



IoT and ICT based Smart Water Management, Monitoring and Controlling System: A Review

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ABSTRACT

Water is a basic human need in all economic operations. Farmland, renewable energy, the industrial industry, and mining are all critical economic areas. Water supplies are under severe strain. With the population increase, the requirement for water from competing economic sectors is increased. So, there is not enough water left to meet human needs and maintain environmental flows that maintain the integrity of our ecosystems. Underground water is becoming depleted in many sectors, making now and future generations near the point of being deprived of protection from the increasing climate variability. Therefore, the critical role that information technology methods and internet communication technologies (ICT) play in water resources managing to limit the excessive waste of fresh water and to control and monitor water pollution. In this paper, we have to review research that uses the internet of things (IoT) as a communication technology that controls the preservation of the available amount of water and not wastes it by homeowners and farmers. In contrast, they use water, and we have also reviewed some researches that preserve water quality and reduce its pollution.

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1. INTRODUCTION

Water management impacts many of the most significant human lives, for example, environmental, water use, food production, treatment of wastewater, cleaning, irrigation, energy balance, etc.[1]. Water supply management has always been a source of many challenges [2]. To guarantee the water supply, some factors need to be considered. Losses in water pipes that take water to our kitchen have significant implications in the water supply process [3]. There are 32 billion cubic meters of treated water being lost each year from urban supplies systems in the developing world [4].

Intelligent monitoring is defined using different computational methods that provide the customers with relevant tools and information in monitoring, control, manage, and optimize the network [5]. The integration of modern information technology with the cyber-physical world produces new applications, such as ubiquitous computing, which renders interactive computers usable though essentially invisible to people [6]. It seeks to break away from desktop computing to include consumers anywhere and at all times with computer resources [7]. The goal is to break away from desktop computers to provide consumers with computing resources anywhere and anytime [8]. Since its inception, the Internet of Things (IoT) has taken the globe by storm. The theory of wireless technology linking everything sums up the IoT [9]. IoT is the connection of devices, software, sensors, actuators, and physical objects are embedded in the network, cars, home appliances, and other products that help these things to communicate and share data [10]. IoT is quickly developing with the latest developments in wireless technology and embedded devices, with low-power Microcontrollers being developed that are ideal for remotely distributed IoT systems to link and run for years without any maintenance [11]. Making IoT not only luxurious but also required data aggregation for defense systems. The number of IoT devices has risen from 8.4 billion in 2017 to a predicted 30 billion by 2020 [12].

Soon, wireless mechatronic devices for support and individual care become more prevalent at home and will be very useful in assistant healthcare, particularly for elderly and Handicapped persons [13,14]. Wireless monistic contain various spatially dispersed sensors with

minimal data storage and processing power to track the environmental issue [15]. Wireless sensor networks (WSNs) are becoming more critical because they can monitor and manage sensitive information in their environments [16,17]. WSNs have made an impact in many industries such as the military, industry, and environmental monitoring. In-home gardens and agricultural areas, the WSNs are progressively being used to regulate water use and track services [18].

There are various systems of water quality monitoring systems based on wireless sensor networks. The number of sensors used for measuring water quality is often limited to between 2 and 4 [19,20]. For environmental protection, the WSN-based water monitoring and control system using ZigBee, GSM, Xbee, and mote WiFi and TCC/IP was designed to transmit sensed data [21].

This paper reviews different components and techniques for water management and quality system control based on IoT, i.e., sensors, controllers, IoT platforms, etc. No consensus as to parameters that should be used to measure different properties of water. The parameters are compared to demonstrate the positive or negative effects of each technique.

2. SMART WATER MANAGEMENT AND SERVICES

The variety of sources of drinking water and the differences are based on geographical characteristics [22]. So, some depend on rivers, and others depend on the extraction of groundwater and other sources. ICT techniques are used to obtain surface water sources such as rivers and determine their depths and areas [23,24]. So remote sensing systems and geographic information systems (GIS) software can facilitate the exploration process by relying on space and aerial images [25]. Building spatial databases and conducting the necessary analyzes to obtain Practical results with savings in effort, time, and cost compared to traditional technical methods of research and exploration [26]. Also, for groundwater exploration, many techniques are used, including remote sensing and geographic information systems [27].

