Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 08 , August - 2026

IoT Enabled Water Quality Monitoring with CNN-Based Contamination Detection

R Srinivasan[1]
M.Tech Student
Department of Electronics and Communication Engineering (ECE)
National Institute of Technical Teachers Training and Research (NITTTR), Chennai

Dr. P. Sivasankar[2]
Professor
Department of Electronics and Communication Engineering (ECE)
National Institute of Technical Teachers Training and Research (NITTTR), Chennai

Dr. G. Kulanthaivel[3]
Professor & Head,
Department of Electronics and Communication Engineering (ECE)
National Institute of Technical Teachers Training and Research (NITTTR), Chennai

***Abstract* - Water quality monitoring has become an essential requirement due to increasing water pollution caused by industrialization, agricultural activities, and improper waste disposal. Traditional water quality analysis methods are time-consuming, require manual sampling, and lack real-time monitoring capabilities. To overcome these limitations, this project presents an IoT Enabled Water Quality Monitoring System with CNN-Based Contamination Detection for continuous and intelligent water quality assessment. The system uses multiple sensors such as pH, turbidity, TDS, and DHT11 sensors interfaced with an Arduino Uno to collect real-time water quality parameters. The collected data is transmitted to a Raspberry Pi Foundation Raspberry Pi, where a Convolutional Neural Network (CNN) model is implemented to classify water as safe or contaminated based on trained datasets. The system is integrated with IoT technology to upload real-time sensor data to a cloud platform for remote monitoring and analysis. A GSM module is used to send alert notifications during abnormal or unsafe water conditions, while an I2C LCD displays instantaneous sensor readings. The proposed system provides improved accuracy, intelligent contamination detection, remote accessibility, and reduced manual effort compared to conventional monitoring methods. The developed solution is cost-effective, scalable, and suitable for applications such as drinking water monitoring, agriculture, industrial water management, and smart environmental monitoring systems.**

Keywords - Water Quality Monitoring, IoT, CNN, Contamination Detection, Arduino Uno, Raspberry Pi, Smart Water Management, Real-Time Monitoring, GSM Alert System.

I. INTRODUCTION

Water is one of the most essential natural resources required for human life, agriculture, and industrial activities. However, increasing pollution, industrial waste, and improper disposal of contaminants have significantly affected water quality, creating a need for continuous monitoring and analysis. Traditional water quality monitoring methods are time-consuming, require manual sample collection, and do not support real-time monitoring capabilities. To overcome these limitations, this project presents an IoT-enabled Water Quality Monitoring System with CNN-Based Contamination Detection. The system uses sensors such as pH, turbidity, TDS, and DHT11 connected to an Arduino Uno for real-time data collection. The collected data is processed using a Raspberry Pi Foundation Raspberry Pi, where a Convolutional Neural Network (CNN) model is implemented to classify water as safe or contaminated. The integration of IoT technology enables remote monitoring and cloud-based data storage, while GSM alerts provide immediate notifications during abnormal conditions. The proposed system offers an intelligent, cost-effective, and scalable solution for modern water quality management applications.

A. PROBLEM STATEMENT

Traditional water quality monitoring systems mainly depend on manual sampling and laboratory analysis, which are time-consuming, expensive, and unable to provide real-time monitoring. Existing IoT-based systems can monitor basic water parameters but mostly rely on predefined threshold values, limiting their ability to detect complex contamination patterns accurately. These systems also lack intelligent decision-making, predictive analysis, and efficient remote monitoring capabilities. In addition, delayed detection of contaminated water can create serious health and environmental risks. Therefore, there is a need for a smart, real-time, and intelligent water quality monitoring system that combines IoT technology with CNN-based contamination detection for accurate analysis, automated monitoring, and instant alert generation.

II. CONTRIBUTIONS

- Development of an IoT-enabled water quality monitoring system using Arduino Uno integrated with multiple sensors for real-time water parameter monitoring.
- Implementation of a Convolutional Neural Network (CNN) model on the Raspberry Pi Foundation Raspberry Pi for intelligent classification of water as safe or contaminated.
- Integration of cloud-based IoT technology for remote monitoring, real-time data storage, and visualisation of water quality parameters.
- Development of a GSM-based alert mechanism to provide instant notifications during abnormal or unsafe water conditions for quick preventive action.
- Development of an intelligent alert system using a buzzer and predictive insights to notify users about hazardous pollution levels and potential health risks.

