CHAPTER 5
WATER QUALITY MONITORING USING INTERNET OF THINGS

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5.1 INTRODUCTION

Water is essential to human life and ecosystems. Thus, the water quality must be protected from time-to-time. Nevertheless, water is now threatened and infected by human interventions and climate change such as urbanisation, industrial waste discharged, agricultural activities, and global warming. To address these issues, water quality monitoring systems have been developed to monitor the quality of the water (Kondo et al., 1987). In particular, the quality of the water can be evaluated by monitoring its parameters such as dissolved oxygen, pH value, temperature value, electric conductivity.

Low concentration of dissolved water, undesired temperature and pH value, and inappropriate salinity concentration can lead to low water quality. This suggests that one can perform water monitoring to collect these data and determine the water quality index. From the water quality index, one can identify whether the water is safe for consumption or aquatic animals. To monitor the water quality, water sensing and sampling processes can be performed.

Specifically, water sensing is referred to as the process of sensing the water parameters (e.g., pH value, temperature and etc.) by using specific sensors, which can be deployed in water bodies such a lake, river and

pond. In contrast, water sampling refers to the process of collecting a sample of water from the water resources such as sea and sewage. Both water sensing and sampling are taken for further processing and analysis.

Traditionally, agents who are responsible for water quality monitoring have to collect the water samples periodically and analyse them in the laboratory. For instance, the agents have to visit specific locations by walking or using a boat to take the water samples. This process takes a lot of time, effort and cost. More importantly, certain locations are difficult and dangerous for the human agents to reach.

During the water sampling process, agents also must use surface contamination clean (SCC) bottles or water samplers (e.g., Van Dorn and Kemmerer samplers) to collect the water sample. When using SCC bottles, agents need to manually dip the bottles into the water. When using water samplers, agents might accidentally spoil or contaminate the water samplers. These situations lead to unwarranted danger and contamination.

Motivated by the above, in this chapter, we propose a water quality monitoring system using IoT. Unlike traditional methods, this technology offers a reliable and cost-effective way to do water quality monitoring. Furthermore, the water sensing and sampling can be performed autonomously in real-time and in places that are formerly inaccessible by human. In the sampling process, the agents' safety is also assured. This is because, using our proposed scheme, the agents do not need to manually collect the water samples. This helps to eliminate any potential danger, wastage, and contamination.

The rest of the chapter is organised as follows: Section 5.2 discusses related works while Section 5.3 details the proposed system. The results and discussions are presented in Section 5.4 and the conclusion is made in Section 5.5.

5.2 WATER SAMPLING TECHNOLOGIES

According to Bartram and Balance (1996), water quality monitoring refers to the process of monitoring the water quality by using some sensors and

collecting water samples while the objective of water sensing and sampling are to assist an agent to analyse the water quality.

Throughout this chapter, water sampling is referred to as the process of collecting a specific quantity of water for study purposes. The water sample is usually obtained from a water resource and stored using water samplers or plastic bottles. The Van Dorn sampler is one of the water samplers available and it is commonly used in water resources that are stratified or shallow. Besides, it can be used when an agent needs many samples from different depths of the same water resource (Koparan et al., 2018).

In practice, human agents need to walk on their feet or use water vessels to collect the water samples. When they reach the targeted location, they need to manually take the water samples and stored them using the SCC bottles or water samplers. The water samples are then taken to and analysed in the laboratory. However, this method cannot be executed if the targeted location is inaccessible to humans. Moreover, this method cannot provide the desired data in real-time (Pasika & Gandla, 2020).

To address this limitation, one may instead employ water sensing. Water sensing refers to the process of using probes (e.g., sensors) to record data at a single point in time or logged at regular intervals over an extended period. Unlike water sampling, water sensing is more time- and cost-efficient. Furthermore, water sensing mechanism can help one to obtain the data in real-time with limited human effort. Nevertheless, certain in-depth analysis cannot be carried out using water sensing since it requires more complicated equipment and time for processing.

In addition, throughout this chapter, the data refers to the water quality parameters over time. Some of the general water quality parameters are dissolved oxygen, pH value, temperature value, electric conductivity, and turbidity (Sabari et al., 2020). More in-depth analysis can also be carried out and such analysis can further determine different elements and ions in the water. However, for simplicity, in this chapter we mainly focus on the water quality parameters such as pH value and temperature.

As discussed above, the traditional water sensing and water sampling are manually done by the human agents. For instance, agents need to take the measurement instruments and get close to the water resource