Measurement: Sensors 27 (2023) 100720

Contents lists available at ScienceDirect

Measurement: Sensors

journal homepage: www.sciencedirect.com/journal/measurement-sensors

Monitoring and controlling the desalination plant using IoT

T. Maris Murugan [a,*], R. Kiruba Shankar [b], Poorani Shivkumar [c], S. Raja Kumar [d], K. Gayathri [e], A. Jeyam [f]

[a] *Department of Electronics and Instrumentation Engineering, Erode Sengunthar Engineering College, Perundurai, Erode-638057, Tamilnadu, India*
[b] *Department of Electronics and Communication Engineering, KPR Institute of Engineering and Technology, Coimbatore-641407, Tamilnadu, India*
[c] *Department of Electrical and Electronics Engineering, Erode Sengunthar Engineering College, Perundurai, Erode-638057, Tamilnadu, India*
[d] *Department of Electronics and Communication Engineering, Panimalar Engineering College, Chennai, Tamil Nadu, India*
[e] *Department of Computer Science and Engineering, PSNA College of Engineering and Technology, Dindigul, Tamil Nadu, India*
[f] *Nuclear Power Corporation of India Limited, Kudankulam, Radhapuram, Tamil Nadu, India*

ARTICLE INFO

Keywords:
Water
Desalination
Internet of things
Sensors
Cloud

ABSTRACT

In this paper, the need for innovative technology and ways to accomplish optimized resource use and desalination treatment, which transforms saltwater into clean drinking water, has been underlined by rising water demands and a degrading environment. The Internet of Things (IoT) now permits to automate a variety of formerly moment and source of energy tasks. One of these is improving water treatment management. This research represents an IoT model for monitoring and controlling a desalination plant. This system monitors the water quality parameters like pH values, temperature, and dissolved oxygen parameters, which are helpful to assess water quality and identify fault parameters at the desalination plant. Here, separate sensors are involved to gather the information and store it in the cloud. It also sends SMS notifications and warnings when it detects misfunctioning, and it regulates the gate valves. This is very needed to rectify the errors, prevent the system from failing, and reduce the maintenance costs as well. This proposed system is highly effective compared to others. According to experimental findings, the proposed technique extends the time by 1.0638%, 6.3829%, and 14.8936% compared to the RO, ED, and FACETS methods.

1. Introduction

Water demand is rising, and the status of the environment has highlighted the need for innovative technologies and ways to achieve optimal resource and desalination control, which transforms salt water into safe drinking water. The IoT is a relatively new concept that has recently gotten much attention. The IoT monitoring using sensors and interfacing circuits is shown in Fig. 1. The Internet of Things (IoT) is a network of physical objects, such as gadgets, automobiles, and buildings, that are linked toward the internet to collect and share data through the use of electronics, programming, sensors, and network access [1]. Desalination is one of the most commonly utilized industrial innovations since many countries rely on the sea and springs for drinking water. Water has always been a source of riches for ancient civilizations and nations. Our forebears recognized the need for huge amounts of pure water for human use. Drinking, washing, gardening, and cleaning are just a few examples. Nature's gift of clean drinking water is recognized as one of the country's most important assets. Water quality, on the other hand, was never fully documented or acknowledged [16–19]. Many procedures are used to filter and purify water from saltwater sources, such as underground brackish water and the sea.

This paper discusses a hands-on IoT sensing experiment that took place at several places across the Aegean Sea. The purpose of this study was to get insight into real-world data sets from which to develop realistic aquatic parameter teaching situations. [2], (Tziortzioti, C.2019). The suggested system checks the hydrogen power (PH) and temperature characteristics of the water; it will be processed at the sewage treatment plant from the water input, preventing the facility from being unable to handle unacceptable industrial effluent [3]. (R.M. Salem, 2022). The monitor system's data (such as air temperatures and relative humidity) is transferred to the cloud for online remote monitoring utilizing Internet of Things (IoT) technology. Users are informed of the status of the system through a GSM module via SMS [4]. (Benghanem, M., 2021).

* Corresponding author.
E-mail addresses: marismuruganlec@gmail.com (T.M. Murugan), kirubashankar.r@kpriet.ac.in (R. Kiruba Shankar), drpooranieee@gmail.com (P. Shivkumar), gayathri1773@psnacet.edu.in (K. Gayathri).

https://doi.org/10.1016/j.measen.2023.100720
Received 13 October 2022; Received in revised form 13 January 2023; Accepted 23 February 2023
Available online 11 March 2023

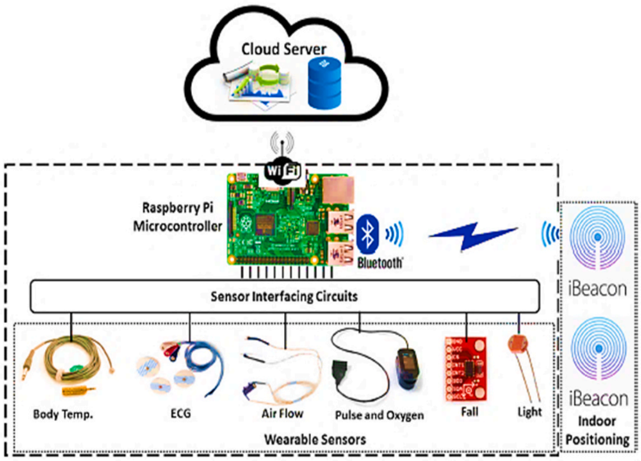

Fig. 1. IoT monitoring using sensors interfacing circuits.

