IOT BASED DAM WATER LEVEL MONITORING AND WATER QUALITY

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ABSTRACT:

The Internet of Things (IoT) has revolutionized the way we interact with our environment, and its potential applications in various fields are vast. One such field is dam water level monitoring and water quality management. With the use of IoT-based systems, the monitoring and management of these critical resources become more efficient and cost-effective. This paper presents an IoT-based dam water level monitoring and water quality management system that utilizes Arduino, Red, Green, and Yellow LED, water level sensors, solenoid valves, buzzers, pH sensors, and ESP 8266 modules. The system uses the sensors to continuously monitor the water level and quality of the dam and sends the data to the cloud via the ESP 8266 module. The system is designed to trigger alarms through the use of the buzzer and the color-coded LED lights (Red, Yellow, and Green) to indicate the water level status. Additionally, solenoid valves are used to regulate the water flow, ensuring optimal water levels in the dam. The pH sensor is used to monitor water quality and send alerts if any deviations are detected. he IoT-based system has several advantages over traditional monitoring systems, including real-time monitoring, remote access, and data analytics. The data collected can be used to make informed decisions regarding water management, such as optimizing water usage, predicting future water levels, and identifying potential hazards. The system is also cost-effective and easy to implement, making it an ideal solution for water resource management. In conclusion, the IoT-based dam water level monitoring and water quality management system presented in this paper has enormous potential in ensuring the efficient management of critical resources. By using readily available components such as Arduino, Red, Green, and Yellow LED, water level sensors, solenoid valves, buzzers, pH sensors, and ESP 8266 modules, this system provides an effective solution for water resource management.

1. INTRODUCTION

Water is one of the most critical resources on the planet, and its management is of utmost importance. Dams are a significant source of water storage, but their management can be challenging, especially with the unpredictability of weather patterns and the increasing demand for water. Traditional dam water level monitoring and water quality management systems are often costly, inefficient, and time-consuming. With the advent of the Internet of Things (IoT), it is now possible to develop cost-effective and efficient systems for monitoring and managing dams. IoT-based systems provide real-time monitoring, remote access, and data analytics capabilities, which can significantly enhance water resource management. These systems use sensors, communication devices, and cloud computing to collect and analyze data, providing insights that can be used to make informed decisions regarding water management. In this paper, we present an IoT-based dam water level monitoring and water

quality management system that utilizes readily available components such as Arduino, Red, Green, and Yellow LED, water level sensors, solenoid valves, buzzers, pH sensors, and ESP 8266 modules. The system continuously monitors the water level and quality of the dam and sends the data to the cloud for analysis. The data collected can be used to make informed decisions regarding water management, such as optimizing water usage, predicting future water levels, and identifying potential hazards. The paper is organized as follows: first, we discuss the need for IoT-based dam water level monitoring and water quality management systems. Second, we present the components and the architecture of the system. Third, we describe the functionalities and the working of the system. Finally, we conclude the paper by discussing the advantages of the system and its potential applications in water resource management.

2. EXISTING SYSTEM

Traditional dam water level monitoring and water quality management systems rely on manual readings, which can be time-consuming and inefficient. The systems usually involve physical inspections and measurements by personnel, which may result in errors and delays in detecting potential issues. Additionally, traditional systems do not provide real-time monitoring capabilities, making it challenging to respond quickly to sudden changes in water levels or quality. The lack of real-time monitoring can result in several challenges, including water shortages, floods, and environmental damage. Water shortages can occur when water levels are not adequately managed, resulting in reduced water supply for irrigation, drinking, and other uses. Floods can occur when water levels rise above the safe level, resulting in property damage, loss of life, and environmental degradation. Poor water quality can also have severe health consequences, including waterborne diseases and contamination of crops and livestock. Therefore, there is a need for an efficient and cost-effective system for monitoring and managing dams that can provide real-time data and enable timely decision-making. The IoT-based dam water level monitoring and water quality management system presented in this paper addresses this need and provides an innovative solution for effective water resource management.

3. DISADVANTAGE

One potential disadvantage is the reliance on technology. The system uses electronic components that may malfunction or require maintenance, resulting in downtime and reduced monitoring capabilities. In such cases, backup systems or redundant components may be necessary to ensure continuous monitoring. Another potential disadvantage is the need for a reliable internet connection. The system relies on the cloud to store and analyze data, and therefore, a stable internet connection is necessary. If the internet connection is disrupted, the system may not be able to send or receive data, resulting in delayed monitoring and potential risks. The system's initial cost may also be a disadvantage, as it requires the purchase of electronic components and communication devices. However, the long-term cost savings of the system may outweigh the initial investment, especially in terms of reduced labor costs and improved efficiency. Finally, the system may require specialized knowledge and skills to install and maintain, which may not be readily available in some regions. This may result in increased training and hiring costs to ensure the system is correctly installed and maintained. While the IoT-based dam water level monitoring and water quality management system presents several advantages, it is essential to consider the potential disadvantages and challenges before implementing the system. Proper planning, backup systems, and continuous maintenance can help mitigate these potential drawbacks.

4. PROPOSED SYSTEM

The proposed IoT-based dam water level monitoring and water quality management system utilizes readily available components such as Arduino, Red, Green, and Yellow LED, water level sensors, solenoid valves, buzzers, pH sensors, and ESP 8266 modules. The system consists of multiple water level sensors that continuously monitor the water level in the dam. The water level sensors are connected to the Arduino microcontroller, which collects the data and sends it to the ESP 8266 module. The ESP 8266 module is responsible for transmitting the data to the cloud using Wi-Fi connectivity. The cloud-based system analyzes the

data collected from the water level sensors and provides real-time monitoring of the water level in the dam. The system also includes a solenoid valve that can be remotely controlled to regulate the water level in the dam. This feature allows for more efficient management of water resources, preventing water shortages or floods. The system also includes pH sensors that monitor the water quality in the dam. The pH sensors are connected to the Arduino microcontroller, which collects the data and sends it to the cloud for analysis. If the water quality falls below a specific threshold, the system activates a buzzer and a red LED to alert the appropriate personnel. In addition, the system includes green and yellow LEDs to provide visual indications of the water level. The green LED indicates that the water level is safe, while the yellow LED indicates that the water level is rising and requires attention. The proposed system provides real-time monitoring of the water level and quality in the dam, enabling efficient water resource management. The system's components are readily available and can be easily installed, making it a cost-effective solution for water management. The system's features, such as remote control of the solenoid valve and alerts for water quality issues, enhance the system's efficiency and effectiveness in managing dams.

5. ADVANTAGE

- Real-time monitoring: The system provides real-time monitoring of water levels and water quality, enabling quick and efficient decision-making. This feature can help prevent water shortages, floods, and environmental damage.

