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# Findings on Various Wireless Sensor Networks for Water Quantity Monitoring and Leakage Detection

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***Abstract***

*A Wireless sensor network (WSN) is a network of micro sensor devices that can sense the information such as temperature, level and communicate the gathered information from its respective position through wireless links to the server. The information is forwarded through multiple nodes, and the data is transfer to other networks such as wireless Ethernet connection using a gateway. WSN consists of compact micro sensors that permits users to detect quantities, monitor, collect data and logged into custom storage. As an autonomous device, WSN have been an attained widespread applicability in water quantity monitoring systems. Various wireless sensors based systems are available for water quantity monitoring in water tanks, pond and lake water, water reservoir, general purpose water tank and city water distribution. Additionally, the aforesaid frameworks are not used again in the additional monitoring application specific sensor nodes. In this research, the energy efficient, self-configurable and reusable WSN water quantity monitoring system is analysed with its merits and limitations. Since, the web-based water quantity monitoring system is designed by combining the sleep scheduling mechanism of sensor nodes and web-based information portal. In this paper, a detailed survey of different kinds of wireless sensors available for water quantity monitoring and leakage is presented. Also the characteristics such as speed, coverage distance, sensitivity of different sensors are studied and comparative analyses is presented.*

***Keywords:*** *Wireless Sensor Network, monitoring system, water bodies, water leakage, water resource, monitoring system.*

## 1. Introduction

Water is a limited resource available in earth which is essential for agriculture, industrial, household and existence of human beings and animals in earth. Water quantity monitoring system is essential to avoid wastage of water from leaking and theft and water quality monitoring is essential to control the physical existence, chemical content and biological nature of water and it provides information about the current health of the water-body for human use, whether the water body meets the preferred quality to use and how its property has changed over time. Information gathered from sensors can be used to propose necessary action to be taken that the water body anticipates that improvement should meet its designed use and to guarantee and restore the health of water-body. For example, drinking water should not contains any toxic substance or chemical materials that could be harmful to health and unusable. Water used in agricultural irrigation should not have sodium content to get best harvesting. The water used in industries should be low in certain inorganic chemicals to avoid machinery defects. The typical parameters such as Temperature, turbidity and PH are collected in river/lake for using in monitoring the water quality. The constraint which affects the water-quality monitoring system are absence of data for the self-diagnosis the system and small-scale localization accuracy.

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Water quantity monitoring has been widely used to monitor level of water available in tanks and to reduce the danger of flooding disasters, ship safeguarding channels and observing the aquatic environment. The monitoring of field by people is still in use, but wireless sensor monitoring is an effective way for high speed water monitoring without human field monitoring. The users need to on-spot automated devices to download the various data for checking and to design remote water environmental monitoring systems. Since, the pollution in the river is monitored by the Ubiquitous Water level Monitoring Analysis and Information services (UWMAIS). This UWMAIS is mainly depends on the static stations that are expensive and it requires human intervention. Subsequently, the autonomous surface vehicle is developed for collecting and computing the properties of water quality to route the waterway's throughput. The utilization of GPS illustrates the less accuracy in localization as well as it expresses the absence of infrastructure for remote collection [1].

The mobile agents-based river water monitoring system is developed with the system that is considered as costly and this system adds the PDAs. A GPRS network is used to monitor a water monitoring platforms by accessing remote data network [2] and [3]. The solution is expensive due to GPRS terminals by replied on the use of WSN using Zig Bee protocol. The gathered data is transmitted between the Zig Bee nodes and the base station over the GPRS/CDMA arrange. The zone is monitored by using a huge amount of nodes and a few small scale pollutions are unidentified by the deployed nodes. The sensor nodes moved with respect to the water flow are autonomous in nature and it has the responsibility for monitoring the quality of the water. The positions of the identified pollutions are controlled by the mobile sensors and the sensitive events are transmitted to the adjacent sensors over the tags.

This position control and transmission of sensitive events are carried out by deploying the pair of RFID tags. The Software Defined Network (SDN) framework introduced programmable wireless LANs for providing support in the form of user authentication, path load balancing, mobility, signal interference management, accountability and authorization [4]. An analytical energy consumption model is created dependent on IEEE 802.11ah WLANs standard, which is required to turn into a technology driver in the advancement of the low power IoT model. The network characteristics the exhibited systematic model can give an estimation of normal energy consumed by a base station in the network, predicting its battery lifetime dependent on a lot of closed-form equations conditions is displayed in [5]. The sensor node's lifetime is maximized by considering the use of an efficient energy. The calculation of energy consumption is difficult for designing the autonomous remote node. The power is consumed during every task for a certain period. The low power wide zone network technology is calculated for optimizing the consumed energy of the sensor nodes and accomplishing an extended communication. For an extension in the vitality utilization, a low power wide region organize innovation is considered by utilizing the modes of various Long Range Wide Area Network (LoRaWAN). The modes of LoRaWAN are communication, size of range payload on the sensor node consumption, spreading factor, acknowledged transmission and coding rate [6].