2.1 Smart Irrigation System

The smart irrigation system is an automatic irrigation schedule that considers environmental conditions to ensure plants and crops receive the ideal amount of water [28]. Convection removes soil moisture, while irrigation and Rainfall bring the added water content. It allows the design of automatic irrigation by identifying conditions specific to each root zone [29]. Fig. 1 represents an intelligent irrigation system suggested by [30]. The design of Fig.1 was generally based on the control board (CB), which comprises ten main sections and other sensors, for the device proposed. They are Arduino Mega 2560, two shield relay, three moisture sensors, two 220V

mini water pumps, and SIM900 GSM Shield. These components are also equipped with two water pumps. For analog input, the first humidity sensors are attached to the Arduino A0 pin to obtain the moisture content of the soil. The Vcc pin (+) is connected to the 5V Arduino pin. The second humidity sensor, which is attached with A1, is connected simultaneously to the bottom of the tank. The third humidity sensor is connected with A2 to get the critically high value when the tank is filled with water. A3 port attaches with an analog pin to the Rain Drop Sensor. It attaches to relay models and connects with two water pumps, D2 and D3 are classified as digital pins. The D18 and D19 bind to GSM Shield so that the homeowner receives SMS. [30].

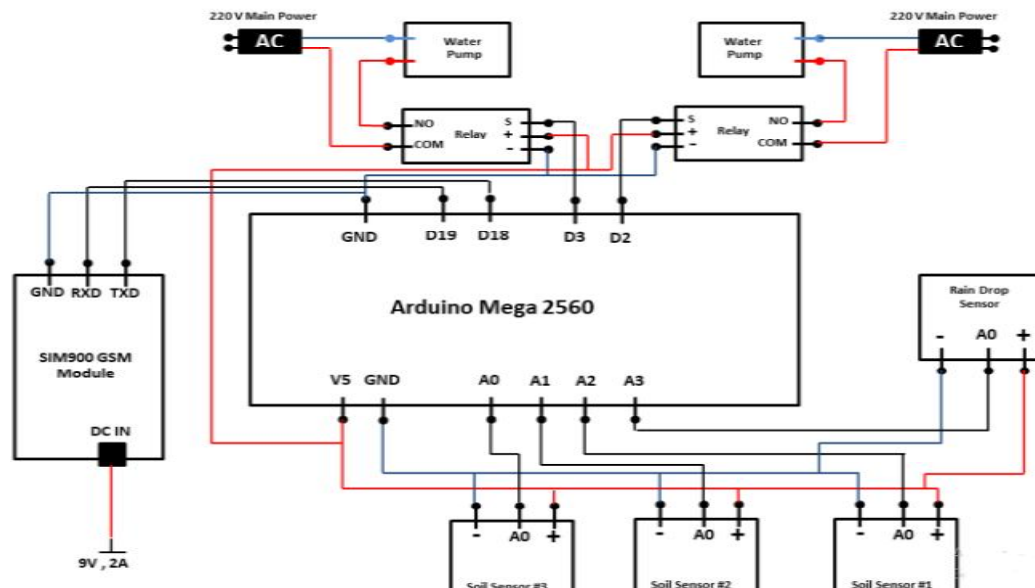


Fig. 1. Irrigation System Architecture

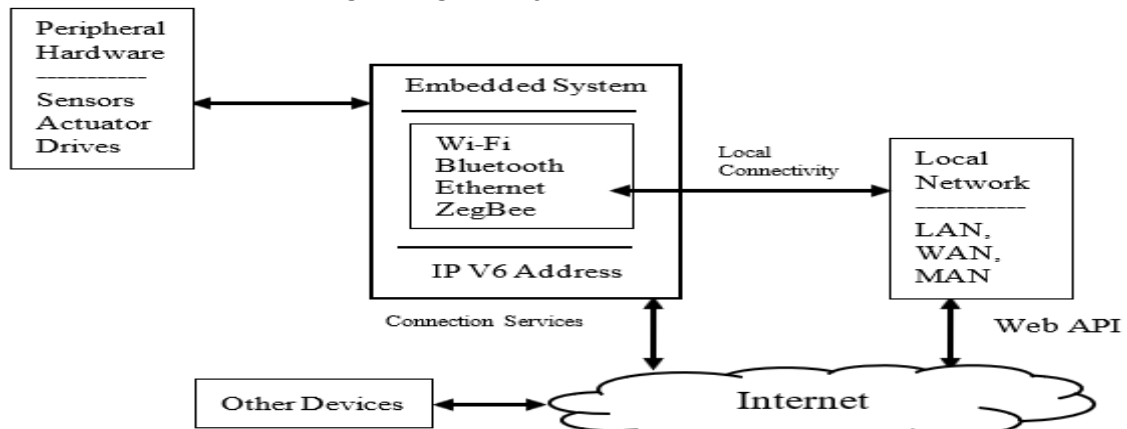


Fig. 2. Basic architecture of IoT

2.2 Internet of Things (IoT)

The development of the Internet of Things (IoT) facilitates connecting devices equipment through the internet, which would be very useful in the automation of the distribution of water and malfunctions or leakage monitoring [31,32].

The principal architecture for IoT comprises three layers: the physical layer, the network layer, and the application layer [33]. At the physical layer, sensors collect data from the outside environment, turn that data into usable information. Well, time-sensitive data should be processed the moment they are collected [34].

Otherwise, the data has to be stored in the cloud to avoid network congestion. The data is collected at the network level and converted into digital streams for data processing [35]. The user-facing layer is responsible for delivering specific services to the user. Figure 2 shows the basic architecture of the IoT [36].

2.3 Sensors

Many sensors are available in electronic stores for water monitoring. Such sensors are fabricated sensors, capacitive sensors, Turbidity Sensor, Soil Moisture sensor, etc. [37].

