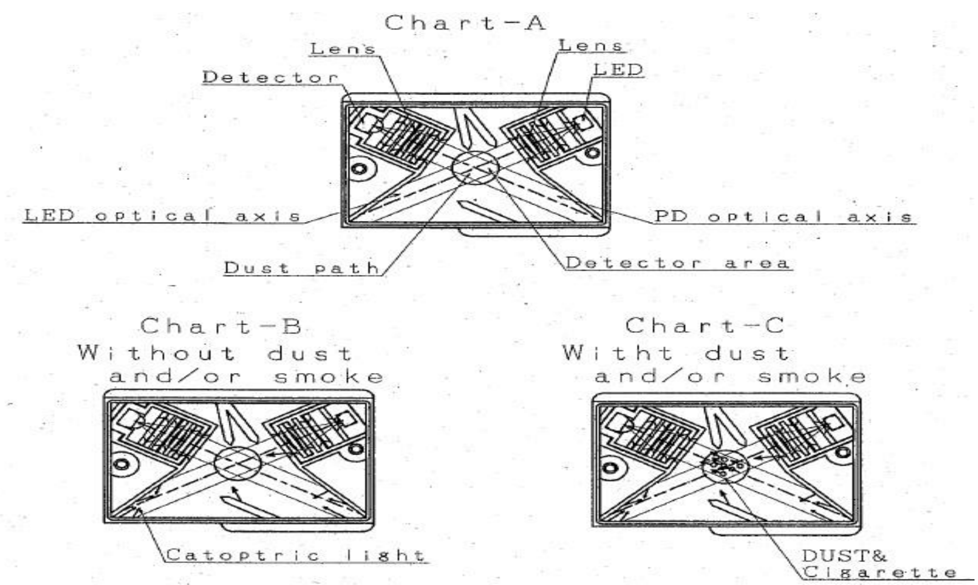


Fig.4.16.Dust Sensor

Chart-C shows how the device works when dust and/or cigarette smoke exists inside of it. In this case, the detector detects the light reflected from the dust and/or a particle of the cigarette smoke.

1. Features of GP2Y1010AU0F

- Compact & thin package (46 × 30 × 17.6mm)
- With application of pulse output system, the device can detect evensingle house dust.
- House dust and cigarette smoke can be distinguished.

2. **Objects to detect**
    - House dust
    - Cigarette smoke

3. **Application**
    - Air conditioner
    - Air purifier.

4.11. LCD DISPLAY

There are many display devices used by the hobbyists. LCD displays are one of the most sophisticated display devices used by them. Once you learn how to interface it, it will be the easiest and very reliable output device used by you! More, for micro controller based project, not every time any debugger can be used.

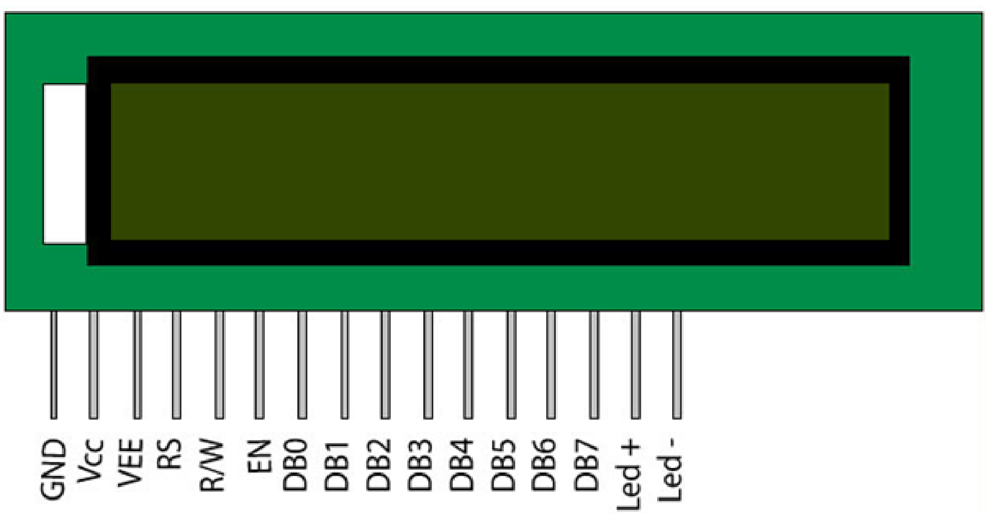


Fig.4.17.LCD Display

LCD accepts two types of signals, one is data, and another is control. These signals are recognized by the LCD module from status of the RS pin.

Now data can be read also from the LCD display, by pulling the R/W pin high. As soon as the E pin is pulsed, LCD display reads data at the falling edge of the pulse and executes it, same for the case of transmission. LCD display takes a time of 39-43µS to place a character or execute a command. Except for clearing display and to seek cursor to home position it takes 1.53ms to 1.64ms. Any attempt to send any data before this interval may lead to failure to read data or execution of the current data in some devices. Some devices compensate the speed by storing the incoming data to some temporary registers.

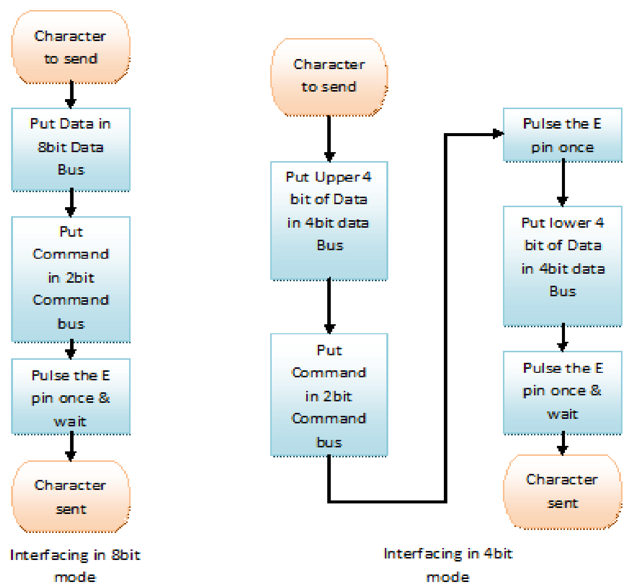


Fig.4.17.1. Flow chart of interfacing LCD display

CHAPTER 5

TESTING AND DISCUSSION

5.1. Testing and Validation

When it comes to testing and validating an IoT-based water pollution monitoring system, there are various approaches that can be taken. Some of the common testing and validation methods for IoT systems include functional testing, performance testing, security testing, and scalability testing.