This paper surveys advances in development of effective wireless sensor network system for water quality monitoring. This research aims to survey different WSN used to perceive water leakage, water quantity monitoring and to meter the water supply remotely with the help of a WSN zone. To the best of our knowledge, this is the first endeavour to provide a wide-ranging overview of the overall frameworks by integrating different types of concepts, methods, approaches and technologies to implement the smart water data management system (SWDMS) are used.

The organization of this paper is as mentioned below, section 2 discussed bout the review on the smart water quality management architecture/platforms, applications, and industrial trends to shape

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next generation water supply infrastructure system to improve performance and increase savings. Section.3, explains about the description of the proposal given in the literature on the water management. Section.4, does a comparative analysis of various algorithms. Section.5, Concludes the paper.

## 2. Wireless Sensors for Smart Water Quantity Management

The main requirement of environmental monitoring process is that the deployment of various wireless sensor devices within the system. The sensors deployed in the monitoring system has the responsibility of measuring the amount of water, leakage and detection of theft in various places. Additionally, the calculated values are preserved in the server node. The sensor is modified through the physical quantity to the electrical signal and the generated output is directly proportional to the given input. An additional segments are required by the sensors for performing the functions of signal processing, storing the calculated measures and these measures are transmitted among the various nodes [7]. Since, the WSN is enormously is used for the controlling and monitoring capacities. Due to the large sensing and development in the technology, the WSN integrated the sensor node utilization with various fields such as human-centric applications, commerce, military applications and environmental monitoring applications. Generally, the information is collected by the sensor nodes and it is send to the sink or controller nodes [8].

The validity issues and concerning fault are caused in the second layer. Each level has a particular deficiency model where faults are developing from different sources, which is given in Figure.1 and Figure.2.

The third layer is illustrated in the system for investigating the sensing information. The expert information on the system model/ multi-sensor fusion techniques are used for deriving the importance of the collected information at the data processing layer. The important attribute in WSN is to check the attribute for the dependability of the applications to be expressed in various ways. The quality of sensor data is more accurate and it is also more possible to incorporate the system for mitigating and check the effects of fault occurring in water quality systems.

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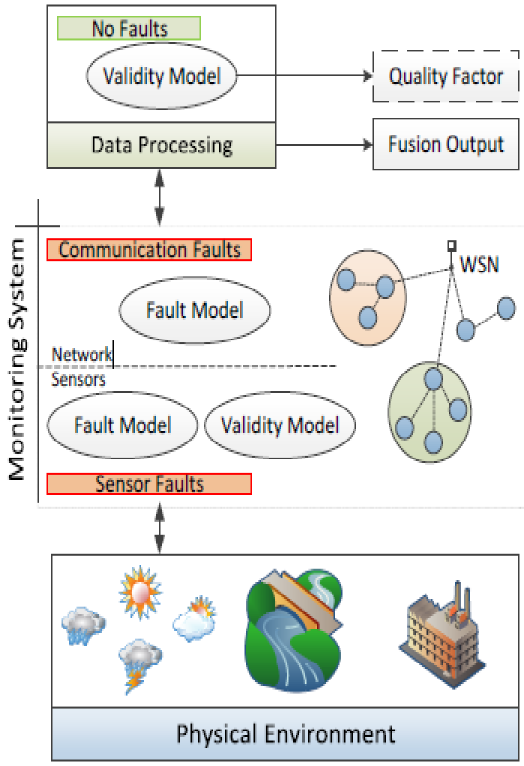


**Figure.1.** Generic View of WSN- based monitoring system

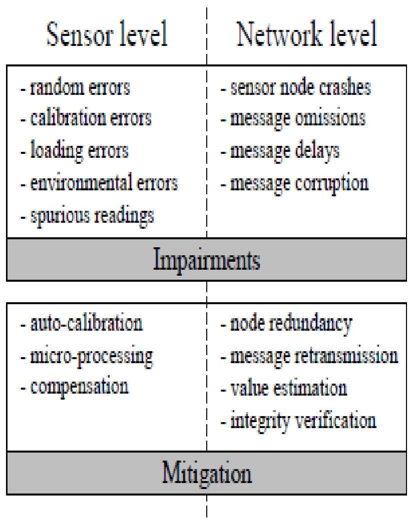


**Figure.2.** Sensor and WSN faults and mitigation solutions

The sensor nodes send new measurements endlessly in the WSN applications to monitor the networks in a more periodic way for satisfying the requirements of temporal accuracy. The sink nodes receive the sequential measurements to the processing node in particular time series.