- **The fabricated sensor** is the sensor of float form. The sensor contains an energy panel and a transmission module as a solar cell, Li-ion battery [38]. The output of this sensor module will directly be connected to the microcontroller without external signal processing electronics [39]. Any of the works already published contain manufactured usability sensors. The sensor for parameter control is used in 2016 by Tomoaki et al. [40].
- **The capacitive sensor** is used for water-level measurement. The advantages of this sensor are low power consumption, linearity, low cost, easy installation, and suitable for use in extreme conditions [41].
- **Turbidity Sensor** is detecting water quality by measuring sedimentation or opacity [42]. It is used to measure water quality in rivers and flows [43], wastewater and effluent measurement, settling pond control instruments, and laboratory research. Analog and digital signaling modes are provided by this liquid sensor [44].

- **Soil moisture sensor** is a simple breakout for soil and similar materials to measure humidity [45]. The sensor of soil moisture is relatively easy to use. The two large exposed pads serve as sensor samples, acting together as a variable resistor [46]. The longer the water in the soil, the better and will result in lower resistance and higher output SIG the conductivity between the pads [47].

2.4 Wireless Communication Technology

Wireless technology is used from the controller to the cloud for communicating between the sensor and the controller [48]. Different technologies have been used in any collaboration situation. For the sharing of information, wireless networking technology is also used [49]. Sensors are remotely connected to the microcontroller by either the Zigbee protocol or URAT protocol in the sensors-controller communication [50]. ZigBee is a technology for wireless transfer. It is intended for control systems with multiple channels [51]. Also, alarm and lighting control and has low energy consumption. ZigBee builds on the physical layer of access control and media defined for low-rate WPANs under IEEE standard 802.15.4 [52]. Zigbee Protocol is applied in smart water systems when the sensors are located remotely from the control system to communicate between the sensor nodes and the controller [53].

Controller-centralized data storage communications are carried out in long-range communication standards such as 3G and the internet [54]. Some of the earlier work is intended to alert the user to water quality in SMS. The proposed systems necessitate using an additional SIM card for the GPRS module attached to the controller [55]. The disadvantages of these schemes are the additional costs for SIM card operation. Furthermore, the user location is incapable of storing or retrieving vast quantities of data [56,57].

