**Real-Time River Water Quality Monitoring and Control System**

**DOMAIN NAME:** IOT

**TEAM ID:** PNT2022TMID29705

**BATCH:** (B11-5A1E)

**TEAM LEADER:** SANTHOSH KUMAR. J[513119106072]

**TEAM MEMBER:** TEENAKUMARI.M[513119106092]

**TEAM MEMBER:** SURENDER. D[513119106086]

**TEAM MEMBER:** MOHAN RAJ. D[513119106054]

**Paper 1**: IOT Based Real-time River Water Quality Monitoring System

**Published year:** FEB 2004

**Author:** Howard B. Glasgow, JoAnn M. Burkholder, Robert E. Reed, Alan J. Lewitus, Joseph E. Klein man

**Journal Name:** Journal of Experimental Marine Biology and Ecology

**Summary:** Recent advances in communication and sensor technology have catalyzed progress in remote monitoring capabilities for water quality. As a result, the ability to characterize dynamic hydrologic properties at adequate temporal and spatial scales has greatly improved. These advances have led to improved statistical and mechanistic Modeling in monitoring of water quality trends at local, watershed and regional scales for freshwater, estuarine and marine ecosystems. In addition, they have greatly enhanced rapid (e.g., real-time) detection of hydrologic variability, recognized as a critical need for early warning systems and rapid response to harmful algal bloom events. Here, we present some of the landmark developments and technological achievements that led to the advent of real-time remote monitors for hydrologic properties. We conclude that increased use and continuing advancements of real-time remote monitoring (RTRM) and sensing technologies will become a progressively more important tool for evaluating water quality. Recent engineering and deployment of RTRM technologies by federal and state regulatory agencies, industries, and academic laboratories is now permitting rapid detection of, and responses to, environmental threats imposed by increased nutrient loadings, development of hypoxic and anoxic areas, toxicants, and harmful algal bloom outbreaks leading to fish kill events and potential human health impacts.

**Methodology Used:** Communications; Harmful algal blooms; Real-time remote monitoring; Sensor technology; Telemetry

**Paper 2:** Water Quality Monitoring Using Wireless Sensor Networks: Current

Trends and Future Research Directions

**Published year:** January 2017

**Author:** KOFI SARPONG ADU-MANU, CRISTIANO TAPPARELLO, WENDI HEINZELMAN, FERDINAND APIETU KATSRIKU and JAMAL-DEEN

**Journal name:** ACM Transactions on Sensor Networks

**Summary:** Water is essential for human survival. Although approximately 71% of the world is covered in water, only2.5% of this is fresh water; hence, fresh water is a valuable resource that must be carefully monitored and maintained. In developing countries, 80% of people are without access to potable water. Cholera is still reported in more than 50 countries. In Africa, 75% of the drinking water comes from underground sources, which makes water monitoring an issue of key concern, as water monitoring can be used to track water quality changes over time, identify existing or emerging problems, and design effective intervention programs to remedy water pollution. It is important to have detailed knowledge of potable water quality to enable proper treatment and also prevent contamination. In this article, we review methods for water quality monitoring (WQM) from traditional manual methods to more technologically advanced methods employing wireless sensor networks (WSNs) for in situ WQM. In particular, we highlight recent developments in the sensor devices, data acquisition procedures, communication and network architectures, and power management schemes to maintain a long-lived operational WQM system**.**

**Methodology used:** Sensor networks; Sensors and actuators

**Paper 3:** Using Synchronous Fluorescence Technique as a Water

Quality Monitoring Tool for an Urban River

**Published year:** January 2008

**AUTHOR:** Jin Hur & Soon-Jin Hwang & Jae-Ki Shin

**Journal name:** Springer

**Summary:** The development of a monitoring tool for

predicting water quality and tracing pollution sources

are important for the management of sustainable aquatic ecosystems in urban areas. In this study synchronous fluorescence technique was applied to18 sampling sites of a typical urban watershed in Korea, some of which are directly affected by the effluent from a wastewater treatment plant (WWTP),to investigate the capability of the technique for biochemical oxygen demand (BOD) prediction and source discrimination. Sampling was conducted three times at the same sites during the low flow period between October and November, 2005. Protein-like fluorescence intensities of the samples showed a positive linear relationship with the BOD values (Spearman’s rho=0.90, p<0.0001). The BOD prediction capability was superior to other monitoring tools such as UV absorption and conductivity measurements particularly for the upstream sites from the WWTP, which ranged from 0.0 to 5.0 mg/l as BOD.The protein-like fluorescence and a ratio of protein-like/fulvic-like fluorescence were suggested as good fluorescence signatures to discriminate different sources of dissolved organic matter (DOM). The samples collected from four different DOM source regions including upstream sites from the WWTP, down-stream sites, discharge from a reservoir, and headwater were distinguished from one another by varying ranges of the two selected fluorescence signatures. Our results suggest that the synchronous fluorescence technique has the potential to be developed into areal-time water quality management tool for the comprehensive monitoring of urban rivers.

