Chapter 8
Monitoring Quality of Tap Water in Cities Using IoT

Asis Kumar Tripathy, Tapan Kumar Das and Chiranji Lal Chowdhary

Abstract During the past decade, water requirement has increased many folds in India. However, it has turned out to be a major challenge for the world in matching the increasing demand for water supply. In other hands, water resource has been continuously polluting due to apathetic usage of water, natural and man-made calamity, global warming, sewages, and garbage. Optimal utility of this resource and above all its preservation is the only way to safeguard future life as it is well known that water is life. In this paper, we present a framework based on Internet of Things (IoT) for water monitoring and control activity, which supports Internet-based data collection on a real-time basis. The system addresses the issue of flow rate measuring and in the same time, this study proposes a method to check wastage of water. It has the provision to measure the quality of water dispensed to every household by deploying PH and conductivity sensors.

Keywords IoT · PH sensor · Wi-Fi · Conductivity sensor · Water quality

8.1 Introduction

The World Health Organization (WHO) has reported that 77 million individuals in India struggle to get clean water. In addition to this, the root cause of one-fifth of sicknesses is hazardous water. In other statistics, it has been stated that 1600 deaths are caused because of loose bowels every day, which is also the consequence of consumption of contaminated water. The crumbling of water assets turns into a typical issue for a human being. The conventional strategies for screening water quality

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Table 8.1 Specified parameters of water and their quality range

Parameters	Range	Resolution	Accuracy	Quality range
Turbidity	0–100 NTU	0.1	±0.5	0–5
ORP	−2000 to 2000 mV	2	±10	600–800
pH	0–14	0.05	±0.1	6.5–8.5
Conductivity	100–20,000 μS/cm	10	5%	500–1000
Temperature	−5–100 °C	0.1	±0.1	–
Flow	1–115 L/min	0.0015	15%	–

include the manual accumulation of water test from various areas. These water tests are tried in the laboratory utilizing the diagnostic innovations. Such methodologies are tedious and did not really to be viewed as proficient. In addition, the flow procedures incorporate an examination of different sorts of parameters of water quality, for example, physical and synthetic. Customary strategies for the water quality recognition have the detriments like entangled system, long sitting tight time for results, low estimation exactness, and high cost. Along these lines, there is a need for non-stop checking of quality parameters progressively. Different parameters of water and their range to ensure the quality of water are depicted in Table 8.1.

The IoT turns into an establishment for interfacing objects, sensors, and other shrewd advances. IoT is an augmentation of the Web. It gives prompt access to data about physical protests and prompts imaginative administration with high effectiveness and productivity [1]. There are a few vital advancements identified with the IoT. They are pervasive processing, RFIP, remote sensing, and distributed computing. Distributed computing is an extensive scale, ease preparing unit, which depends on IP, an association for estimation and capacity. The qualities of distributed computing have been examined in various papers [2–6]. The IoT application zones incorporate home robotization, water condition observing, water quality checking, and so on; the water quality checking application includes expansive dispersed exhibit of observing sensor and an extensive circulation organize [7, 8]. It likewise requires isolate checking calculations as inspected in [9, 10]. Above all, various forms of automation were made simpler by using IoT [11].

8.2 Preliminaries

The capacity to screen water level and to shield water from wastage is a critical issue through the fields of the earth and additionally building. The IoT framework is controlling the flow of water through solenoid valves which are controlled by the ultrasonic sensors, water quality sensors, and stream rate sensors. The block diagram for the IoT framework is depicted in Fig. 8.1. There are different subsystems working for this model: (a) focal estimation: it gathers the water quality from the sensors, stores