3. LITERATURE REVIEW

In 2016, S. Geetha et al. [58] offers a solution dependent on 'Internet of Things technologies to measure in-pipe water quality. The model is used to test water samples and analyze data posted on the web. The method also helps increase the accuracy of the water and address differences from the predefined values. Moreover, the

controller with a built-in WiFi module is used to track parameter pH, turbidity, and conductivity using a lower cost, less complex intelligent water quality monitoring device. The system also provides a warning system to warn the user of water quality variance parameters. The experimental set-up calculates five parameters: conductivity, pH, turbidity, temperature, and water level. The installation is attached to the network Ubidots. The findings calculated are contrasted with WHO-defined requirements for drinking water quality.

In 2017, S. Hwang et al. [59] proposed that real-time input data from IoT devices. They used an android phone to remotely monitor and control the drips from the smart farm irrigation system. Zigbee communicates between different nodes (sensor, base station, and hub). The software enables real-time data handling and visualization on a network server using web-based Java toolkits. Wireless monitoring of field irrigation system allows remote monitoring and controlling of an irrigation system by remote applications. The advent of cloud computing is a viable solution for the high volume of data generated by smart sensor networks. The device is manually and automatically modeled. For decision-making and monitoring behavior, real-time sensed data are processed on the cloud server. The user can watch monitor the farm's regulating activities and regulate irrigation on the farmers' mobile phones via the Android app.

In 2018, B. Alomar et al. [60] propose an irrigation system based on the Internet of Things that will reduce watering frequency and increase crop production rate using fuzzy logic. The system consists of a Mamdani fuzzy controller that acquires environmental variables such as soil sensors and temperature sensors, then applies fuzzy rules to control the flow of water from the water pump and supply water at the appropriate time and frequency. This can be created and programmed using MATLAB. A plan to create an informed irrigation solution to water preservation and improved irrigation management in areas of elevated water stress was described as fuzzy logic and IoT technologies. Using trapezoidal and triangular component functions based upon Mamdani fuzzification, the developed fuzzy controller efficiently determines the irrigation time and length for a particular crop. The fumigation control application helped keep the soil's moisture above a predefined value with smooth variations that avoid repeated device exhaustion

and save water and electricity. A large ZigBee wireless network was also used to track the device in real-time.

In 2018, M. Bennet et al. [61] proposed a system whereby water flow can be monitored by mobile application and allows access for specific users with privileges to access mechanic controls and other community members to raise an issue regarding water contamination, water leakage, and check the water status. The status of the agreement can be carefully monitored. As people own mobile phones, this water management system creates a well-established communication between them and their society. The system is projected by using the IoT module, which is the principal system module source. In his proposed method, the authors used pic16f877a as a microcontroller. This cloud microcontroller achieves the highest and minimum speeds. The Arduino board obtains these values. The current value level is achieved, and the motor will automatically turn off/on based on this value.

In 2018, K. Gupta et al. [62] Proposed a device that mobile app from everywhere can constantly monitor. The engine can be automatically managed, and complete intelligent automation can be accomplished. It is a stable device that is simple to mount and has minimal dimensions. The project enables residents to track and regulate the system of water management through smartphones remotely. The project will facilitate the company managers to take the necessary measures if the water quantity decreases from a certain threshold. The project essentially uses an ultrasonic indicator of water depth and a turbidity sensor. The sensor will continuously track the water level and relay data to the company's inhabitants through the cloud. This will enable the secretary, as the water level decreases, to call for a water tanker. When selecting water utilities, a turbidity sensor will track fundamental water quality features, which would be helpful as historical evidence was present in a graph of quality vs. quantity.

In 2019, H. D Paula et al. [63] emphasize the need for designing, building, and approving the framework for remote monitoring of the water utility system, which recognizes changes and disturbances. There are many practical applications that nanotechnology can be used in. The suggested fix followed the Internet of Things method and can easily be adapted for this type of system. It was verified, examined, evaluated, and

probed. The method suggested can shut off the water supply in order to prevent leaks. Users and other applications may use IoT middleware to access data obtained by sensors. An IoT middleware uses the architecture Publish/Subscribe and the Message Queue Telemetry Transport (MQTT) protocol. The middleware is responsible for storing, displaying, and transferring data to other IoT-related devices that can automate action based on sensor data.