- Cost-effective: The system utilizes readily available and affordable components, making it a cost-effective solution for water management. Additionally, the system's remote monitoring capabilities reduce the need for personnel to physically inspect the dam regularly, resulting in reduced labor costs.

- Improved efficiency: The system's features, such as remote control of the solenoid valve and alerts for water quality issues, enhance the system's efficiency and effectiveness in managing dams. This feature allows for more efficient management of water resources, preventing water shortages or floods.

- Easy installation and maintenance: The system's components are readily available and can be easily installed, making it an accessible solution for water management. Additionally, the system's cloud-based platform allows for remote maintenance and updates, reducing the need for physical maintenance.

- Scalable: The system can be easily scaled to monitor multiple dams, making it a versatile solution for water management in different regions.

6. BLOCK DIAGRAM
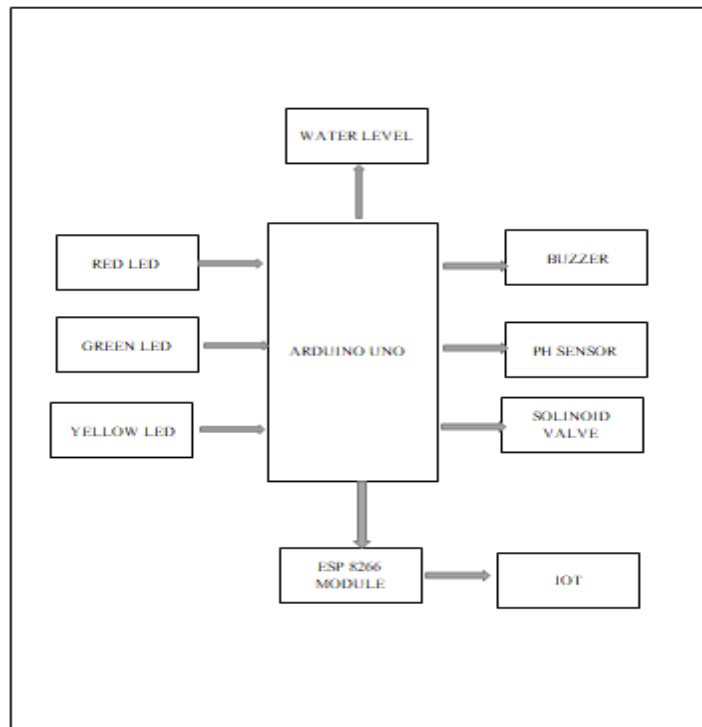
7. CIRCUIT DIAGRAM
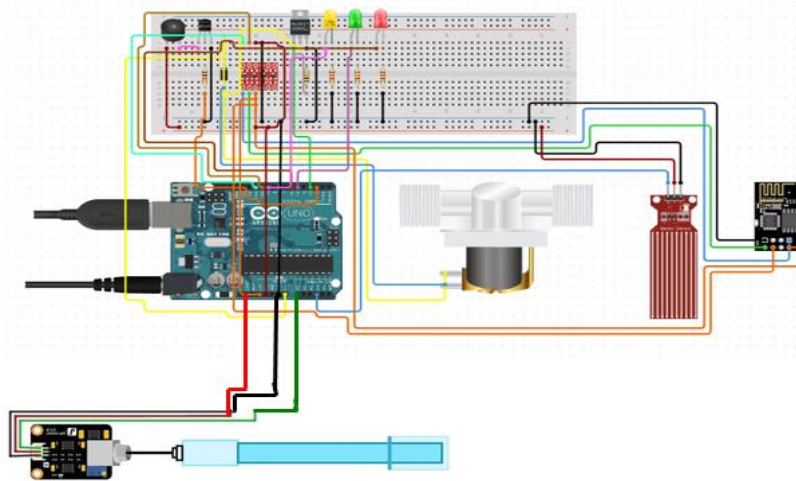
8. **COMPONENETS**

HARDWARE REQUIRED

Arduino UNO:

Arduino is an open-source electronics platform based on easy-to-use hardware and software.

Pin Description

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 – 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.

Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Arduino Uno Technical Specifications

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V/
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Other Arduino Boards:

Arduino Nano, Arduino Pro Mini, Arduino Mega, Arduino Due, Arduino Leonardo.

Overview:

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller.

Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

How to use Arduino Board:

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming.

Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

•   Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.

•   External Interrupt Pins 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.

•   PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using analogWrite() function.

•   SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.

•   In-built LED Pin 13: This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

•   Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

•   AREF: Used to provide reference voltage for analog inputs with analogReference() function.

•   Reset Pin: Making this pin LOW, resets the microcontroller.

Communication

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx).

An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required.

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

Arduino Uno to ATmega328 Pin Mapping:

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two


PH SENSOR

A pH sensor is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH. The pH sensor measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH sensor is sometimes referred to as a "potentiometric pH sensor". The difference in electrical potential relates to the acidity or pH of the solution. The pH me is used in many applications ranging from laboratory experimentation to quality control. This pH-Sensor. PAA-IOA (Poly Acrylic Acid co – Iso Octyl Acrylate) is the dielectric material over the in-plane interdigitated gold electrodes where PAA IOA acts as an H+ ion sensing layer. The changes in the capacitance of the sensor when the sensor is dipped into different pH solutions will be quantized accordingly. The dipping setup is built in such a way that the electrodes (containing the polymer layer) can be easily dipped into different pH liquids and to eliminate any contact between the polymer and set-up (e.g. pressure effects on the sensor). From the setup it is visible that the gold electrodes are not subjected to any external force as in the case of the setup used previously. Three phases of experiments have been used in this project to get a clear view on the working principle of the polymer. The effect of pH is only considered in this project, as we already have the evidences for the salt sensitiveness of PAA IOA from the work done in the past. The influence of various pH on polymer is observed as capacitance measurements. Response time is more than 5 minutes for PAA IOA. ΔC decreases with frequency and frequency choice depends on application/electronics. The degree of other ions influence is not clear but they have a minor influence in the resistance.