**Methodology used:** Water quality monitoring . BOD .

Source discrimination . Fluorescence measurement Urban rivers

**Paper 4:** Real-time monitoring of water quality to identify pollution pathways in

small and middle scale rivers

**Published year:** October 2018

**AUTHOR:** Angelika M. Meyer**,** *Christina Klein, Elisabeth Fünfrocken, Ralf Kautenburger, Horst P. Beck*

**Journal name:** Science of the Total Environment

**Summary:** The quality standards for surface waters increase steadily bearing new challenges for water policy. Precise knowledge of the sources and transport pathway of various impacts in a catchment area is of particular importance for any management activities. Online measurements with high temporal resolution are particularly suited for this purpose especially in small and middle scale catchments. In this paper we present an approach applying mobile measuring stations in which commercial available sensors and wet chemical analysers are combined in a new set to enable real-time monitoring of various parameters. The resulting data and the interpretation of their relationships allow the identification of diverse pollution situations in a river. In this paper some examples of impacts from diffuse and point sources are given to illustrate the high information density obtained through the use of this system.

**Methodology used:** Diffuse and point sources, Mobile station, Online measurement

Pollution Sensor ,Wet chemical analyser

**Paper5:** Internet of things enabled real time water quality monitoring system **Published year:** July 2017

**AUTHOR:** S. Geetha, S. Gouthami

**Journal name:** Springer Nature

**Summary:** Smart solutions for water quality monitoring are gaining importance with advancement in communication technology. This paper presents a detailed overview of recent works carried out in the field of smart water quality monitoring. Also, a power efficient, simpler solution for in-pipe water quality monitoring based on Internet of Things technology is presented. The model developed is used for testing water samples and the data uploaded over the Internet are analyzed. The system also provides an alert to a remote user, when there is a deviation of water quality parameters from the pre-defined set of standard values

**Methodology used:** Water quality, Smart solution, Internet of things, Wi-Fi, Cloud storage

**Paper 6:** Water quality monitoring in smart city: A pilot project

**Published year:**

**AUTHOR:** Y. Chen, D. Han

**Journal name:** Automation in Construction

**Summary**: A smart city is an urban development vision to integrate multiple information and communication technology(ICT), “Big Data” and Internet of Things (IoT) solutions in a secure fashion to manage a city’s assets for sustainability, resilience and liveability. Meanwhile, water quality monitoring has been evolving to the slates Wireless sensor network (WSN) based solutions in recent decades. This paper presents a multi-parameter water Quality monitoring system of Bristol Floating Harbour which has successfully demonstrated the feasibility of Collecting real-time high-frequency water quality data and displayed the real-time data online. The smart city Infrastructure – Bristol Is Open was utilised to provide a plug & play platform for the monitoring system. This New system demonstrates how a future smart city can build the environment monitoring system benefited by the Wireless network covering the urban area. The system can be further integrated in the urban water management System to achieve improved efficiency.

**Methodology used: Water quality monitoring,High-frequency**

**Real-time Internet of Things**

**Paper 7:**IoT Based Real-time River Water Quality Monitoring System

**Published year:** August 2019

**AUTHOR: Mohd. Manjur Alama, Nurul Absara,** Karl Anderson, Subhasish Ghosh, Mohammad Shahadat Hossaind, Talha Bin Emran, Nurul Absara, Mohammad Salah Uddin CChowdury

**Journal name:** Elsevier

**Summary:** Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. This paper proposes a sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors.Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered. Therefore, our Proposed system will immensely help Bangladeshi populations to become conscious against contaminated water as well as to stop polluting the water.

**Methodology used:** sensors**;** Water quality monitoring**;** Internet of things;Big Data Analytics System

**Paper8 :** Real Time Biomonitoring of Surface Water

Toxicity Level at Water Supply Stations

**Published year:** December 2007

**AUTHOR: S.V.** KHOLODKEVICH, A.V. IVANOV, A.S. KURAKIN, E.L. KORNIENKO, AND V.P. FEDOTOV

**Journal name:** Taylor & Francis Group

**Summary:** It is widely accepted that efficient water resource management should be based on ecological safety criteria and hence must include assessment of valid and contemporary information about state of natural aquatic ecosystems. Methods of Biomonitoring and in particular those that use biomarker approaches seem to be the most effective andreliable to obtain such information. Within the framework of such an approach there was created a System for Industrial Biological Water Quality Monitoring (SIBWQM)based on an original fiber-optic method for registration and analysis of cardiac activity of benthic invertebrates. This system is aimed toward providing a real time monitoring of water toxicity levels. Such automatic systems have been set up at all water intakes of St. Petersburg and used in industrial operations for more than two years. Results of relevant experience and futureperspectives are discussed.