In 2019, A. Hasibuan et al. [64], a smart water monitoring system that can predict the user's water usage over time, was proposed. This water control device takes advantage of the Internet of Things (IoT). They have a water flow sensor embedded with a NodeMCU 8266 microcontroller. In the water drain, they mounted a microprocessor device with sensors. Once the data is collected, it will be saved in cloud storage. This application developed will assist users in monitoring their water usage in real-time. The water used in an online portal can be viewed. Any operation for water use is transferred to a dictionary element (cloud storage). Then these dictionaries measure the amount of water monitoring data gathered, and each water use operation is put depending upon the category of higher or lower water used. Furthermore, the behavior can be predicted based on the volume of water ingested.

In 2019, C. Patel et al. [65] A remote monitoring and control systems for the IoT-based monitoring and control of the flow rate were installed at the end of the ultrasonic user sensor and water pump to control the water level in the main supply tanner. The use of chlorine in water, therefore, maintains the water quality. This smartphone-friendly web-based device to know the state of the remote-control space. In the smartphone android program, these captured data display in real-time. The scheme solves a fundamental problem for all users, namely the distribution of equal water quantity, water quality, and equal flow rate. A manual valve for changing the direction of a valve with a stepper engine rotation ensures the same flow rate. The system is designed for end consumers of an online payment system. End users only pay for the water used and therefore reduce grievances.

In 2019, N. Rapelli et al. [66] focus on water utilization in big apartment complexes and ensure proper water management. The main focus of this essay is water management, monitoring, and wastewater recycling. The

system will ensure that the available water level is maintained continuously. The system has been implemented with an embedded system and Internet of Things (IoT) communications. The system constantly updates the water used and storage required in the central location. All information will be cloud-updated by IoT. The smartphone application for the demand, tracking, and billing system will connect to users.

In 2019, R. Jisha et al. [67] provide solutions and utilities for agricultural purposes and domestic water requirements. LUCC believes that it can play a significant role in solving various issues through smart IoT. In addition to automatically consuming the electric power from the wall outlet, it also alerts its users through their mobile phones for home use water waste. The system can track both the water level in the water tank and the soil remotely. There is no going back for this medical system and its activity monitoring system. The authors concentrate on water levels in the container. The ultrasound rays emitted from the ultrasound sensor reflect by touching the water surface, measuring how much of the water container/tank an ultrasound sensor is fixed in the container top. A limit and a minimum threshold are set to allow the relay state to be deleted and an error note transmitted to the user if the water in the tank exceeds the maximum value. A motion sensor is used to measure the moisture in the soil. The method supplies water based on the humidity of soils and crops. It notifies the user's telephone of the moisture status to be aware of the quantity of water in the water tank and the soil. This proposed model would improve household and agricultural water pumping systems, i.e., there is no additional pressure on the customer in controlling the depth of the water.

In 2019, I. Herath, [68] the author focused on micro factors involved in household water usage that significantly impact a community. Our leaking water tank, water leakages in nearby taps, and the overflow of Our over Our tank are the primary sources of water waste. The IoT-sensor, "Smart Water Buddy," tracks water usage with IoT devices like Arduino. These IoT devices will track how much water is being used and potentially where it is going, providing a "watchdog" to help to optimize the usage.

In 2019, A. Arun et al. [69] proposed an irrigation system that focuses on managing water supplies to agricultural land. Water is the significant and predominant set of nutrients that are supplied for

agriculture. 69% of the world's freshwater is gathered for use in agricultural operations. Since people use much water, it is time to conserve groundwater efficiently with the Internet of Things and automation assistance. This module uses LM35. LM35. Temperature sensor for predicting the real-time agricultural land temperature value, DHT11 for the humidity sensor, PH sensor for measuring solution of hydrogen ion activity.