The main objective of this project is to develop a capacitive pH-Sensor that requires very low power consumption and low packaging space. These characteristics offer the sensor some advantages in remote applications. The basic idea to construct a capacitive pH sensor has been developed by Imego within the Intellisense RFID project (Nordic program). The layout and working principles of the sensor chip was designed in such a way that it is the same for several sensors (e.g. Humidity, pH, etc). Only the sensing layers are selected different for different sensors according to their usage for detection. Capacitive pH sensor is a device which is used to indicate the H+ ion concentration of any aqueous liquid in terms of capacitance. It is hard to calculate the H+ ion concentration and the pH at the same time, so quantization of H+ ion concentration in terms of the capacitance is done by constructing the calibration curves. This curve consists of the capacitance ranges whose pH is already known. Using this curve one can determine the concentration of the H+ ion concentration in various unknown solutions available without calculating the pH of the solution. The most common pH sensing device used in these days is the Standard pH Meter. Its functional mechanism is described in the section APPENDIX-1. Capacitive sensing is becoming very popular due to their low power consumption requirements and less packaging space. The special swelling and shrinking properties of the polymer PAA IOA which is a pH sensitive polymer has been used in the resonance frequency measurements, and conductimetric measurements. We have used the pH sensitive polymer PAA IOA on a capacitor consisting of interdigitated gold electrodes on a glass substrate to develop the capacitive pH sensor. The kinetics about swelling & shrinking of polymers and the hydro gels have been discussed

LED
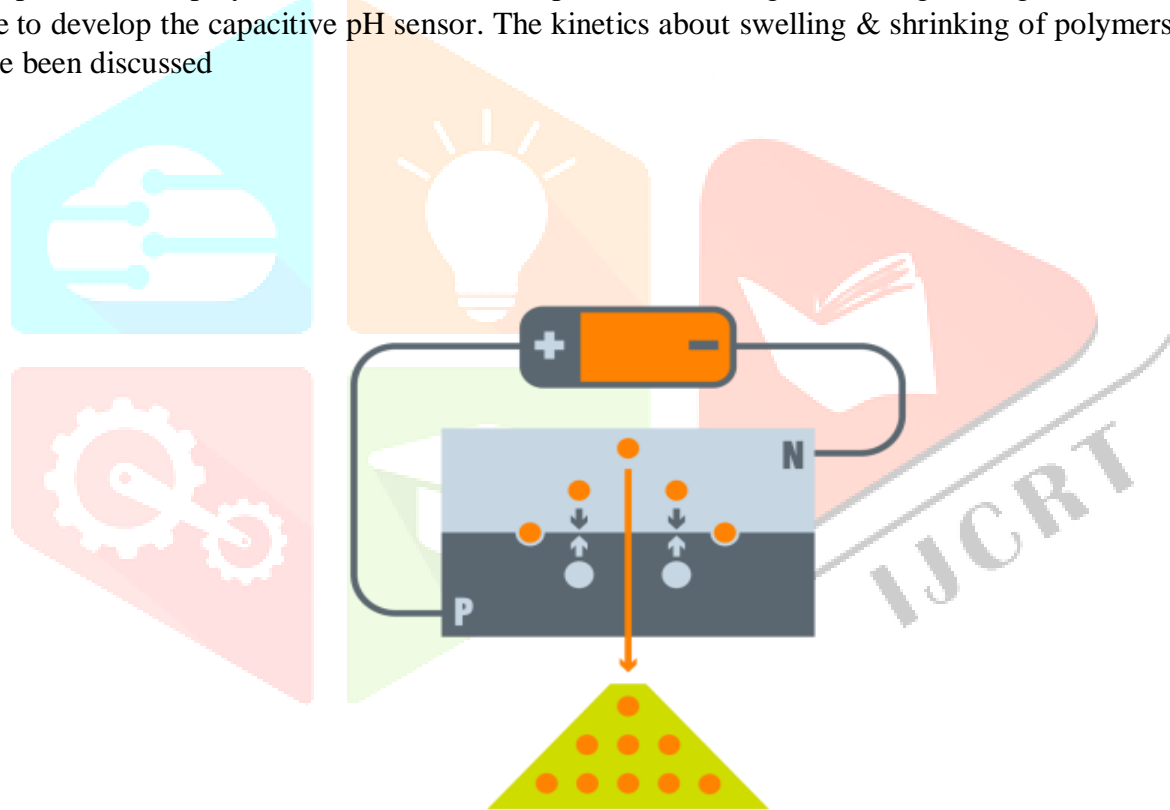
A Light Emitting Diode (LED) is a semiconductor device, which can emit light when an electric current passes through it. To do this, holes from p-type semiconductors recombine with electrons from n-type semiconductors to produce light. The wavelength of the light emitted depends on the bandgap of the semiconductor material. Harder materials with stronger molecular bonds generally have wider bandgaps. Aluminum Nitride semiconductors are known as ultra-wide bandgap semiconductors.

RED LIGHT-EMITTING DIODES

Red LEDs have the deepest tissue penetration of the visible wavelengths and are therefore used to target dermal structures, such as adnexa and fibroblasts.13 Red LEDs have been studied for a wide variety of uses, including wound healing, photodamage, the treatment of NMSCs, precancers, warts, and the prevention of oral mucositis in cancer patients.

A split-face study of red LED (633nm) in patients who had undergone blepharoplasty and periocular resurfacing demonstrated a statistically significant improvement of edema, erythema, bruising, and pain on the treated side of the face.14 Red LED (633nm) following erbium-doped yttrium aluminum garnet (Er:YAG) ablation of palmoplantar verrucae has been shown to speed recovery.15 A retrospective blinded study by Sakamoto et al16 found aminolevulinic acid (ALA) or methylester aminolevulinic acid (MAL) combined with red LED to statistically improve scar appearance after two or more treatments. In 2011, a prospective, split-face, double-blind, randomized, controlled trial by Sanclemente et al17 found that MAL combined with red LED demonstrated superior efficacy in treatment of global facial photodamage compared with placebo and red LED based on Dover's modified global photodamage score. The treatment was well-tolerated and resulted in high patient satisfaction in 80.4 percent of subjects.17 A similar prospective randomized trial of MAL-PDT with red light also found global clinical improvement in 10 of 14 patients and histologically found increased collagen fibers and decreased elastic fibers.18

Red LED light appears to be a promising treatment option for premalignant and malignant lesions. Successful treatment of NMSC with red LED was demonstrated by Calzavara-Pinton et al19 who used two MAL-PDT sessions to treat 112 biopsy-proven Bowen's disease (BD) lesions. The complete response rates were 73.2 percent at three months and 53.6 percent at 24 months post-treatment. They found that the best clinical response was in well-differentiated (Broders' scores I and II) BD lesions and worst in nodular, invasive, and/or poorly differentiated (Broders' scores III and IV) BD lesions.19 NMSC with red LED PDT was demonstrated by Wong et al20 who used a red (630nm) custom-made LED array in conjunction with 2% ALA to treat Bowen's disease of the digit. The treatment was delivered at 240J/cm2 in two 50-minute sessions. Complete clinical clearance occurred in 3 out of 4 patients, all of which healed without scarring. Histologic clearance was confirmed in one of these patients.20 Lopez et al21 demonstrated effective treatment of extensive Bowen's disease using red LED PDT preceded by application of MAL cream. Eighteen patients were treated and 90 percent of their lesions showed a complete clinical response after 12 weeks with good or excellent cosmetic outcomes in 94 percent of patients at a 12-month follow-up.21 Indeed, a 2011 review article of three databases found that MAL combined with LED had the highest response rates of 95 percent compared with 82 percent with ALA-PDT.22 In the United Kingdom, Baas et al23 have shown promising results in basal cell carcinoma (BCC) treatment after use of a second-generation intravenous photosensitizer, meta-tetrahydroxyphenylchlorin (mTHPC), in conjunction with a red LED (652 nm).23