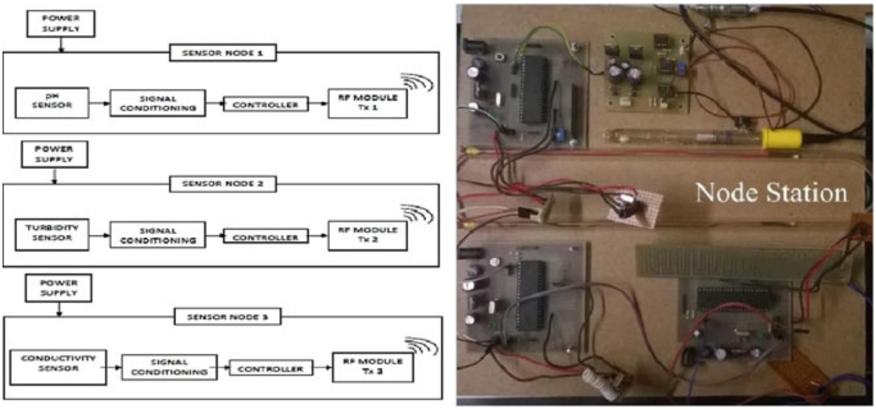

Fig. 8.1 Block diagram of the model

in a database, and then transmits information to different hubs; (b) sending message: after the focal estimation, hub gathers all the information; it will analyze the data and finally, sends email or messages to the responsible persons. Solenoid valve is used to close the principle water valve from capacity tank in the event of any pollution found. The focal estimation hub fills in as the sensor hub. The thought is to introduce these sensor hubs in numerous buyer destinations in a spatially distributed way to shape a WSN that will screen the drinking water quality in the water conveyance framework from the source to the tap.

8.3 Proposed Methodology

The proposed IoT system can be utilized in any of the water tanks, where there is a need to have safe water and minimization of water loss. Whenever the water will be supplied to the water tanks, at that point of time, the pH level of the water will be checked. If the PH level of the supplied water is within the predefined range then we can check the conductivity of water. In this case, when both the pH and conductivity of the supplied water are not in the safe range, then the water supply can be blocked to all the household tanks by blocking the respective valves. We can continue the same process until the water comes in a safe range. Once the water tanks get full based on the availability of safe waters, then the valves will be opened for household use. This model also looks after equal distribution to all the consumers. All the data we are using here for the quality purpose will be sent to the cloud for future use. Once the data are available in the cloud, it can be accessed from anywhere in the world by using authentication mechanism. The quality check and flow of water can be monitored through the Web once the data are available on cloud. In Fig. 8.2, the methodology of the proposed scheme is described.