The disposal of industrial wastes into urban sewage systems has certain unfavorable impacts on biological treatment processes since it inhibits the growth of bacteria, which is one of the most important variables in biological treatment effectiveness. The most important factors that influence the bacterial rate of growth are temperature, pH, oxygen, and poisonous chemicals. The treatment processes are all examples of water treatment methods, among the techniques used. In groundwater situations, desalination gradually delivers potable water [20–22]. Because IoT comes within the CPS paradigm, it may be utilized to operate and monitor renewable-based desalination systems. The technology under consideration is a hybrid desalination plant built with the internet in mind from an IoT viewpoint [5]. (Yaqub, U., 2019).

Over a billion people live in arid, water-scarce areas across the world, yet 98% of the water in the world is salty. By 2025, one out of every four people would face a water crisis. Because 20% of the world's population lives in spatially constrained locations, water scarcity would affect one in every three individuals on each continent. Contending water demands, as well as population increase, urbanization, climate change effects, and household and industrial growth, are all factors to consider and can exacerbate these problems. Desalination is used to desalinate water with a fluctuating salinity, such as brackish, estuarine, or ocean; in certain circumstances, it is the major supply of drinking water. As a result, many countries rely on the conversion of salty saltwater into potable or transportable water Most plants have relied on fossil fuels to manage their inventory up until now.

The remaining sections of the research are ordered as follows: The literature review is described in Section II. The planned technique is defined in Section III. The experimental outcomes are described in Section IV, besides the study concludes including some suggestions for further investigation in Section V.

2. Literature survey

Much research has been done in recent years to address privacy concerns in the area of IoT. Authentication and authorization techniques for IoT networks have been developed by various researchers and are discussed in this section.

In 2022Orozco-Lugo, A. G., et al.,developed a concept for using winged ad hoc networks (FANETs) to monitor water worth on a shrimp farmhouseto begin, the critical observing indicators for water quality classification are emphasized, as are their intended operational assortments. Following the completion of the laboratory studies, the recommended treatment will be made available to shrimp agriculturalists in the Mexican government of Colima. These factors have an immediate influence on shrimp existence and growing. Constructed on the explored sensing sense modality, aorientation architecture for constructing a cost-effective FANET-based mobile detection platform is created [6].

In 2022 J Khadim et al. suggested smart and affordable, better-efficiency in IoT employment water quality detecting device which, checks for pH, TDS, temperature, and turbidity water excellence parameters constantly Forty water sample assessments from four separate groups were taken to estimate the generated model for water model that is harmless for consumption and Water Quality Index designated as drinking purpose. Using a WQI analysis of a water sample, this context can keep a adjacent check on water asset contamination and deliver a positive scenario for appropriate drinking water or not. In contrast, this provides for a well-regulated water quality norm [7].

In 2021 Rajalashmi*et al.*, proposes an IoT-based system for monitoring water quality. The water quality in every step may be checked using the sensors once each process is completed. The sensors can detect the value of water and provide users with a safe solution. As a consequence of this project's outcome, several potentially harmful errors can be prevented. The data is collected by the sensors and uploaded to the global positioning system (GPS) data connection [8].

In 2019 El Sayed et al. proposed a smart automation system for a water treatment plant that was created to handle bigData gathered from a variety of sensors and devices, allowing for real-time reactions and access to cloud platform services for the internet of things (IoT)s. The risk alerts and risk management strategies may be sent using a cloud platform like thing speak, which can evaluate, visualize, and respond based on big data analytics [9].

In 2020 Martínez et al., proposed this study describes the combination with a wireless sensor node, and early at the directly adjacent phase of the market, A low-cost water monitoring device was validated in a wastewater treatment model. When laboratory and device data are combined, it is clear that the system and analytical method being employed efficiently in the device are both reliable [10].

In 2021 Hong et al., proposed an Arduino-based sensing model for evaluating water condition During the week, onsite testing on a modest samplecontaining of a microcontroller and several linked detectors was undertaken at regular intervals. Although the system has been demonstrated to be reliable, it is still dependent on human involvement and disposed to data mistakes. The initiative,in short on the other hand, lays a solid basis for future growth projects in the same category, allowing it to become the internet of things (IoT) friendly [11].

In 2020 Hategekimana et al. proposed the use of an IPM a piece of configurable equipment to protect IoT devices, As a dynamic divider between devices, an isolated security mechanism used the infrastructure. The proposed method considers how a centralized cloud-based authority could be used to extend IPM information beyond a single IoT device [12].

In 2021, Li, B., et al. proposed an AI method for data enhanced encryption that may be employed in IoTs' endpoints and intermediate nodes. In this paper, a three-dimensional Arnold magically morph is created for data unit value cryptology at the end of IoTs, and then a quantum logic intelligent simulation is generated that effectively diffuses the data encryption units to decrease the direct relation of image data to improve IoT edge data security [13].