Additional studies have evaluated the effectiveness of red LED PDT in the treatment of AKs. Wiegell et al24 have shown red LED to be more effective than continuous, ultra-low-intensity artificial daylight in AK therapy.24 In two other studies, patients underwent two MAL-PDT treatments one week apart. The first study found a complete response rate of 59.2 percent in the treatment group versus 14.9 percent in the placebo group.25 The second study found 68.4 percent a complete response rate for the treatment group versus 6.9 percent in the placebo group.26 A recent study of 50 patients, however, showed no difference between the effectiveness of MAL-PDT and pulsed dye laser (PDL) on AKs, although PDL appears to be easier to use and less painful.27

A retrospective analysis of off-label PDT with MAL in Italy suggested a therapeutic role for treatment of granulomatous dermal disorders and follicular inflammatory diseases, such as acne vulgaris, granuloma annulare, and necrobiosis lipoidica.28 Despite these suggestions, a 2011 multicenter study by Berking et al29 did not recommend MAL-PDT as first-line therapy of necrobiois lipoidica due to its response rate of 39 percent.

Red LED (660nm) has been shown to prevent ultraviolet (UV)-induced erythema. In a study by Barolet et al,30 subjects experienced an increase in minimal erythema dose (MED) corresponding to approximately a sun protection factor (SPF) of 15 after a series of 5 to 10 red LED treatments.30 Whether LED exposure provides a true reduction in UV damage or just a reduction in erythema was not assessed.

Lastly, Whelen et al31 found a beneficial effect of daily red LED (670nm) treatments on the incidence and severity of oral mucositis (OM) in pediatric patients undergoing myeloablative therapy.31 Similarly, Corti et al32 reported that red LED treatment is safe and capable of reducing the duration of chemotherapy-induced OM in adults.

YELLOW LIGHT-EMITTING DIODES

Yellow LEDs penetrate the skin between 0.5 and 2mm. Much of yellow LED application has been focused on photoaging and as an adjuvant therapy to laser treatment. Recently, it has also been shown to decrease the intensity and duration of erythema after fractional laser skin resurfacing.33

In a large study, Weiss et al6 reported their clinical experience with photomodulated yellow LED (590nm) in a total of 900 patients with photoaged skin. Patients received LED treatment alone or in combination with intense pulsed light (IPL), PDL, potassium-titanyl-phosphate (KTP) laser, or infrared lasers. Patients who received LED alone self-reported a softening of skin and a reduction in fine lines. Post-thermal/nonablative-treated patients self-reported a reduction in post-treatment erythema of the primary treatment. In two studies by Weiss et al, a yellow LED (590nm) was used on 93 and 90 patients, respectively, with mild-to-moderate photoaging. In the first study, an independent observer determined that photoaging was decreased by one Fitzpatrick wrinkle class in 90 percent of subjects.8 In the second study, optical profilometry showed a 10-percent improvement by surface topographical measurements, and histology showed increased collagen in 100 percent of post-treatment subjects.34

Despite these promising results, a study by Boulos et al35 suggests that these results are complicated by placebo effect or observer bias. They conducted a study designed to replicate the results of Weiss. They found similar patient perceptions, but were unable to replicate the objective data using a panel of 30 blinded experts, including ophthalmologists and oculoplastic surgeons.35 The authors' experience, which will be discussed later, is consistent with Boulos' results.

Khoury and Goldman36 performed a split-face study in which subjects received two photomodulated yellow LED treatments after IPL. A blinded observer determined an approximate 10-percent reduction in erythema on the treated side. Four patients also reported decreased pain.36 Similarly, photomodulated yellow LED has also been shown to speed healing and reduce erythema after fractionated laser therapy.33

DeLand et al37 investigated the value of yellow LED photomodulation therapy (590nm) in regards to preventing or improving the skin's tolerance to radiation dermatitis. Patients were treated with yellow LED after a series of intensity-modulated radiation treatments. The majority of patients experienced a minimal skin reaction to radiation (grade 0 or 1 radiation dermatitis) and only 5.3 percent of patients had

to interrupt radiation therapy due to a skin reaction as compared to 68 percent of controls. This suggests that LED treatments reduced the incidence and degree of radiation-induced skin reactions as well as the incidence of treatment interruption because of skin reaction. However, in a similarly sized study that evaluated yellow LED photomodulation in patients with radiation dermatitis, the authors found statistically insignificant differences between the treatment groups' and the control groups' graded reactions post-radiation therapy. The percentage of LED-treated patients with grade 0, grade 1, grade 2, and grade 3 reactions were 0, 33, 67, and 0 percent, respectively; the non-treated groups were 7, 27, 60, and 7 percent, respectively. The authors concluded that it did not reduce any incidence of radiation-induced skin reactions.

APPLICATION

The rate and outcome of chemical reactions taking place in water often depends on the acidity of the water, and it is therefore useful to know the acidity of the water, typically measured by means of a pH meter. Knowledge of pH is useful or critical in many situations, including chemical laboratory analyses. pH meters are used for soil measurements in agriculture, water quality for municipal water supplies, swimming pools, environmental remediation; brewing of wine or beer; manufacturing, healthcare and clinical applications such as blood chemistry; and many other applications.

Advances in the instrumentation and in detection have expanded the number of applications in which pH measurements can be conducted. The devices have been miniaturized, enabling direct measurement of pH inside of living cells. In addition to measuring the pH of liquids, specially designed electrodes are available to measure the pH of semi-solid substances, such as foods. These have tips suitable for piercing semi-solids, have electrode materials compatible with ingredients in food, and are resistant to clogging.

TYPES OF pH

Soil pH meter

In general there are three major categories of pH meters. Benchtop pH meters are often used in laboratories and are used to measure samples which are brought to the pH meter for analysis. Portable, or field pH meters, are handheld pH meters that are used to take the pH of a sample in a field or production site. In-line or in situ pH meters, also called pH analyzers, are used to measure pH continuously in a process, and can stand-alone, or be connected to a higher level information system for process control.

pH meters range from simple and inexpensive pen-like devices to complex and expensive laboratory instruments with computer interfaces and several inputs for indicator and temperature measurements to be entered to adjust for the variation in pH caused by temperature. The output can be digital or analog, and the devices can be battery-powered or rely on line power. Some versions use telemetry to connect the electrodes to the voltmeter display device.

