International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

"Arduino-Controlled Turbidity Meter: A Technical Study"

Vishal Mishra[1], Tarun Yadav[2], Akash Tripathi[3], Nilesh Rao[4], Dr. Abhinav Bhargava[5]

[1,2,3,4]Students, [5]Dr. Abhinav Bhargava, Department of Electronics and Communication Engineering, Bhopal Lakshmi Narain College of Technology & Science, Bhopal, India

***Abstract*-- Water quality assessment is a critical requirement in environmental monitoring, industrial processing, and public health management. Turbidity, which indicates the presence of suspended particles in water, must be measured accurately to prevent contamination-related hazards. However, conventional turbidity measurement systems are often expensive and require skilled handling, limiting their accessibility. To overcome these challenges, an Arduino-controlled turbidity meter is proposed, capable of providing low-cost, real-time turbidity monitoring with high reliability.**

The system uses an optical turbidity sensor based on light scattering principles to detect variations in water clarity. The sensor output is processed by an Arduino UNO microcontroller, which converts the analog readings into standardized Nephelometric Turbidity Units (NTU). An LCD module displays live turbidity values, while optional data logging and IoT connectivity allow remote monitoring. The design ensures stable operation through proper calibration, noise filtering, and controlled illumination using an infrared LED and photodiode pair.

***Keywords:-* Turbidity Meter, Arduino UNO, NTU Measurement, Water Quality Monitoring, Infrared LED–Photodiode Sensor, Signal Conditioning, LCD Display Module, IoT-Based Data Logging.**

I. INTRODUCTION

Water quality plays a crucial role in safeguarding human health, environmental balance, and industrial processes. One of the key indicators of water quality is turbidity, which represents the concentration of suspended particles such as silt, microorganisms, and chemical impurities. High turbidity levels can lead to contamination, reduced treatment efficiency, and potential health hazards. In many cases, manual sampling and laboratory testing are still relied upon, which are time-consuming, require skilled personnel, and often fail to provide real-time monitoring. Without timely detection, even minor changes in turbidity can escalate into major water quality issues, affecting communities and ecosystems.This system provides an efficient, economical, and user-friendly method for turbidity measurement, enabling quick detection of water contamination and reducing the risk of health and environmental hazards.

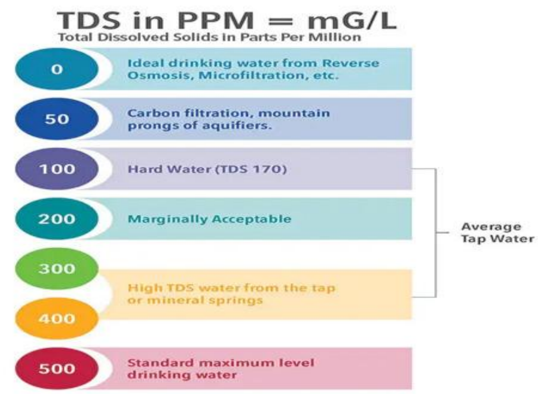

Fig 1: Total Dissolved Solids

II. PROBLEM FORMULATION

Water contamination is a serious issue that can lead to significant health risks, environmental degradation, and financial loss in treatment processes. In many cases, the quality of water cannot be assessed accurately in real time because traditional turbidity measurement methods rely on manual sampling and laboratory testing. Such methods are slow, prone to human error, and unsuitable for continuous monitoring. As a result, harmful levels of suspended particles, microorganisms, or sediments may go undetected until they become a major threat. The automated turbidity meter continuously analyzes water samples, alerts users to abnormal turbidity levels, and supports timely corrective actions. This ensures improved water safety, reduced human involvement, and a more reliable approach to maintaining water quality.

III. LITERATURE SURVEY

Md. Tanvir Rahman et al. proposed a low-cost turbidity measurement system based on the principle of light scattering, using an infrared LED and photodiode pair. The sensor output was processed through an Arduino platform to display turbidity in NTU units, making the system suitable for laboratory and field applications. [1]

S. Kumar and A. Thomas developed a portable water-quality monitoring device incorporating a turbidity sensor, temperature sensor, and pH probe. The system used a microcontroller to process sensor data and transmit readings wirelessly for remote monitoring. Their work highlighted the need for multitier environmental monitoring systems. [2]

R. B. Patil and team designed an IoT-based turbidity monitoring system using a TSD-10 optical sensor with an ESP8266 module for cloud data upload. Their system enabled continuous real-time analysis and automatic threshold alerts for sudden changes in water clarity. [3]