III. LITERATURE SURVEY

This paper presents an IoT-based water quality monitoring and alert system for real-time analysis of water parameters. Various sensors are used to measure important water quality indicators, and the collected data is transmitted to a cloud platform for remote monitoring and visualization. The system also generates alerts during abnormal conditions to improve

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 08 , August - 2026

safety and monitoring efficiency. Although the model supports continuous monitoring and remote accessibility, it does not include advanced CNN-based intelligent contamination detection and deep learning analysis[1].

This presents an IoT-based water quality monitoring and alert system for real-time analysis of water parameters. Various sensors are used to measure important water quality indicators, and the collected data is transmitted to a cloud platform for remote monitoring and visualization. The system also generates alerts during abnormal conditions to improve safety and monitoring efficiency. Although the model supports continuous monitoring and remote accessibility, it does not include advanced CNN-based intelligent contamination detection and deep learning analysis[2].

This presents an IoT-enabled system for detecting and analysing microplastic pollution in water using Convolutional Neural Networks (CNNs). The system collects real-time image data from distributed IoT sensor nodes and uses a trained CNN model to identify and quantify microplastics of different shapes, sizes, and colours in water samples. Edge computing is incorporated to reduce processing delay and improve responsiveness. The proposed approach enables scalable, real-time monitoring of water systems and provides accurate environmental analysis, making it useful for pollution control and water quality management[3].

This paper proposes an integrated IoT and machine learning framework for water quality monitoring and prediction. It uses IoT sensors such as pH, temperature, turbidity, and TDS to collect real-time water data. The collected data is pre-processed and analysed using multiple machine learning models to predict Water Quality Index (WQI) and classify Water Quality Class (WQC). Regression models (MLP, LSTM, SVR, NARNet) are used for WQI prediction, while classification models (Random Forest, SVM, XGBoost) are used for water quality classification. The results show that MLP performs best for prediction tasks and Random Forest achieves the highest accuracy for classification, demonstrating the effectiveness of the IoT-based machine learning approach for water quality analysis[4].

This paper proposes an integrated IoT and machine learning framework for water quality analysis and prediction. Water quality parameters such as pH, temperature, turbidity, and total dissolved solids are collected using IoT sensors. The data is preprocessed and analyzed using multiple machine learning models to predict Water Quality Index (WQI) and classify water quality levels (WQC). Both regression and classification techniques are evaluated, with models like MLP and Random Forest showing the best performance. The system demonstrates effective real-time water quality monitoring and predictive capability using IoT-based data acquisition and machine learning techniques[5].

This paper proposes an IoT-based framework for water quality monitoring and analysis. It integrates IoT sensors to collect water parameters such as pH, turbidity, temperature, and dissolved solids. The collected data is processed using machine learning techniques to evaluate and predict water quality conditions. The system supports real-time monitoring and intelligent decision-making for efficient water resource management. The study demonstrates that combining IoT and AI improves the accuracy and effectiveness of water quality assessment systems[6].

This paper proposes a hybrid deep learning approach for water quality prediction. It uses water quality parameters such as pH, temperature, turbidity, and dissolved solids collected from datasets or sensors. The system applies deep learning and machine learning models to predict water quality levels and improve classification accuracy. The performance of different models is compared, and the proposed hybrid approach shows better accuracy in predicting water quality compared to traditional methods. The study demonstrates the effectiveness of AI-based techniques for environmental water quality analysis[7].

This paper proposes an IoT-based water quality monitoring system integrated with machine learning techniques for analyzing and predicting water quality conditions. The system collects real-time data using sensors such as pH, temperature, turbidity, and dissolved solids. The collected data is processed using intelligent algorithms to assess and classify water quality levels. The framework enables continuous monitoring and improves decision-making for environmental management. The study demonstrates that combining IoT with machine learning enhances the accuracy and efficiency of water quality monitoring systems[8].

This paper reviews recent advancements in IoT-based water quality monitoring and wastewater management systems. It discusses various sensor technologies, communication protocols, and cloud-based architectures used for real-time water monitoring. The study also highlights the integration of IoT with machine learning and AI techniques to improve water quality analysis and decision-making. The paper further identifies challenges such as scalability, data accuracy, and system integration, and suggests future research directions in smart water management systems[9].

