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Enhancing Water Sustainability For Efficient Agricultural Irrigation And Consumer Consumption

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ABSTRACT

Water is a fundamental requirement for human, animal, and plant survival. As consumers use water, primarily sourced from pipes and springs located around towns, contamination, leakages, and pilferage happen. A major issue nowadays is the disposal of harmful chemicals, industrial waste, and other contaminants into water sources. The quality of the water determines how well plants, animals, and people can survive. IoT and Machine Learning offer a promising solution to address these challenges. To ensure a secure Drinking and Irrigation purpose water supply, it is imperative to continuously monitor its quality in real-time. The main objective is to design the system for real-time monitoring of water quality through the Internet of Things (IoT) and Machine Learning approach.

1. INTRODUCTION

Real-time monitoring of water quality encounters obstacles due to factors like global warming, limited water resources, and burgeoning population. Despite numerous technological advancements, the proliferation of pollution and global warming poses significant challenges, jeopardizing the availability of safe drinking water on a global scale. The system incorporates multiple sensors to gauge both physical and chemical water parameters, including Temperature, PH, and Turbidity. The obtained data from these sensors are processed by a central controller, with the Esp model serving as a viable option. The sensor data can be accessed online using a Wi-Fi system which act as input for the Machine Learning Model which is for detecting the water quality with better accuracy.

In the 21st century, despite numerous technological advancements, the proliferation of pollution and global warming poses significant challenges, jeopardizing the availability of safe drinking water on a global scale. Real-time monitoring of water quality encounters obstacles due to factors like global warming, limited water resources, and a burgeoning population. Consequently, there is an imperative to devise more effective methodologies for real-time monitoring of water quality parameters. Key water quality parameters include PH, which quantifies the concentration of hydrogen ions and indicates whether water is acidic or alkaline. Pure water possesses a ph value of 7, with values below 7 signifying acidity and values above 7 indicating alkalinity. The ph scale ranges from 0 to 14, with the recommended range for drinking water being 6.5-8.5. Turbidity assesses the quantity of invisible suspended particles in water; higher turbidity levels elevate the risk of diseases such as diarrhea and cholera, while lower turbidity signifies cleaner water. Temperature sensors provide informationabout whether water is hot or cold, providing insight into its thermal conditions.

The availability of water is a crucial aspect of human life and is now recognized as a fundamental human right. Access to clean water is also enshrined in the 17 Sustainable Development Goals (SDGS) established by the United Nations in 2015, aimed at creating a better future for all. Notably, the sixth goal focuses on ensuring and sustaining universal access to water and sanitation.

Clean drinking water is also intertwined with the third SDG goal – promoting good health and well-being. Contaminated water can act as a vector for diseases such as cholera, typhoid, and diarrhea, collectively the leading causes of mortality, especially among children, in developing nations of Africa and Asia. Water plays a pivotal role in agriculture and food production. Recent statistics reveal that around 10% of the global population is malnourished, with developing countries bearing the brunt, and starvation being a contributing factor in about 45% of infant mortality. Addressing these water- related challenges is of paramount importance.

2. LITERATURE SURVEY

Title: Water Quality Classification Using an Artificial Neural Network(ANN)

Author: Khadijah Sulaiman1, Lokman Hakim Ismail1,

Year:

Description: Malaysia is currently a rapidly developing country to achieve a 2020 vision. However the development that has been carried out contributed to a negative impact on the environment especially on water quality. Due to the deterioration of water quality, serious management efforts on water quality has been taken. Thus, the aim of this study is to investigate a technique that can automatically classify the water quality. The technique is based on the concept of Artificial Neural Network (ANN). Since the greater part of their methodologies depend on the idea of `pattern recognition'. Thus, it is convenient to inspect its ability in classify water quality. There are six environmental data were used in this study such as pH, total suspended solids (TSS), dissolved oxygen (DO), chemical oxygen demand

(COD), biological oxygen demand (BOD), and ammonia. The data was obtained by in-site measurement and laboratory analysis. Then, the data was used as the feeder of input variables in the ANN database system. After training and testing the network of ANN, the result showed that 80.0% of accuracy classification with 0.468 of root mean square error (RMSE). This showed the encouraging results for classification.