In 2019, J. Vithanage et al. [70] smart One bottle was introduced to provide water for hygienic consumption and ensure good quality water. The initial version of the water bottle was instituted as a combination of hardware and mobile application, and it was validated for its ability to track goals and events. The cleanliness of the drink, consumer intake details, and location of the water resources used by the container can be determined by a smart water bottle. In the Smart One, pH and turbidity sensor readings have been used to profile the purity of the stream. The sensor readings from the button, moisture, and ultrasonic sensors fuse the information relating to one drink case, i.e., water volume and validity. In addition, a mobile app for tracking location information on sources of water and monitoring water usage based on sensor information was created. The mobile app also acts as the interface between the bottle and the user.

In 2020, G Lakshmi et al. [71] presents the entry-level of IoT (Internet of Things) and the infrastructure that aims to streamline data transfer from cloud to android application. A combination of an application with an interactive user interface can facilitate users in making judicious decisions concerning water usage. Considering the world water crisis, their product can be launched at both community and household level. Using the data will result in monetization by small-scale infrastructure and housing projects of construction. By preaching the value of water and its management, the scheme is imbuing people with a sense of obligation. The dashboard for tracking offers tips for conservative everyday use and helps users set limits on the same. When approaching the limit or reaching the limit, the buyer will be notified of the same, and there will be no space to reduce its use.

In 2020, M. Pincheira et al. [72] Suggest a technology platform focused on the convergence of the Internet of Things (IoT) and Blockchains aimed at incorporating a compensation scheme

for more efficient water conservation activities in agriculture. The framework presents a software design specially made for a blockchain water distribution system where constrained IoT devices can directly transact sensed data without any third-party support on a public blockchain network. Using the off-the-shelf hardware devices, the proposed solution is deployed for the intended goal. A thorough benchmarking is undertaken in storage, program size, connectivity expense, and energy usage.

In 2020. A. Ray et al. [73] proposed developing and implementing smart water meters based on the Internet of Things (IoT) and Cloud computing installed with machine learning algorithms to identify a level of standard and excessive water usage in any area. Nowadays, the conservation of clean water resources is becoming a challenge all over the world. By using a smart water meter to manage water resources, Singaporeans could conserve water for future generations. Sensors will provide monitoring for the hydraulic data and automatic control and alarm warnings in Cloud technology. A critical evaluation of this study will allow one to take meaningful action. Therefore, they propose an intelligent water metering system to be used by Pakistani citizens and worldwide. This system will help reduce the wastage of water. We propose server-less architecture because it would be quickly adopted and implemented on a large scale.

In 2020, A. Hamid et al. [74] Ali suggested designing the Smart Water Quality Monitoring System (SWQMS) and the assessment by DOE and ANOVA statistical tools of factors affecting pH importance and swimming pool temperature. The experimental results show that the volume of the pool and its interaction factors do not affect the pH value, but the time of day affects the swimming pool's water temperature. Every five minutes, the pH sensor supplies the processing unit with data. The natural state, acidity, and alkaline condition are three conditions for the pH level. The pH value required to satisfy this criterion is between 7.20 and 7.80 in condition one that is a common condition. The acidic second condition is below 7.20, and the third state is higher than 7.80 showing the alkaline environment. The acidic condition is the pH value. Each adjustment to the pH level, as seen in the flowchart, also gives the user a message via telegram apps. The machine triggers a pump for pumping solution to balance the pH value before the pH changes to normal levels for the

second and third conditions, which are too acidic and too alkaline. To check the current state of pools and take appropriate steps, the users can access the SWQMS Tracking System. The machine measures the temperature and pH of the pool water continuously in real-time.

In 2020, A. Kumar [75] Presented the concept of an IoT-based device that would monitor water leakage in real-time, which would allow the authorities concerned to take adequate measures to mitigate the loss of water. The proposed method provides the idea and definition of wireless networking technologies and flow sensors to prevent leakage and stealing of water. The idea is to speak about the project's construction at the city level, where the pipelines are distributed across the whole city for kilometers in length.