In 2020 Muñoz, M., et al. proposes an IoT clouds architecture constructed on the FIWARE standard for connecting the various negotiators that form the agro-industrial system. In this design also contains an efficient supervision system based on a typical predictive controlling technique designed at lowering operating expenses. The obtained findings demonstrate that the proposed strategy may save around 75% of overall operating expenses, which might be extremely significant in lowering the price of desalinated water and, therefore, ensuring the agricultural system's sustainability [14].

In 2021 Mohammed, M., proposed research will evaluate the impacts of managed shortage irrigation by means of two contemporary micro-irrigation technologies on fruit production, gas exchange, water consumption efficiency (WUE), and date palm quality (Khalas cv.). Among the soaking systems were drip irrigation (DI) and subsurface irrigation

(SI) systems. The outcomes demonstrated that employing the SI system with 50% ETc preserved the date palm's monetary output and fruit superiority when compared to DI and conventional irrigation systems at 100% ETc (Khalas cv.). With 50% ETc deficit irrigation water, the SI system has the highest WUE value (1.09 kg m3), followed by the DI (0.52 kg m3) and a typical irrigation system (0.59 kg m3) with 100% ETc [15].

The major issues considered in the existing methods are less reliability, less robustness, high cost, slow response, and poor efficiency. But with the help of an efficient IoT device, most of the drawbacks can be eliminated.So, to achieve better efficiency, fast response with high robustness, and reliability propose an IoT approach using NodeMCU.the main aim of this concept is controlling and monitoring desalination.It provides the best result based on the sensed data.

2.1. Internet of things in desalination plant

In this proposed method, here to choose the IoT module is Nodemcu esp8266. The five types of sensors are linked to a chlorination plant. All the information's or readings getting from the sensor are stored in the cloud. It has to be monitoring the user. Sometimes, the user missed monitoring the process means, the alarm sound will be automatically ON due to 5–8 s and SMS service will be provided to the user. When the alarm is ON, the system will shut OFF. This will be preventing the system from failing and reduces the maintenance cost also.

2.2. System overview

This system is involved in monitoring and controlling the desalination plants, and collected parameters include pH, turbidity, temperature, water level, and electric fault detection. The information gathered is uploaded to a web server that may be accessed from anywhere in the world. The entire system readings are monitored and stored. If any error occurs means, the alert message will be automatically provided. Block map of a proposed approach is shown in Fig. 2.

2.2.1. SMS services

The suggested system's SMS service serves as a mechanism for reporting unexpected values and difficulties. The SIM900A module is used to implement this service. Three types of SMS alerts are handled by the proposed SMS service: "WATER QUALITY IS LOW", "FAULT OCCURS" and "WATER IS LEAKING.

From the above block diagram, the chlorination plant contains sensors like pH sensors, temperature sensor, turbidity detectors, water level detectors, and electrical path-detecting sensors. Sensors are going to the IoT module in this proposed method. Next, the IoT module sends to the sim module and sends the Alert message to the user. The IoT module is supervised using monitoring and the alarm.

2.3. Description of hardware parts

(i) Nodemcu esp8266:

Nodemcu esp8266 is shown in Fig. 3. The NodeMCU (Node Microcontroller Unit) is an open-source software package with hardware development settings built around a budget System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and developed by Espressif Systems, covers the crucial fundamentals of a computer like CPU, RAM, networking (WiFi), and even a recent operating system and SDK. This makes it an admirable choice for the Internet of Things (IoT). The NodeMCU has existingwithseveral package formats. The most frequent is the base ESP8266 core, which consists of the standard with a 30-pin arrangement. The technical specification for the NodeMCU ESP8266 is given in Table 1. In the proposed model, NodeMCU leads data to the cloud through Wi-Fi, and it is automated with the Arduino IDE to alter the data received. This module is also set up to test the WiFi connection.

(ii)GSM module Sim 900A:

If the Wi-Fi connectivity is lost, the SIM 900A is used in the proposed model for sending SMS warning messages to users and communicating data to the cloud through a network link. Sim module 900A is shown in Fig. 4.

(iii) Temperature sensor (LM75):