Specialty meters and probes are available for use in special applications, such as harsh environments and biological microenvironments. There are also holographic pH sensors, which allow pH measurement colorimetrically, making use of the variety of pH indicators that are available. Additionally, there are commercially available pH meters based on solid state electrodes, rather than conventional glass electrodes.

LED

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.[5] White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device

Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared (IR) light.[7] Infrared LEDs are used in remote-control circuits, such as those used with a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red. Early LEDs were often used as indicator lamps, replacing small incandescent bulbs, and in seven-segment displays. Recent developments have produced LEDs available in visible, ultraviolet (UV), and infrared wavelengths, with high, low, or intermediate light output, for instance white LEDs suitable for room and outdoor area lighting. LEDs have also given rise to new types of displays and sensors, while their high switching rates are useful in advanced communications technology with applications as diverse as aviation lighting, fairy lights, automotive headlamps, advertising, general lighting, traffic signals, camera flashes, lighted wallpaper, horticultural grow lights, and medical devices.[8]
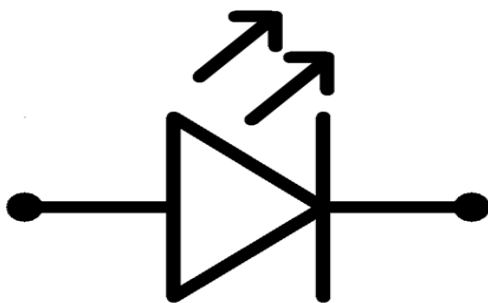
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LEDs have many advantages over incandescent light sources, including lower power consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. In exchange for these generally favorable attributes, disadvantages of LEDs include electrical limitations to low voltage and generally to DC (not AC) power, inability to provide steady illumination from a pulsing DC or an AC electrical supply source, and lesser maximum operating temperature and storage temperature. In contrast to LEDs, incandescent lamps can be made to intrinsically run at virtually any supply voltage, can utilize either AC or DC current interchangeably, and will provide steady illumination when powered by AC or pulsing DC even at a frequency as low as 50 Hz. LEDs usually need electronic support components to function, while an incandescent bulb can and usually does operate directly from an unregulated DC or AC power source

SOLENOID VALVE

A **solenoid valve** is an electromechanically operated valve.Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate a flow or use a three or more port design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold.

Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high-reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

9. PRINCIPLE OF OPERATION

Potentiometric pH meters measure the voltage between two electrodes and display the result converted into the corresponding pH value. They comprise a simple electronic amplifier and a pair of electrodes, or alternatively a combination electrode, and some form of display calibrated in pH units. It usually has a glass electrode and a reference electrode, or a combination electrode. The electrodes, or probes, are inserted into the solution to be tested.

The design of the electrodes is the key part: These are rod-like structures usually made of glass, with a bulb containing the sensor at the bottom. The glass electrode for measuring the pH has a glass bulb specifically

designed to be selective to hydrogen-ion concentration. On immersion in the solution to be tested, hydrogen ions in the test solution exchange for other positively charged ions on the glass bulb, creating an electrochemical potential across the bulb. The electronic amplifier detects the difference in electrical potential between the two electrodes generated in the measurement and converts the potential difference to pH units. The magnitude of the electrochemical potential across the glass bulb is linearly related to the pH according to the Nernst equation.

The reference electrode is insensitive to the pH of the solution, being composed of a metallic conductor, which connects to the display. This conductor is immersed in an electrolyte solution, typically potassium chloride, which comes into contact with the test solution through a porous ceramic membrane. The display consists of a voltmeter, which displays voltage in units of pH.

On immersion of the glass electrode and the reference electrode in the test solution, an electrical circuit is completed, in which there is a potential difference created and detected by the voltmeter. The circuit can be thought of as going from the conductive element of the reference electrode to the surrounding potassium-chloride solution, through the ceramic membrane to the test solution, the hydrogen-ion-selective glass of the glass electrode, to the solution inside the glass electrode, to the silver of the glass electrode, and finally the voltmeter of the display device. The voltage varies from test solution to test solution depending on the potential difference created by the difference in hydrogen-ion concentrations on each side of the glass membrane between the test solution and the solution inside the glass electrode. All other potential differences in the circuit do not vary with pH and are corrected for by means of the calibration.

For simplicity, many pH meters use a combination probe, constructed with the glass electrode and the reference electrode contained within a single probe. A detailed description of combination electrodes is given in the article on glass electrodes.

The pH meter is calibrated with solutions of known pH, typically before each use, to ensure accuracy of measurement. To measure the pH of a solution, the electrodes are used as probes, which are dipped into the test solutions and held there sufficiently long for the hydrogen ions in the test solution to equilibrate with the ions on the surface of the bulb on the glass electrode. This equilibration provides a stable pH measurement.

10. OPERATION

There are many valve design variations. Ordinary valves can have many ports and fluid paths. A 2-way valve, for example, has 2 ports; if the valve is **open**, then the two ports are connected and fluid may flow between the ports; if the valve is **closed**, then ports are isolated. If the valve is open when the solenoid is not energized, then the valve is termed **normally open** (N.O.). Similarly, if the valve is closed when the solenoid is not energized, then the valve is termed **normally closed** (N.C.). There are also 3-way and more complicated designs. A 3-way valve has 3 ports; it connects one port to either of the two other ports (typically a supply port and an exhaust port).

The solenoid valve (small black box at the top of the photo) with input air line (small green tube) used to actuate a larger rack and pinion actuator (gray box) which controls the water pipe valve.

Solenoid valves are also characterized by how they operate. A small solenoid can generate a limited force. An approximate relationship between the required solenoid force F_s, the fluid pressure P, and the orifice area A for a direct acting solenoid valve is:

Where d is the orifice diameter. A typical solenoid force might be 15 N (3.4 lb$_f$). An application might be a low pressure (e.g., 10 psi (69 kPa)) gas with a small orifice diameter (e.g., $\frac{3}{8}$ in (9.5 mm) for an orifice area of 0.11 in^2 (7.1×10^{-5} m^2) and approximate force of 1.1 lbf (4.9 N)).

If the force required is low enough, the solenoid is able to directly actuate the main valve. These are simply called **Direct-Acting** solenoid valves. When electricity is supplied, electrical energy is converted to mechanical energy, physically moving a barrier to either obstruct flow (if it is N.O.) or allow flow (if it is N.C.). A spring is often used to return the valve to its resting position once power is shut off. Direct-acting valves are useful for their simplicity, although they do require a large amount of power relative to other types of solenoid valves.