In 2020, V. Ranjan et al. [76] Presents a concept that allows smart rainwater harvesting using IoT. The model consists of a segregation system that divides the two tanks with a 60-40 percent ratio. The rainfall detection sensor is placed on the top of the system to detect whether it is raining. Two bottles of water were used to run the model's operating evaluation. One bottle had regular drinking water, and we pushed the lemon in the other bottle to make it mildly acidic. The machine calculates the rainwater's pH value and checks if the water's pH is higher than 5. The servo motor on the hinge rotates in the clockwise direction with the filled tank on the right-hand side. If the pH is less than 5, the hook rotates in the opposite direction, and the tank is loaded on the left side. Separating the drinking water from acidic water is achieved to isolate pH five or more significant, i.e., pH less than 5. This is all feasible, and it is possible to do so with the NodeMCU module WiFi.

In 2020, S Konde et al. [77] Proposed the traditional way of measuring the content of water to obtain samples of water manually and send them to the laboratory for testing and examination. This approach takes time, wastes man's power, and is not economical. The water quality monitoring device that they have put in place monitors the quality of water in real-time by different sensors to test water quality. As a difference in the magnitude of this parameter, it

refers to the existence of contaminants. The system's WiFi module transfers the data obtained by the sensors to the microcontroller and transfers the data to the smartphone/PC. This system can maintain a tight regulation over the contamination of water supplies and have a healthy drinking water environment.

4. DISCUSSION

Our review of the research in the previous section notes that all research has reached an optimal solution to reduce water waste by relying on the internet of things in the private and public agriculture sectors. This type of research also helps homeowners from consuming water excessively. Planting soil sensors in fields and water reservoirs, water contamination sensors, and connecting them to a microcontroller to control water waste, tracking, and temperature. Table 1. shows a comparison between the researchers concerned with controlling and managing water resources in terms of their use of MC type, sensors, the programming language adopted in the MC, the technology used in ICT, and finally, the results they reached.

The comparison involves five key features that meet their patterns to validate the goals laid out in their methodology in Smart Water Applications. The comparison performed in terms of Microcontroller, Embedded Programming Language, Sensors, Comm. Module and Protocol to achieve their Significant Satisfied Aims. It is evident from the table that the researchers used different types of Microcontroller like TI CC3200, Mamdani Fuzzy Controller, Raspberry Pi zero w, Arduino UNO, NodeMCU V3, LPC2148. Also, different Embedded Programming Languages are used, such as Energia IDE, Arduino C, MATLAB, PYTHON, C Language. Also, there are different types of sensors like Water Level, pH, YL-69 Conductivity, turbidity, YF-S201, Solenoid Valve, pH, Rainfall, Ultrasonic. Various methods are used, such as Recurrent Neural Networks, Convolutional Neural Networks, and Gated Graph Neural Networks, using Protocol its HTTP, WAP, and MQTT. Finally, Communication Modules used by researchers are ZigBee, GSM, Raspberry pi WiFi build in, Arduino Ethernet Shield, ESP8266.

Table 1. Comparison of various Smart Water Applications features based on IoT Technologies