5.1.1. Functional Testing:

Functional testing involves testing the system's features and functions to ensure that they are working as expected. This can be done by checking the data collected by the various sensors, verifying that the data is being transmitted to the database, and ensuring that the data can be accessed and analyzed correctly.

5.1.2. Performance Testing:

Performance testing involves testing the system's performance under different conditions, such as high traffic, low bandwidth, or poor network connectivity. This can help identify any performance issues and determine the system's ability to handle varying conditions.

5.1.3. Security Testing:

Security testing involves testing the system's security features to ensure that the data collected by the sensors is protected from unauthorized access. This can include testing access controls, authentication mechanisms, and data encryption.

5.1.4. Scalability Testing:

Scalability testing involves testing the system's ability to scale up or down to meet changing demands. This can help determine whether the system can handle an increase in the number of sensors or the amount of data being collected.

S.No	Turbidity	TDS	pH	Gas	Dust
1.	2900	990	7.6	12	24
2.	2800	960	7.8	8	26
3.	1500	250	6.5	8	10
4.	1500	278	6.3	10	12
5.	1900	550	7.5	11	10
6.	2000	565	7.4	9	10

Fig.5.1. Testing and Validation

The system is tested using scientifically valid methods and calibrated sensors to ensure accurate readings (above tabular column) of the pollution levels. The data collected are analyzed and compared to established pollution thresholds and regulatory standards by validate the system's effectiveness.

5.2 Result

This is the module of the proposed system. Here the sensors are connected with the microcontroller.

OUTPUT: DEVICE SETUP

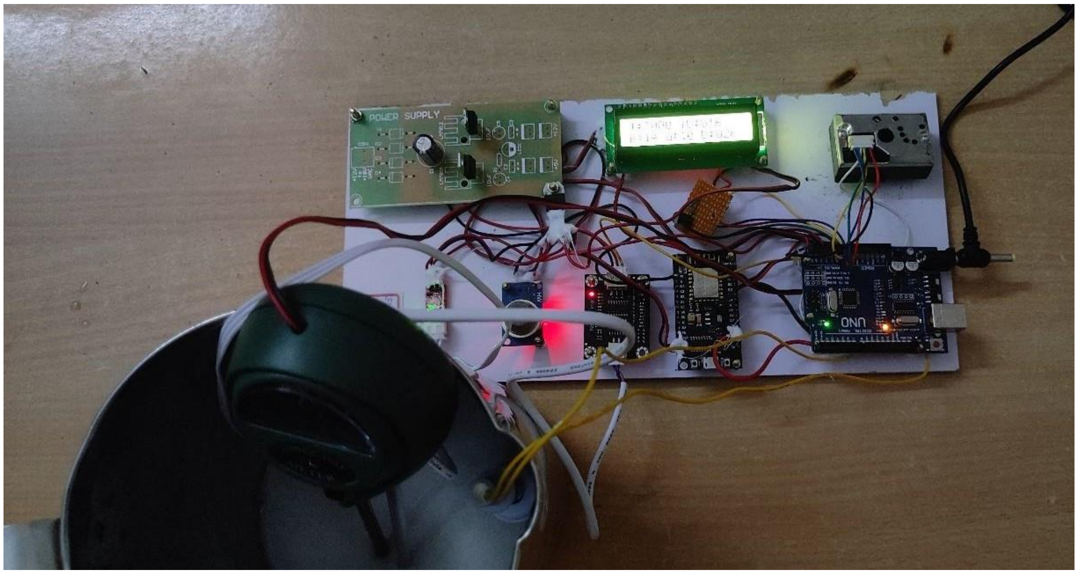


Fig.5.2.1. With Polluted Water

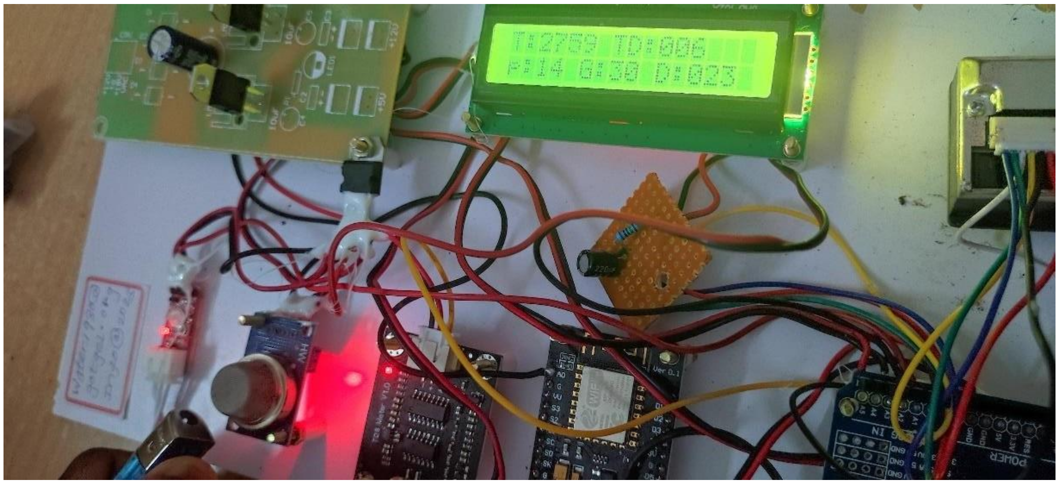


Fig.5.2.2. Without Polluted Water

NOTIFICATION PURPOSES

Fig.5.2.3. Water Pollution

Fig.5.2.4. Water Level High

Fig.5.2.5. Gas Leaked

SAMPLE PARAMETER – 1:

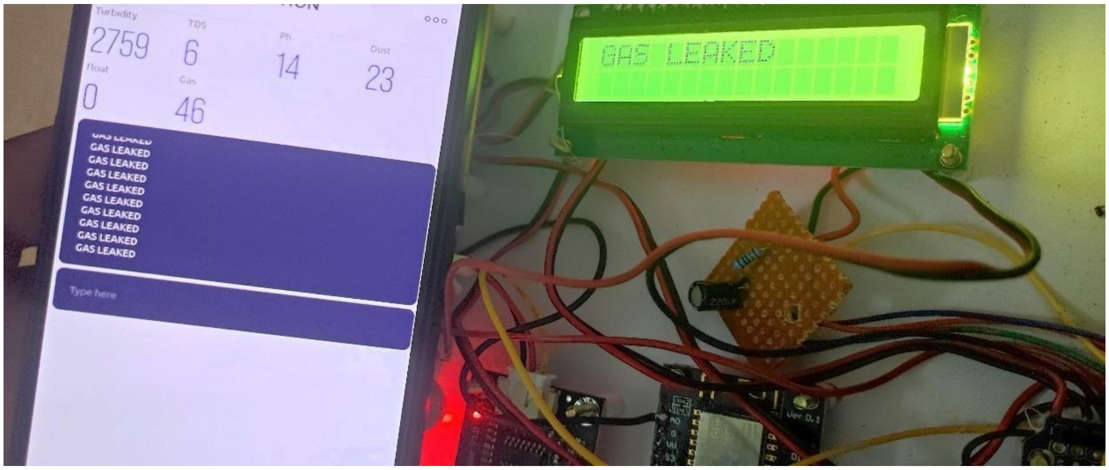


Fig.5.6. Sample Parameter – 1

SAMPLE PARAMETER – 2:

Fig.5.7. Sample Parameter – 2

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1. CONCLUSION

An IoT based water pollution monitoring system offers a comprehensive and efficient approach to monitoring water quality in real-time. It enables quick and accurate detection of contaminants in water bodies, making it easier to take appropriate measures to prevent further pollution. With the help of various sensors and communication technologies, the system can collect and transmit data, where it can be analyzed and visualized for decision-making purposes. The system can be integrated with other technologies, to provide insights and predictions that can aid in proactive decision-making. Overall, an IoT based water pollution monitoring system has the potential to revolutionize the way we manage and conserve our water resources. Finally, an IoT based water pollution monitoring system can play a crucial role in ensuring water security and sustainability. By monitoring water quality and identifying potential sources of pollution, authorities can take proactive measures to protect and conserve the water resources for future generations.

6.2.FUTURE SCOPE

Monitoring of the water quality in real-time is possible thanks to IoT technologies, which can provide precise and recent data. IoT devices can quickly respond to pollution incidents by using cognitive algorithms to detect and identify toxins in the water. Citizens are encouraged to take action to stoppollution by using citizen management to raise awareness of the problem.

Developing the things more accurate and to enhance the efficiency of the system includes,

- Ensuring the data to be very accurate so that we can able to detect thepollution earlier and keep ourselves from water-borne diseases.
- Continuous internet connectivity will be provided so that we can able toprovide the system with real time monitoring.
- Ensuring regular maintenance and upkeep the functionality specular aboutthe systems so that accurate parameters can be configured.
- Less complexity to design and system implementation, particularly for theorganizations with technical expertise.