If fluid pressures are high and orifice diameter is large, a solenoid may not generate enough force on its own to actuate the valve. To solve this, a **Pilot-Operated** solenoid valve design can be used. Such a design uses the pressurized fluid itself to apply the forces required to actuate the valve, with the solenoid as a "pilot" directing the fluid (see subsection below). These valves are used in dishwashers, irrigation systems, and other applications where large pressures and/or volumes are desired. Pilot-operated solenoids tend to consume less energy than direct-action, although they will not work at all without sufficient fluid pressure and are more susceptible to getting clogged if the fluid has solid impurities.

A direct-acting solenoid valve typically operates in 5 to 10 milliseconds. Pilot-operated valves are slightly slower; depending on their size, typical values range from 15 to 150 milliseconds.
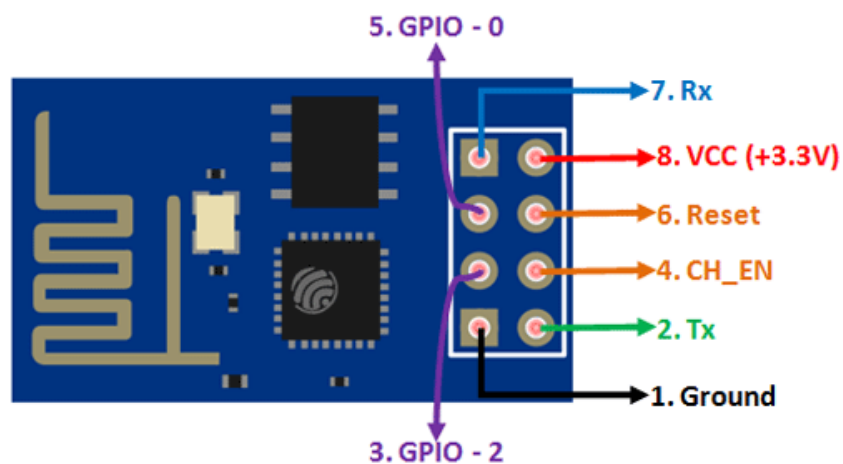
Power consumption and supply requirements of the solenoid vary with application, being primarily determined by fluid pressure and orifice diameter. For example, a popular 3/4" 150 psi sprinkler valve, intended for 24 VAC (50 – 60 Hz) residential systems, has a momentary inrush of 7.2 VA, and a holding power requirement of 4.6 VA. Comparatively, an industrial 1/2" 10000 psi valve, intended for 12, 24, or 120 VAC systems in high pressure fluid and cryogenic applications, has an inrush of 300 VA and a holding power of 22 VA. Neither valve lists a minimum pressure required to remain closed in the un-powered state.

ESP8266 Module:

The **ESP8266** is a very user friendly and low cost device to provide internet connectivity to your projects. The module can work both as a Access point (can create hotspot) and as a station (can connect to Wi-Fi), hence it can easily fetch data and upload it to the internet making Internet of Things as easy as possible. It can also fetch data from internet using API's hence your project could access any information that is available in the internet, thus making it smarter. Another exciting feature of this module is that it can be programmed using the Arduino IDE which makes it a lot more user friendly. However this version of the module has only 2 GPIO pins (you can hack it to use upto 4) so you have to use it along with another microcontroller like Arduino, else you can look onto the more standalone ESP-12 **or** ESP-32 versions.

There are so many methods and IDEs available to with ESP modules, but the most commonly used on is the Arduino IDE. So let us discuss only about that further below.

The ESP8266 module works with 3.3V only, anything more than 3.7V would kill the module hence be cautions with your circuits. The best way to program an ESP-01 is by using the FTDI board that supports 3.3V programming. If you don't have one it is recommended to buy one or for time being you can also use an Arduino board. One commonly problem that every one faces with ESP-01 is the powering up problem. The module is a bit power hungry while programming and hence you can power it with a 3.3V pin on Arduino or just use a potential divider. So it is important to make a small voltage regulator for 3.31v that could supply a minimum of 500mA. One recommended regulator is the LM317 which could handle the job easily.

ESP8266 Pin Configuration

Pin Number	Pin Name	Alternate Name	Normally used for	Alternate purpose
1	**Ground**	-	Connected to the ground of the circuit	-
2	**TX**	GPIO – 1	Connected to Rx pin of programmer/uC to upload program	Can act as a General purpose Input/output pin when not used as TX
3	**GPIO-2**	-	General purpose Input/output pin	-
4	**CH_EN**	-	Chip Enable – Active high	-
5	**GPIO – 0**	Flash	General purpose Input/output pin	Takes module into serial programming when held low during start up
6	**Reset**	-	Resets the module	-
7	**RX**	GPIO - 3	General purpose Input/output pin	Can act as a General purpose Input/output pin when not used as RX
8	**Vcc**	-	Connect to +3.3V only	

ESP8266-01 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 combined
- Supports Deep sleep (<10uA)
- Supports serial communication hence compatible with many development platform like Arduino
- Can be programmed using Arduino IDE or AT-commands or Lua Script

ESP8266-01

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ESP8266 Module

There are so many methods and IDEs available to with ESP modules, but the most commonly used on is the Arduino IDE. So let us discuss only about that further below.

The **ESP8266 module** works with 3.3V only, anything more than 3.7V would kill the module hence be cautions with your circuits. The best way to program an **ESP-01** is by using the FTDI board that supports 3.3V programming. If you don't have one it is recommended to buy one or for time being you can also use an Arduino board. One commonly problem that every one faces with ESP-01 is the powering up problem. The module is a bit power hungry while programming and hence you can power it with a 3.3V pin on Arduino or just use a potential divider. So it is important to make a small voltage regulator for 3.31v that could supply a minimum of 500mA. One recommended regulator is the LM317 which could handle the job easily. A **simplified circuit diagram for using the ESP8266-01 module** is given below
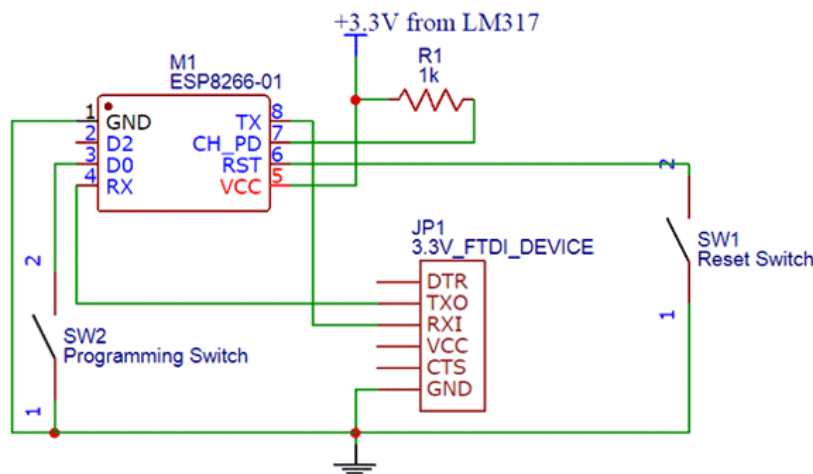
The switch SW2 (Programming Switch) should be held pressed to hold the GPIO-0 pin to ground. This way we can enter into the programming mode and upload the code. Once the code is released the switch can be released.