Ref.	Year	Microcontroller	Embedded Programming Language	Sensors	Comm. Module	Protocol	Result
[58]	2016	TI CC3200	Energia IDE	Water Level, pH, YL-69 Conductivity, turbidity	ZigBee	HTTP	The low-cost water quality control system is less complex
[59]	2017	AtMega328	Arduino C	LM 393, soil moisture, the M116 water level	ZigBee	HTTP	The system optimizes the use of water for irrigation purposes. Furthermore, water consumption has decreased.
[60]	2018	Mamdani Fuzzy Controller	MATLAB	Soil Moisture, DHT11	ZigBee	HTTP	Reducing water consumption during irrigation
[61]	2018	PIC16f877	C Language	ultrasonic, Flow Sensor, pH	GSM	WAP	control to water impurity, water wasted, and low water flow
[62]	2018	Raspberry Pi zero w	C Language	Ultrasonic level, Turbidity,	WiFi Build-in	MQTT	enable the users to monitor and manage the water management systems remotely from their smartphone.
[63]	2019	MSP 430	Arduino C	Water Flow, Pressure, solenoid valve	CC2650	MQTT	detect water leakages, control water wastage, and avoid natural water waste.
[64]	2019	NodeMCU	LUA	Flow Rate	ESP8266 - 12E	HTTP	increase people's awareness about saving water for sustainable water resources.
[65]	2019	Raspberry pi Arduino Uno	PYTHON Arduino C	Ultrasonic, Turbidity Water Flow	Raspberry pi WiFi build in	HTTP	distributed the same amount of water to all consumers, maintain water quality, and maintain a water level in the main water tank.
[66]	2019	Arduino UNO	Arduino C	Ultrasonic, Flowmeter	ESP 8266	MQTT	Water wastage is fully controlled, a cost-effective system to save water and money.
[67]	2019	Arduino UNO	Arduino IDE	Ultrasonic, Soil Moisture	Arduino Ethernet Shield	HTTP	reduce the burden of the user in monitoring the water level and makes it a user-friendly system.

Ref.	Year	Microcontroller	Embedded Programming Language	Sensors	Comm. Module	Protocol	Result
[68]	2019	NodeMCU	C language	YF-S201, Solenoid Valve	ESP8266	MQTT	design detection model for water usage anomaly in households.
[69]	2019	Arduino Mega	Arduino C	LM35, DHT11, pH, and moisture	GSM/GPRS	WAP	the model is to come up with a solution for conserving water.
[70]	2019	NodeMCU	Arduino IDE	pH, turbidity	ESP8266	MQTT	refining the water bottle with fuzzy theory to fine-tune the calculation goal of water and smartly suggestions technique.
[71]	2020	Raspberry Pi Zero	MATLAB	YF-S201	Build-in Microcontroller	HTTP	The system utilizes live water usage data from water flow meters at household and draws proper inferences from it
[72]	2020	Raspberry Pi 3B	Python	YF-201, Hall-Effect	RFM95W	HTTP	incur an additional 6% of the energy consumed for their typical interactions with a gateway.
[73]	2020	NodeMCU ESP8266	Lua scripting	YF-S201	WiFi build in MC	MQTT	detect excess water consumption by using machine learning.
[74]	2020	NodeMCU V3	Lua scripting	pH2.0	ESP8266	MQTT	automatically updates the status of water quality, real-time monitoring, less operational maintenance.
[75]	2020	Arduino nano, Arduino UNO	Arduino C	YF-S201	Zigbee, Rola	HTTP	save water resources in areas where pipeline connection is in use.
[76]	2020	NodeMCU V3	Lua scripting	pH, Rainfall, Ultrasonic	ESP8266	MQTP	retain the quality of precious rainwater, collect rainwater in areas of tiny size houses
[77]	2020	LPC2148	Arduino C	pH, EC, turbidity, LM35	ESP8266	MQTP	low cost, efficient, real-time water quality monitoring

5. CONCLUSION

Smart water management is a technology designed to collect meaningful and actionable data on a city's water supply, pressure, and delivery. Its primary aim is to ensure that the facilities and electricity used to move water are efficiently handled.

Economic growth, climate change, and the increasing population affect the availability of water resources. Information and communication technology has a distinctive role in this issue through several technologies that help improve and reduce water waste, controlling water quality, and water management. There are many smart technologies for water services, including prospecting, technical methods, filtering & processing, etc.

This paper aimed to discuss active approaches to developing Smart Water Applications. Several active pathways play critical roles in Smart Water Applications. Embedded Programming Languages that are extremely powerful are used. As a result, efficient Smart Water Applications or frames have been created. Many water treatment schemes have been proposed in the past, each with a high cost and energy demand to solve the problem. The pursuit of an intelligent water management scheme is gaining traction with the introduction of the Internet of Things (IoT).

As a result of the KOMMUNAL 4.0 program, smart machines will become standard equipment in water treatment shortly. Selected operation-relevant data enables local machine management, connects systems/objects, and ensures effective operation across the entire infrastructure environment.

COMPETING INTERESTS DISCLAIMER

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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