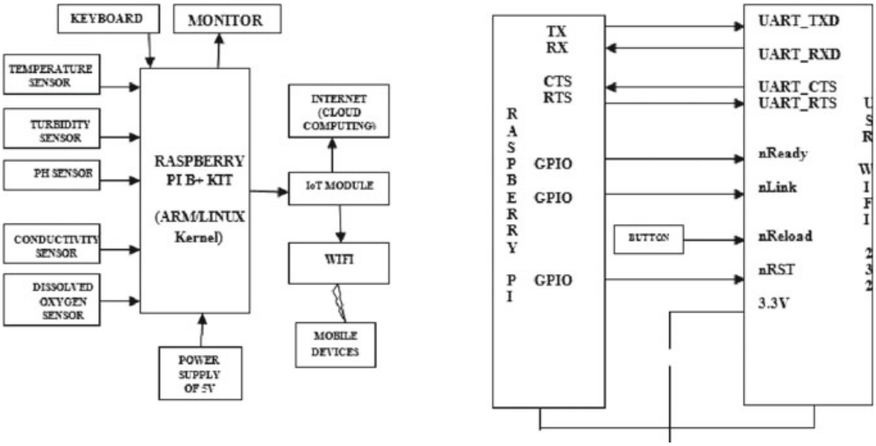

Fig. 8.2 Working model of the proposed scheme

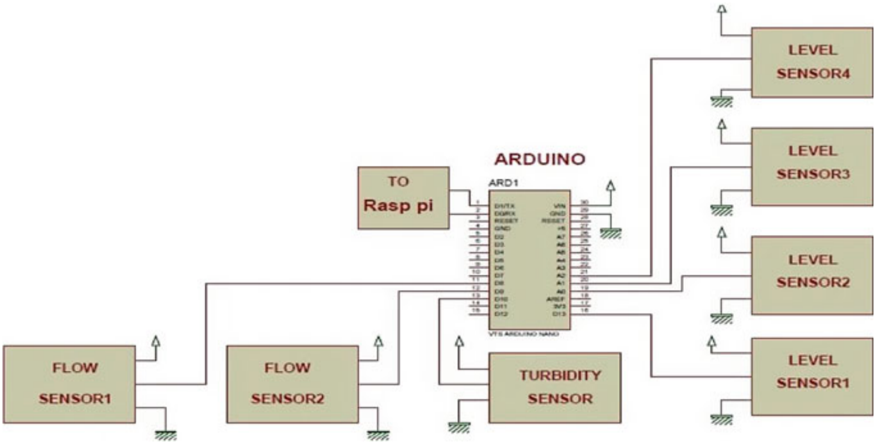

Fig. 8.3 Detailed description of the Arduino system

8.3.1 Detailed Diagram of the System

In this model, the Raspberry Pi and one Arduino board are used for communication purpose. Different sensors are used for data collection, and the examples of those sensors are flow sensor, level sensor, GSM module, and a turbidity sensor. The hardware used in this model is showcased in Fig. 8.3.

The Raspberry Pi, we used in this model, is a tiny size computer board capable of processing the data received from different sensors. Most of the IoT applications prefer to use Raspberry Pi devices for the implementation; as a result, it gives better performance in terms of lifetime. The Raspberry Pi device collects all the data from the Arduino board and sends it to the cloud continuously. We are using here the microcontroller of 8 bits which is attached to the Arduino nano-board. It has fourteen input/output pins to be connected to the sensors. The level sensors and the flow sensors used in this model are always connected to the analog input pins and to digital input pins, respectively. Whereas, the water flow sensors measure the amount of liquid flown through that valve. The flow rate of the water is calculated in milliliter/sec. In addition, the quantity of suspended particles in the water is measured by the turbidity sensors.

8.4 Results and Discussion

It is highly recommended by some applications to observe the quality of the water before using it. For example, if you want to use any lake water for drinking purpose then your first job is to test the quality of the water. Pollution detection in drinking water is another important application, which requires a different strategy for checking the quality of the water. In this framework, the water quality parameters can be show cased on the Web by utilizing cloud computing paradigm. All the parameters collected from the water samples are kept in some independent servers on the cloud. The water quality parameters can be seen by the authorized devices on the cloud.

Figure 8.4 demonstrates the quality of the water by using different scenarios based on IoT platform.

8.4.1 Configuring the Wi-Fi Module

The ESP8266 device Wi-Fi is configured in such a way that it can send/receive data toward the server. The Wi-Fi device is first connected to the Arduino and then programmed to send data to the server. Table 8.2 represents connections of ESP8266 to Arduino.

After flashing the module, the RX and TX pins are reversed and the Arduino device can be programmed to send or receive data. Figure 8.5 shows the setup for configuring the Wi-Fi module.

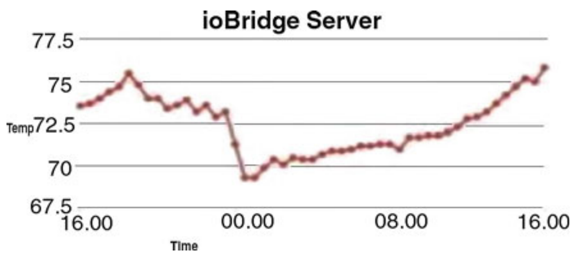

Fig. 8.4 Performance analysis of the model

Table 8.2 Connection of ESP 8266 to Arduino for flashing

ESP8266	Arduino Uno
RX	Receive
TX	Transmit
GND	Ground
RESET	Ground
CH_PD	3.3 V (external supply)
VCC	3.3 V (external supply)

