SMART WATER SURVEILLANCE SYSTEM

A Project report submitted in partial fulfillment of requirements
for the award of the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES (UGC AUTONOMOUS)

(*Permanently Affiliated to AU, Approved by AICTE and Accredited by NBA & NAAC with 'A' Grade*)

Sangivalasa, Bheemili mandal, visakhapatnam dist.(A.P)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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CERTIFICATE

This is to certify that the project report entitled **"SMART WATER SURVEILLANCE SYSTEM"** submitted by **T. Vandana (319126512183), Y. Bhaskar(320126512l20) , P. Chandra Lekhya (319126512139), V. John Sandeep Kumar (319126512187)** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Engineering in Electronics and Communication Engineering** of Andhra University, Visakhapatnam is a bonafied work carried out under my guidance and supervision.

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ABSTRACT

IoT-based intelligent water surveillance systems primarily measure the quantity of water consumed, PH level, temperature, turbidity, TDS, and conductivity of the water supplied to households. We can use this prototype for the village panchayat water tank to monitor the quantity and quality of the water at a low cost. A water meter, and various sensors are interfaced with Node MCU (Micro controller unit) using a simple analog multiplexer in the proposed systems. The data received from multiple sensors will transmit to a user-friendly mobile application through internet. The mobile app also provides real- time information on the status of action taken by the administrators; whenever this water is not portable, it will notify with an alert. The prototype can be fixed on the water tanks of villages to monitor the water quality, and instantly, the status will reach to relevant panchayat administrator to take the necessary action immediately.

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CHAPTER -1

INTERNET OF THINGS

1.1 Introduction

Fig 1.1 Internet of Things

Source: https://www.organworks.com/images/Blog/IoT/IoTimage.jpg

The term "Internet of Things" (IoT) refers to the concept of connecting machines, objects, and devices to the internet so they can trade and collect data. Simple wearables and sensors to sophisticated industrial machinery and automobiles can all be considered IoT devices. These devices can collect data that can be utilised for a variety of things, including process automation, monitoring, and control. By enabling the development of smarter, more effective, and more sustainable systems and surroundings, the IoT has the potential to fundamentally alter the way we live and work. Yet it also brings up challenges that need to be addressed in terms of ethics, security, and privacy.

When a device or object is connected to the internet, it becomes part of a larger networked environment, where it can communicate with other devices and systems, share and receive data, and perform various functions and tasks. This connectivity is what makes the device "smart" and enables it to perform a range of functions and tasks that were not possible before. By sending and receiving information, the device can collect and analyse data, monitor its own operations, communicate with other devices, and provide useful insights and information to users. The Internet of Things (IoT) ecosystem offers a vast array of services and capabilities that can be leveraged by smart devices, making them more useful and effective in a variety of contexts.

Access to information is crucial for intelligence. And with advancements in technology, we now have access to vast amounts of information through the internet, cloud storage, and other sources. As you mentioned, we don't necessarily need to store all this information on a single device to be intelligent. Instead, we can connect to remote storage or computing resources to access the information we need.

This concept is the basis for cloud computing, where data and applications are hosted on remote servers and accessed over the internet. Smartphones, for example, can connect to cloud servers to stream music, access online services, and perform complex computations. The three categories of the Internet of Things encompass all internet-connected devices:

1. Collecting and Sending Information

In modern agriculture, the use of sensors and other smart farming technologies has become increasingly popular as it allows farmers to monitor and manage their crops more efficiently and effectively. Soil moisture sensors, for example, can help farmers determine when to irrigate their crops by providing real-time data on the moisture levels in the soil. This data can be used to automate irrigation systems or provide alerts to farmers when the soil moisture levels fall outside of optimal conditions.

Using such data-driven decision-making processes can help farmers optimize their use of water resources, reduce water waste, and avoid over- or under-watering their crops. This can result in better crop yields, improved quality of produce, and reduced costs associated with irrigation systems and water usage. Additionally, smart farming technologies can also help farmers detect and manage pests, monitor weather conditions, and track the growth and development of their crops, allowing for more precise and effective agricultural practices.

2. Receiving and Acting on Information

The Internet of Things (IoT) refers to a network of physical objects that are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet. These devices can range from simple sensors to complex systems such as smart homes, smart cities, and industrial automation.

The potential applications of the IoT are vast and varied, from improving energy efficiency in homes and buildings to optimizing supply chains and improving public safety. As the number of connected devices continues to grow, the IoT is expected to play an increasingly important role in our daily lives.

3.Doing Both: The Goal of an IoT System

Once the data is collected by the sensors, it is transmitted to the cloud or a local data storage facility through a network connection. The network connection may be wired, wireless, or a combination of the two, depending on the application requirements. The data is then processed and analysed by software running on cloud servers, gateways, or even on the devices themselves. Data processing includes sorting and organising data, applying algorithms to the data, and generating insights and predictions. The processed data can then be visualised through a user interface that may be a web application, a mobile app, or a dashboard.

The user interface allows the user to interact with the data and control the devices remotelyThe user interface also allows the user to set rules and alerts based on specific conditions or events, such as receiving a notification when the temperature in a room exceeds a certain level.

A user interface, network connectivity, sensor systems/devices, and data processing make up an IoT system. Together, these components collect, transmit, analyse, and display data to deliver insightful information and enable remote control of devices. We will delve deeper into each of these components in the next chapters and talk about how they work together to form an entire IoT system.

1.2DEFINITION AND EXAMPLE OF IOT

1.2.1 DEFINITION BY ITU-T

"From a broad viewpoint, the Internet of Things can be seen as a vision having ramifications for both technology and society. IoT can be seen as a global infrastructure for the information society from the standpoint of technological standardisation, enabling advanced services by linking things based on interoperable information and communication technologies that are both current and developing. The Internet of Things (IoT) fully utilises objects to provide services to a wide range of applications while keeping the necessary privacy. It does this by utilising identifying data collecting, processing, and communication capabilities.

Fig 1.5.1 Applications of IOT

Source:https://micro.ai/wp-content/uploads/2018/08/iot-1.jpg

1.2.2 ELEMENTS OF IOT

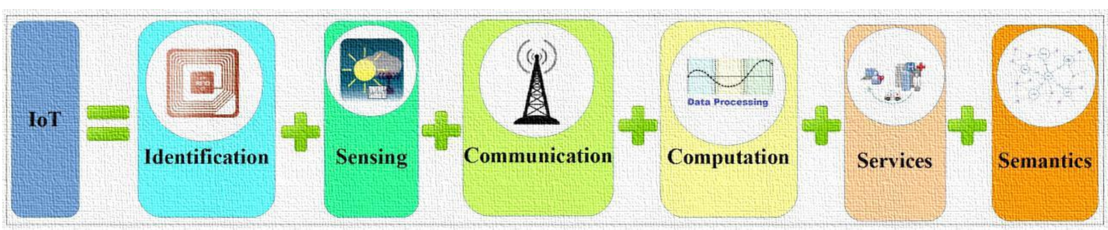


Fig 1.5.2 Elements of IOT

Source:https://images.slideplayer.com/27/9162428/slides/slide_9.jpg

There are six elements in IoT. They are identification, sensing, communication technologies, computation, services and semantic.

A pattern used to specifically identify a single entity (instance identifier) or a group of entities (i.e. type identifier) in a given context is called an identifier.

Ex: Electronic Product Code (EPC)

A tool or sensor used to identify and quantify physical occurrences in the environment is referred to as a sensing element. As they enable data to be gathered from the physical environment and communicated to IoT devices for processing and analysis, these sensors are crucial parts of IoT systems.

Ex: temperature sensors.

Communication elements are the parts that allow devices to talk with one another as well as with the cloud-based services and programmes that govern and control them. These pieces combine hardware and software elements to provide a cohesive ecosystem.

The term "computation" in the context of the Internet of Things (IoT) refers to a device's local processing and analysis of data, independent of centralised computing resources. Since data processing occurs at the network's edge, near the devices that produce the data, this practise is frequently referred to as edge computing.

Services in the context of IoT (Internet of Things) relate to the software, hardware, and platforms that make it possible to manage, track, and analyse IoT data.

1.3 APPLICATIONS OF IOT

There are a lot of applications for lot. We list some application scenarios as follows.

1. **Smart homes:** Automated, energy-efficient, and secure homes can be built using IoT. Remote control and monitoring of smart home appliances like thermostats, lighting controls, and security systems is possible thanks to the Internet of Things.
2. **Industrial automation:** IoT may be used to monitor equipment, automate production operations, and automate industrial processes. IoT sensors provide for real-time

monitoring and analysis of energy use, ambient conditions, and machine performance.

3. **Healthcare:** The Internet of Things (IoT) can be used to improve medical care, track patient health, and cut costs. The use of IoT devices, such as wearables and sensors, to track medicine consumption and monitor vital signs enables remote monitoring and the early identification of health problems.
4. **Transportation:** The Internet of Things (IoT) can be utilised to increase public safety, decrease traffic congestion, and improve transportation efficiency. IoT sensors can be used to track vehicle performance, parking availability, and traffic flow, allowing for real-time analysis and optimization.
5. **Agriculture:** The Internet of Things (IoT) can be used in agriculture to increase agricultural productivity, optimise crop yields, and use less water. IoT sensors can track soil moisture, crop health, and weather, allowing for in-the-moment analysis and decision-making.
6. **Smart cities:** IoT may be utilised to design sustainable, effective, and liveablesmart cities. IoT sensors can be used to track energy use, traffic movement, and air quality, allowing for real-time monitoring and service optimization.