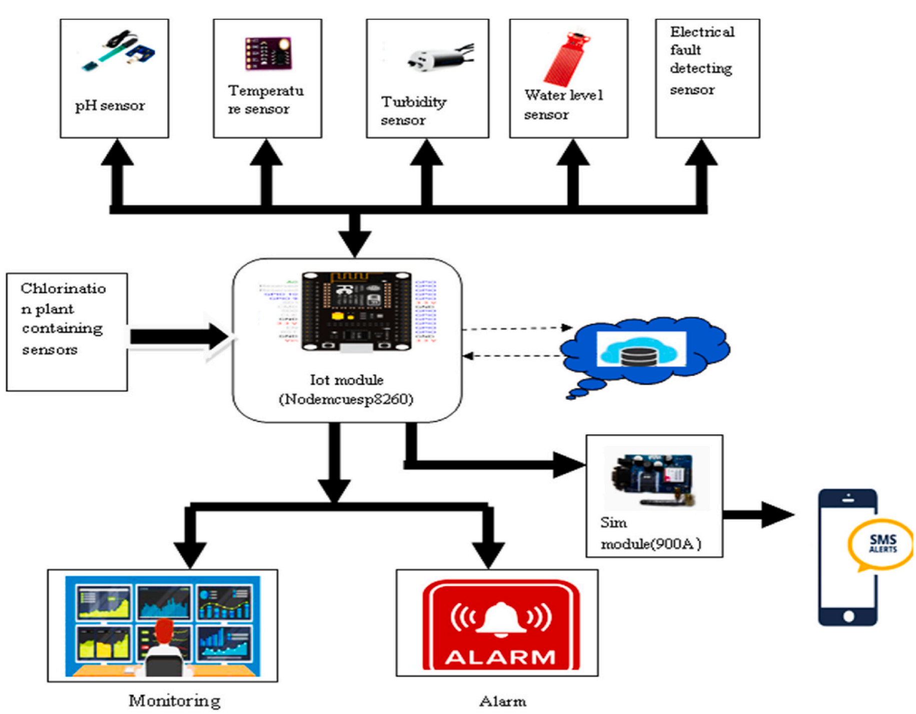

Fig. 2. Block map of a proposed approach.

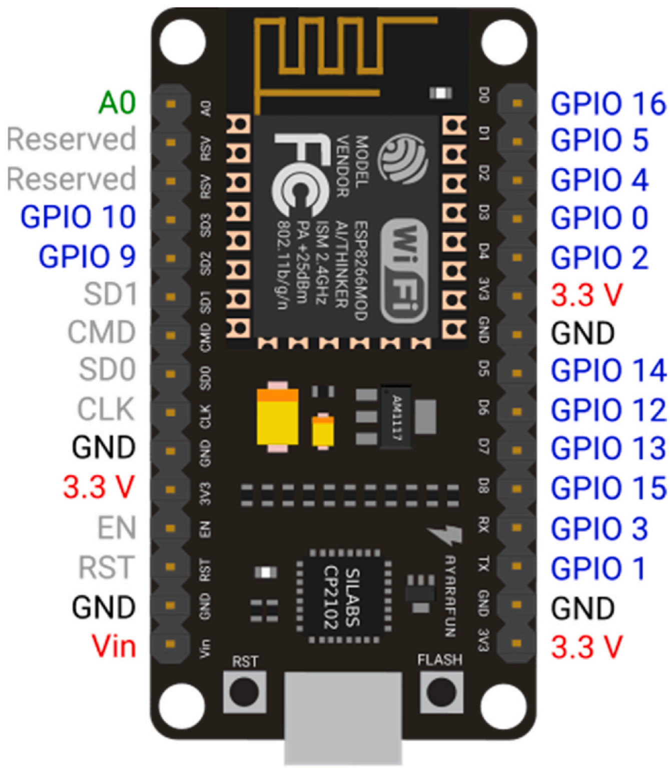

Fig. 3. Nodemcu esp8266.

Table 1
Technical specifications for NodeMCU ESP8266.

Sl.No	Parameter	Descriptions
1.	NodeMCU Size	49 mm × 26 mm
2.	Clock Frequency	80 MHz
3.	Flash drive to Serial	CP2102
4.	Flash drive Connector	Micro USB
5.	Operational Voltage	3.3V
6.	Supply Voltage	4.5V–10V
7.	Memory size	4 MB/64 KB
8.	Digital I/O Pins	11
9.	Analog input	1
10.	Range of ADC	0–3.3V
11.	Peripheral ports UART/SPI/I2C	1/1/1
12.	WiFi	802.11 b/g/n
13.	Range of Temperature	−40C - 125C

LM75 temperature sensor is shown in Fig. 5. The suggested scheme monitors the water temperature at the desalination plant's intake and pump stations with an LM75 monitor, with the temperature values being accepted by the Nodemcu Esp8266 module.

(iv) Analog pH sensor:

An analog pH meter, which reacts with acidity or alkalinity, is used to determine the pH of a solution. Analog pH sensor is shown in Fig. 6. It's frequently used in aquaponics, aquaculture, and water quality checking in the environment. The NodemcuEsp8266 has an inbuilt analog-to-digital converter with 10-bit ADC and one ADC channel. The pH sensor's information is captured on the NodemcuEsp8266 analog pin and converted it analog to digital.

(v) Turbidity sensor (tur 621):

The Nodemcu Esp8266 module was modified to receive turbidity readings from the tur 621 sensor is shown in Fig. 7, which was used to monitor the turbidity of the water at the desalination plant's intake and pump facilities.

(vi) water level sensor: Water level sensor is shown in Fig. 8. This sensor is used to measure the water level as well as identify leaks.
(vii) Electrical fault detecting sensor:

By monitoring one or more conductors and creating an input signal that represents one or more electrical signal conditions in the circuit to be monitored, an electrical fault detector system identifies electrical defects in a desalination system. The Fig. 9 shows the flow of activity of the system.