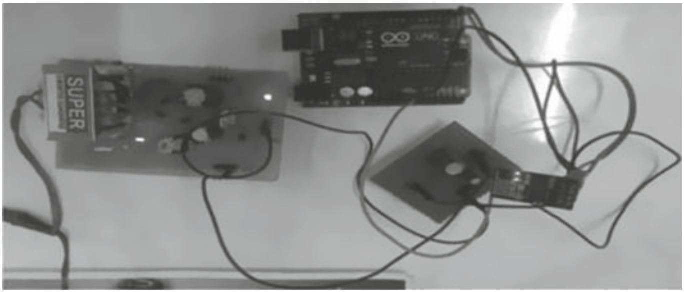

Fig. 8.5 Setup for configuring the ESP 8266

8.4.2 Calibration of pH Sensor

The steps to calibrate a pH sensor are:

- Take two buffer solutions with pH 4.00 and pH 9.20.
- First, dip the probe in the 4.00 pH buffer solution and set the sensor to get pH as 4.00.
- Wash the probe with distilled water.
- Dip the probe in the 9.20 pH buffer solution and check the sensor reading. The reading could be less or more than 9.20. The difference in the reading is the error.
- Then, take the solution for which the pH is to be obtained.
- Dip the probe into the solution and get the reading.
- Actual pH = pH reading ± error.

First, the average value of six sample values is taken by storing in a buffer. Then, the analog average value is converted to millivolt (mV) using the formula: Value = average value * 5.0/1024/6. Then, the value of the PH can be calculated by using the formula as, pH Value = 3.5* Value + Offset; offset is a parameter to change for the calibration.

8.5 Conclusion

The system explains continuous monitoring of the quality of water supplied to the household automatically. The automation of this process would simplify and would enable to impose the strict quality check standards by the authority. In addition to this, the prevailing practice of the manual field tour for auditing would be resolved. However, the recorded water quality time-series data can be further analyzed to have more insights as to how the quality of water is affected by monsoon or in summer or by wind speed and by different geographical parameters.

References

1. Patawala, A.H., Bansode, N.P., Bhong, Y.P., Zadbuke, A.S.: IOT based water management system for smart city. Int. J. Adv. Res. Ideas Innovations Technol. **3**(2) (2017)
2. Kulkarni, P.V., Joshi, M.S.: An IOT based water supply monitoring and controlling system with theft identification. Int. J. Innovative Res. Sci. Eng. Technol. **5**(9) (2016)
3. Bhatt, J., Patoliya, J.: IOT Based water quality monitoring system. In: IRF International Conference (2016)
4. PradeepKumar, M., Monisha, J., Pravenisha, R., Praiselin, V., Suganya, K.D.: The real time monitoring of water quality in IoT environment. Int. J. Innovative Res. Sci. Eng. Technol. **5**(3) (2016)
5. Khurana, M.K., Singh, R., Prakash, A., Chhabra, R.: An IoT based water health monitoring system. IJCTA **9**(21), 07–13 (2016)
6. Vijayakumar, N., Ramya, R.: The real time monitoring of water quality in IoT environment. In: 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015]. https://doi.org/10.1109/iccpct.2015.7159459 (2015)
7. Ramprabu, J., Paramesh, C.: Automated sensor network for monitoring and detection of impurity in drinking water. Int. J. Res. Appl. Sci. Eng. Technol. **3**(1) (2015)
8. Chavan, P.J., Mechkul, M.A.: IoT based water quality monitoring. Int. J. Mod. Trends Eng. Res. **3**(4), 746–750 (2016)
9. Robles, T., Alcarria, R., Martin, D., Navarro, M., Calero, R., Iglesias, S., & Lopez, M. (n.d.). An IoT based reference architecture for smart water management processes. J. Wireless Mobile Netw. Ubiquit. Comput. Dependable Appl. **6**(1), 4–23
10. Barabde, M., Danve, S.: Real time water quality monitoring system. Int. J. Innovative Res. Comput. Commun. Eng. **3**(6) (2015)
11. Tripathy, A.K., Mishra, A.K., Das, T.K.: Smart lighting: intelligent and weather adaptive lighting in street lights using IOT. In: 2017 International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), pp. 1236–1239 (2017)