CHAPTER – 2

LITERATURE SURVEY

The proposed monitoring system by Sathish Pasika and Sai Teja Gandla [1] is a useful approach to track water quality in various contexts. By using multiple sensors, the system can measure several water quality characteristics, including turbidity, pH value, water level, wetness of the surrounding environment, and water temperature. The use of an MCU to connect the sensors and a PC for additional processing makes the system efficient and reliable. The authors also suggest expanding the system to include analysis of additional characteristics, such as nitrates, electrical conductivity, dissolved oxygen, and free residual chlorine in the water, as a future direction. This expansion would enable the monitoring system to measure a more comprehensive set of water quality parameters, providing more detailed information about the water quality. Overall, the proposed monitoring system is a promising approach to track water quality. The suggested expansion of the system to include analysis of additional parameters would enhance its capabilities and make it even more useful in monitoring water quality.

The system developed by Alexandar T. Demetillo, Michelle V. Japitana, and Taboada E.B. [2] is aninnovative approach to monitoring water quality in real-time, even in distant lakes, rivers, and otherwater resources. The system's primary components, including a microprocessor, sensors, and awireless communication system, enable the system to measure pH, dissolved oxygen, and watertemperature at pre-programmed intervals. The system's effectiveness was evaluated based on itsability to withstand harsh environmental conditions, energy consumption, data transmissionefficiency, and information presentation in a web-based portal. According to the experiment's results, the device can be used to monitor the environment practically and provide users with fast informationfor more effective action planning. To expand the system's capabilities, the authors suggestconsidering the use of batteries and adding heavy metallic ions as parameters of interest. Includingheavy metallic ions in the system's parameters would enable the monitoring of water quality in termsof heavy metal contamination, which is a significant concern in many water bodies worldwide.Overall, the developed system is a promising approach to monitoring water quality in real-time, evenin distant water resources. The suggested expansion of the system& capabilities would make it evenmore useful in monitoring water quality and providing valuable information for better decision-making in protecting the environment and human health.

A thorough overview of IoT-based smart water quality monitoring systems (IoT-WQMS) forresidential applications is given in the study by Jan F., Min-Allah, and N. Dustegor D [3]. It discussesa variety of WQM characteristics, such as their safe drinking water restrictions, related smart sensors, and a critical analysis of contemporary IoT-WQMS. The authors also discussed the deployment of aneffective system and presented an empirical metre for analysis. The report also offers designrecommendations for a successful IoT-WQMS.

In their study, Segun O. Olatinwo and Trudi-H. Joubert [4] focused on evaluating energy-efficientwireless sensor system options for water quality monitoring at sampling sites. One of the mainconcerns they identified was the limited energy supply available to nodes for monitoring waterquality, as well as a lack of energy-saving solutions. To address these challenges, the authorsconducted a comprehensive review of some of the most important solutions developed for wirelesssensor systems designed for monitoring water quality. They summarized the various solution methodsunder consideration and categorized them based on their problem-solving techniques, noting theirrespective advantages and disadvantages. Finally, the authors offered several recommendations forenhancing energy efficiency in wireless sensor systems for water quality monitoring. Byimplementing these recommendations, it is possible to increase the lifespan of the network andimprove the accuracy and reliability of the monitoring data collected.

Mukta et al. [5] have developed an IoT-based system called Smart Water Quality Monitoring(SWQM) system. This system is designed to continuously monitor the quality of water using fourdifferent parameters, namely, turbidity, pH, temperature, and electric conductivity. The systemconsists of four sensors that are linked to an Arduino Uno to measure these parameters. The measuredata is sent to a desktop application created with the.NET framework. The desktop applicationextracts the information from the sensors and contrasts it with the reference values to determine thequality of water. The developed SWQM model uses a fast classifier to evaluate the water qualityparameters and determine if the water is potable or not. Overall, this system is useful in ensuring thatthe quality of water is continuously monitored, and any potential issues are detected quickly. The useof IoT technology allows for real-time monitoring and analysis of water quality parameters, making iteasier to maintain safe drinking water standards.

The proposed strategy by Konde and Deosarkar [6] for creating an IoT-based Smart Water QualityMonitoring (SWQM) system using sensors, an FPGA board, and a wireless communication modulehas several benefits. The SWQM system can monitor six different water quality measures in real-time, including turbidity, pH, humidity, water level, water temperature, and carbon dioxide (CO2) onthe water’s surface. One advantage of the SWQM system is that it is programmable, which means thatit can be customized according to specific requirements. The wireless communication module used inthe system is based on Zigbee, which is a low-power wireless technology that enables devices tocommunicate with each other over a short distance. This feature makes the SWQM system energy-efficient and cost-effective. In conclusion, the proposed strategy can help to protect the ecosystemsurrounding water bodies by maintaining ecological and environmental balance and is a cost-effectiveand time-efficient method for testing water quality.

Amruta and Satish [7] proposed a solar-powered water quality monitoring system that utilises awireless sensor network to gather and transmit data from various sensors. The system architecturecomprises of a base station and distributed sensor nodes, linked together using Zigbee WSNtechnology. The underwater wireless sensor network (UWSN) technology used in this system allowsfor the monitoring of water quality in multiple areas. Each node is powered by solar or photovoltaicpanels, making the system energy-efficient and environmentally friendly. The nodes gather data onvarious water quality parameters, such as turbidity, oxygen levels, and pH values, and transmit thisdata to the base station via WSN technology. The gathered data can be displayed in a readable format, and base station analysts can perform analysis using simulation tools. The system has several benefits, such as lower power consumption, no carbon emissions, and greater flexibility, making it an idealsolution for monitoring water quality in remote areas where power sources may be limited.

The IoT-based system designed by Sughapriya et al. [8] for evaluating water quality uses many sensormodules to measure various water quality parameters. To detect the parameters of water, the system uses sensors. The sensor data is read by an Arduino controller, and IoT is used to analyse the gathereddata. Water pollution can be researched methodically using the data gathered from the sensors. One ofthe significant advantages of the system is that it can notify concerned authorities and the public of the water quality through warnings and notifications. The system can also be used by individuals with less training to monitor the quality of water as it is easy to put the water quality monitoring deviceclose to the water sources. The system utilises numerous sensors that can compute water quality datain real-time, providing a rapid response to any water quality issues. The technology is perfect formonitoring water quality because it is accurate, affordable, and time-consuming. Overall, the systemis novel and efficient method of evaluating water quality that has the potential to be advantageous toboth individuals and the larger community.

The system developed by Unnikrishna Menon et al. [9] is a wireless sensor network-based approach for monitoring the water quality of rivers. The system enables remote and continuous monitoring of water quality indicators, with pH being the primary factor affecting water quality. The system design includes a sensor node, which comprises a CPU module, signal conditioning module, power module, and wireless communication module (Zigbee module). The pH sensor constantly monitors the level of the water and sends the data wirelessly to the base station. At the base station, the received data undergoes necessary signal processing and conditioning steps before being analysed. The sensor node’s circuit is designed, simulated, and constructed using appropriate circuit components to ensure that the system uses less electricity and is cost-effective. Overall, this system provides an efficient and cost-effective approach for monitoring the water quality of rivers using wireless sensor networks.

Prasad et al. [10] developed a smart water quality monitoring system in Fiji by combining remote sensing and IoT technology. The system uses potential hydrogen (pH) and oxidation and reduction potential (ORP) indicators to assess water quality, with a focus on developing an early warning system for water contamination. The authors recommended the adoption of a continuous data collection network for remote sensing and IoT-based water quality monitoring, with many monitoring stations and an efficient monitoring strategy. The developed system was tested for accuracy by analysing four water sources hourly over a 12-hour period, with the outcomes compared to reference metrics for temperature, conductivity, and pH. The results showed that the system provided precise and trustworthy values for real-time water monitoring. GSM technology was used to send alerts to end users for immediate action, based on reference metrics gathered from each of the four separate water sources. The authors also employed neural network analysis to automate water examination. Overall, the study highlights the effectiveness of combining remote sensing and IoTtechnology to develop a smart water quality monitoring system in Fiji. The system's ability to providereal-time data and early warning of contamination can help ensure the safety of the water supply and protect public health.

The Smart Water Quality Monitoring System proposed by Jerom B. et al. [11] is an innovative and efficient approach to monitor water quality in real-time using IoT and cloud-based technologies. The traditional method of manual water sampling and lab testing is time-consuming, expensive, and may not provide immediate results. With the help of IoT sensors and deep learning algorithms, this system can continuously monitor water quality, and the results are available immediately. The system consists of IoT sensors and Node-MCU, which continuously check water quality parameters like pHlevel, temperature, dissolved oxygen, turbidity, etc. The data collected by these sensors are sent to the cloud using the integrated Wi-Fi module in the Node-MCU. In the cloud, deep learning algorithms are used to analyse the data and predict whether the water is safe for consumption or not. The use of deep learning algorithms is an important feature of this system as it helps to identify and predict the quality of water accurately.

The system can detect various pollutants, including heavy metals, pesticides, and organic compounds, which are harmful to human health. This Smart Water Quality Monitoring System has immense potential to improve the quality of life and well-being of people by providing a continuous and affordable water quality monitoring solution. It can be implemented in various water resources, including rivers, lakes, and wells, and can be used by individuals, communities, and industries to ensure safe and clean water for consumption and other purposes.