A flowchart is also a diagrammatic representation of an algorithm, a step-by-step approach to explanation taken by the server when it collected the IoT module by initializing the Nodemcu esp8266. Let's see whether the threshold level is reached or not; if the threshold level is reached, the server sends the alert message to the user; if the threshold is not reached, the user contacts the server and collects the input sensors, and the process will be continued. The overall technical descriptions for the sensors used in the proposed hardware setup have been described in Table 2.

2.4. Working on water grade monitoring

Pipes are castoff to transferring the water. According to the schematic design, the sensor is fixed in a particular sequence when the water is flowing. Sensors are used to keep track of every water drop. No chemical ingredient or present solid particles are therefore allowed to

Fig. 4. sim module 900A

Fig. 5. LM75 temperature sensor.

Fig. 6. analog pH sensor.

Fig. 7. tur 621 turbidity sensor.

Fig. 8. water level sensor.

pass through it precisely. The sensors are used to gather information on temperature, turbidity, and pH value. Chemical substances or contaminated water, on the other hand, the action sensors will be able to be locked. The transmitting and receiving ends are utilized to assist in signal transmission. The receiving end is fixed in the circuit design. The Nodemcu esp8266 has a fixed receiving end. Both ends of the components are present. It is linked at random. It sends a signal to another receiver, and the receiver sends a signal to another transmitter. As a result, the signal transmission is accurate. The Nodemcu esp8266 is programmed with the Lua language. When a flaw is discovered, a signal is sent out right away, and the impact is visible on the display and the buzzer. The mistake is displayed on the monitor. And there will be a

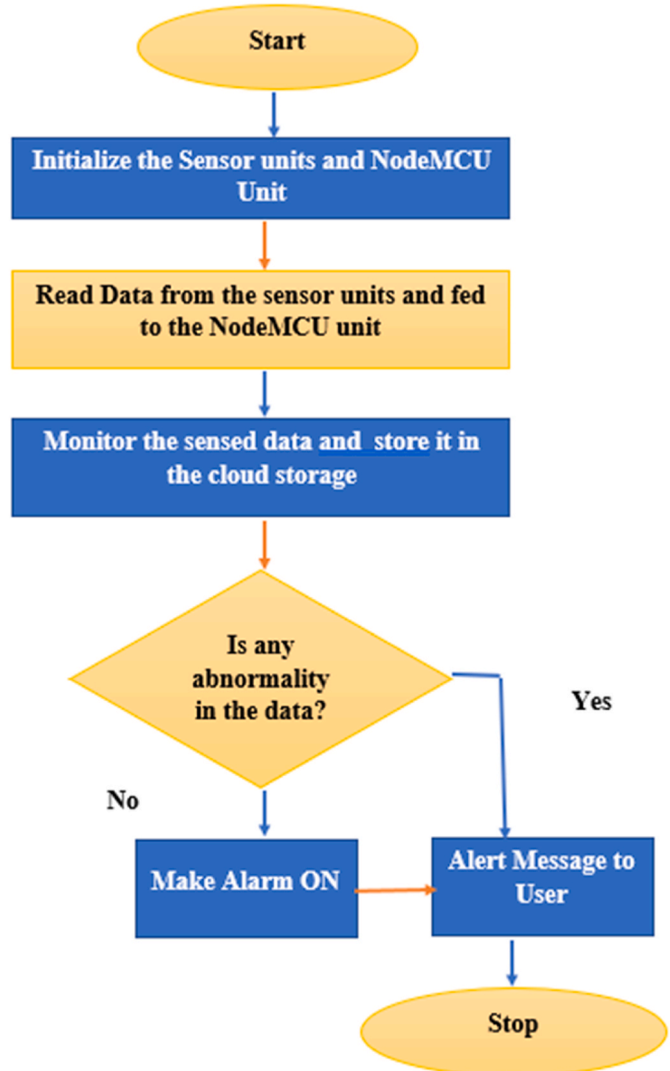

Fig. 9. Flow chart of a proposed model.

sound in the buzzer to warn the operator that there is a problem with the device. However, the operator was unable to determine the source of the issue. Because there are five sensors at this location. And here, the mistake might occur in any sensor. The issue might be with the pH or temperature sensor, or it could be elsewhere. For situations like this, GPS and GPRS connectivity are employed. These can be placed where they belong. For 10 s, a buzzer or warning alarm will sound. The system as a whole will be forced to shut down even if a manual stop is detected.

2.4.1. IoT cloud

To increase their value, the IoT and cloud can be merged. Since IoT devices are connected, widely scattered, and constrained devices, they can store and analyze their sensory information using virtually endless Memory, which is a cloud entity capacity and processing. By expanding cloud computing's reach to include practical applications, the IoT has the potential to improve cloud computing. New phones, as well as information about them and where they will be implanted, can be included. For entirely recorded data, with sensor analysis reports, reports of faults, and the dates when they happened, a daily and weekly report function is now accessible. By sending a message to the computer and then retrieving the command from the database through an IoT device, all IoT devices can be managed remotely via the web server. The IoT module is created in the computer language Lua to accomplish this.

Table 2
Technical descriptions for the sensors in the proposed hardware system.