CHAPTER 7
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CHAPTER 8

APPENDIX

PROGRAM

Embedded Code :

```
#include <Wire.h>
#include <LCD_I2C.h>
LCD_I2C lcd(0x27);
#include <EEPROM.h>
#include "GravityTDS.h"
#define ph A0
#define measurePin A2
#define ledPower 7
int samplingTime = 280;
int deltaTime = 40;
int sleepTime = 9680;
float voMeasured = 0;
float calcVoltage = 0;
int dustDensity = 0;
int sensorPin = A1;
float volt;
int ntu,phv,f1,tdsValue = 0;
#define TdsSensorPin A3
GravityTDS gravityTds;
#define float1 4
float temperature = 25;
unsigned int m=0,act=0,val;
String inputString = "";
unsigned char a[200];
void setup()
{
Serial.begin(9600);
Wire.begin(); // gpio 2 and gpio 0 which are D4, and D3
pinMode(ph,INPUT);
pinMode(ledPower,OUTPUT);
pinMode(float1,INPUT_PULLUP);
gravityTds.setPin(TdsSensorPin);
```

```
gravityTds.setAref(5.0);  //reference voltage on ADC, default 5.0V on ArduinoUNO
gravityTds.setAdcRange(1024);  //1024 for 10bit ADC;4096 for 12bit ADC
gravityTds.begin();
lcd.begin();                  //Init the LCD
lcd.backlight();              //Activate backlight
lcd.home();
lcd.setCursor(0,0);lcd.print("WATER");
lcd.setCursor(3,1);lcd.print(" POLLUTION");
delay(3000);
lcd.clear();
}
void loop()
{
while(Serial.available())
{
char data;
data=Serial.read();

a[m]=data; if(a[0]
== '*')
{
if(m<=3)
{m++;}
}
}
if(m > 1)
{
val = (a[1]-0x30)*100 + (a[2]-0x30)*10 + (a[3] - 0x30);m=0;
}

volt = 0;
for(int i=0; i<800; i++)
{s
volt += ((float)analogRead(sensorPin)/1023)*5;
}
volt = volt/800;
volt = round_to_dp(volt,2);
```

```
if(volt < 2.5){
ntu = 3000;
}else{
ntu = -1120.4*square(volt)+5742.3*volt-4353.8;
}
lcd.setCursor(0,0);lcd.print("T:");
if(ntu <= 9){lcd.print("000");lcd.print(ntu);}
else if(ntu <= 99){lcd.print("00");lcd.print(ntu);}
else if(ntu <= 999){lcd.print("0");lcd.print(ntu);}
else if(ntu <= 9999){lcd.print(ntu);}
gravityTds.setTemperature(temperature); // set the temperature and executetemperature
compensation
gravityTds.update(); //sample and calculate
tdsValue = gravityTds.getTdsValue();
lcd.setCursor(7,0);lcd.print("TD:");
if(tdsValue<= 9){lcd.print("00");lcd.print(tdsValue);}
else if(tdsValue <= 99){lcd.print("0");lcd.print(tdsValue);}
else if(tdsValue <= 999){lcd.print(tdsValue);}

phv=analogRead(ph);
Serial.print("ph:");
Serial.println(phv);
phv=map(phv,0,55,14,0);
lcd.setCursor(0,1);lcd.print("p:");
if(phv>=14){phv=14;}
else if(phv<=0){phv=0;}
if(phv <= 9){lcd.print("0");lcd.print(phv);}
else if(phv <= 99){lcd.print(phv);}
lcd.setCursor(5,1);lcd.print("G:");
if(val <= 9){lcd.print("0");lcd.print(val);}else
if(val <= 99){lcd.print(val);}
if(val>50)
{
lcd.clear();
lcd.setCursor(0,0);
lcd.print("GAS LEAKED");
lcd.setCursor(0,1);
lcd.print(""); delay(1000);
lcd.clear();
}
```

```
digitalWrite(ledPower,LOW); // power on the LED
delayMicroseconds(samplingTime);
voMeasured = analogRead(measurePin); // read the dust value
delayMicroseconds(deltaTime);
digitalWrite(ledPower,HIGH); // turn the LED off
delayMicroseconds(sleepTime);
calcVoltage = voMeasured * (5.0 / 1024.0);
dustDensity = 170 * calcVoltage - 0.1;
lcd.setCursor(10,1);lcd.print("D:");
if(dustDensity<= 9){lcd.print("00");lcd.print(dustDensity);} else
if(dustDensity <= 99){lcd.print("0");lcd.print(dustDensity);}else
if(dustDensity <= 999){lcd.print(dustDensity);}

if(digitalRead(float1)==HIGH)
{
f1=1;
lcd.clear(); lcd.setCursor(0,0);
lcd.print("WATER LEVEL");
lcd.setCursor(0,1);
lcd.print(" HIGH      ");
delay(1000);
lcd.clear();
}
else{ f1=0;}
Serial.println(f1);
sendata();
delay(1000);
}
float round_to_dp( float in_value, int decimal_place )
{
float multiplier = powf( 10.0f, decimal_place ); in_value
= roundf( in_value * multiplier ) / multiplier;return
in_value;
}
void sendata()
{
Serial.print('*');
```

```
if(ntu <= 9){Serial.print("000");Serial.print(ntu);} else
if(ntu <= 99){Serial.print("00");Serial.print(ntu);}else
if(ntu <= 999){Serial.print("0");Serial.print(ntu);}else
if(ntu <= 9999){Serial.print(ntu);}

if(tdsValue<= 9){Serial.print("00");Serial.print(tdsValue);}
else if(tdsValue <= 99){Serial.print("0");Serial.print(tdsValue);}else
if(tdsValue <= 999){Serial.print(tdsValue);}

if(phv<= 9){Serial.print("00");Serial.print(phv);}
else if(phv <= 99){Serial.print("0");Serial.print(phv);}
else if(phv <= 999){Serial.print(phv);}

if(dustDensity<= 9){Serial.print("00");Serial.print(dustDensity);}
else if(dustDensity <= 99){Serial.print("0");Serial.print(dustDensity);}
else if(dustDensity <= 999){Serial.print(dustDensity);}

if(f1<= 9){Serial.print("00");Serial.print(f1);}
else if(f1 <= 99){Serial.print("0");Serial.print(f1);}
else if(f1 <= 999){Serial.print(f1);}
}
```

Application Code :

```
//pir12@gotgel.org
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#define BLYNK_TEMPLATE_ID "TMPLZs-mKWfy"
#define BLYNK_TEMPLATE_NAME "WATER POLLUTION"
#define BLYNK_AUTH_TOKEN "lMUjECvpbhBefQ-cRXxqkKzstCmHJpSc"
// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "IOT";
char pass[] = "123456789";
char auth[] = BLYNK_AUTH_TOKEN;
unsigned int m=0,act=0,val,val1,val2,val3,val4,val5;
#define gas A0
String inputString = "";
unsigned char a[200];
int gasv;
```

```
void setup()
{
Serial.begin(9600);
pinMode(gas,INPUT);
Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
}
void loop()
{
gasv=analogRead(gas);
Serial.print("gasv:");
Serial.println(gasv);
gasv=map(gasv,100,1024,0,99);
while(Serial.available())
{
char data;
data=Serial.read();
a[m]=data;
if(a[0] == '*')
{
if(m<=16)
{m++;}
}
}
if(m > 1)
{
val = (a[1]-0x30)*1000 + (a[2]-0x30)*100  + (a[3] - 0x30)*10+(a[4] - 0x30);
val1 = (a[5]-0x30)*100 + (a[6]-0x30)*10  + (a[7] - 0x30);
val2 = (a[8]-0x30)*100 + (a[9]-0x30)*10 + (a[10] - 0x30);
val3 = (a[11]-0x30)*100 + (a[12]-0x30)*10  + (a[13] - 0x30);
val4 = (a[14]-0x30)*100 + (a[15]-0x30)*10 + (a[16] - 0x30);m=0;
}
Blynk.virtualWrite(V0,val);
delay(100);
Blynk.virtualWrite(V1,val1);
delay(100);
Blynk.virtualWrite(V2,val2);
delay(100);
Blynk.virtualWrite(V3,val3);
delay(100);
Blynk.virtualWrite(V4,val4);
delay(100);
```

```
if(val4==1){Blynk.virtualWrite(V6,"WATER LEVEL HIGH");
Blynk.virtualWrite(V5,gasv);
delay(100);
if(gasv>=50){Blynk.virtualWrite(V6,"GAS LEAKED");}
Blynk.run();
sendata();
delay(100);
}
void sendata()
{
Serial.print('*');
if(gasv<= 9){Serial.print("00");Serial.print(gasv);}
else if(gasv <= 99){Serial.print("0");Serial.print(gasv);}
else if(gasv <= 999){Serial.print(gasv);}
}
```

