AN INNOVATION OF WATER QUALITY IN PUBLIC POOLS

SUBMITTED BY:

1) VINAYAN.B
2) KOVENDAN.M
3) MUGESHWARAN.P
4) SAKTHIKUMAR.A
5) SARAVANAN.N

1. Introduction

Swimming is a kind of sport fancied by many people;not only children, but also adults.

This sport makes ourbody healthy, because when we swim, we use almost allmuscles in our body.

Swimming is not only a sport, but also a recreational activity.

Nowadays, there are many public swimming pools available for recreation orcompetition.

As the pools are used by many people, watercleanliness triggers health issues. Swimming in a dirtypool can cause infectious diseases, such as skin diseases, diarrhea, eye irritation, and respiratory tract irritation.

In swimming pools, we can control disease-causing
bacIn swimming pools, we can control teria by adding chlorine in the water. Water acidic orthe pH level is very important to determine how effective the disinfectant can kill germs.

However, people can get
eye or respiratory tract irritation due to the vapor from chlorine that is formed by chlorine and sweat or urine.

Therefore, changing pool water regularly is necessary to
improve water quality and hygiene.

A simple solution isusing a fixed schedule to change the water,
For example, once a week or every two weeks.

Our contributions inthis paper are two-folds:

1) Firstly, we design and implement a wireless system to monitor water quality in public swimming pools using an Arduino Uno, an ESP8266 ESP-01 WiFimodule, a DS18B20 temperature sensor, a pH sensor, and a turbidity sensor.

2) Then, we utilize a data-mining prediction model topredict the quality of water in public swimming pools using the decision tree Iterative Dichotomous 3 (ID3)algorithm.

2. Related Works

The Internet of Things (IoT) enable physical

Objectsequipped with smart sensors, *i.e.* from gas sensors [3] tomedical sensors, to transmit data using wirelesstechnology.

One of the implementations of the Internet ofThings is a Wireless Sensor Network-based monitoringand control system based on the use of electrical energy[4].

In this study, wireless sensor nodes are designed tomeasure electrical parameters of Alternating Current (AC)as effective voltage, effective current, active power,apparent power, power factor and total electrical energyconsumption using the ESP8266 module as a link withWiFi.

Power consumption monitoring through the Internetcan show several electrical parameters with the same datafrom the data logger recap taken from an SD-Cardinstalled in a wireless sensor node through an Androidapplication and web browser.

In [5], the authors monitor the quality of lake waterbased on the parameters of acidity (pH), turbidity,dissolved oxygen (DO) and water temperature to providean early warning when the lake water quality isapproaching a given threshold, so that the loss of fishfarmers in the lake can be minimized.

The data of waterquality measured by existing sensors is collected in a datalogger and forwarded using a cellular network.

The data isstored and displayed on a website and can be accessedfrom anywhere.