Sl. No	Sensor Name/Type	Parameters	
1.	Sim 900 A/Wireless Module	supply voltage:	3.4V–4.5V
		Frequency bands:	SIM900A Dual-band: EGSM900, DCS1800
		Transmitting power:	For EGSM 900 Class 4 (2W), For DCS 180 Class 1 (1W)
		Operating Temperature:	−30 °C to +80 °C
		DATA GPRS:	Max download 85.6Kbps, Max upload 42.8Kbps
		Assists	CSD, USSD, SMS, FAX, MIC, and Audio Input
2.	LM 75/Temperature Sensor	Operating temperature range (C)	−55 to 125
		Supply voltage (V)	2.7–5.5
		Interface type	I2C, SMBus
		Source current (Max) (uA)	500
		Temp resolution (Max) (bits)	9
		Features	ALERT, UL recognized
3.	SEN0161/Analog PH Sensor	Segment Power	5.00V
		Module Size	43mm × 32 mm
		Measurement Range	0-14 PH
		Measurement Temperature	0–60 °C
		Accurateness	±0.1 pH (25 °C)
		Responding Time	≤1min
4.	Tur 621/Turbidity Sensor	Operational Voltage	5V DC
		Operational Current	40 mA (MAX)
		Time for response	<500 ms
		Resistivity	100 M (Min)
		Output Method	Analog output: 0–4.5V Digital Output: High/Low-level signal
		Operational Temperature	5 °C–90 °C
		Storage Temperature	10 °C–90 °C
5.	REL_35/water level sensor	Functional Voltage (VDC)	3–5
		Max. Functional Current (mA)	20
		Detection Range	40 × 16 mm
		Operational Temperature (°C)	−10 to 30
		Range of Humidity	10%–90% non-condensing
		Type of Sensor	Analog Detection
6.	Thingy:53/ Electrical fault detecting sensor	operating temperature range	0–35 °C
		Operating Voltage (VDC)	2.3–4.35 V
		Buzzer	Piezoelectric, 4 kHz
		Sensing parameter	Senses lighting conditions, Temperature, humidity, air quality, and air pressure.

3. Result and discussion

The processing plant's sensors detected a high level of released commercial salt distillation water and took appropriate action. Pumping station warning alerts (SMS, online notice) can assist the supervisor in predicting the water's arrival time depending on the separation of the pumping station from the following pumping station. The pumping station of PH Reading Time is shown in Fig. 10.

The measured water quality result is shown in Table 3 below. The buzzer and the device won't function as intended if the water quality is good. If any of the sensors, including the pH, turbidity, temperature,

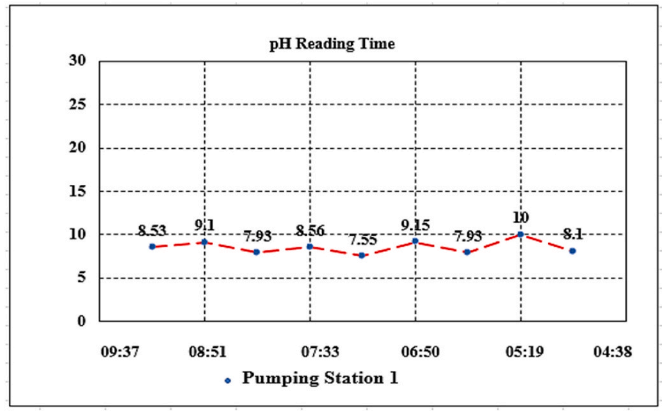

Fig. 10. Pumping station of PH Reading Time.

Table 3
Observedoutcome of the quality of water.

S. No	Quality of water	Sensors	Alarm	System
1	Good	Nil	OFF	Works normally
2	Poor	pH sensor	ON	OFF
3	Bad	Turbidity sensor	ON	OFF
4	Bad	Temperature sensor	ON	OFF
5	Bad	Water level sensor	ON	OFF

water level, and electrical fault sensors, signal ON, the system will be turned off and the buzzer will sound.

At 10-min intervals, sensors collect readings from the desalination of water. The sensors gather and deliver data on monitoring parameters to the IoT module. Testing of the system's functioning and practical application was placed at the point illustrated in the dash-monitoring and -controlling overview, which depicts the board.

The main water quality metrics and their ideal operating ranges is shown in Table 4. The graph below shows the oscillations in the sensor and the observed data (pH and temperature) over period for the storage tanks pumping station temperature reading time is shown in Fig. 11. It was the closest station to the treatment facility. The pH of the water declined from 8.53 at 7.93 p.m. to 8.10 at 7.55 p.m., and at 5:05 p.m., the pH value at the treatment plant decreased from 9.10 to 8.10 p.m., suggesting that the desalination of salt water released into the pumping station.

The afternoon turbidity readings are greater, as seen in Fig. 12. The aforementioned stream is fake; its contents are drawn from nighttime-only subsurface conduits. Remaining particles from desalination that collect on the riverbed result in lower turbidity levels. The readings should be higher in the morning, according to theory. One potential culprit is the river's calmness at midday and the oversaturation of suspended particles. When there is no flow and no sediment movement downstream, salts stay in the stream and add to turbidity levels.