In conclusion, Geetha and Gouthami's [12] work is a significant step towards developing affordable and user-friendly smart water quality monitoring systems. The integration of incongruity detection techniques and the use of IoT devices can further enhance the effectiveness of such systems in ensuring safe and clean water supply. Furthermore, the use of IoT devices in water quality monitoring can help in the effective management of water resources by enabling remote monitoring and analysis of water quality data. This, in turn, can aid in the efficient utilization of water resources and reduce wastage. In addition to the previous response, it is worth noting that the integration of incongruity detection techniques in water quality monitoring systems is crucial for preventing potential health hazards caused by contaminated water. The system's ability to provide real-time alerts to users in case of any irregularities in water quality can aid in the timely detection and resolution of water quality issues.

In addition to its cost-effectiveness and efficiency, this Sengupta et al.'s [13] system also has environmental benefits, as it allows for the optimization of water usage and reduces wastage. The system can be easily customized to suit the specific needs of different locations, making it a versatile solution for water quality management. Overall, the proposed system for real-time water quality monitoring and control using IoT technology is a significant step towards ensuring access to safe and clean water. It has the potential to revolutionize water management practices and improve the quality of life for individuals and communities around the world.

Overall, this IoT-based real-time water quality monitoring system developed by Kumar and Samalla[14] appears to be a sophisticated and reliable solution for monitoring water quality. By utilizing cloud-based wireless communication devices, the system can be monitored remotely, providing real-time data on the water quality. This could be very useful in a variety of applications, such as in water treatment plants, industrial sites, or in natural bodies of water, to help ensure that the water is safe for human consumption and the environment. the system is very advanced and comprehensive, and it has the potential to greatly improve our ability to monitor water quality in real-time. By using a variety of sensors to measure different parameters of water quality, the system can provide a complete and more accurate picture of the state of the water. The Raspberry Pi controller acts as the central unit that processes the data from these sensors and sends it to the cloud for further analysis, which allows for quick and easy access to the data from anywhere.

Anuradha et al. [15] developed this system which has the potential to ensure access to clean and safe water, especially in areas where water quality may be a concern. With real-time monitoring and data collection, it can help identify potential water quality issues before they become a larger problem. Additionally, by using inexpensive and easily accessible technology like a Raspberry Pi controller, this type of system can be implemented in various settings and locations, including rural or remote areas.

The study by Hamid et al. [16] demonstrated the effectiveness of a Smart Water Quality Monitoring System (SWQMS) in continuously monitoring the temperature and pH value of swimming pool water. By using statistical methods such as Design of Experiment (DOE) and Analysis of Variance(ANOVA), the researchers were able to determine that the pH value of the water was not affected by various factors while the temperature was affected by the time of day. The implemented application was able to automatically update the water quality status and adjust the pH level through IoT. Overall, the proposed method was found to be effective and required minimal maintenance, making it a useful tool for pool owners to maintain optimal water quality.

CHAPTER -3

PROJECT DESCRIPTION

3.1 ABOUT THE PROBLEM:

For general scenario such as the household environment, we need water which is safe enough for drinking and other household purposes, failing may lead to many human diseases. So, there is a need for better methodologies to monitor the different parameters present in the water.

IoT sensors can be used to monitor various water quality parameters such as pH, dissolved oxygen, temperature, turbidity, and conductivity. These sensors can be installed in water supply systems, water storage tanks, and individual households to continuously monitor water quality parameters in real-time.

Even through there are many traditional techniques to monitor the parameters of water ,they have several flaws like

1.They are laborious.

2.Very cost effective.

3.Not user convenient.

4.Doesn’t give accurate readings.

So, there is a need for Continuous monitoring of water quality and quantity through an IOT system, accessed through a mobile application.

3.2 INTRODUCTION:

Water is the basis of all life and has a direct bearing on health. It is a material that permeates every aspect of daily life and is essential to human survival as well as the growth of industry and agriculture. The issue of water quality has progressively come to light as a result of the social economy's quick development.

The capacity of ecosystems to self-purify is greatly exceeded by the discharge of industrial sewage as well as domestic sewage from urban and rural areas. Safe and readily available water is required for activities such as drinking, housekeeping, food production, and recreation in order to maintain public health. The life and health of the populace will be significantly affected once the water source is contaminated.

Farmers are primarily responsible for long-term water quality and environmental monitoring in traditional aquaculture.

Understanding the fish pond's water quality factors, such as water temperature, PH level, and salinity, is the most crucial task in

the culture process. Farmers must often and for a long time monitor the water quality because these water quality parameters directly affect the survival rate of farmed species.

An automated system's measurement of water quality often sends the data to the back end over a wireless network.

As a result, the cost of cultivating will rise because the transmission of information about water quality uses too much energy. To address the issue of high energy usage in transmitting water quality information, it may be useful to explore alternative technologies or methods that can reduce energy consumption while still providing accurate and timely information. For example, using wireless sensors or automated monitoring systems that are powered by renewable energy sources could be a potential solution.

The devices used to measure water quality, collect data, and transmit that data make up the water quality monitoring system. Equipment for measuring water quality is mostly based on several types of sensors.

In most cases, an MCU is used to control data collecting devices. Wired transmission and wireless transmission make up the two primary categories of data transmission systems. The pH, turbidity, and water temperature are typically measured for a general situation, such as the home setting, to analyze the water quality thoroughly, which can essentially reflect the water condition. The primary monitoring technique now in use is routine manual sample and analysis. But it costs a lot and requires more manual labour. So, we are working to create an effective model.

3.3 BLOCK DIAGRAM:

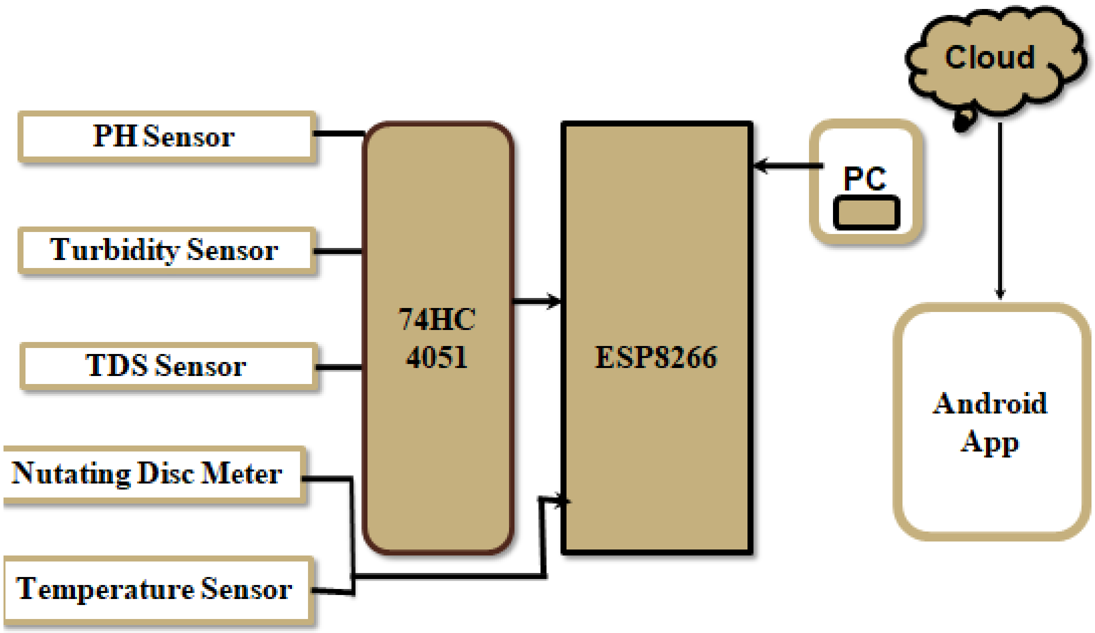


Fig 3.3Block Diagram of Smart Water Surveillance System using IOT

3.4 SOFTWARE TOOLS/HARDWARE REQUIRED

ESP8266 Node MCU Module.

74HC4051 Multiplexer.

The PH sensor.

The Turbidity Sensor.

TDS (Total dissolved solids) Sensor.

Nutating Disc Meter.

MIT App Inventor.

DS18b20 Temperature Sensor.

CHAPTER-4

ESP8266 Node MCU

4.1 WHAT IS NODE MCU:

The Node MCU development board is designed to make it easy for developers to program and interact with the ESP8266 chip. It includes a USB-to-serial adapter and a voltage regulator, as well as pins for connecting sensors, actuators, and other components. The Node MCU also has built-in support for Lua scripting, which allows developers to write code directly on the board.

One of the key advantages of the Node MCU and ESP8266 is their low cost, making them accessible to hobbyists and developers on a tight budget. Additionally, the built-in Wi-Fi capabilities of the ESP8266 make it easy to connect to the internet and control devices remotely.The Node MCU and ESP8266 are commonly used in a variety of IoT projects, including home automation, weather monitoring, and smart appliances. They are also popular in educational settings, as they provide an affordable and easy-to-use platform for learning about embedded systems and programming.

Overall, the Node MCU and ESP8266 offer a powerful and affordable option for developers looking to create IoT projects or experiment with embedded systems. Their flexibility and ease of use make them a great choice for a wide range of applications.

4.2 WHY NODE MCU:

Node MCU is equipped with a more potent processor, greater memory, supports larger designs, and is capable of working with more sophisticated external devices. It is smaller and includes a number of extra features.

• The memory and processor are improved.

• It is IoT ready and features a built-in TCP/IP stack.

• The price is lower.

• It is small and suitable for breadboards.

4.3 WHAT DOES NODE MCU DO:

Node MCU is a development board that is built around the ESP8266 Wi-Fi module. It offers easy access to the GPIO pins, allowing you to control a wide range of devices and sensors. You can program the Node MCU using the Lua programming language or the Arduino IDE, which makes it easy for both beginners and experienced programmers to work with.