This paper proposes an IoT and machine learning-based framework for water quality monitoring and analysis. The system collects real-time water quality data using sensors such as pH, temperature, turbidity, and dissolved solids. The collected data is processed using machine learning techniques to evaluate and predict water quality conditions. The framework enables continuous monitoring and intelligent decision-making for water resource management. The study shows that combining IoT with machine learning improves the accuracy and efficiency of water quality monitoring systems[10].

Table 1 *Hardware Components and Their Functions in IoT Enabled Water Quality Monitoring System*

S.No	Components	Specifications / Model	Function in System
1	Arduino Uno	Microcontroller Board	Collects and processes sensor data
2	Raspberry Pi	Single Board Computer	Performs CNN-based contamination detection
3	pH Sensor	Analog pH Sensor Module	Measures acidity and alkalinity of water
4	TDS Sensor	Total Dissolved Solids Sensor	Measures dissolved solids

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 08 , August - 2026

			concentration in water
5	Turbidity Sensor	Turbidity Sensor Module	Detects water clarity and suspended particles
6	DHT11 Sensor	Temperature & Humidity Sensor	Temperature & Humidity Sensor
7	GSM Module	GSM Communication Module	Sends alert messages during abnormal conditions
8	Connectors	Jumper Wires	Connects components and sensors
9	I2C LCD	16x2 LCD Display Module	Displays real-time water quality parameters
10	Buzzer	Piezoelectric Buzzer	Provides alert during unsafe water conditions
11	Web Camera	USB Camera Module	Captures visual monitoring data
12	Micro SD Card	Storage Module	Stores collected sensor data
13	Power Supply	5V / 12V DC Supply	Provides power to the system
14	Adapter	Regulated DC Supply	Provides stable voltage to the system

IV. EXISTING SYSTEMS

Existing water quality monitoring systems mainly depend on manual sampling and laboratory analysis methods, which are time-consuming, costly, and unsuitable for continuous monitoring. With the development of IoT technology, some systems use sensors and microcontrollers to monitor parameters such as pH, turbidity, and TDS in real time. These systems can upload data to cloud platforms and provide remote access to water quality information.

However, most existing systems rely on predefined threshold values for contamination detection, which limits their ability to identify complex pollution patterns accurately. They also lack intelligent analysis, predictive capabilities, and automated decision-making mechanisms. In addition, many systems do not provide efficient alert generation or advanced data classification techniques, reducing overall reliability and monitoring efficiency in dynamic environmental conditions.

V. PROPOSED METHODOLOGY

The proposed system presents an IoT Enabled Water Quality Monitoring System with CNN-Based Contamination Detection for real-time and intelligent water quality assessment. The system integrates multiple sensors such as pH, turbidity, TDS, and DHT11 with an Arduino Uno to continuously monitor important water quality parameters. The collected sensor data is transmitted to a Raspberry Pi Foundation Raspberry Pi, which acts as the central processing unit for advanced analysis and decision-making.

A Convolutional Neural Network (CNN) model is implemented on the Raspberry Pi to classify water as safe or contaminated based on trained datasets. The sensor data is pre-processed and analyzed by the CNN model to improve contamination detection accuracy and identify complex pollution patterns. The CNN model is trained using water quality datasets containing safe and contaminated water samples.

Convolution layers extract important features from the input data, while pooling and fully connected layers perform classification. Based on learned patterns, the model predicts whether the water is safe or contaminated with improved accuracy. The system is integrated with IoT technology to upload real-time data to a cloud platform for remote monitoring, visualization, and storage. An I2C LCD is used to display instantaneous sensor readings, while a GSM module sends alert notifications during abnormal or unsafe water conditions.