The accuracy is compared between existing and proposed methods, as shown in Fig. 13. One possible explanation is an overabundance of suspended particles in the noon calm river. Solids stay in the stream and raise turbidity levels when there is not at all flow or deposit migration downstream. It is similarly well identified that temperature and

Table 4
The main water quality metrics and their ideal operating ranges.

Water Parameters	Normal Level
Liquified Oxygen (mg/L)	>5
pH	6.5–9.5
Saltiness (ppt)	15–23
Temperature (°C)	20–30

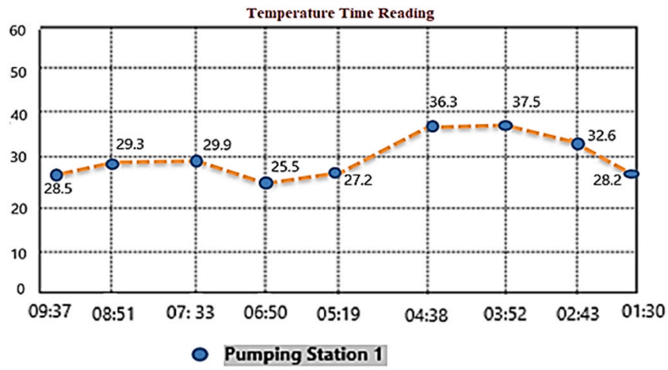

Fig. 11. Pumping station of Temperature Reading Time.

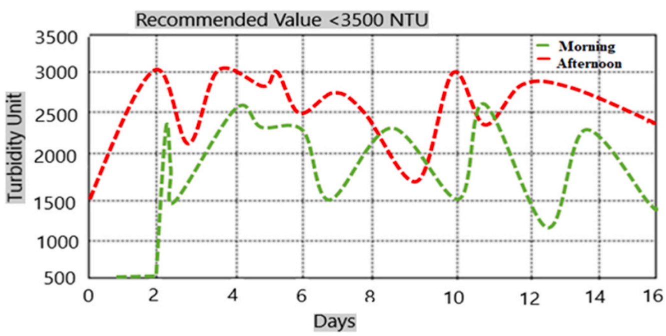

Fig. 12. Turbidity variation.

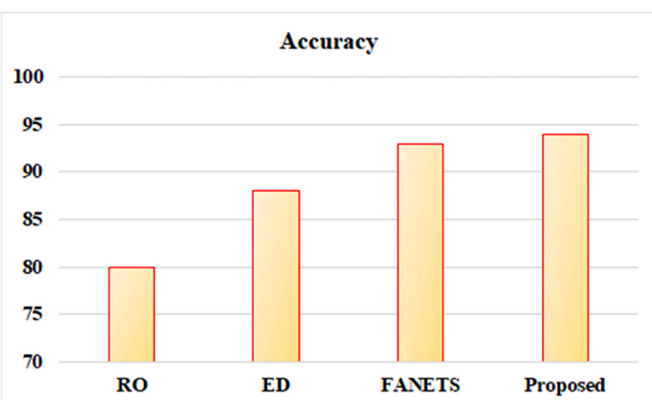

Fig. 13. Comparison graph.

turbidity are positively correlated. Due to their greater heat capacity than water, suspended particles may absorb more heat, raising the temperature. Indeed, the afternoon has higher temperatures and turbidity. However, it should be noted that finding the precise turbidity number is challenging owing to normal variations in seasons, limited geology, seawater, meteorological conditions, and environment. Despite this, a value of fewer than 3500 NTU is thought to be optimum.

The proposed technique outperforms RO, ED, and FANETS in terms of accuracy.

4. Conclusion

In this article, an innovative desalination framework constructed on the IoT with sensors and a cloud is proposed for gathering, monitoring, and analyzing the data from the desalination plant. The proposed framework involves separate sensors to monitor the water quality, and fault detection is very helpful to prevent the system from failing. These sensors are low-cost, highly efficient, and flexible. These are linked to a Node mcu as an IoT module. Finally, the observed values are viewed, and control is performed over the internet through Sim module 900A to mobile devices. Thus, the system maintains a long-lasting. This study has yielded good results. It allows the secure monitoring of desalination process data through the internet. From here, it will be possible to avoid failure scenarios and keep desalination plant downtime to a minimum. This is very needed to rectify the errors, prevent the system from failure and reduce the maintenance costs as well. This proposed system is highly effective compared to others. They wish to build a working prototype of our suggested trust assessment framework and conduct further research using the suggested trust evaluation approaches in a true cloud context.

CRediT authorship contribution statement

T. Maris Murugan: Conceptualization, design of study, revising the manuscript critically for important intellectual content. **R. Kiruba Shankar:** acquisition of data, revising the manuscript critically for important intellectual content, Approval of the version of the manuscript to be published. **Poorani Shivkumar:** Formal analysis, Approval of the version of the manuscript to be published. **R. Raja Kumar:** Formal analysis, Approval of the version of the manuscript to be published. **A. Jeyam:** Drafting the manuscript, Approval of the version of the manuscript to be published.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgements

The author with a deep sense of gratitude would thank the supervisor for his guidance and constant support rendered during this research.