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IoT BASED WATER POLLUTION MONITORING SYSTEM

Ashwini R [1], Dhanu Shree P [2], Gunasekhar C [3], Hari Prakash P [4], Jagadish V [5]

Assistant Professor, Department of C.S.E, Jansons Institute of Technology, Coimbatore, India[1]

UG Students, Department of C.S.E, Jansons Institute of Technology, Coimbatore, India [2 - 5]

ABSTRACT

Water pollution monitoring system is intended to continuously monitor the quality of water in a specific area. The sensors measure pH, TDS, turbidity, dust, MQ2, and water level, among other water quality parameters. If any of the water quality parameters exceeds the safe levels, the system generates real-time alerts. The alerts can be delivered to the appropriate authorities and individuals via a mobile application. The system's goal is to provide a low-cost, high-efficiency solution for monitoring water quality and preventing water pollution. The system's effectiveness was tested in a real-world scenario, and the results showed that it has the potential to monitor water pollution and promptly notify authorities, which can help prevent disease spread and protect aquatic life. It's inexpensive, scalable, and simple to implement, making it suitable for use in a variety of settings.

KEYWORDS

IoT, LED Display, Water level Sensor, Dust Sensor, pH Sensor, TDS Sensor, Turbidity Sensor, MQ2 Sensor, MC Arduino.

INTRODUCTION

The Internet of Things (IoT) has transformed our interactions with the physical world by allowing us to collect and analyse data from a vast array of connected devices. Water pollution is one of the most pressing issues we face today, with far-reaching consequences for both the environment and human health.

Water pollution monitoring systems based on IoT with alert capabilities provide a powerful solution to this problem by providing real-time data on water quality and allowing for early detection of contamination events. These systems typically consist of a network of sensors deployed in bodies of water and linked via the internet to a central data processing unit. pH, TDS, turbidity, dust, MQ2, and water level are all measured by the sensors. The sensor data is then transmitted to the central unit, which processes it and generates alerts if certain thresholds are exceeded.

The alerts can be sent to a variety of stakeholders, including water authorities, environmental organisations, and local communities, via SMS, email, or mobile apps. This allows for faster response times and faster action to mitigate the effects of pollution events. Water pollution monitoring systems based on IoT with alert capabilities have the potential to revolutionise the way we monitor and manage water quality, allowing us to protect our water resources while also ensuring the health and well-being of humans and the environment.

RELATED WORKS

1. **IoT-Based Water Quality Monitoring System using Raspberry Pi**

"IoT-Based Water Quality Monitoring System using Raspberry Pi" by S. S. Shinde and S. K. Shukla. This paper presents an IoT-based water quality monitoring system using Raspberry Pi that measures different water quality parameters such as pH, temperature, and turbidity.

Description

Various sensors are used to measure the water quality parameters, including pH sensor, temperature sensor, turbidity sensor, and water level sensor. The collected data is then transmitted to the Raspberry Pi, which acts as a central processing unit, through a wireless communication module. The system also uses a web-based interface to display the real-time data of the water quality parameters, which can be accessed remotely by the users. The users can monitor the water quality parameters and take necessary actions if any parameter is found to be beyond the acceptable limit.

A data analysis algorithm that uses machine learning techniques to predict the water quality parameters based on the collected data. This algorithm can help in predicting the water quality parameters in real-time, which can be helpful in detecting any water pollution at an early stage.

Overall, this paper presents a cost-effective and efficient IoT-based water quality monitoring system using Raspberry Pi, which can help in ensuring the safety of water resources and detecting any water pollution at an early stage.

2. **Wireless Sensor Network-Based Water Quality Monitoring System**

"Wireless Sensor Network-Based Water Quality Monitoring System" by M. A. Hoque and M. A. Rahman. This paper presents a wireless sensor network-based water quality monitoring system that uses multiple sensors to monitor different water quality parameters.

Description

Various sensors to measure the water quality parameters, including pH, dissolved oxygen, temperature, and conductivity. These sensors are placed at different locations in the water body, and the data collected by these sensors is transmitted wirelessly to a central data collection unit using ZigBee communication protocol. The collected data is then processed and analysed using a microcontroller-based system. The authors proposed an algorithm to monitor the water quality parameters and send alerts to the concerned authorities if any parameter is found to be beyond the acceptable limit. The system also has a web-based interface that displays the real-time data of the water quality parameters, which can be accessed remotely by the users.

The results showed the effective monitoring water quality parameters and send alerts in real-time if any parameter is found to be beyond the acceptable limit. Overall, this paper presents a wireless sensor network-based water quality monitoring system that can help in ensuring the safety of water resources and detecting any water pollution at an early stage. The proposed system is cost-effective, efficient, and can be easily deployed in remote areas with limited infrastructure.