One of the main advantages of Node MCU is that it can be used as a web server, which means you can build web-based interfaces to control your devices and sensors. This makes it ideal for building Internet of Things (IoT) projects, where you need to connect multiple devices and sensors to the internet.

Another advantage of Node MCU is that it can act as an access point, allowing other devices to connect to it over Wi-Fi. This means that you can use it to create a wireless network for your IoT devices, which can communicate with each other and with the internet. Node MCU also supports direct USB port flashing, which means you can easily upload your code to the board without needing any additional hardware. This makes it very convenient for rapid prototyping and development.

Overall, Node MCU is a powerful and flexible development board that is well-suited for a wide range of IoT projects. Its easy-to-use programming interface, web server capabilities, and Wi-Fi networking features make it a popular choice among hobbyists and professional developers alike.

4.4 NODE MCU USES:

• Affordable

• Built-in WIFI network support

• The board's size was decreased.

• Little use of energy

4.5 TYPES OF NODE MCU:

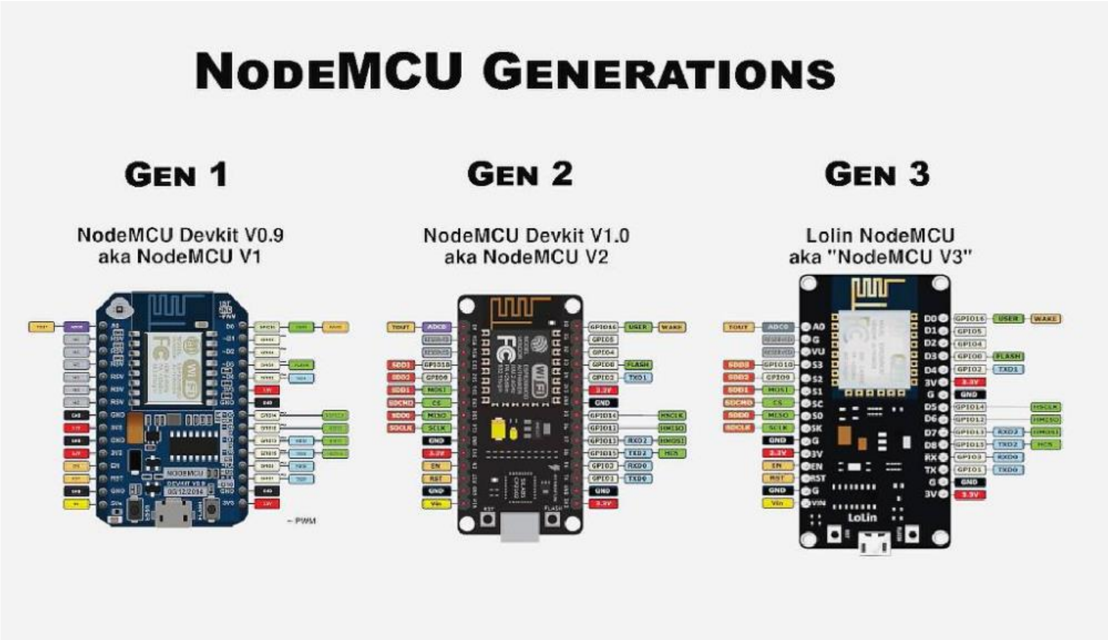


Fig 4.5Types of Node MCU’s

Source: https://www.etechnophiles.com/nodemcu-esp8266-pinout-specs-board-layout/

Node MCU is available in two versions, 0.9 and 1.0, with ESP-12 in version 0.9 and ESP-12E (where E stands for "Enhanced") in version 1.0. The most recent version of this well-liked module, the ESP8266 Node MCU V1. 0 ESP-12E Wi-Fi module, can be used as an Arduino alternative in many applications because it has Wi-Fi capabilities. Subsequently, assist for the 32-bit ESP32 MCU was included. The ESP-12 chip is installed in the 0.9 version, which is blue, whereas the ESP-12E (ESP-12E stands for "improved") chip is installed in the 1.0 version, which is black. The latter version of the chip has 22 pins, but the earlier one has only 16. This is one of numerous significant variations between the two chips.

The ESP8266 can operate in three different modes: "Station" mode, "Access Point" mode, and "AP + Station," which enables the device to function both as a Wi-Fi client and an access point at once.

Comparison of Node MCU development boards:

The size difference between first- and second-generation boards makes them easier to distinguish. The ESP-12E chip, which is newer and more advanced, is used in the second version, while both models use ESP-12 chips with 4MB flash.

4.5.1 1st generation / v0.9 / V1:

Source:https://raw.githubusercontent.com/nodemcu/nodemcu-devkit/master/Documents/NodeMCU_DEVKIT_V0.9.png

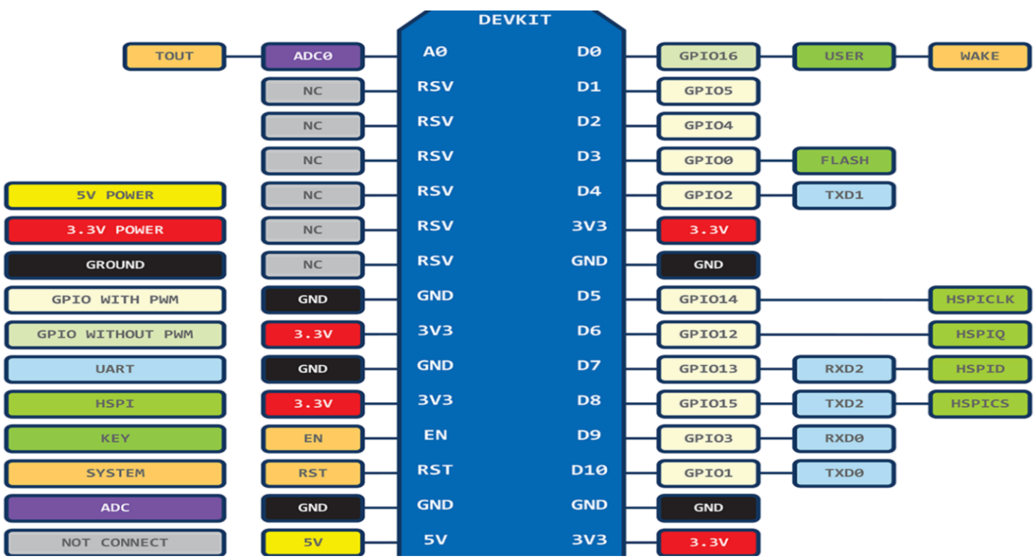


Fig 4.5.1Node MCU 1st Generation

Source: https://dziadalnfpolx.cloudfront.net/blog/wp-content/uploads/2015/09/esp8266-nodemcu-dev-kit-v1-pins.png

The original, now-outdated development kit is generally broad and came with a great yellow board. It is extremely challenging to use because it takes up all 10 pins on a typical bread board due to its size, which is 47mm by 31mm. Included are an ESP-12 module and a 4MB flash memory.

4.5.2 2nd generation / v1.0 / V2:

Source:**https://www.electronics-lab.com/getting-started-with-the-nodemcu-esp8266-based-development-board/**

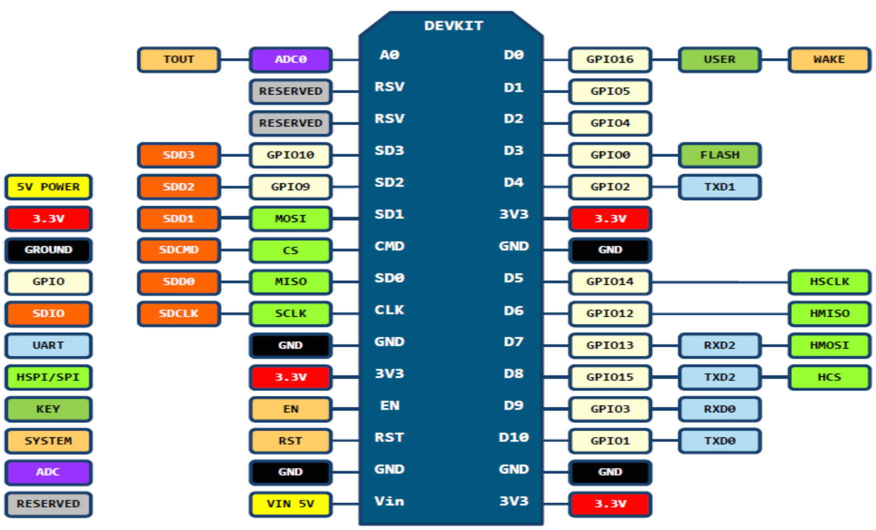
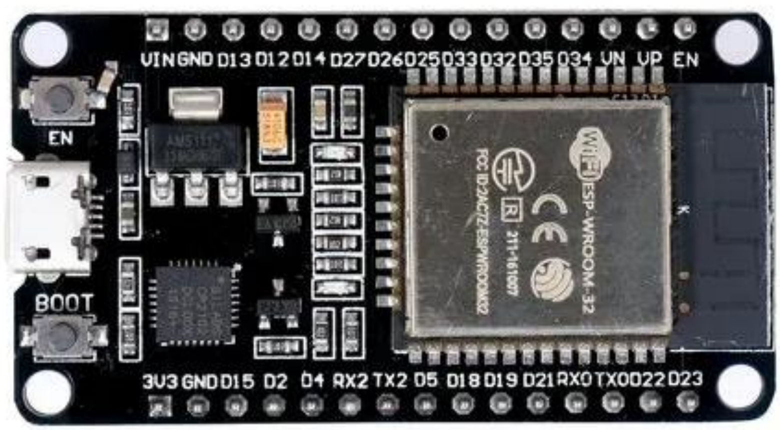


Fig 4.5.2Node MCU 2nd Generation

Source: https://github.com/nodemcu/nodemcu-devkit-v1.0

The V2 board improves upon the shortcomings of the original; it is narrower and fits well into bread boards. A ESP-12E was substituted for the original ESP-12 chip.