References

[1] X. Li, Q. Wang, X. Lan, X. Chen, N. Zhang, D. Chen, Enhancing cloud-based IoT security through trustworthy cloud service: an integration of security and reputation approach, IEEE Access 7 (2019) 9368–9383.
[2] C. Tziortzioti, D. Amaxilatis, I. Mavrommati, I. Chatzigiannakis, IoT sensors in the sea water environment: ahoy! Experiences from a short summer trial, Electron. Notes Theor. Comput. Sci. 343 (2019) 117–130.
[3] T.M. Murugan, R.K. Shankar, The Implementation of a Coefficient Diagram Method Based Polynomial Controller for a Non-Linear Process with a Distributed Control System in a Chlorine Scrubber System, Gospodarka Surowcami Mineralnymi – Min. Resour. Manag. 38 (2022) 231–255.
[4] M. Benghanem, A. Mellit, M. Emad, A. Aljohani, Monitoring of solar still desalination system using the internet of things technique, Energies 14 (21) (2021) 6892.
[5] U. Yaqub, A. Al-Nasser, T. Sheltami, Implementation of a hybrid wind-solar desalination plant from an Internet of Things (IoT) perspective on a network simulation tool, Appl. Comput. Informat. 15 (1) (2019) 7–11.
[6] A.G. Orozco-Lugo, D.C. McLernon, M. Lara, S.A.R. Zaidi, B.J. González, O. Illescas, R. Rodríguez-Vázquez, Monitoring of water quality in a shrimp farm using a FANET, Internet. Things. 18 (2022), 100170.
[7] H. J Khadim, F. K Obaed, H. M Rashid, Water Quality Detection using cost-effective sensors based on IoT, SVU-International Journal of Engineering Sciences and Applications 3 (1) (2022) 98–103.
[8] K. Rajalashmi, N. Yugathian, S. Monisha, N. Jeevitha, IoT based water quality management system, Mater. Today Proc. 45 (2021) 512–515.
[9] H.Y. El Sayed, M. Al-Kady, Y. Siddik, Management of smart water treatment plant using iot cloud services, in: 2019 International Conference on Smart Applications, Communications and Networking (SmartNets), IEEE, 2019, December, pp. 1–5.

[10] R. Martínez, N. Vela, A. El Aatik, E. Murray, P. Roche, J.M. Navarro, On the use of an IoT integrated system for water quality monitoring and management in wastewater treatment plants, Water 12 (4) (2020) 1096.
[11] W.J. Hong, N. Shamsuddin, E. Abas, R.A. Apong, Z. Masri, H. Suhaimi, M.N.A. Noh, Water quality monitoring with arduino based sensors, Environments 8 (1) (2021) 6.
[12] F. Hategekimana, T.J. Whitaker, M.J.H. Pantho, C. Bobda, IoT Device security through dynamic hardware isolation with cloud-Based update, J. Syst. Architect. 109 (2020), 101827.
[13] B. Li, Y. Feng, Z. Xiong, W. Yang, G. Liu, Research on AI security enhanced encryption algorithm of autonomous IoT systems, Inf. Sci. 575 (2021) 379–398.
[14] M. Muñoz, J.D. Gil, L. Roca, F. Rodríguez, M. Berenguel, An iot architecture for water resource management in agroindustrial environments: a case study in almería (Spain), Sensors 20 (3) (2020) 596.
[15] M. Mohammed, A. Sallam, M. Munir, H. Ali-Dinar, Effects of deficit irrigation scheduling on water use, gas exchange, yield, and fruit quality of date palm, Agronomy 11 (11) (2021) 2256.
[16] M. Azrour, J. Mabrouki, G. Fattah, A. Guezzaz, F. Aziz, Machine learning algorithms for efficient water quality prediction, Modeling Earth Sys. Environ. 8 (2) (2022) 2793–2801.
[17] M.M. Rashidi, I. Mahariq, N. Murshid, S. Wongwises, O. Mahian, M.A. Nazari, Applying wind energy as a clean source for reverse osmosis desalination: a comprehensive review, Alex. Eng. J. 61 (12) (2022) 12977–12989.
[18] W. Zhang, F. Ma, M. Ren, F. Yang, Application with Internet of things technology in the municipal industrial wastewater treatment based on membrane bioreactor process, Appl. Water Sci. 11 (3) (2021) 1–12.
[19] M. Alshehri, A. Bhardwaj, M. Kumar, S. Mishra, J. Gyani, Cloud and IoT based smart architecture for desalination water treatment, Environ. Res. 195 (2021), 110812.
[20] T. Maris Murugan, R. Kiruba Shankar, Water desalination plant fault detection using Artificial Neural Network, Global Nest, 24 (2023) 1–7, Januray.
[21] A.A. Hassan, A.E. Elwardany, S. Ookawara, H. Sekiguchi, H. Hassan, Energy, exergy, economic and environmental (4E) assessment of hybrid solar system powering adsorption-parallel/series ORC multigeneration system, Process Saf. Environ. Protect. 164 (2022) 761–780.
[22] K. Oikonomou, M. Parvania, Optimal participation of water desalination plants in electricity demand response and regulation markets, IEEE Syst. J. 14 (3) (2019) 3729–3739.