a. BLOCK DIAGRAM

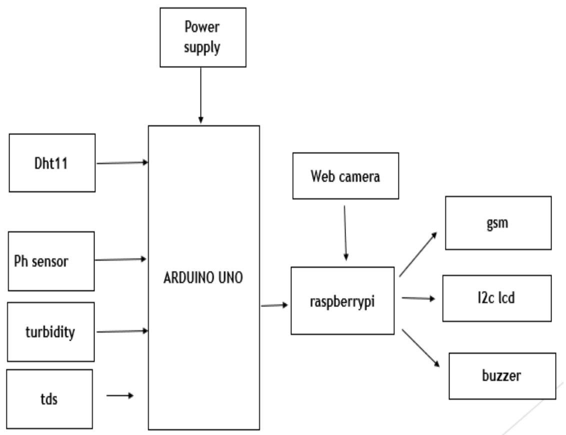

Fig. 1. Block Diagram of Proposed IoT Enabled Water Quality Monitoring System with CNN-Based Contamination Detection

Fig. 1 shows the block diagram of the proposed IoT-enabled water quality monitoring system with CNN-based contamination detection. The system consists of pH, turbidity, TDS, and DHT11 sensors connected to an Arduino Uno for real-time acquisition of water quality parameters. The collected data is transmitted to a Raspberry Pi, where a CNN model performs intelligent contamination detection and water quality classification. A web camera is used for visual monitoring, while the GSM module provides alert notifications during abnormal conditions. The I2C LCD displays real-time sensor

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 08 , August - 2026

readings, and the buzzer generates local alerts when unsafe water conditions are detected. The processed data can also be uploaded to a cloud platform for remote monitoring and analysis.

b. FLOW CHART

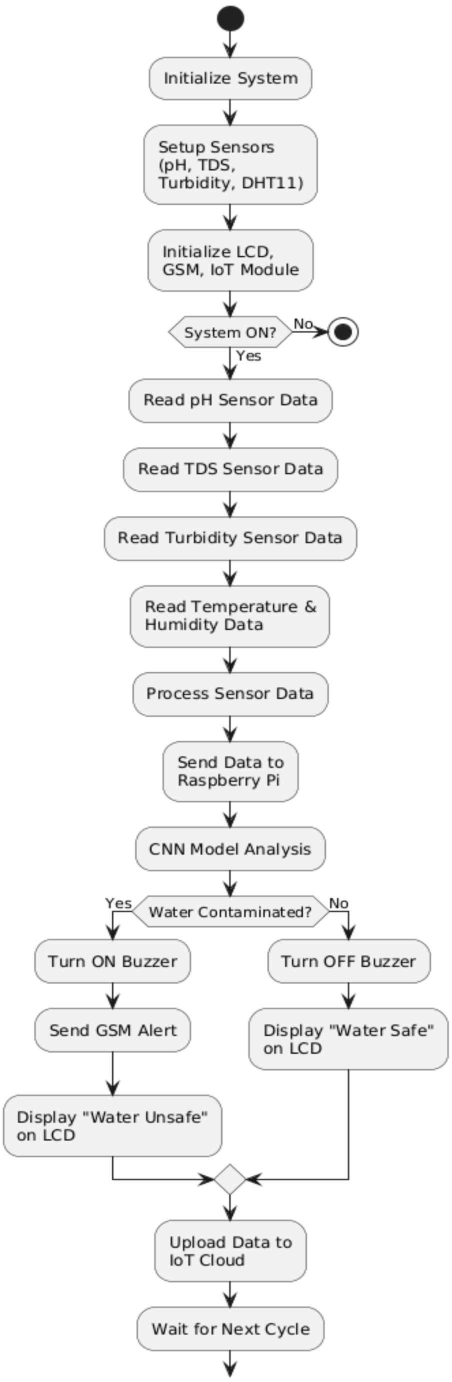

Fig. 2. Flow Chart of Proposed IoT Enabled Water Quality Monitoring System with CNN-Based Contamination Detection

Fig. 2 illustrates the workflow of the proposed IoT-enabled water quality monitoring system. The Arduino Uno collects data from the pH, TDS, turbidity, and DHT11 sensors and sends it to the Raspberry Pi for CNN-based contamination analysis. Based on the classification result, the system generates buzzer and GSM alerts for contaminated water or displays a safe status on the LCD. The monitored data is then uploaded to the IoT cloud platform for remote monitoring and storage.