Title: WaterNet: A Network for Monitoring and Assessing Water Quality for Drinking and Irrigation Purposes

Author: Zaheed Gaffoor, Kevin C, Antoine B.

Year: 2022

Description: The World Health Organization has guidelines which stipulate the threshold levels of various parameters present in water samples intended for consumption or irrigation. Collecting water samples from different sources, measuring the various parameters present, and bench-marking these measurements against pre-set standards, while adhering to various guidelines during transportation and measurement can be extremely daunting. To this end this study proposes a network architecture to collect data on water parameters in real-time and use Machine Learning (ML) tools to automatically determine suitability of water samples for drinking and irrigation purposes. Three ML models - Random Forest (RF), Logistic Regression (LR) and Support Vector Machine (SVM) were considered for the water classification process and results obtained showed that LR performed best for drinking water, while SVM was better suited for irrigation water.

Title: Use of Water Quality Index as a Tool for Urban Water Resources Management

Author: A.R. FinottI, R. Finkler, N. Susin , V.E. Schneider

Year: 2020

Description: The quality of water resources in urban areas has undergone degradation due to the discharge of domestic and industrial wastewaters and urbanization among other factors. Despite the legal instruments that aim to preserve water bodies, other mechanisms should be implemented, such as monitoring networks and reporting results. Another challenge is the interpretation of the results that may support decision making on the actions that must be taken to preserve the water quality. In this study, we examined the results of physicochemical and microbiological analyses in a monitoring network that comprised 12 sampling stations. Results were compared with water quality standards established in legislation and calculation of two water quality indexes, the Canadian Council of Ministers of the Environment water quality index (CCME WQI) and the National Sanitation Foundation–Environmental Sanitation Technology Company of the State of São Paulo (Cetesb) WQI. Conclusion is that the comparison with quality threshold limits as defined in the legislation, although complete, prevents the reporting on the overall quality of the water body. Application of the quality index allowed communication and interpretation of the results. Another conclusion is that the Cetesb WQI can indicate the degree of contamination of waters impacted by domestic sewage, while the CCME WQI is an effective tool to assess water resources considering different sources of contamination and current legal aspects.

Title: IoT based Smart Water Quality Monitoring System Author: Varsha Lakshmikantha, Aruna Patted

Year: 2021

Description: Pollution of water is one of the main threats in recent times as drinking water is getting contaminated and polluted. The polluted water can cause various diseases to humans and animals, which in turn affects the life cycle of the ecosystem. If water pollution is detected in an early stage, suitable measures can be taken and critical situations can be avoided. To make certain the supply of pure water, the quality of the water should be examined in real-time. Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication, and Internet of Things (IoT) technology

Title: Water Quality Monitoring Using IoT & Machine LearningAuthor: Andrew Omambia, Benard Maake, Anthony Wambua **Year:** 2022

Description: Safe water access is fundamental form of human survival and it ispresented as a fundamental human right. As consumers use water, primarily sourced from pipes and springs located around towns, contamination, leakages, and pilferage happen. IoT and Machine Learning offer a promising solution to address these challenges. Premised on these technologies, the authors propose a system that monitors water quality and pilferage and wastage that uses machine learning algorithms for decision making.

3. PROPOSED SYSTEM

The proposed system is designed and developed as a low-cost system for real time monitoring of the water quality based on IOT (Internet of Things) and Machine Learning. The system consists of several sensors used to measuring physical and chemical parameters of the water. The parameters such as temperature, PH, turbidity, measured. The measured values from the sensors can be processed by the core controller. The ESP8266 model can be used as a core controller.

4. MODULES

4.1.1 Sensor Data Presentation

The IoT sensor module in a water quality detection system is a pivotal element responsible for the accurate and real-time collection of crucial data. Placement of sensors is strategically considering factors such as potential pollutant sources to capture representative data. The system incorporates multiple sensors to gauge both physical and chemical water parameters, including Temperature, PH and Humidity.