3. **Design and implementation of an IoT-based water pollution monitoring system using LoRa**

"Design and implementation of an IoT-based water pollution monitoring system using LoRa" by H. Kim, D. Kim, and H. Lee. This paper presents an IoT-based water pollution monitoring system that uses LoRa (Long Range) technology to transmit water quality data to a remote server.

Description

Various sensors to measure water quality parameters, including pH, temperature, dissolved oxygen, and turbidity.

The collected data is processed and transmitted wirelessly using LoRa technology, which allows for long-range communication and low power consumption. The system consists of three main components: sensor nodes, a gateway, and a remote server. The sensor nodes are responsible for collecting the water quality data, which is then transmitted to the gateway. The gateway acts as a bridge between the sensor nodes and the remote server and is responsible for transmitting the data to the server. The remote server is responsible for storing and processing the collected data, which can be accessed by the users using a web-based interface. The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit.

The results showed the effective monitoring water quality parameters and transmit the data over a long range with low power consumption. Overall, this paper presents an efficient and cost-effective IoT-based water pollution monitoring system using LoRa technology. The proposed system can help in ensuring the safety of water resources and detecting any water pollution at an early stage, especially in remote areas with limited infrastructure.

4. **Development of a low-cost IoT-based water quality monitoring system using Arduino**

"Development of a low-cost IoT-based water quality monitoring system using Arduino" by S. S. Suresh and S. M. N. Rao. This paper presents a low-cost IoT-based water quality monitoring system using Arduino that measures various water quality parameters such as pH, temperature, and dissolved oxygen.

Description

Various sensors, including a pH sensor, a temperature sensor, and a dissolved oxygen sensor, to measure the water quality parameters. The collected data is then transmitted wirelessly using Wi-Fi technology to a remote server. The remote server is responsible for storing and processing the collected data, which can be accessed by the users using a web-based

interface. The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit.

The results showed the effective monitoring water quality parameters and transmit the data over Wi-Fi with low power consumption.

Overall, this paper presents a low-cost IoT-based water quality monitoring system using Arduino that can help in ensuring the safety of water resources and detecting any water pollution at an early stage. The proposed system is cost-effective, efficient, and can be easily deployed in remote areas with limited infrastructure.

5. **IoT-based water quality monitoring system for smart cities**

"IoT-based water quality monitoring system for smart cities" by S. K. Lim and K. H. Kim. This paper presents an IoT-based water quality monitoring system for smart cities that integrates water quality data with other smart city systems such as traffic management and waste management.

Description

Various sensors to measure water quality parameters such as pH, temperature, and dissolved oxygen. The collected data is then transmitted wirelessly using Wi-Fi technology to a cloud server, where it is processed and integrated with other smart city systems. The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit. The integrated system allows the authorities to make informed decisions and take necessary actions based on the collected data.

The results showed the effective monitoring water quality parameters and integrate the data with other smart city systems. Overall, this paper presents an innovative approach to water quality monitoring that integrates water quality data with other smart city systems. The proposed system can help in ensuring the safety of water resources and improving the overall quality of life in smart cities.

6. A Smart Water Quality Monitoring System for IoT-enabled Smart Cities

"A Smart Water Quality Monitoring System for IoT-enabled Smart Cities" by N. K. Sharma et al. This project aims to design and develop a smart water quality monitoring system for smart cities using IoT technologies.

Description

Various sensors to measure water quality parameters such as pH, temperature, and dissolved oxygen. The collected data is then transmitted wirelessly using LoRa (Long Range) technology to a cloud server. The cloud server is responsible for storing and processing the collected data and providing real-time information to the users.

The system also has an alert mechanism that sends notifications to the concerned authorities if any water quality parameter is found to be beyond the acceptable limit. The proposed system is designed to be cost-effective, energy-efficient, and scalable, making it suitable for deployment in smart cities with limited infrastructure.

The results showed the effective monitoring water quality parameters and transmit the data over LoRa with low power consumption. Overall, this project presents an innovative approach to water quality monitoring using IoT technologies. The proposed system can help in ensuring the safety of water resources in smart cities and improving the overall quality of life for the citizens.

EXISTING SYSTEM

The accuracy of the data collected by IoT devices can be affected by several factors such as calibration, sensor accuracy, and environmental conditions.

It is important to ensure that the data collected is accurate and reliable. IoT devices require a power supply to operate. In remote or hard-to-reach locations, providing a reliable power supply can be a challenge. The use of renewable energy sources such as solar power can be a solution to this problem. Therefore, there is a need to develop the efficiency of accurate data parameters and to enhance the system of continuous power supply to the objective.

PROPOSED SYSTEM

- The objective of a water polluted ion management system in IoT is to monitor and manage water quality in real-time to prevent or minimize pollution.
- Real-time water quality monitoring: IoT systems can continuously monitor the water quality in real-time, providing accurate and up-to-date information.
- IoT systems can use intelligent algorithms to detect and identify pollutants in the water, enabling quick response to pollution events.
- To improve the quality of water resources, protect human health, and promote sustainable water management practices.

MERITS

- Improved early diagnosis of water borne diseases is made possible by real-time data on water quality factors.
- IoT-based water pollution monitoring systems that enable remote access by authorities.
- Effective data are continuously and automatically collected without the need for manual data entry.

DRAWBACKS

- The accuracy and dependability of IoT-based water pollution monitoring systems must be maintained on a regular basis.
- Certain sensors might not be able to detect all sorts of pollution or could need to be calibrated often.
- Sensors, communication tools, and other hardware expenses may be expensive upon overall setup costs.

MODULE DESCRIPTION

A module is a software, hardware or part of a program that execute the definition of particular routine of an objective.

Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Sensors

A device that provides a usable output in response to a specified measurement. The sensor attains a physical parameter and converts it into a signal suitable for processing (e.g. electrical, mechanical, optical) the characteristics of any device or material to detect the presence of a particular physical quantity.

The output of the sensor is a signal which is converted to a human-readable form like changes in characteristics, changes in resistance, capacitance, impedance, etc.

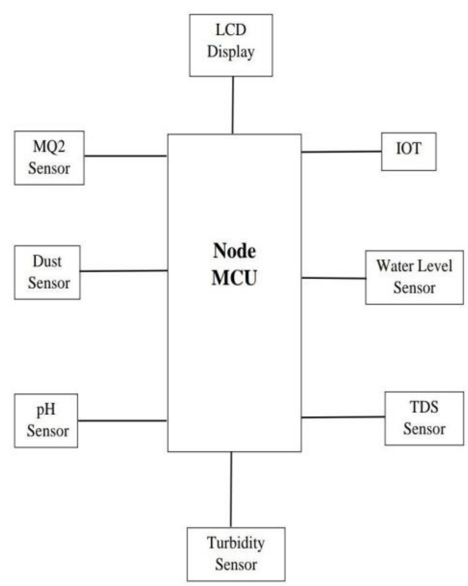
Node MCU

The module is mainly based on ESP8266 that is a low-cost Wi-Fi microchip incorporating both a full TCP/IP stack and microcontroller capability. It is introduced by manufacturer Espresso Systems. The ESP8266 Node MCU is a complex device, which combines some features of the ordinary Arduino board with the possibility of connecting to the internet.

Arduino Modules and Microcontrollers have always been a great choice to incorporate automation into the relevant project. But these modules come with a little drawback as they don't feature a built-in Wi-Fi capability, subsequently, we need to add external Wi-Fi protocol into these devices to make them compatible with the internet channel. Node MCU V3 is an open-source firmware and development kit that plays a vital role in designing an IoT product using a few script lines. 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.

ESP8266 Module

ESP8266 Wi-Fi modules or Wi-Fi microcontrollers are used to send and receive data over Wi-Fi. They can also accept commands over the Wi-Fi. Wi-Fi modules are used for communications between devices. They are most commonly used in the field of Internet of Things.



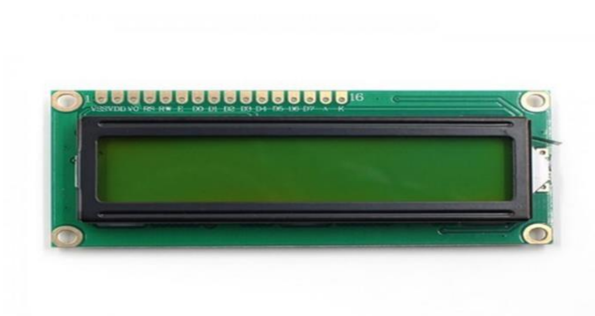
Block Diagram - Module

RESULTS AND DISCUSSIONS

LCD Display

An LCD display is made up of a lot of closely spaced LCDs. The diodes work together to create an image on the display by individually adjusting their brightness.

The concepts of additive colour mixing, in which new colours are formed by combining light in different colours, are utilised to create brilliant colour images. Red, green, and blue LCDs are arranged in a predefined configuration to make up an LCD display. A pixel is made up of these three colours combined. It is possible to create billions of different colours by varying the diode intensity. The LCD screen's matrix of coloured pixels appears as a picture from a particular distance.



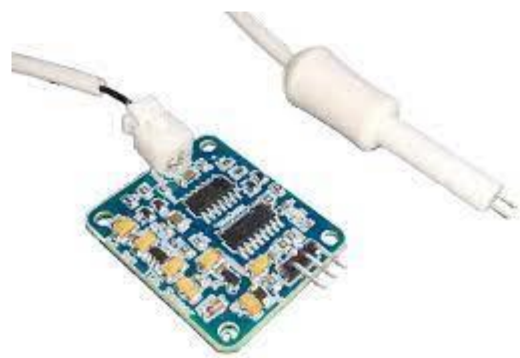
Water Level Sensor

The pressure on the sensor's front surface is translated into the water level height according to the water level sensor's operating principle when the sensor is inserted into the liquid to be measured at a specific depth. H indicates how far into the liquid the sensor is lowered. It is a tool that gauges a liquid's high or low level in a stationary vessel.

The method of measuring liquid level has two categories: touch and non-contact. The contact measurement known as an "input water level transmitter" transforms the height of the liquid level into an electrical signal output. At the moment, it is a water level transmitter that is frequently utilised.

TDS Sensor

A TDS metre is a tiny, portable instrument used to measure the amount of total dissolved solids (TDS) in a solution, often water. Due to the fact that dissolved ionised solids, such as salts and minerals, enhance a solution's conductivity, a TDS metre detects the solution's conductivity and infers the TDS from that value.



Turbidity Sensor

The nephelometric approach contrasts the amount of light scattered in a reference solution with how light is dispersed in a water sample. Turbidity is frequently measured with an electronic hand-held metre. The turbidity of water is continuously monitored and measured using turbidity sensors. Two components make up these sensors: a light source and a detector. The water is illuminated by the light source, and the detector calculates how much light is dispersed by the suspended particles.

pH Sensor

An essential tool for determining a solution's alkalinity or acidity is a pH sensor, often known as a probe or electrode. H+ ions can be detected by the glass membrane at the end. In comparison to pH papers and titration techniques, pH metres offer a significantly more accurate result because they use a viewable digital display. As pH metres are portable, it is simple to provide accurate readings wherever pH solutions need to be tested.

Dust Sensor

A dust sensor that uses optical sensing to measure the airborne dust particle concentration. The device has an optically organised photo-sensor and an infrared light emitting diode (IR LED). The photo-sensor picks up the IR LED light that airborne dust particles reflect.