VI. RESULT

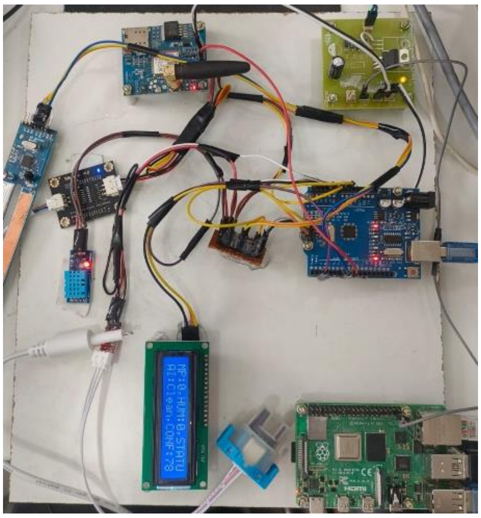

Fig. 3. Hardware Implementation of IoT-Based Water Quality Monitoring System

Fig. 3 represents the hardware implementation of the proposed IoT-enabled water quality monitoring system. The prototype consists of pH, TDS, turbidity, and DHT11 sensors interfaced with an Arduino Uno for real-time data acquisition. The collected sensor data is transmitted to the Raspberry Pi, which performs CNN-based contamination detection and water quality classification. An I2C LCD displays real-time monitoring results, while the GSM module and buzzer provide alert notifications during unsafe water conditions. The integrated hardware setup demonstrates a low-cost and intelligent solution for continuous water quality monitoring and remote IoT-based analysis.

Fig. 4. LCD Display Showing Real-Time Water Quality Status and Environmental Parameters

Fig. 4 represents the real-time output displayed on the 16×2 I2C LCD module of the proposed water quality monitoring system. The LCD shows important monitoring parameters, including humidity, water quality status, and the contamination prediction generated by the CNN model. The displayed "Clean" status indicates that the monitored water sample is safe and within

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 08 , August - 2026

acceptable quality limits. The LCD provides immediate visual feedback, enabling users to monitor water conditions in real time.

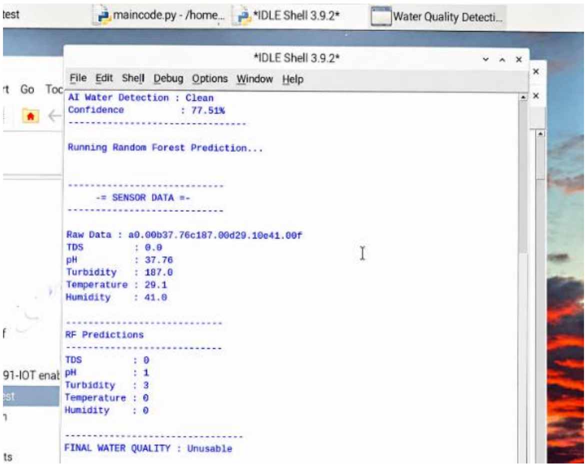

Fig. 5. CNN and Random Forest Based Water Quality Prediction Output

Fig. 5 represents the water quality prediction output generated using CNN and Random Forest models. Real-time sensor parameters such as pH, turbidity, TDS, temperature, and humidity are analyzed to classify water quality. The system predicts the water condition as "Unusable" with a confidence score of 77.51%, demonstrating the effectiveness of intelligent contamination detection and automated water quality assessment.

VII. CONCLUSION

The proposed IoT Enabled Water Quality Monitoring with CNN-Based Contamination Detection system provides an efficient and intelligent solution for real-time water quality assessment. By integrating sensors with Arduino Arduino Uno, continuous monitoring of important parameters such as pH, turbidity, TDS, and temperature is achieved. The implementation of a CNN model on Raspberry Pi Foundation Raspberry Pi improves contamination detection accuracy by intelligently classifying water as safe or contaminated. The integration of IoT technology enables remote monitoring and cloud-based data storage, while the GSM module provides instant alerts during abnormal conditions. Compared to traditional methods, the proposed system reduces manual effort, improves reliability, and supports real-time decision-making. Overall, the system is cost-effective, scalable, and suitable for applications such as drinking water monitoring, agriculture, industrial water management, and smart environmental monitoring systems.