4.1.2 Data Aggregation

Data aggregation within the context of a water quality detection system is a critical process that involves the collection, organization, and consolidation of sensor- generated data for meaningful analysis. The obtained data from these sensors are processed by a central controller, with the Esp model serving as a viable option. Ultimately, the sensor data can be accessed online using a Wi-Fi system to the central system.

4.1.3 Framework Formulation

Model development module in water quality detection system, responsible for creating robust models that can accurately predict water quality based on historical data. It involves a series of key steps to ensure the effectiveness and reliability of the Machine Learning model. Firstly, it encompasses feature selection, where relevant features from the water quality dataset are identified. Secondly, the module involves data preprocessing, where the collected data undergoes various treatments such as normalization, handling missing values, and addressing outliers. The core of the module is the actual training of Machine Learning model. Algorithm such as Decision Tree model is used based on the nature of the prediction task.

4.1.4 Model Consolidation

Model integration is a crucial phase within the water quality detection system that involves seamlessly incorporating machine learning models into the broader Internet of Things (IoT) infrastructure. Once Machine Learning model is trained to predict water quality based on historical data, the model integration module acts as the bridge between the data processing layers and the real-world application. This module ensures that the trained model can receive input data from sensors, make predictions, and communicate their results effectively within the system.

5. CONCLUSION

The developed work focused on the proposal of real-time water monitoring network for gathering data on water parameters from water bodies. The system exhibits excellent flexibility as it can be adapted to monitor various water quality parameters by simply replacing sensors and adjusting relevant software programs. The modular nature of IoT-based systems allows for scalability and adaptability to diverse water bodies and environmental contexts. This flexibility ensures that the predictive models remain effective across varying geographical locations and changing conditions. The fusion of IoT and machine learning holds immense promise for creating sustainable solutions to ensure clean and safe water for generations to come.