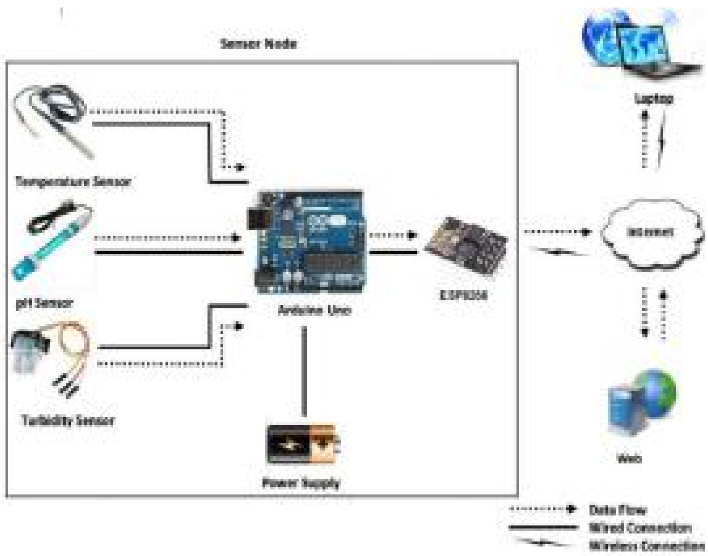


Figure 1. The monitoring system

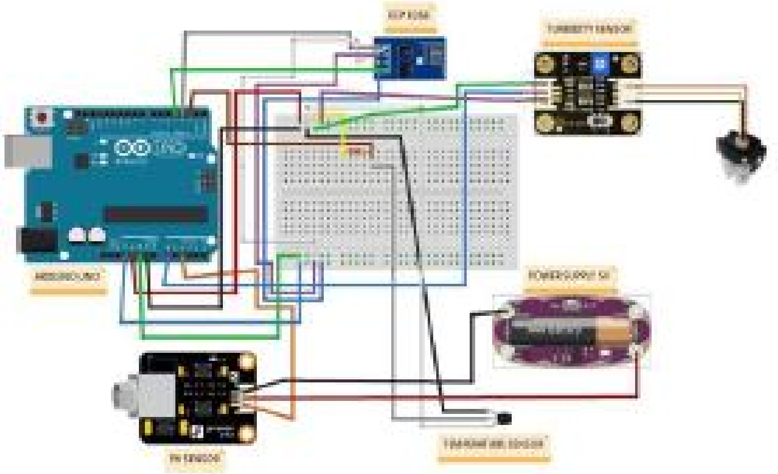


Figure 2. The sensor node design

3. System Design and Implementation

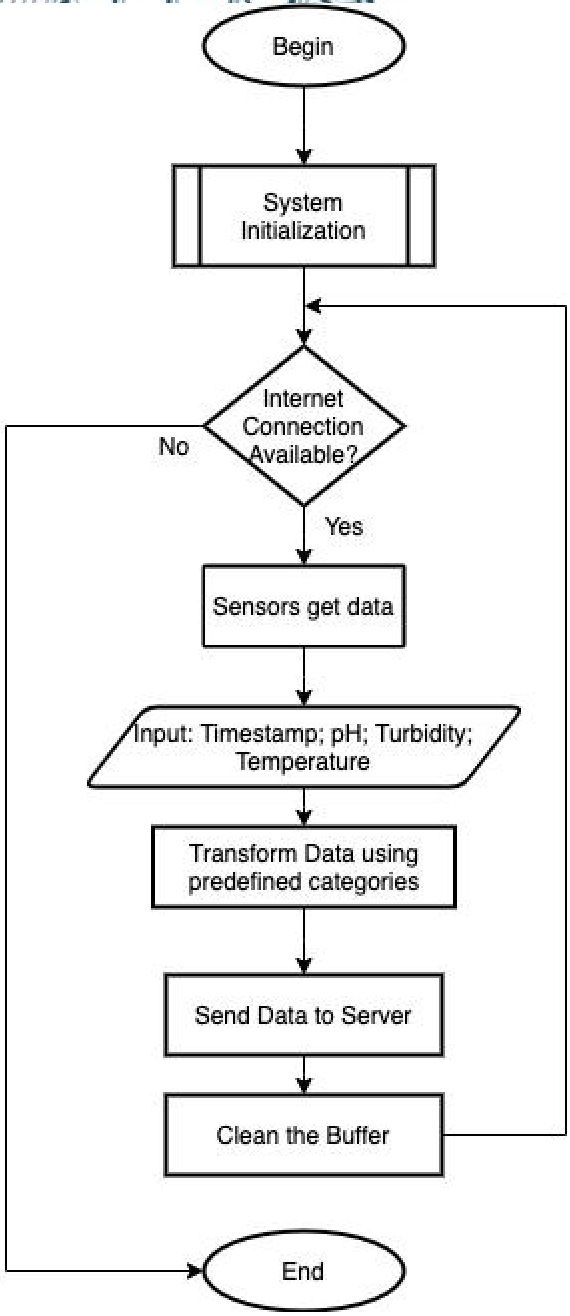
The wireless system for water quality monitoring inswimming pools is depicted in Fig. 1. Our system consistsof one sensor node that periodically gathers data from aswimming pool and sends the data wirelessly via theInternet to the web server to be processed further.

A usercan then access the information using a web browser.

The main components of our sensor node are anArduino Uno [11], an ESP8266 ESP-01 WiFi module[12], and three sensors, *i.e.* a DS18B20 temperaturesensor, a pH sensor and a turbidity sensor.

The threesensors and ESP8266 ESP-01 are connected to Arduinovia wired connections.

The sensor node design is shown in Fig. 2. Arduino periodically collects data from the threesensors and utilizes the WiFi module to send datawirelessly to the web server. We show the sensor nodedesign in Fig. 2, the real image of the sensor node in Fig. 3 and the list of our hardware and software used in Table1



4. Prediction Methods

In this section, we will discuss about the predictionmethods, *i.e.* the decision tree methods with the ID3algorithm on training data to predict water quality.

TheID3 algorithm is an algorithm used to construct a decisiontree that uses ahierarchical structure for supervisedlearning.

The process of constructing the decision tree isdone recursively

The classification process is divided into two phases,namely learning and test.

In the learning phase, most of thedata that has been known its class of data are fed to modelestimates.

Moreover, in the test phase, the model formedfrom the learning phase is tested with most of other data todetermine the accuracy of the model.