4.5.3 V3:



Source:https://m.indiamart.com/proddetail/nodemcu-esp-wroom-32-cp2102-based-15326088673.html

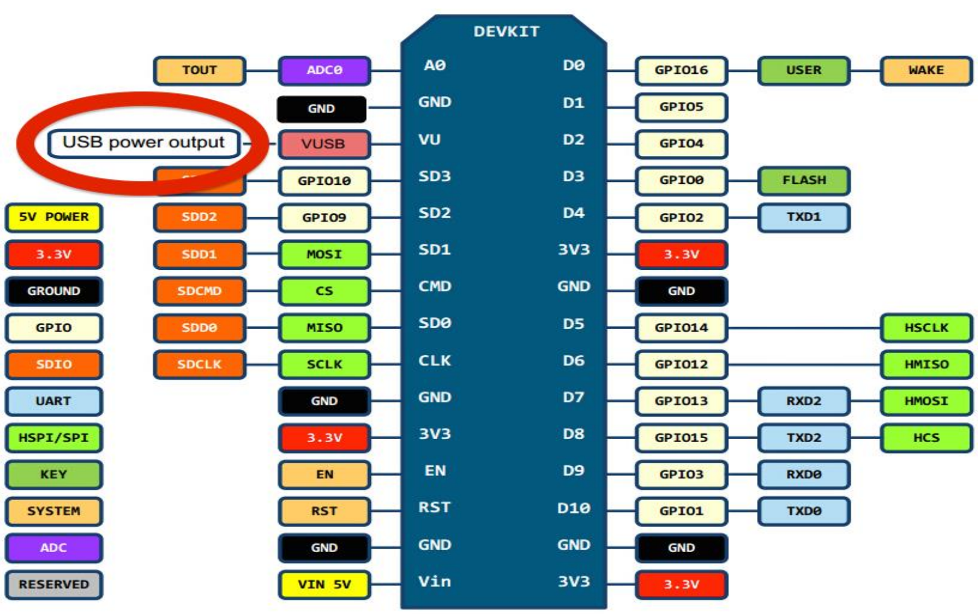


Fig 4.5.3Node MCU3rd Generation

Source:https://dziadalnfpolx.cloudfront.net/blog/wp-content/uploads/2015/09/esp8266-nodemcu-dev-kit-v3-pins.jpg

Node MCU has not yet published a new specification. Producer Lolin created the term "V3" to describe a few minor upgrades to the V2 boards. They assert that their USB port is more durable, among other things.

4.6 ESP8266:

Espress if Systems created the inexpensive Wi-Fi chip known as the ESP8266. It can be utilised as a stand-alone unit or as a UART to Wi-Fi converter to enable Wi-Fi connectivity for other microcontrollers. To add Wi-Fi functionality to our Arduino board, for instance, we can attach an ESP8266. The use of it as a standalone device is the most practical application.

Similar to how an Arduino allows us to control inputs and outputs, the ESP8266 also has Wi-Fi capabilities. This entails that we may publish our projects online, which is perfect for applications including home automation and the internet of things.

4.6.1 DIFFERENCES WITH OTHER BOARDS:

The ESP8266 is a microcontroller that has Wi-Fi capabilities. There are numerous modules and development boards with this system. Some development boards employ simple esp8266 modules, while others combine the antenna and chip flash memory on the PCB. The ESP8266 is part of the NODEMCU development board, which also includes the corresponding firmware.

Improved Memory and Processor: The Node MCU contains 4MB of flash memory and an 80MHz clock speed. The Node MCU has a Wi-Fi connection and is able to create a wireless internet connection thanks to the IoT's integrated TCP/IP stack. Overall, the combination of the ESP8266 microcontroller and the NodeMCU development board provides a flexible and affordable platform for building a wide range of IoT applications.

4.7 ESP8266 FUNCTIONAL BLOCK:

4.7.1 Programming

How to programme any ESP8266 chip in the most basic and general manner possible:

- Do the following when attaching the USB-UART adapter to the ESP8266.
- VCC -> VCC, GND -> GND, RX -> TX and TX ->RX.
- To GND, pull the GPIO 0 pin.
- Join the computer and the adapter.
- Launch a UART flashing application, such as ESP Simple.
- Choose the suitable COM port for uploading binary file. Press the Flash button.
- reset ESP8266,after success.

The process described above is perhaps the most common. This method can be used to programme any ESP chip.

Any method we employed to create the binary file is irrelevant. Choose a setting that we are familiar with and enjoy.

A programmer is integrated into some of them, such as the Arduino IDE. Hence, flashing the ESP8266 chip doesn't require the usage of any other external software. Others can program OTA, such as ESP Home (Over the Air). A binary file can be created in numerous other ways, though.

Choose C language and one of the officially supported SDKs if we wish to optimize the code for size or speed. But nothing prevents us from using preferred language, whether it's Python, Lua, Visual Basic, or JavaScript.

The Node MCU Development Board may be easily programmed with the Arduino IDE thanks to its user-friendly interface. Programming a Node MCU using the Arduino IDE won't take more than 10 to 20 minutes. All we require is the Node MCU board itself, the newest Arduino IDE, and a USB cable.

4.7.2 Memory

Instruction RAM of 32 KiB. Memory with a 32 KiB instruction cache. 80 KiB RAM for user data.

4.7.3 Input and Output

Digital I/O

Like a typical Arduino, the ESP8266 has digital input/output pins, also referred to as GPIO or I/O pins. As their name implies, they can be used as digital outputs to output either 0V (sink current) or 3.3V or as digital inputs to read a digital voltage. (Source current).

Voltage and current restrictions

Since the ESP8266 is a 3.3V microprocessor, its I/O also operates at this voltage. The chip will malfunction if any pin receives a higher voltage than 3.6V because the pins are not 5V tolerant.

Only 12mA of current can be supplied by a single GPIO pin.

Usable pins

Only 11 of the ESP8266's 17 GPIO pins (0-16) are now available for use because the remaining 6 pins (GPIO 6–11) are utilized to connect the flash memory chip. This is the little chip with eight legs that is placed next to the ESP8266. The program may crash if we attempt to use one of these pins.

Since GPIO 1 and 3 act as the hardware serial port's TX and RX, you often cannot use them as conventional I/O for sending and receiving serial data. (UART).

Boot modes

Certain I/O pins, as was indicated in the preceding chapter, have a specific purpose during boot: Users choose one of three boot modes:

GPIO15	GPIO0	GPIO2	Mode
0V	0V	3.3V	UART Bootloader
0V	3.3V	3.3V	Boot sketch (SPI flash)
3.3V	X	X	SDIO mode (not used for Arduino)

Table 4.1: GPIO pins and their modes

Notably, the internal pull-up resistor for GPIO2 is activated at boot, so we don't need to install an external one.

- Since GPIO15 is always pulled low, the inbuilt pull-up resistor is ineffective. When utilising GPIO15 as an input to read a switch or when connecting it to a component with an open-collector (or open-drain) output, such I2C, you must take this into account.
- Since GPIO0 is normally pulled high, we are unable to use it as a Hi-Z input.
- Since GPIO2 cannot be low at boot, a switch cannot be attached to it.

Internal pull-up/-down resistors

Similar to an Arduino, each GPIO 0 to15 has a built–in pull–up resistor. A pull-down resistor is already present on GPIO16.

PWM

The ESP8266 does not support hardware PWM, unlike the majority of Atmel chips (Arduino), although all digital pins can enable software PWM. It is possible to alter the PWM range from 10-bits @ 1kHz to >14-bits @ 1kHz.

Analog input

The ESP8266 has a single analogue input with a 0 to 1.0 V input range. For instance, the chip will be harmed if 3.3V is supplied. A resistive voltage divider is included into some boards, such as the Node MCU, to make obtaining an easier 0 to 3.3V range possible. As a voltage divider, we could alternatively just use a trim pot.The 10 bits of resolution on the ADC (analog to digital converter) are used.

4.7.4 Communication

Serial

The ESP8266 has two hardware UARTS (Serial ports): UART0 is located on pins 1 and 3 (TX0 and RX0, respectively), and UART1 is located on pins 2 and 8. (TX1 and RX1, correspondingly). The connection to the flash chip, however, is made using GPIO8. Thus, the only thing UART1 can transmit is data. Hardware flow control is additionally present on pins 15 and 13 of UART0. respectively (RTS0 and CTS0). It is also possible to use different TX0 and RX0 pins in place of these two.

I²C

On the ESP, the TWI (Two Wire Interface) is implemented in software as opposed to hardware. In light of this, we can use just about any two digital pins. Pins 4 and 5 are used as SDA and SCL, respectively, by default in the I2C library. (GPIO2 is designated as SDA and GPIO14 as SCL on the data sheet.) The maximum speed is about 450kHz.

SPI

One SPI connection, known as HSPI, is made available to users of the ESP8266. It employs GPIOs 14, 12, MISO, 13, and 15 as CLK, MOSI, and Slave Select, respectively (SS). It can be utilised in Master mode and Slave mode (in software).

Power Pin

If we have a regulated 5V power supply, the ESP8266 and its accessories can be powered straight from the VIN pin. The on-board voltage regulator's output, the 3V3 pin, may deliver up to 600mA.GND stands for ground pin.