S. S. Shinde et al. constructed a Nephelometric Turbidity System using a laser diode as a light source to increase accuracy. Their design achieved improved sensitivity for low-turbidity samples and demonstrated reliable calibration curves for NTU measurement. [4]

M. U. Chowdhury and colleagues proposed an Arduino-controlled water-quality station integrating turbidity, conductivity, and dissolved-oxygen sensors. Their study emphasized modularity and low power consumption, making the system suitable for remote environmental monitoring. [5]

IV. METHODOLOGY

The main objective of this work is to develop an automated system capable of sensing and measuring water turbidity in real time without human intervention. The methodology consists of three major parts: the design structure, hardware implementation, and programming workflow. All these components were integrated together and tested to obtain accurate turbidity readings and display them in NTU values.

A. Design Structure

In this section, the prototype of the turbidity-monitoring system is presented. The system consists of a turbidity sensor, Arduino UNO microcontroller, LCD display module, connecting wires, and a stable water-sample chamber. Fig. 2 shows the basic prototype of our turbidity measurement setup.

The system performs four main functions:

1. *Initialization* – The Arduino initializes the turbidity sensor and LCD module once power is supplied.
2. *Sensing* – The turbidity sensor emits infrared light into the water sample and measures the amount of scattered/reflected light.
3. *Processing* – The Arduino converts the analog voltage output of the sensor into NTU values using a programmed calibration equation.
4. *Display & Monitoring* – The processed turbidity value is shown on the LCD display, and the system continuously updates readings for real-time monitoring.

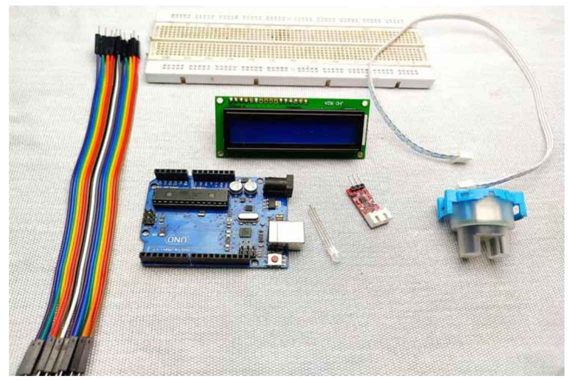

Fig 2: Prototype

B. Hardware Implementation

The hardware unit plays a crucial role in the construction of the turbidity-monitoring system. It includes the Arduino UNO, turbidity sensor, LCD display, power supply unit, and signal-conditioning circuitry. Fig. 3 shows the block diagram of the turbidity meter, where the turbidity sensor acts as the primary input to the system.

The Arduino UNO functions as the microcontroller that reads the sensor data, performs ADC conversion, executes the calibration algorithm, and sends output to the LCD. The turbidity sensor module typically contains an **IR LED and photodiode pair** to detect suspended particles. The LCD module (16×2) is used to display real-time NTU values. A stable container is used to hold the water sample for consistent readings.

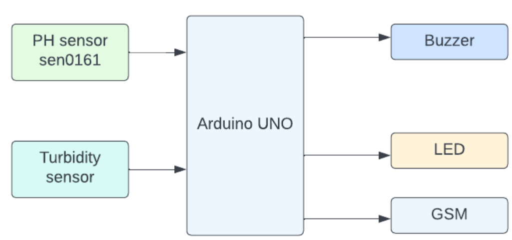

Fig 3: Block diagram

C. Hardware Used

1. ATmega328P IC(Arduino UNO)

Fig 4. shows the Arduino UNO board. It is basically a micro-controller kit that is used to get data from peripheral devices (sensors, motors, etc.).

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

The Arduino UNO Micro-controller board is based on the ATmega328P IC. The ATmega328P is good platform for robotics application which makes robot to extinguish fire in real time. Arduino UNO board consist the sets of digital and analog pins that may act as an interface to various expansion boards and other circuits. It contains everything needed to support the microcontroller.