**Methodology used:** real time biomonitoring, water quality, physiological biomarkers, cardiac activity of invertebrates

**Paper 9:**Using higher organisms in biological early warning systems for Real-time toxicity detection

**Published year:** 2001

**AUTHOR:** William H. van der Schalie, Tommy R. Shedd, Paul L. Knechtges, Mark W. Widder.

**Journal name:** Elsevier Science

**Summary:** Many biological early warning systems (BEWS) have been developed in recent years that evaluate the physiological and behavioural responses of whole organisms to water quality. Using a fish ventilatory monitoring system developed at the US Army Centre for Environmental Health Research as an example, we illustrate the operation of a BEWS at a groundwater treatment facility. During a recent 12-month period, the fish ventilatory system was operational for 99% of the time that the treatment facility was on-line. Effluent-exposed fish responded as a group about 2.8% of the time. While some events were due to equipment problems or non-toxic water quality variations, the fish system did indicate effluent anomalies that were subsequently identified and corrected. The fish monitoring BEWS increased treatment facility engineers’ awareness of effluent quality and provided an extra measure of assurance to regulators and the public. Many operational and practical considerations for whole organism BEWS are similar to those for cell- or tissue-based biosensors. An effective biomonitoring system may need to integrate the responses of several biological and chemical sensors to achieve desired operational goals. Future development of an ‘electronicanary’, analogous to the original canary in the coal mine, could draw upon advances in signal processing and communication to establish a network of sensors in a watershed and to provide useful real-time information on water quality

**Methodology used:** Biological early warning systems; Automated biomonitoring; Fish; Lepomis macrochirus; Wastewater; Monitoring

**Paper 10:** A remote wireless system for water quality online monitoring in intensive Fish culture

**Published year:** October 2009

**AUTHOR:** Xiuna Zhu, Daoliang Li, Dongxian He, Jianqin Wanga, Daokun Maa, Feifei Li a.

**Journal name:** Elsevier

**Summary:** Water quality monitoring and forecasting plays an important role in modern intensive fish farming management. This paper describes an online water quality monitoring system for intensive fish culture in China, which combined web-server-embedded technology with mobile telecommunication technology.Based on historical data, this system is designed to forecast water quality with artificial neural network (ANNs) and control the water quality in time to reduce catastrophic losses. The forecasting model for Dissolved oxygen half an hour ahead has been validated with experimental data. The results demonstrate that multi-parametric, long-distance and online monitoring for water quality information can be Accurately acquired and predicted by using this established monitoring system.

**Methodology used:** Water quality monitoring Wireless communication technology Intensive fish culture

**Paper 11:** The impact of agricultural activities on water quality: A case for collaborative catchment-scale management using integrated wireless sensor networks

**Published year:** May 2013

**AUTHOR:** Huma Zia , Nick R. Harris , Geoff V. Merrett , Mark Rivers , Neil Coles

**Journal name:** Elsevier

**Summary:** The challenge of improving water quality is a growing global concern, typified by the European Commission Water Framework Directive and the United States Clean Water Act. The main drivers of poor water quality are economics, poor water management, agricultural practices and urban development. This paper reviews the extensive role of non-point sources, in particular the outdated agricultural practices,with respect to nutrient and contaminant contributions. Water quality monitoring (WQM) is currently undertaken through a number of data acquisition methods from grab sampling to satellite based remote sensing of water bodies. Based on the surveyed sampling methods and their numerous limitations, it is proposed that wireless sensor networks (WSNs), despite their own limitations, are still very attractive and effective for real-time spatial-temporal data collection for WQM applications. WSNs have been employed for WQM of surface and ground water and catchments, and have been fundamental in advancing the knowledge of contaminants trends through their high resolution observations. However, these applications have yet to explore the implementation and impact of this technology for management and control decisions, to minimise and prevent individual stakeholder’s contributions, in an autonomous and dynamic manner. Here, the potential of WSN-controlled agricultural activities and different environmental compartments for integrated water quality management is presented and limitations of WSN in agriculture and WQM are identified. Finally, a case for collaborative networks at catchment scale is proposed for enabling cooperation among individually networked activities/stakeholders (farming activities,water bodies) for integrated water quality monitoring, control and management.

**Methodology used:** Wireless sensor networks Agricultural activities Water quality monitoring and management

**Paper 12:**Design of Smart Sensors for Real-Time Water Quality Monitoring

**Published year:** July 2016

**AUTHOR:** NIEL ANDRE CLOETE, REZA MALEKIAN, AND LAKSHMI NAIR

**Journal name:** IEEE

**Summary:** This paper describes work that has been done on design and development of a water quality monitoring system, with the objective of notifying the user of the real-time water quality parameters. The system is able to measure the physiochemical parameters of water quality, such as flow, temperature, pH,conductivity, and the oxidation reduction potential. These physiochemical parameters are used to detect water contaminants. The sensors, which are designed from first principles and implemented with signal conditioning circuits, are connected to a microcontroller-based measuring node, which processes and analyzes the data. In this design, ZigBee receiver and transmitter modules are used for communication between the measuring and notification nodes. The notification node presents the reading of the sensors and outputs an audio alert when water quality parameters reach unsafe levels. Various qualification tests are run to validate each aspect of the monitoring system. The sensors are shown to work within their intended accuracy ranges. The measurement node is able to transmit data by ZigBee to the notification node for audio and visual display. The results demonstrate that the system is capable of reading physiochemical parameters, and can successfully process, transmit, and display the readings.

**Methodology used:** Water quality monitoring, flow sensor, pH sensor, conductivity sensor, temperature sensor,ORP sensor, ZigBee, wireless sensor networks.