Interrupt Pins

All GPIOs, except for GPIO16, can be set up as interrupts.

Control Pins

To turn on the ESP8266, utilize the EN (sometimes spelled CH PD or Chip Power Down) pin. The chip is enabled when it is pulled HIGH; when it is pulled LOW, it uses little power. The reset pin, or RST pin, is often maintained high. By briefly pulling it low, it can be utilized to reset the ESP8266 system. The on-board RST button would need to be pressed in its place. The ESP8266 uses the FLASH pin to control when to enter the bootloader during bootup. At power-up, the bootloader will begin if the pin is held low. The on-board FLASH button would need to be pressed in its place. To awaken the ESP8266 from deep sleep, utilize the WAKE pin.

4.7.5 Reset button

By pressing and holding the reset button during bootup, GPIO0 must be low in order to put the ESP into program mode. program button pressed and held. The ESP will boot into program mode after we release the reset button.Hold down the RESET button (or FLASH button for Node MCU modules) until the blue light goes solid, around 10 seconds. After rebooting, the device's configuration will be erased. If the gadget is in a quick reboot loop, this might not work.

4.7.6 Voltage Regulator

The Thing contains an internal 3.3V regulator to provide a safe, constant voltage to the ESP8266 because its highest operating voltage is 3.6V.

4.7.7Applications

- Smart locks and surveillance cameras are examples of smart security equipment.
- Smart energy appliances, such as thermostats and HVAC systems.
- Programmable logic controllers, among other smart industrial equipment (PLCs).
- Wearable health monitors are among the smart medical equipment.
- Portal access points.
- Projects involving networks and IOT.
- Low power battery operated applications.
- Wireless data logging.
- Used in studying the foundations of networking.
- Projects that call for a variety of I/O interfaces with Bluetooth and Wi-Fi capabilities.
- Smart home automation system.
- Sockets and smart bulbs

CHAPTER-5

ARDUINO PROGRAMMING

The three primary components of the Arduino programming language are functions, values (variables and constants), and structure.Therefore, the following syntax should be used while writing programmes for Arduino:

- The block is enclosed in parenthesis. Blocks in a software can include instructions, variable declarations, functions, or loops.
- To indicate completeness, a semicolon ";" is used at the end of the sentence.
- A remark can be added to each line of code to explain how the statement functions. You can achieve this by starting the comment with a double forward slash "//" if it is a single line.

5.1 STRUCTURE

Set-up and loop functions make up the two main sections of the Arduino programme structure. setup() is used for planning, and loop() is used for execution. Both activities are necessary for the programme to run.

The code's libraries and variables are initialised using the setup() function. This function also defines the Arduino pin modes in a manner similar to that. It also establishes connectivity between the Arduino board and the PC. One run is made only. The setup() function is used at the beginning of a sketch. Use it to initialise the variables, pin modes, and begin utilising libraries. The setup function only executes once when the Arduino board is turned on or reset.

5.1.1 SETUP

When the programme first launches, the setup function is called once. It is used to launch serial communication or to initialise pin modes. Even if there are no statements to execute, it must be in the programme.

5.1.2 LOOP

The loop() method exactly accomplishes what its name implies; it performs repeated loops, enabling the programme to modify, react, and control the Arduino board.

5.1.3 OTHER STRUCTURES

1. CONTROL STRUCTURES

Programming languages use a variety of control structures, including if, if else, do while switch case, for, continue, break, return, and goto. The flow of a programme's execution is governed by Control Statements, which are parts of the source code.They are primarily employed for controlling after a specific condition is met. The following is a list of several control structures utilised in this project.

IF

It requires a statement or group of statements as well as an expression included in parenthesis. The statement or block of statements is executed if the expression is true; else, these statements are skipped.

If..else

If..else provides for "either-or" judgments, where else will run when the expression is false. For instance, if we wanted to test a digital input and perform one thing if the input went high or do another thing in its place if the input went low, we could follow an if statement with an optional else statement.

Even though there is no limit to the number of these else branches that might exist, only one set of statements will be executed in accordance with the test requirements.

While

The expression enclosed in the parenthesis will continue to be true indefinitely, or until the while loop terminates. The tested variable must be altered for the while loop to break. This could be an internal condition, like a variable that is incremented.

2. FURTHER SYNTAX

Programming also makes use of other syntax, such as semicolons, curly brackets, single-line and multiline comments, #define, and #include.

2.1. #define

In the Arduino platform, defined constants don't **occupy any** chip memory for programmes. At compile time, the compiler will swap out references to these constants for the defined value.

#define constant Name value

2.2. #include

To incorporate external libraries in your sketch, use the #include command. As a result, the programmer has access to several typical Arduino libraries.

#include<LibraryFile.h>

3. ARITHMETIC OPERATORS

Arithmetic operators include addition, subtraction, multiplication, division. They return the sum, difference, product or quotient (respectively) of the two operands.

4. LOGICAL OPERATORS

Commonly used to compare two expressions, logical operators typically yield either TRUE or FALSE, depending on the operator. If statements frequently employ the logical operators AND, OR, and NOT, which are three in total.

* Logical AND: If both expressions are true, then if (x>3 && x7) is true.
* Logical OR: If either of the phrases is true, then if (x>3 || x7) is true as well.
* Logical NOT: Only the expression is false if (!x>3) is true.

5. COMPARISON OPERATORS

If statements frequently use comparisons of one variable or constant against another to determine whether a certain condition is true.

6. COMPOUND OPERATORS

Compound operators align a variable with an arithmetic operation. They are frequently discovered in for loops. The most popular compound operators are

5.2 VARIABLES

A numerical value can be named and stored in a variable to be used by the programme at a later time. Contrary to constants, whose value never changes, variables are numerical values that can be adjusted over time. It is necessary to declare a variable and, possibly, assign it a new value.

Aurduino Datatypes and constants are the variables.

5.2.1 CONSTANTS

Constants are predefined values in the Arduino programming language. They are employed to simplify the programme's reading. Groups are used to classify constants:

i. Tue/False

ii. high/Low

iii. Input/Output

5.2.2DATATYPES

n Arduino, the term "data types" refers to a complex system for declaring variables or functions of various types. The type of a variable dictates how much storage space it takes up and how the stored bit pattern is interpreted.

All the data types that you will utilise when programming Arduino are listed in the following table. variables or functions of different types.

short	Double	char	Unsigned char	long	String-object	Unsigned int	Unsigned long
byte	word	void	float	boolean	String-char array	array	int

Table 5.1:Datatypes in Arduino programming

5.2.3 VARIABLE SCOPE

A variable may be defined locally within a function, at the start of a programme before void setup(), or occasionally within a statement block such as a for loop. The variable scope, or the extent to which specific portions of the programme may use the variable, is determined by where the variable is defined.A global variable is one that every function and statement in a programme can view and utilise.

5.3 FUNCTIONS

By breaking out code into functions, a programmer can produce modular chunks of code that carry out a specific task before returning to the section of code from which they were "called." When an activity needs to be carried out more than once in a program, that is the typical situation in which a function is created.

5.3.1 DIGITAL I/O

digitalRead(pin)

It reads the value from a designated digital pin, producing a HIGH or LOW signal. The pin can be provided as a constant (0–13) or a variable.

Example: Value-digitalWrite(pin); //sets 'value' equal to the input pin

digitalWrite(pin, value)

Outputs either high or low at(turn off or on) a specified digital pin. The pint can be specified as either a variable or constant (0-13). Example: digitalWrite(pin, HIGH), //sets 'pin' to high.

5.3.2 ANALOG I/O

analogRead(pin)

With a 10-bit resolution, it reads the value from the chosen analogue pin. 0 to 5 are the only analogue in pins that this function supports. The integer numbers that are obtained range from 0 to 1023. Unlike digital pins, analogue pins do not require an initial declaration as an input or output. Value-analogRead(pin):

analogWrite(pin, value)

It uses hardware-enabled pulse width modulation (PWM) to output a pseudo-analog value to an output pin allocated for PWM. After using the hardware function, the pin will continue to emit a wave until you use analogWrite again (or digitalRead or digitalWrite on the same pin).

analogReference(type)

The reference voltage for analogue input is set by analogReference. (i.e. the value used as the top of the input range). Options include:

AVR Boards for Arduino (Uno, Mega, Leonardo, etc.)

SAMD Boards for Arduino (Zero, etc.)

MegaAVR Arduino Boards (Uno WiFi Rev2)

SAM Arduino Boards (Due)

5.3.3 OTHER FUNCTIONS

1.TIME FUNCTIONS

i. delay (ms)

ii. millis()

2. MATH FUNCTIONS

i. **min(x,y):**The smaller number is returned after determining the minimum of two numbers of any data type. min(value, 100); yields the smaller value of 100.

ii. **max(x,y) :**The largest number out of a calculation for a maximum of two numbers of any data type is returned as 100.

3. SERIAL COMMUNICATION

Serial.begin(rate)

specifies the baud rate for serial data transmission and opens serial. Although additional speeds are supported, the computer's default baud rate is 9600. Digital pins 0 (RX) and 1 (TX) cannot be utilised simultaneously during serial communications.

Serial.println(data)

It outputs data to the serial port, followed by a line feed and automatic carriage return.Although easier to see data on the serial monitor. Example: Sends the value of "analog value" via serial.println(analogValue);

5.4 LIBRARIES

Like the majority of programming platforms, the Arduino environment may be expanded by using libraries. Libraries offer tools for handling data manipulation on hardware.Libraries are collections of coding that facilitate the connection of modules, displays, sensors, etc. There are numerous library features.