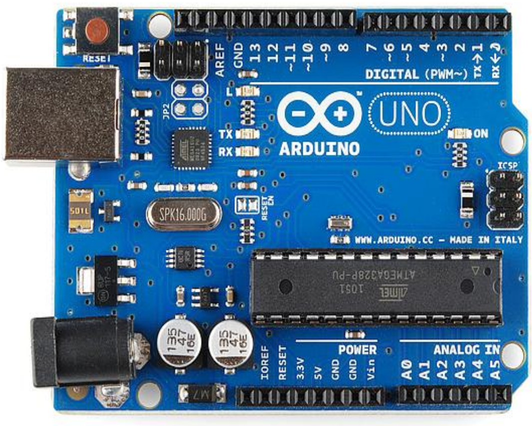

Fig 4: Arduino Uno

2. Fig. 5 shows the turbidity sensor module. The sensor works on the **light scattering principle**, where an infrared LED projects light into the water sample, and a photodiode measures the degree of scattering caused by suspended particles. Higher turbidity leads to higher scattering and lower received light intensity.

Fig 5: Turbidity Sensor

3. Fig. 6 shows the LCD module used to display NTU values. This display is interfaced with the Arduino using digital pins or the I2C interface, depending on the module. The LCD updates readings in real time, making the system user-friendly and suitable for continuous water-quality monitoring.

Fig 6: LCD Module

4. Fig. 7 shows the I²C communication module used with the LCD display. The I²C (Inter-Integrated Circuit) interface allows data transfer between the Arduino and LCD using only two lines—SDA for data and SCL for clock. This significantly reduces wiring complexity and frees multiple I/O pins on the microcontroller. The I²C module ensures stable, synchronized communication and provides efficient real-time display of turbidity values on the LCD.

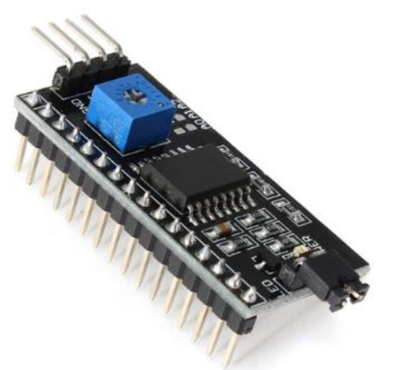

Fig 7: Servo Motor

5. Fig. 8 shows the interfacing components. Jumper wires connect the turbidity sensor, LCD, and Arduino. A regulated 5V supply powers the entire system. Proper grounding and wiring ensure stability in sensor readings.

International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 14, Issue 12, December 2025)

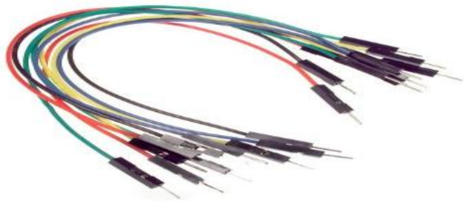

Fig 8: Jumper Wires

6. Fig. 9 shows the water sample container. A transparent, stable container is used to hold the water sample for measurement. Proper positioning ensures consistent optical alignment between the LED and photodiode, improving measurement accuracy.

Fig 9: Water sample container

V. CONCLUSION

The Water Turbidity Meter developed in this study provides an effective and low-cost solution for real-time monitoring of water quality. The project aims to design a system capable of continuously measuring turbidity levels and displaying them in NTU using simple and reliable hardware components.

The turbidity sensor detects variations in water clarity through light scattering, while the Arduino UNO processes the sensor output and calculates turbidity values. The use of an LCD display enables clear and immediate visualization of the measured data.

This system offers an efficient method to identify changes in water purity and can be applied in laboratories, filtration plants, aquaculture systems, and environmental monitoring. By automating turbidity measurement, the device reduces human effort, improves accuracy, and contributes to timely detection of contamination. Overall, the proposed turbidity meter serves as a practical and accessible tool for maintaining and evaluating water quality.

REFERENCES

[1] Md. Tanvir Rahman, M. A. Rahman, “Design and Development of a Low-Cost Turbidity Measuring System Using Optical Sensor and Microcontroller”, International Journal of Scientific & Engineering Research, Vol. 8, Issue 4, 2017.

[2] S. Kumar, A. Thomas, “Portable Water Quality Monitoring System Using Microcontroller-Based Sensors”, International Journal of Engineering Research & Technology, Vol. 5, Issue 3, 2016.

[3] R. B. Patil, S. Shinde, P. Ingale, “IoT Based Water Turbidity and Quality Monitoring System”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 12, 2017.

[4] S. S. Shinde, P. Patil, “Laser-Based Nephelometric Turbidity Measurement System”, IEEE International Conference on Electronics, Communication and Aerospace Technology (ICECA), 2018.

[5] M. U. Chowdhury, S. Haque, M. Rahman, “Arduino-Controlled Water Quality Station with Multi-Parameter Sensing”, Proceedings of the International Conference on Informatics, Electronics & Vision (ICIEV), 2019.