## 3. Review of WSN for smart water network management

The water mater requires an adequate physical connector like Sequential port e.g., RS485/ Universal Synchronous Bus (USB) and RS232. The wired system is provided with less interference degree and

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high information security. Since, the time and cost is the main reason for the installation of water meter in various environments. User-driven reading collection dependent on mobile phones is advantageous [9] in certain applications, however it isn't reasonable for autonomous systems, real-time monitoring or regular readings. Here, the wireless system is used to set the sequential line, where a remote sensor node is integrated among the water meter and gateway device.

The Zigbee information is used in the low information bit rate sensors and this Zigbee installs the protocol stack of IEEE 802.15.4 (i.e., remote standard). This helps to transmit the low-cost and energy efficient solution to the sensor network in the range of 10-100 meters. Since, the device's range is extended by building the network topology within the network. An example of the network topology is cluster network, mesh network and star network [10]. A various revolution is required for the smart water communication that depends on the network topology and remote infrastructure [11].

In any case, the satellite tends to be complex and costly. Since, the satellite requires the steady maintenance plan. The design schemes for remote system which connects water reading system is mainly based on 802.15.4 [12]. An additional system is developed based on the hybrid systems which uses the robust networking topologies such as the GSM and Zig Bee [13]. The main concerns faced by this system are operation and maintenance, power consumption and hierarchical network architecture [14]. In power lines, the Broadband over Power-Line (BPL) is used as medium for data communication. The integration of smart water meter systems and BPL technology is used to obtain the bidirectional broadband communication [15]. The BPL is considered as a costly system that has different components such as base stations, collector and concentrator. By using an open physical layer, the security problems arise. Hence, the reduction in the cables are used in the open physical layer in order to avoid the long-distance communication.

## 4. Comparative Analysis

Table.2 shows Wireless Sensor Network Technologies used for water quantity measurement system.

**Table.2. Wireless Network Technologies based on Local communication**

| Ref./year/Author | Technology used | Coverage, frequency, sensitivity and salinity | Speed | Advantages | Disadvantages |
|---|---|---|---|---|---|
| Ho et al. 2013 [16] | Zig Bee | 50m coverage and 2.4-2.48GHz | 20/40/250 kbps | Low cost, , potential to support huge amount of users and low power consumption | Penetration of building and low speed is not up to the level for calculation. |
| Feng et al. 2014 [17] | WiFi Direct | 200m with 2.4 and 5GHz | Up to 150 Mbps | Low cost, easy to set up, ad-hoc and high speed. | Limited platform support, high power consumption and scalability. |
| Laird Technologic | RF module | 8 km and 2.4 GHz | 250 KBs | High resistance to noise and | Requires complex demodulator |

| | | | | | |
|---|---|---|---|---|---|
| s et al. 2012 [18] | | | | dissimilarities in signal strength | and low speed. |
| Rahanoma 1993 [19] | GSM | 10km and 900-1,800 GHz | 9.6Kbps | Wide distribution, 2 factor authentication, support for roaming | Low speed, high energy consumption, requires distinct processing to handle handoffs. |
| Dhawan et al. 2007 [20] | WiMAX | 5-100 km and 2.11GHz;10-66GHz | Up to 80 Mbps | Less expensive for deploying secure and reliable network, high speed and coverage | Trade-off among bit rate and coverage, inadequate spectrum limited diffusion |
| Lee and Wong 2010 [21] | LTE | 100Km | 698-960MHz and 300 Mbps DL; 75Mbps UL | Less latency, high speed and capacity, backward compatible | Equipment expensive, high energy consumption |
| Lorenzo Parri et al. 2019 [22] | LoRaWAN transmitter | Distance of 8.33 km. | Bandwidth of 125 KHz was abused. | The distance among the offshore breeding cage and the plant belonging to the firm was successfully covered. | A propagation of the antennas are located in higher elevations along with the acceptance of small CRs. |
| Duangchak Manyvone et al. 2018 [23] | BEAT sensor nodes (RF Module–NRF24L01) | Salinity range is 0.58 %~6.48%. | Power consumption is 500uW, water level in range 3.5~10.5cm with average power consumption of 70 uW. | BEAT sensor effectively calculates salinity, water level and PH of water. | The beat sensor is applied to applications of AGRI and aqua-culture for low power nature, and also for monitoring the wireless water quality |

## 5. Conclusion

Researchers across the world explored various wireless sensors to enhance and detect leakage of water with sufficient amount of water supply remotely with the help of a WSN zone in a manner. The sensor nodes is randomly deployed by allowing opportunities even inaccessible areas by

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randomly deploying nodes. This research studied different WSN platform based on Bluetooth, Zigbee, RF module, cellular GSM 3G, Wifi and LORAWAN for water quantity management. As there is lot of uncertainty present in the selecting sensors for water quality management, which are subjected to be useful for researchers, engineers, health professionals, and policymakers working in the area of the effective wireless sensor network system for water quality monitoring. From this survey, LORAWAN based water monitoring system shows better performance in terms of data rate, coverage distance and power consumption compared to other WSN systems.

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