5.4.1 ONE WIRE

With 1-wire devices, One Wire can communicate. You can use the One Wire Slave library to simulate a 1-wire device. One 4.7K pullup resistor must be placed between the pin and your power source in order to use One Wire. A resistor in the 1K to 2.7K range can be necessary when using very long lines or with 3.3V power and fake DS18B20 chips.Simply connect the pin and ground to each 1-wire device at this point. Some 1-wire devices have power connections or use the signal wire as their power source. Please refer to the 1-wire device specifications that you are using.

5.4.2 DALLAS TEMPERATURE

The Dallas 1-Wire protocol is used by the one-wire digital temperature sensor known as the DS18B20. This indicates that all that is needed to communicate with the Arduino is one data line and GND. The DS18B20 can measure temperatures between 0 and 255 degrees Celsius with an accuracy of 0.5 degrees Celsius thanks to its 9-bit resolution. Additionally, it features an alarm feature that can be utilised to start an event when a specific temperature is reached.It could be a power source for electronic devices that can operate on data line power (also known as "parasite mode") or an external power source. The latter option does away with the necessity for an external power source.

The DS18B20 is a 1-wire digital temperature sensor. It requires only a single wire to send data to a microcontroller, making it perfect for embedded applications. The sensor can measure temperatures from -55°C to +125°C with a resolution of 0.5°C. It also has an alarm function that can be used to signal when a certain temperature has been exceeded.

5.4.3 SOFTWARE SERIAL

The chip's circuitry includes a UART that offers native serial capabilities. The Software Serial library was developed to enable serial communication on other digital pins of the Arduino by using software to imitate the capability. (thus "SoftwareSerial" as a name).

5.4.4 NEW PING

A library that facilitates the use of ultrasonic sensors. The author claims that he was dissatisfied with how poorly an ultrasonic sensor operated when he first got it. He soon understood that the accessible ping and ultrasonic libraries were the actual source of the issue, not the sensor itself. These issues are completely resolved by the NewPing library, which also adds a tonne of new capabilities and gives these incredibly cheap distance sensors new life. The arm, megaavr, esp32, and avr architectures are all compatible with this library.

CHAPTER-6

HARDWARE COMPONENTS USED

6.1 74HC4051 Multiplexer:

The 74HC4051 is a digital multiplexer IC (Integrated Circuit) that allows multiple analog signals to be switched and routed to a single output based on digital control signals. It has 8 analog input channels and one common output channel.

The IC can be controlled using a microcontroller or any other digital circuit. By toggling the digital control signals, one of the analog inputs can be selected and passed through to the output. This makes it useful in a variety of applications such as audio and video signal routing, sensor data acquisition, and multiplexing analog signals.

The 74HC4051 is a popular and widely used IC due to its ease of use, low cost and compatibility with a wide range of digital devices.

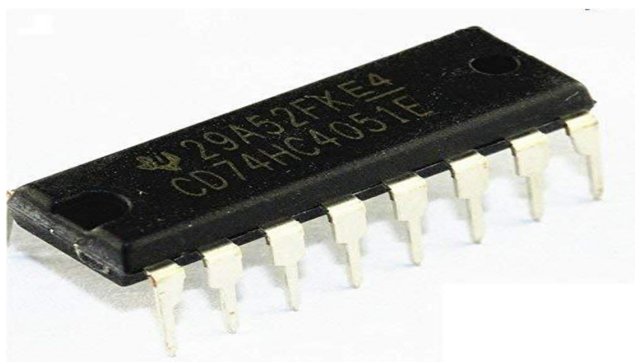


Fig 6.174HC4051Multiplexer

Source**:** https://m.media-amazon.com/images/I/41sO+0uOIaL.jpg

6.2 The PH Sensor:

A pH sensor is an electronic device that is used to measure the pH level of a solution. The pH level of a solution indicates its acidity or basicity, and ranges from 0 (very acidic) to 14 (very basic).

The pH electrode contains a sensitive glass membrane that responds to changes in the concentration of hydrogen ions in the solution. When the hydrogen ion concentration changes, the voltage across the glass membrane changes, which is measured by the sensor and converted into a pH value.They are commonly used to ensure that solutions are within a specific pH range to maintain quality and safety standards.

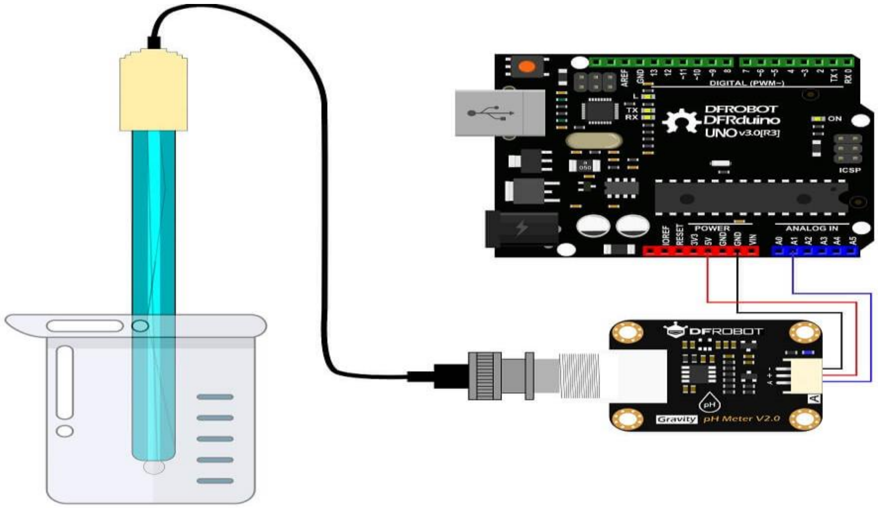


Fig 6.2PH Sensor

Source: https://image.dfrobot.com/image/data/SEN0161-V2/SEN0161-V2-Arduino%20Connection%20Diagram.jpg

Substance	**Range**
Drinking Water	6.5-8.5
Sea Water	6.0
Ground Water	6.0-8.5
River Water	7.4

Table 6.1: PH range for different substances

6.3 DS18B20 Temperature Sensor:

The DS18B20 is a digital temperature sensor that operates on the 1-wire interface principle of temperature measurement. With an accuracy of 0.5°C, it can measure temperatures between -55°C and +125°C. The sensor's resolution can be between 9 and 12 bits, with 12 bits being the norm.

When the sensor is powered up, it enters a low-power inactive state. To measure the temperature, a convert-T command is issued, which initiates the temperature measurement and conversion of analog-to-digital (A-to-D) signal. The resulting temperature data is stored in a 2-byte register in the sensor, and the sensor returns to its inactive state.

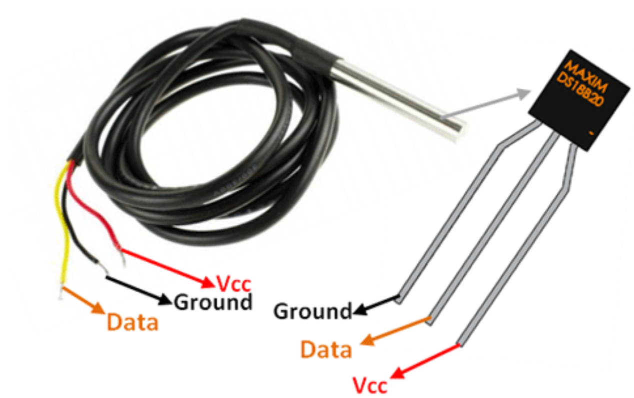


Fig 6.3DS18B20 Temperature Sensor

Source: https://components101.com/sites/default/files/component_pin/DS18B20-Pinout.png

Substance	**Range**
Drinking Water	60
Sea Water	20
Ground Water	7-174

River Water	30

Table 6.2: Temperature range for differentsubstances

6.4Turbidity Sensor:

Similar to smoke in the air, turbidity is the cloudiness or haziness of a fluid brought on by numerous small particles that are typically imperceptible to the unaided eye. A crucial evaluation of water quality is the measurement of turbidity. Particles suspended or dissolved in water that scatter light and make the water look foggy or murky are the source of turbidity.

When there is an huge amount microbial organisms in the water than there will be high turbidity value.A turbidity sensor is an electronic device that is used to measure the amount of suspended particles or solids in a liquid. The measurement is based on the principle of light scattering, where a beam of light is passed through the liquid, and the amount of light that is scattered is measured by the sensor. The more particles present in the liquid, the lighter is scattered, and the higher the turbidity reading. Turbidity sensors are used in a wide range of applications, including water treatment plants, industrial processes, and environmental monitoring.

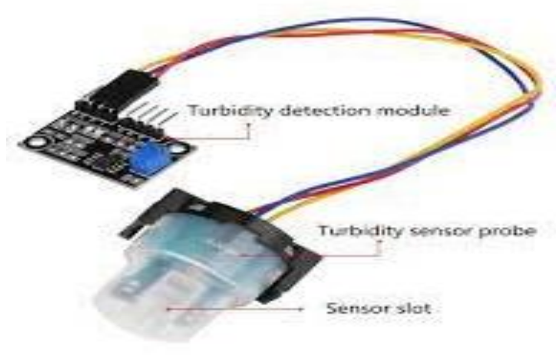


Fig 6.4Turbidity Sensor

Source: https://robocraze.com/products/turbidity-sensor

Substance	Turbidity(NTU)
Drinking Water	<1
Sea Water	1-3
Ground Water	<1-More than 1000
River Water	<10

Table 6.3: Turbidity range for differentsubstances

6.5 TDS SENSOR:

The amount of inorganic and organic materials that are dissolved in water is measured by the term "total dissolved solids" (TDS). Because high levels of TDS can signal the presence of contaminants including minerals, salts, and other chemicals, it is frequently used as a general indication of water quality.The TDS sensor works by measuring the electrical conductivity of the liquid. Dissolved solids in the liquid increase its electrical conductivity, and the sensor measures the electrical conductivity and converts it into a TDS reading. The TDS reading is typically displayed in parts per million (ppm).