Applications

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

2D – Model
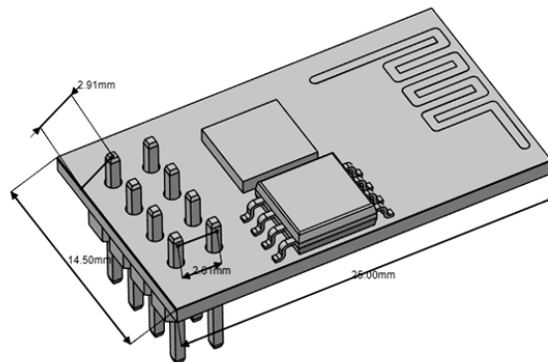
IOT

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.A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.
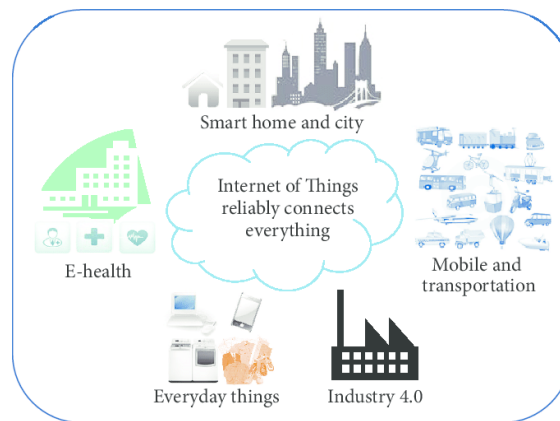
IoT works:

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.

The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

IoT can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

IoT is important:

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.

IoT enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions.

As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive

WATER LEVEL SENSOR

water level indicator is a system that relays information back to a control panel to indicate whether a body of water has a high or low water level. Some water level indicators use a combination of probe sensors or float switches to sense water levels. "The Water Level Indicator employs a simple mechanism to detect and indicate the water level in an overhead tank or any other water container.Basic level sensors can be used to identify the point at which a liquid falls below a minimum or rises above a maximum level. ... Some types use a magnetic float,

which rise and fall with the liquid in the container. Once the liquid, and by extension, the magnet, reach a certain level, a reed magnetic switch is activated.
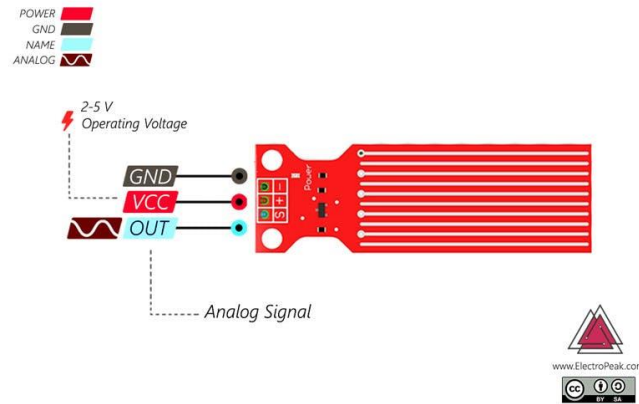
Purpose of Water Level Indicator

The purpose of a water level indicator is to gauge and manage water levels in a water tank. The control panel can also be programmed to automatically turn on a water pump once levels get too low and refill the water back to the adequate level.

| Status: Dry | Status: Partially submerged | Status: Fully submerged |
| Test Reading: ~0 | Test Reading: ~420 | Test Reading: ~520 |
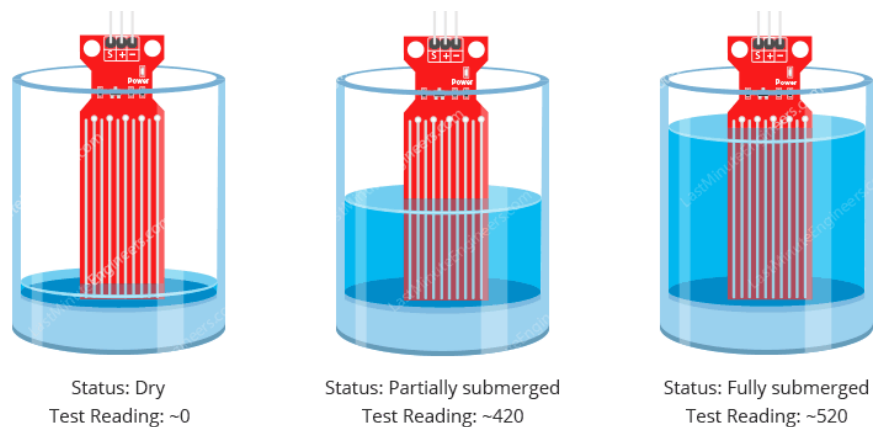
Water Level Indicator Sensor

A water level indicator sensor, also known as a probe sensor, is what tells the control panel that corrective action is needed. A combination of high and low sensors are used to tell the control panel when water levels are too high or too low. The control panel will then automatically turn the pump on or off depending on the corrective action needed.

The working principle of a water level indicator is actually quite simple. Water level indicators work by **using sensor probes** to indicate water levels in a storage tank. These probes send information back to the control panel to trigger an alarm or indicator. As mentioned above, the control panel can be programmed to automatically turn on your pump to refill the water again.

1. The water level is full – Nothing happens
2. Water level drops to the reference probe – Alarm is triggered
3. Fill start is triggered automatically turning on the water to fill the tank
4. Once the water is full, fill stop is triggered and the system automatically stops the pump
5. The system resets and waits for water levels to drop again

Depending on the manufacturer, some water level indicators will have 3 probes while others might have as much as 7. 3 Probe water level indicators use a reference probe, fill start probe and fill stop probe to manage water levels. These probes work together to manage the water levels in a tank. The reference is the lowest point you want the water level to go to before the water starts filling again. The fill start probe is usually the same length as the reference probe to ensure the pump starts filling the water once it has reached its lowest point.

5 probe water level indicators use more probes to also include alarms. They have the same reference probe but also come with a low alarm & high alarm probe that will tell you if water levels become too low or too high.

11.SOFTWARE REQUIRED

ARDUINO IDE

Arduino IDE IDE stands for "Integrated Development Environment" :it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go. In this article, we will introduce the Software, how we can install it, and make it ready for developing applications using Arduino modules.