VIII. FUTURE SCOPE

The proposed IoT Enabled Water Quality Monitoring system can be further enhanced by integrating advanced artificial intelligence and cloud computing technologies for more accurate and predictive analysis. Future improvements may include the use of advanced deep learning models for better contamination classification and early detection of harmful pollutants. Additional sensors can also be integrated to monitor more water quality parameters such as dissolved oxygen, ammonia, and chlorine levels. The system can be expanded with mobile application support for real-time monitoring and alert notifications from anywhere. Integration with smart city infrastructure and large-scale water distribution networks can improve automated water management and environmental monitoring. Furthermore, renewable energy sources such as solar power can be incorporated to make the system more energy-efficient and suitable for remote area deployment.

REFERENCES

[1] A. R. Gour, R. Kumar, V. Reddy, U. D. Amruthaluru, S. Hariharan, and V. Kukreja, "Detection of Water Quality for Health Monitoring through CNN Image Analysis," Proceedings - 2024 4th International Conference on Pervasive Computing and Social Networking, ICPCSN 2024, pp. 31–36, 2024, doi: 10.1109/ICPCSN62568.2024.00013.

[2] M. Velammal, V. Rakesh, K. Kartheeban, K. Ali Qidwai, G. Shyamala, and T. Thulasimani, "Intelligent IoT-Based Water Quality Monitoring System Using TD-CNN-LSTM Approach," International Conference on Self Sustainable Artificial Intelligence Systems, ICSSAS 2023 - Proceedings, pp. 1300–1305, 2023, doi: 10.1109/ICSSAS57918.2023.10331871.

[3] M. D. A. Hasan, K. Balasubadra, G. Vadivel, N. Arunfred, M. V. Ishwarya, and S. Murugan, "IoT-Driven Image Recognition for Microplastic Analysis in Water Systems using Convolutional Neural Networks," 2024 2nd International Conference on Computer, Communication and Control, IC4 2024, 2024, doi: 10.1109/IC457434.2024.10486490.

[4] M. A. Rahu, A. F. Chandio, K. Aurangzeb, S. Karim, M. Alhussein, and M. S. Anwar, "Toward Design of Internet of Things and Machine Learning-Enabled Frameworks for Analysis and Prediction of Water Quality," IEEE Access, vol. 11, pp. 101055–101086, 2023, doi: 10.1109/ACCESS.2023.3315649.

[5] S. Chopade, H. P. Gupta, R. Mishra, A. Oswal, P. Kumari, and T. Dutta, "A Sensors-Based River Water Quality Assessment System Using Deep Neural Network," IEEE Internet Things J., vol. 9, no. 16, pp. 14375–14384, Aug. 2022, doi: 10.1109/JIOT.2021.3078892.

[6] A. K. Shakir, C. Bharathi, P. Girish, M. Aich, and R. Susan Poonguzhali, "LoRa-Based Intelligent Edge Framework for Water Quality Monitoring Using CNN with Squeeze-and-Excitation," 2nd International Conference on Intelligent Algorithms for Computational Intelligence Systems, IACIS 2025, 2025, doi: 10.1109/IACIS65746.2025.11210895.

[7] K. P. Rasheed Abdul Haq and V. P. Harigovindan, "Water Quality Prediction for Smart Aquaculture Using Hybrid Deep Learning Models," IEEE Access, vol. 10, pp. 60078–60098, 2022, doi: 10.1109/ACCESS.2022.3180482.

[8] A. P. Gopi and K. Jairam Naik, "A Model for Analysis of IoT based Aquarium Water Quality Data using CNN Model," 2021 International Conference on Decision Aid Sciences and Application, DASA 2021, pp. 976–980, 2021, doi: 10.1109/DASA53625.2021.9682251.

[9] A. Alshami, E. Ali, M. Elsayed, A. E. E. Eltoukhy, and T. Zayed, "IoT Innovations in Sustainable Water and Wastewater Management and Water Quality Monitoring: A Comprehensive Review of Advancements, Implications, and Future Directions," IEEE Access, vol. 12, pp. 58427–58453, 2024, doi: 10.1109/ACCESS.2024.3392573.

[10] M. S. Pillai, B. Vidyapeeth, and N. B. Vidyapeeth, "Binary Image Classification of Water Samples Using Convolutional Neural Networks and Transfer Learning for Environmental Monitoring," Nov. 2025, doi: 10.21203/RS.3.RS-7828607/V1.