Fig 6.5TDS Sensor

Source:https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcT___Y5D7c8SUBOyhrkVm_Qp5nIeCq932U2Cw&usqp=CAU

Substance	**TDS(PPM)**
Drinking Water	50-250
Sea Water	>35,000
Ground Water	1,000-10,000
River Water	100-20,000

Table 6.4: TDS range for differentsubstances

Substance	**EC(S/M)**
Drinking Water	0.5-3
Sea Water	3-6
Ground Water	<150
River Water	200-1000

Table 6.5: EC range for differentsubstances

6.6 Nutating Disc Meter:

A Nutating Disc Meter is a type of positive displacement flow meter that is used to measure the flow rate of liquids. It consists of a disc that is mounted on a ball bearing and nutates, or wobbles, as liquid flows through it. The motion of the disc is used to measure the volume of liquid that has passed through the meter.

The Nutating Disc Meter is a highly accurate and reliable flow meter, capable of measuring flow rates with a high degree of precision. It is commonly used in the petroleum, chemical, and water industries, where accurate measurement of liquid flow rates is critical for process control and quality assurance.

Fig 6.6: Nutating Disc Meter

Source: https://amzn.eu/d/dNnn6LZ

CHAPTER-7

MIT APP INVENTOR

7.1 MIT APP INVENTOR INTERFACE

MIT App Inventor is a web-based software development platform that allows users to create mobile applications for Android devices without requiring any prior programming experience. It is based on the visual block programming language, which allows users to drag and drop components to create applications easily. MIT App Inventor has a user-friendly interface, and it provides a wide range of features and tools to enable users to design and develop their applications with ease. It is a popular tool for beginners and educators who want to introduce programming and app development to their students. MIT App Inventor is free to use and is maintained by the Massachusetts Institute of Technology (MIT).

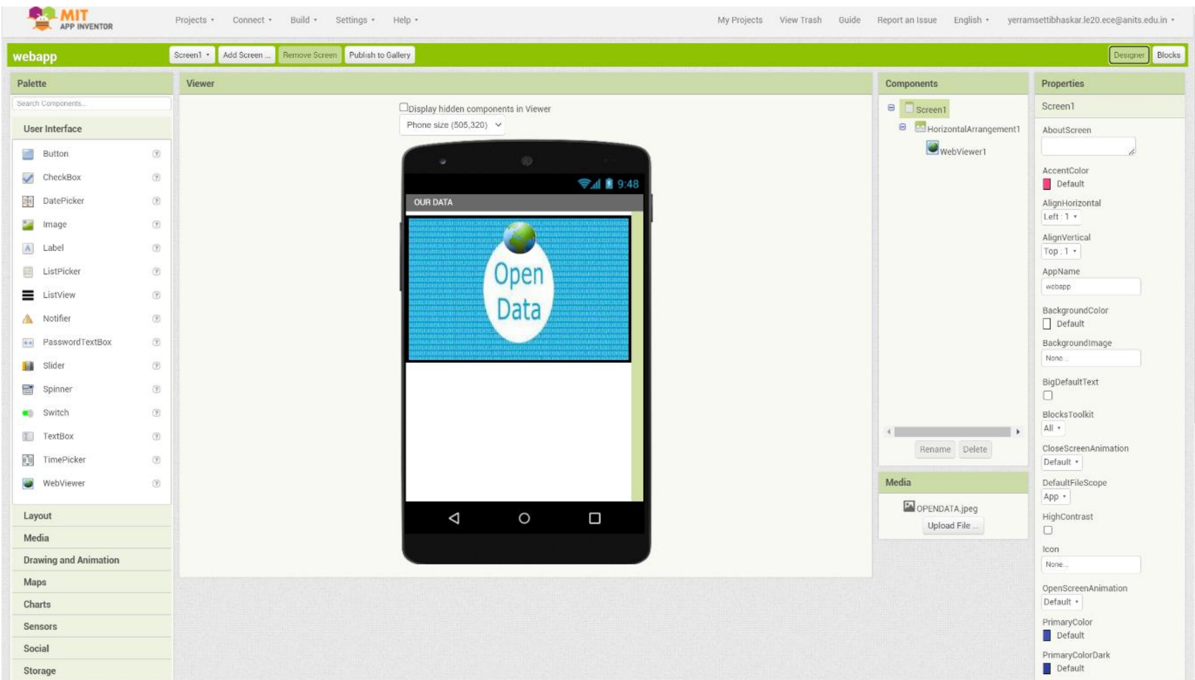


Fig 7.1MIT APP INVENTOR INTERFACE

7.2 STEPS TO DESIGN THE BLOCKS OF WEB APPLICATION

App Inventor has a component called WebViewer. We can load a webpage/website into an app using WebViewer component.

To do that, the following steps are used:

1. Drag the screen1 to the main screen .

2. Open the screen1.

3. On screen1 insert the horizontal arrangement1.

4. Insert a image called "Open Data" to the horizontal arrangement1.

5. Drag the WebViewer component to horizontal arrangement1.

6. Set the **HomeUrl** property of the **WebViewer** to the webpage we want to view when the app boots up.

7.Save all the changes and download the APK file

.**Fig7.2 App Interface in the Mobile**

7.3 ADVANTAGES

MIT App Inventor is a visual programming language and development platform that allows users to create mobile applications for Android devices. Here are some key advantages of using MIT App Inventor:

1. Easy to use: MIT App Inventor has a simple, user-friendly interface that allows even beginners to create functional apps quickly and easilywithout having to learn complicated coding languages.
2. Visual programming: MIT App Inventor uses visual programming blocks that users can drag and drop to create the logic and functionality of their app. This makes it easy to create complex apps without having to write a lot of code.
3. Free and open source: MIT App Inventor is free to use and open source, which means that anyone can use it to create apps without having to pay for expensive software or licenses.
4. Large community: MIT App Inventor has a large and active community of users and developers who share their knowledge and expertise, offer support, and provide feedback on apps created using the platform.
5. Integration with other services: MIT App Inventor integrates easily with other services such as Google Drive, Firebase, and Google Maps, making it easy to add features to apps without having to write additional code.
6. Real-time testing: MIT App Inventor allows users to test their apps in real-time on an Android device connected to their computer, which means they can see how their app will behave on a mobile device before publishing it.
7. Rapid app development: With MIT App Inventor, users can quickly prototype and develop apps, which is particularly useful for individuals or small businesses who need to bring their ideas to market quickly.

7.4 **SIGNIFICANCE OF MIT APP INVENTOR OVER OTHER SOFTWARE:**

1.Simple and User-Friendly Interface: MIT App Inventor has a drag-and-drop interface, which makes it easy to use for beginners who have no experience in programming.

2. Free and Open Source: MIT App Inventor is completely free and open source, making it accessible to everyone who wants to create mobile apps.

3. Cross-platform Development: MIT App Inventor allows you to create mobile apps for both Android and iOS platforms.

4. Integration with Google Services: MIT App Inventor is integrated with several Google services such as Google Maps, Google Drive, and Google Sheets, which makes it easy to use these services in your mobile apps.

5. Real-time Testing: With MIT App Inventor, you can test your mobile apps in real-time on your mobile device, which allows you to see how your app will work before you publish it.

6. Community Support: MIT App Inventor has a large community of developers who offer support and resources to help you create better mobile apps.

CHAPTER-8

CONCLUSION AND FUTURE SCOPE

8.1 Conclusion:

Because water is such a valuable resource, it is critical to keep track of it in order to maintain a healthy lifestyle.

This problem arose due to the scarce water resources, increasing population, and ageing infrastructure. As a result, better strategies for observation of state of water and traditional methods of water characterization are required.

Despite the fact that current approaches analyse physical, chemical, and biological agents, they have serious shortcomings, such as insufficient spatiotemporal coverage, labor-intensive and high costs (people, operation, and equipment), and a lack of real-time water quality data to support critical public health decisions. As a result, constant water quality monitoring is required, necessitating the use of this model.

8.2 Future Scope :

- Automation: IoT-based water quality monitoring systems can be automated to perform tasks such as sample collection, analysis, and data transmission. This will reduce the need for human intervention and make the monitoring process more efficient.
- integration with smart cities: Smart water surveillance systems can be integrated with other smart city technologies, such as smart traffic systems, to create a more efficient and sustainable city.
- Use of advanced sensors: Smart water surveillance systems can use advanced sensors, such as spectroscopy and hyperspectral imaging, to detect a wider range of water contaminants and provide more detailed information on water quality.
- Integration with blockchain: Smart water surveillance systems can be integrated with blockchain technology to create a secure and transparent system for managing water usage and transactions.

- Implementation of machine learning: Smart water surveillance systems can use machine learning algorithms to analyse large amounts of data and improve the accuracy of predictive analytics and anomaly detection.
- Incorporation of autonomous systems: Smart water surveillance systems can be upgraded to include autonomous systems, such as drones and underwater robots, to collect data in hard-to-reach areas and improve the efficiency of water management.
- Use of mobile apps: Smart water surveillance systems can be integrated with mobile apps to provide real-time information on water quality and usage to customers, allowing them to take proactive measures to conserve water and reduce waste.

By upgrading smart water surveillance systems with these technologies, we can further enhance their effectiveness in managing water resources and ensuring the sustainability of our water.

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