Dust monitoring systems continually track particulate emissions through an air filtration system and notify when levels reach a set threshold, allowing them to identify particulate matter concentrations that exceed regulatory limits and might be hazardous to worker health.

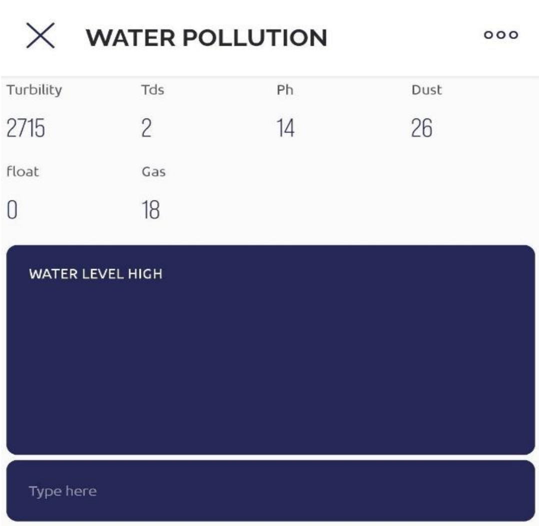
MQ2 Sensor

An electronic sensor called the MQ2 gas sensor measures the number of gases in the air, including LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide. Chemi resistor is another name for the MQ2 gas sensor. When the sensing component comes into touch with the gas, the resistance of the component changes. The detection of gas uses this variation in resistance value.

An IoT-based water pollution management system can significantly improve the efficiency and effectiveness of water quality monitoring and management. The algorithms that used here is to analyse the data collected by the sensors to provide real-time insights and predictions. This could help to detect pollution sources faster and reduce the risk of waterborne diseases.

Readings from Hardware

Mobile Application Readings



CONCLUSION AND FUTURE WORK

For monitoring water quality indicators in real-time, IoT-based water pollution monitoring systems utilising Arduino Uno and Node MCU are a potential alternative. These systems may gather and send data on variables like pH, temperature, and dissolved oxygen to a cloud platform or server for analysis with the aid of sensors and Wi-Fi connectivity.

The versatility and cost of Arduino Uno and Node MCU for monitoring water pollution are two of its main benefits. These microcontroller boards are generally accessible and simple to programme to meet the requirements of a particular application. Moreover, Node MCU's Wi-Fi connectivity provides real-time water quality monitoring, which can assist in identifying and preventing pollution events before they significantly impact the environment.

However, it is important to note that the accuracy and reliability of sensor data can be affected by factors such as sensor calibration, environmental conditions, and data transmission issues. Therefore, it is important to ensure that the system is properly calibrated and maintained to ensure accurate and reliable sensor readings.

In conclusion, IoT-based solutions for monitoring water pollution that use the Arduino Uno and Node MCU have the potential to completely change how water quality is managed and monitored. These systems have the potential to be a crucial instrument for guaranteeing the sustainability of our water resources and safeguarding both human health and the environment with further research and development.

Monitoring of the water quality in real-time is possible thanks to IoT technologies, which can provide precise and recent data. IoT devices can quickly respond to pollution incidents by using cognitive algorithms to detect and identify toxins in the water. Citizens are encouraged to take action to stop pollution by using citizen management to raise awareness of the problem.

Developing the things more accurate and to enhance the efficiency of the system includes,

- Ensuring the data to be very accurate so that we can able to detect the pollution earlier and keep ourselves from water-borne diseases.
- Continuous internet connectivity will be provided so that we can able to provide the system with real time monitoring.
- Ensuring regular maintenance and upkeep the functionality specular aboutthe systems so that accurate parameters can be configured.
- Less complexity to design and system implementation, particularly for the organizations with technical expertise.

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Ashwini R
Assistant Professor, Department of C.S.E, Jansons Institute of Technology, Coimbatore, India

Dhanu Shree P
Department of C.S.E, Jansons Institute of Technology, Coimbatore, India

Gunasekhar C
Department of C.S.E, Jansons Institute of Technology, Coimbatore, India

Hari Prakash P
Department of C.S.E, Jansons Institute of Technology, Coimbatore, India

Jagadish V
Department of C.S.E, Jansons Institute of Technology, Coimbatore, India

Abstract

The purpose of a water pollution surveillance system is to continuously monitor the quality of water in a specific area. Among other water quality parameters, the sensors measure pH, TDS, turbidity, dust, MQ2, and water level. The system generates real-time alerts if any of the water quality parameters exceeds the safe levels. A mobile application can deliver the alerts to the appropriate authorities and individuals. The system's goal is to provide a low-cost, high-efficiency solution for water quality surveillance and pollution prevention. The system's effectiveness was tested in a real-world scenario, and the results revealed that it has the potential to monitor water pollution and promptly notify authorities, which can aid in disease prevention and aquatic life protection. It's cheap, scalable, and easy to set up, making it suitable for use in a variety of situations. This data can be used to identify potential sources of water pollution, such as industrial waste discharges, agricultural runoff, and sewage outflows, and to take immediate action to prevent water resource contamination. Furthermore, the system can be used to ensure compliance with regulatory water quality standards and to protect public health by detecting and alerting authorities in the event of any water quality issues. Overall, the Internet of Things-based water pollution surveillance system is a valuable tool for preserving the quality of water resources for future generations. The system is useful for identifying potential sources of water pollution and can be used to help prevent water body contamination. The system can also be used to notify authorities of any water quality issues upon application, allowing for quick action to protect public health. In conclusion, the Internet of Things-based water pollution surveillance system is a valuable tool for ensuring the quality of water resources for future generations.

Keywords

IoT, LED Display, Water Level Sensor, Dust Sensor, pH Sensor, TDS Sensor, Turbidity Sensor, MQ2 Sensor, MC Arduino

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