**Arduino IDE Definition :**

1.   Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.

2.   It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.

3.   It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

4.   A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.

5.   Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

6.   The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.

7.   The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.

8.   This environment supports both C and C++ languages.

How to get Arduino IDE :

we can download the Software from Arduino main website. As I said earlier, the software is available for common operating systems like Linux, Windows, and MACos,we select to download the correct software version that is easily compatible with our operating system.

Details on IDE: The IDE environment is mainly distributed into three sections

- Menu bar
- Text editor
- Output pane
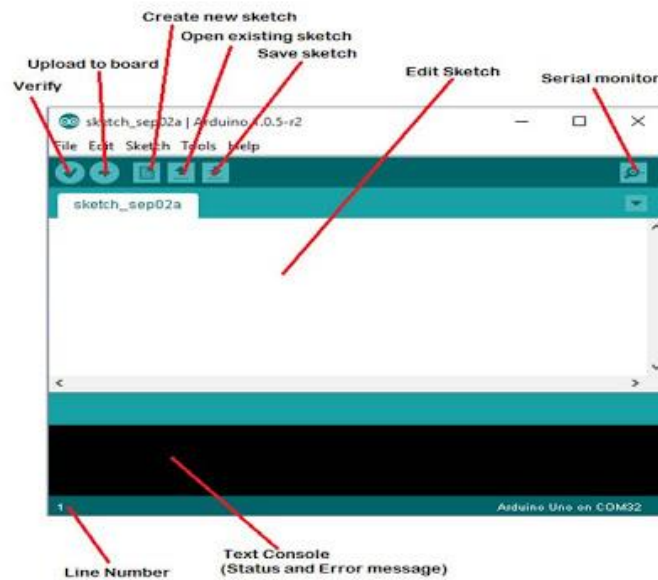
The bar appearing on the top is called Menu Bar that comes with five different options as follow :

- File – You can open a new window for writing the code or open an existing one. Following table shows the number of further subdivisions the file option is categorized into.
- Edit – Used for copying and pasting the code with further modification for font Sketch – For compiling and programming
- Tools – Mainly used for testing projects. The Programmer section in this panel is used for burning a bootloader to the new microcontroller.
- Help – In case you are feeling skeptical about software, complete help is available from getting started to troubleshooting. The Six Buttons appearing under the Menu tab are connected with the running program as follow.

  The Six Buttons appearing under the Menu tab are connected with the running program as follow. A separate pop up window appers as an independent terminal and plays a vital role for sending and receiving the Serial Data. You can also go to the Tools panel and select Serial Monitor pressing Ctrl+Shift+M all at once will open the Serial Monitor.
- The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating. Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor.

Porgram Structure :

- Declarations
- Variables :

  Whenever you're using Arduino, you need to declare global variables and instances to be used later on. In a nutshell, a variable allows you to name and store a value to be used in the future. For example, you would store data acquired from a sensor in order to use it later. To declare a variable you simply define its type, name and initial value. It's worth mentioning that declaring global variables isn't an absolute necessity. However, it's advisable that you declare your variables to make it easy to utilize your values further down the line.

- Instances

    In software programming, a class is a collection of functions and variables that are kept together in one place. Each class has a special function known as a constructor, which is used to create an instance of the class. In order to use the functions of the class, we need to declare an instance for it.

- Setup()

    Every Arduino sketch must have a setup function. This function defines the initial state of the Arduino upon boot and runs only once. Here we'll define the following:

    1. Pin functionality using the pinMode function

    2. Initial state of pins

    3. Initialize classes

    4. Initialize variables

    5. Code logic Loop() The loop function is also a must for every Arduino sketch and executes once setup() is complete. It is the main function and as its name hints, it runs in a loop over and over again. The loop describes the main logic of your circuit

Serial Ploter Arduino :

    serial plotter is another component of the Arduino IDE, which allows you to generate a real-time graph of your serial data. The serial plotter makes it much easier for you to analyze your data through a visual display. You're able to create graphs, negative value graphs, and conduct waveform analysis

12.SYSTEM TESTING AND IMPLEMENDATION

- **Component testing:** Each component of the system should be tested to ensure its proper functioning. This includes testing the water level sensors, pH sensors, solenoid valve, LEDs, and buzzers.
- **Integration testing:** Once each component has been tested, they should be integrated into the system to ensure that they work together correctly. This includes testing the communication between the Arduino microcontroller, ESP 8266 module, and cloud-based platform.
- **Performance testing:** The system should be tested to ensure that it performs correctly under different scenarios, such as low internet connectivity, high traffic, and various water levels.
- **Field testing:** The system should be tested in a real-world scenario to ensure its reliability and accuracy in monitoring water levels and water quality.
- **Implementation:** Once the system has been thoroughly tested and found to be reliable, it can be implemented in the target dam. The system should be installed according to the manufacturer's instructions, and personnel should be trained to use the system effectively.
- **Maintenance:** Regular maintenance of the system is essential to ensure its proper functioning. This includes regular checks of the sensors and communication devices, updating the software and firmware, and replacing any faulty components.

    Thorough testing and proper implementation are crucial to ensure the reliability and accuracy of the proposed IoT-based dam water level monitoring and water quality management system. Regular maintenance is also essential to ensure its long-term effectiveness in managing water resources.

13. CONCLUTION

In conclusion, the proposed IoT-based dam water level monitoring and water quality management system offers significant advantages over traditional systems. It provides real-time monitoring of water levels and water quality, enabling quick and efficient decision-making to prevent water shortages, floods, and environmental damage. The system is cost-effective, easy to install and maintain, and scalable, making it a versatile solution for water management in different regions. Its features, such as remote control of the solenoid valve and alerts for water quality issues, enhance the system's efficiency and effectiveness in managing dams. However, thorough testing and proper implementation are crucial to ensure the reliability and accuracy of the system. Regular maintenance is also essential to ensure its long-term effectiveness in managing water resources. The proposed system presents a practical and innovative solution to the challenges of water resource management, and its implementation has the potential to positively impact the environment and the communities that rely on the dams.

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11. FEATURES

- Real-time monitoring: The system provides real-time monitoring of water levels and water quality, enabling quick and efficient decision-making.
- Remote control: The solenoid valve can be controlled remotely using the system, making it easier to manage water resources.

- Alert system: The system can send alerts for water quality issues, allowing for timely action to prevent contamination.
- Cost-effective: The system is cost-effective, making it accessible to different regions.
- Easy installation and maintenance: The system is easy to install and maintain, reducing the overall cost and effort involved.
- Scalable: The system is scalable and can be adapted to different sizes of dams and water bodies.
- Efficient water management: The system can improve water management, preventing water shortages, floods, and environmental damage.