6. RESULT

Fig 1: Temperature and Humidity Variation

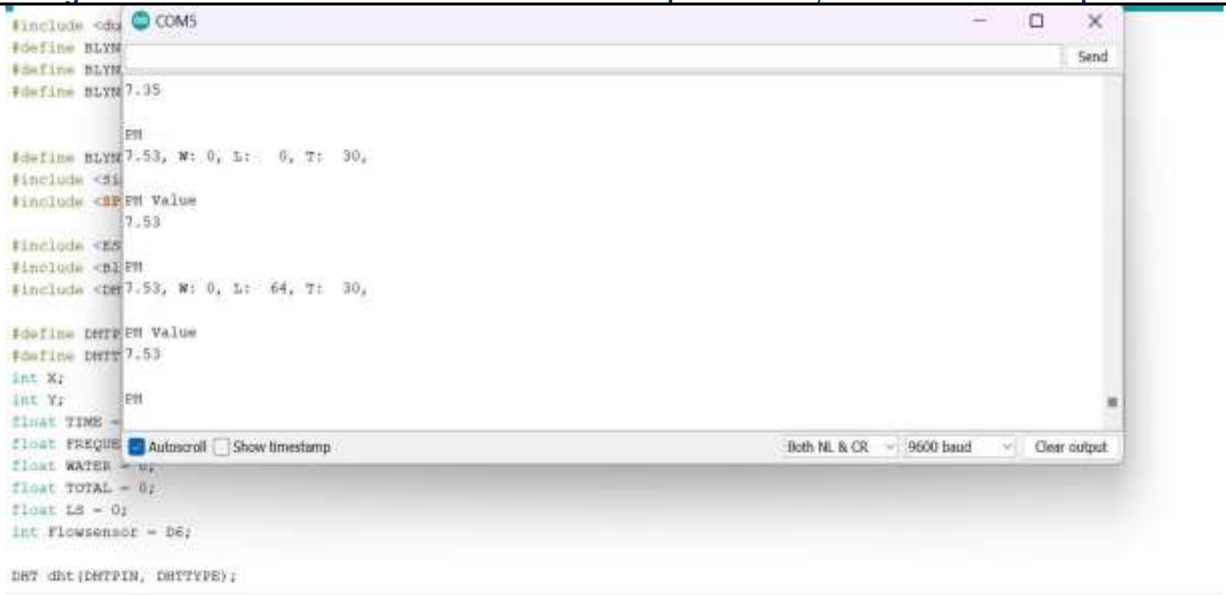

Fig 2: PH value Detected Using the Hardware Component

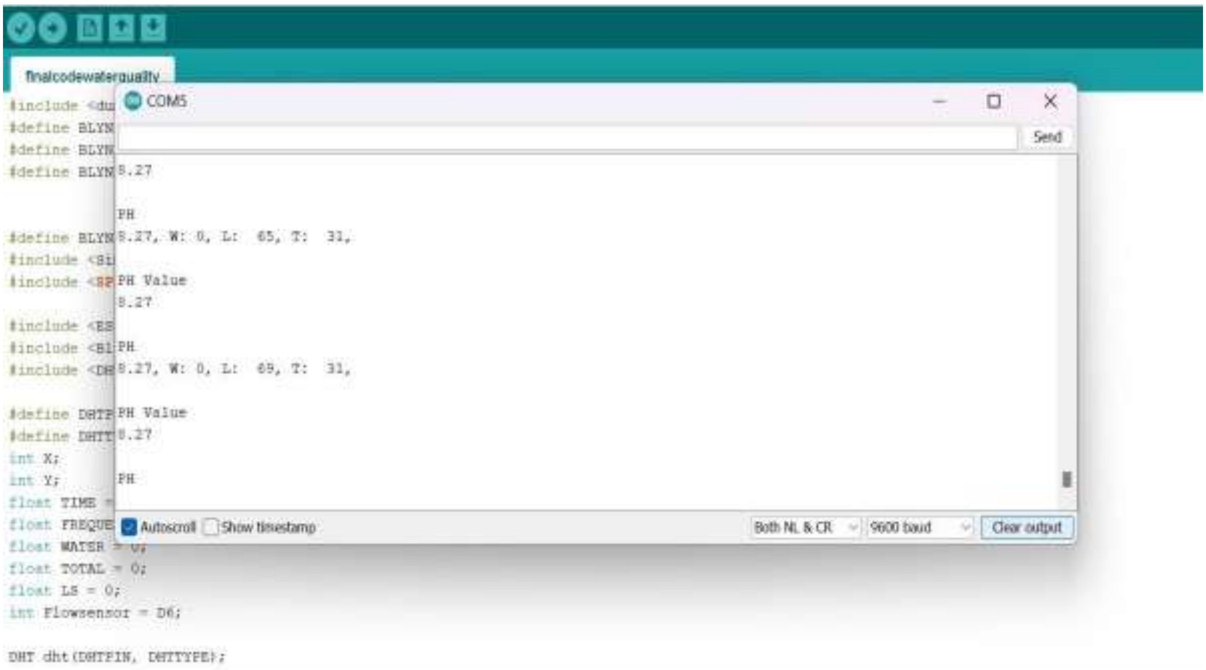

Fig 3: Varied PH value Detected

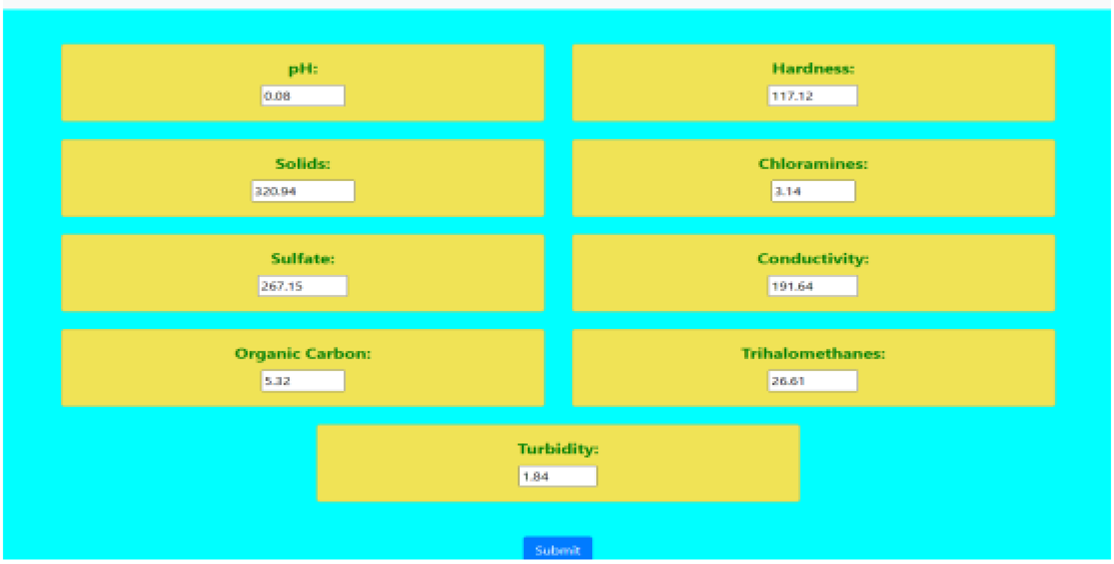

Fig 4: Inserted Water Quality Prediction Data

Fig 5: Visualizing Predicted Result

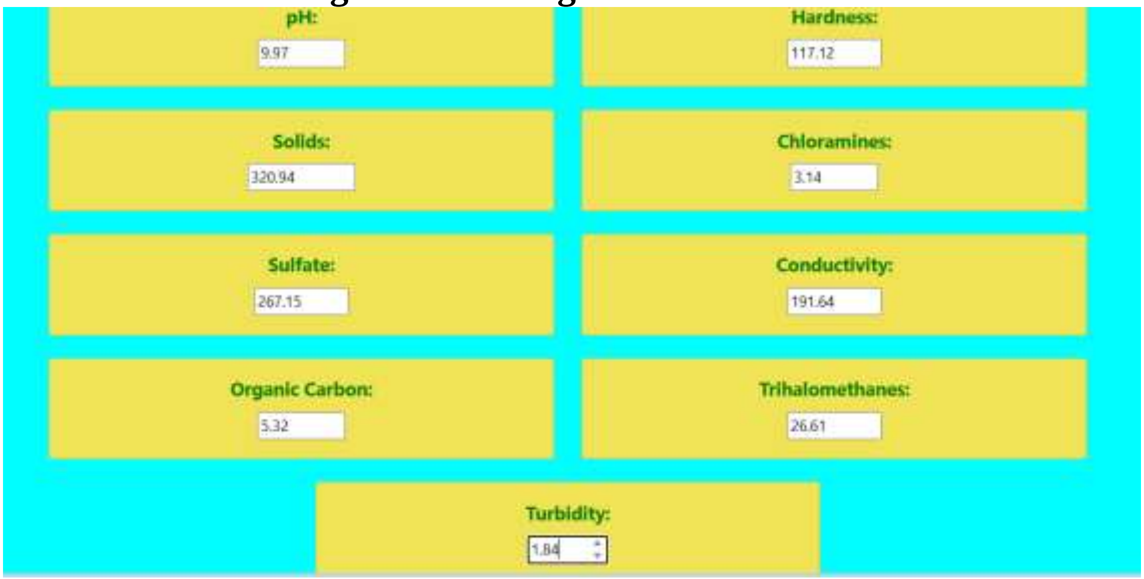

Fig 6: Inserted Water Quality Prediction Data 1

Fig 7: Visualizing Predicted Result 1

7. FUTURE SCOPE

As a future directive is to use latest sensors for detecting various other parameters of quality, use wireless communication standards for better communication and IoT to make a better system for water quality monitoring and the water resources can be made safe by immediate response.

Developing methods to quantify and communicate prediction uncertainty is crucial for enhancing the reliability and trustworthiness of water quality predictions. By incorporating uncertainty estimation techniques into machine learning models, stakeholders can make informed decisions considering the confidence levels associated with predictions.

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