This model is usedfor our prediction.

$$P_i = \frac{\sum_k^m X_k \in (i)}{S} \quad (1)$$

$$Entropy(S) = \sum_i^n -P_i Log_2(P_i) \quad (2)$$

$$Gain(S,A) = Entropy(S) - \sum_{v \in Values(A)} \frac{Sv}{St} EntropySv \quad (3)$$

Entropy(s) = (-(10/14) *log2* (10/14) + (-(4/10) *log2* (4/10))= 0.863120569 (4)

5. Evaluation and Result

We evaluate the wireless monitoring system by firstlyshowing that the sensor node and the system workcorrectly.

Then, we show the result of our ID3 algorithm'ssimulation using data gathered from the sensor node.

5.1. Hardware evaluation

To test whether the sensor can sense correctly, firstlywe test it by using spring water. We put spring water,which has neutral acidity, clear turbidity, and normaltemperature, in a container as shown in Fig. 6(a).

Then, welet the sensor detect the water quality and send the data tothe web server to be processed and displayed at the webbrowser as depicted in Fig. 6(b).

The second test uses hotcoffee, which is acidic, not clear (cloudy), and hot, asshown in Fig. 7(a).

This test too can be displayed correctlyat the web browser as depicted in Fig. 7(b).

5.2. System evaluation

We evaluate our wireless monitoring system to showthat the sensor node is able to capture acidity, turbidity andtemperature data from a swimming pool, transform, send,and store the data correctly in our database.

In ourevaluation, the sensor node senses the environment every10 minutes.

However, for a better presentation in this paper, we only capture several chunks of data from thedatabase that show different monitoring conditions.

Notethat in this system, the sensor node does not sendnumerical data, but only the transformed data. Figure 8 shows the acidity transformed data, Figure 9shows the turbidity transformed data, and Figure

10 showsthe temperature transformed data, where one time unit isequivalent to 10 minutes.

As we can retrieve this data from
the database, it means our wireless monitoring system isable to collect data from the three sensors, transform, andsend the data to the web server correctly.

Table 2 showsthe transformed data and the classes (clean and dirty) usedin prediction.

Figure 8. Acidity transformed data

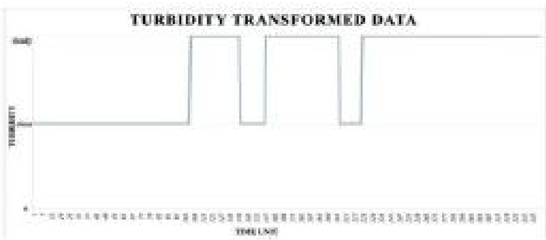


Figure 9. Turbidity transformed data

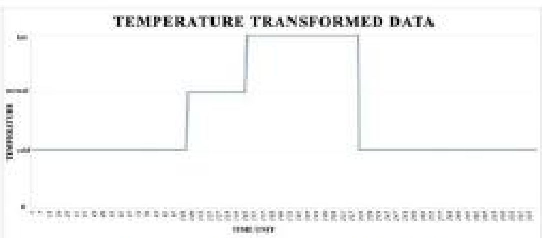


Figure 10. Temperature transformed data

5.3. ID3 simulation

In this phase, we conduct two trials. In the first trial,we build the water quality monitoring application.

Userscan see the sensor data in real time and make predictionsusing ID3, which is shown in Fig. 11.

The second trial use Weka to conduct simulations

onlearning data that we get to calculate the accuracy andkappa values. We divide the simulations into threedifferent experiments.

In the first experiment, we split the data into 80% learning data and 20% test data. In thesecond experiment, we split the data into 70% and 30%,then in the third experiment, we split it into 60% and 40%.

Figure 12 shows the results of the first experiment,

Figure 13 shows the second experiment, and

Figure 14shows the third one. From these results, it can be seen thatthe accuracy value obtained from these three experimentsis 100% with a kappa statistical value of 1 and 0% errorrate. Figure 15 shows the comparison of executiontime

from the first experiment to the third experiment, wherethe second and the third experiments have better executiontime.

6. Conclusion and Future Work

In this paper, we propose a wireless solution based onthe Internet of Things to monitor and predict water qualityin public swimming pools.

Our system consists of one sensor node that periodically sends temperature, pH, andturbidity conditions to a web server for further processing.

We utilize the Decision Tree method, namely IterativeDichotomiser 3, to predict the water quality.

We show byexperiment that our sensor node and the wirelessmonitoring system work correctly.

Then, based on theWeka simulations, we show that the experiments achieve100% accuracy with a kappa statistical value of 1 and 0%error rate.

Currently, our monitoring system has only one sensornode.

In the future, we plan to add more sensor nodes anddeploy them at different places in apool.

We also plan toutilize more sensors, so we can get more variables forprediction.

As our current system can only monitor and predict water quality, we would like to incorporateautomation capability into the system.

For example,adding chlorine automatically to improve the pool's waterquality

THANK YOU