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New Water Quality Model using Smart Decision Maker and Internet of Things for the Determination of Water Quality of River Shatt Al-Arab in Iraq

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Abstract: Water pollution has become a major problem which needs to be addressed. Water quality is monitored by going to the water bodies and collecting water samples which are then sent for testing in laboratories. This is a time-consuming process and an ineffective method plus it's separate. In order to automate this process, we verified the water quality remotely. This was done with the help of sensors, transceiver modules and microcontroller Arduino Model. The system used three sensors: a pH sensor (SKU SEN0161), turbidity sensor (SEN0244) and a temperature sensor (DS18B20). All data collected were wirelessly transmitted to smartphones. In order to facilitate this transmission, we used the WiFi transmitter of which module was connected to Arduino. These sensors were deployed in the water bodies which were connected to a microcontroller. The data collected from the sensors were sent from the transmitter through the receiver to the smartphone.

Key words: Water quality model, smart decision maker, internet of things, water quality sensors, River Shatt Al-Arab, turbidity sensor

INTRODUCTION

Water contamination has become an important issue now a days. One of the main obstacles in this process is the current water quality detection system which is tested by going to water bodies, collecting samples and returning them to laboratories. These samples are then tested for impurities and contaminants. After that, a report is published about all the water bodies. This is an intermittent and time-consuming process as is the case after taking a sample of one aquatic body, the following sample is taken to the same aquatic body over a long period. During this time, the level of contamination may rise and become harmful. If detected early, it is possible to be treated at an early stage (Anuradha *et al*., 2018).

The proposed system provides the Water Quality (WQ) monitoring remotely and gives real-time updates. We have deployed three sensors in the water, namely, pH sensor, turbidity sensor and temperature sensor. These sensors collect data which are transferred to the smartphone application. This intelligent application displays real-time values for all sensors and uploads data to the ThinkSpeak channel. It also sends an SMS to the relevant authorities if the sensor readings are out of bounds (Bhardwaj, 2011).

Literature review: The rapid growth of the population stems from the depletion of available water resources and the decline in water quality. In addition, the quality of groundwater has been infected with herbicides and as a result of the accumulation of remnants of war. Rivers in Iraq are polluted by industrial waste and untreated wastewater (Annymous, 2019).

Ye *et al*. (2002) measured approximately describing the connection of sensors and environmental monitoring applications and refer mainly to the minimum energy consumption in wireless network applications. Papageorgiou (2003) analyzed different wireless modes, configurations and networks. He also analyzed protocols and layers in a wireless network while Tuan *et al*. gave a brief description of the characteristics and sensor design (Le Dinh *et al*., 2007). Qiao and Song (2010) introduced the quality monitoring system based on GPRS/GSM. The module collects the data and sends it to the monitoring center via. GPRS. It is an artificial method of data collection and other processes are slowly completed Qiao and Song (2010) while Amruta and Satish (2013) used the Base Station (BS) to collect information from distant remote sensors. The BS associated with the ZigBee module was powered by a skirting board in sunlight as a source of energy.

Liang *et al*. in the new arrival and evolution of the internet have been clarified to use the internet of things and the different techniques have been explained (Wang *et al*., 2015).

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While Barabde and Danve (2015) used the system to determine the physicochemical factors of water quality such as temperature, pH, conductivity and the oxidation-reduction potential by ZigBee, Barabde and Danve (2015), Pavana and Padma (2016) studied water quality factors through Wireless composite Sensor Networks (WSN) and used the Raspberry Pi module with the Linux version (Pavana and Padma, 2016).

Problem statement: More likely to become regular monitoring in real time of the quality of drinking water is an essential feature of urban life for the possibility of natural or deliberate pollution. Among the different criteria used to measure the quality of water, the pH is the standard of evaluation which is particularly important. In order to be compatible with the World Health Organization (WHO), for example, a generally acceptable alkaline range of pH must be provided from 6.5-8.5 which avoids the erosion of the skin at the acid end and irritation of the skin and mucous membranes at the basic end (Sim *et al*., 2015; Siyang and Kerdcharoen, 2016; Wiranto *et al*., 2015).

In our country, there is no pH monitoring at defined frequencies or average data published on publicly accessible websites. Therefore, the Environmental Protection Agency (EPA) is concerned because of the growing fear of polluted water supplies by criminal industrial and environmental incursions (Taufiqurrahman *et al*., 2016; Oscanoa *et al*., 2016; Murphy *et al*., 2015).

The increased risk of water disruption in the local and global levels is likely to occur more frequently than is happening today. This proposed method will effectively help integrate technology into growing wireless sensor networks which would allow rapid collation, detection, monitoring of pollution and pollution site identification (Marais *et al*., 2016; Kafli *et al*., 2016; Haider *et al*., 2016).

Implementation: This system uses three sensors (turbidity, temperature and pH) and the Arduino controller connected to the internet of things, the microcontroller processing module and the GSM transmission module. The three sensors acquire data in the analogy signals by using the ADC converter that converts the three information signals into digital format. The digital signals are passed to the Arduino controller which is together with the transmission module. The microcontroller of Arduino examine itself and deal with digital information, the GSM Model sends the water quality factors to the smartphone through SMS which can be viewed on the LCD screen.

MATERIALS AND METHODS

Proposed system: The proposed method is used to overcome defects in existing methods. Arduino Board (AB) was adopted as a basic controller for various sensors to control water quality. Figure 1 shows the water quality monitoring system. The Arduino microcontroller

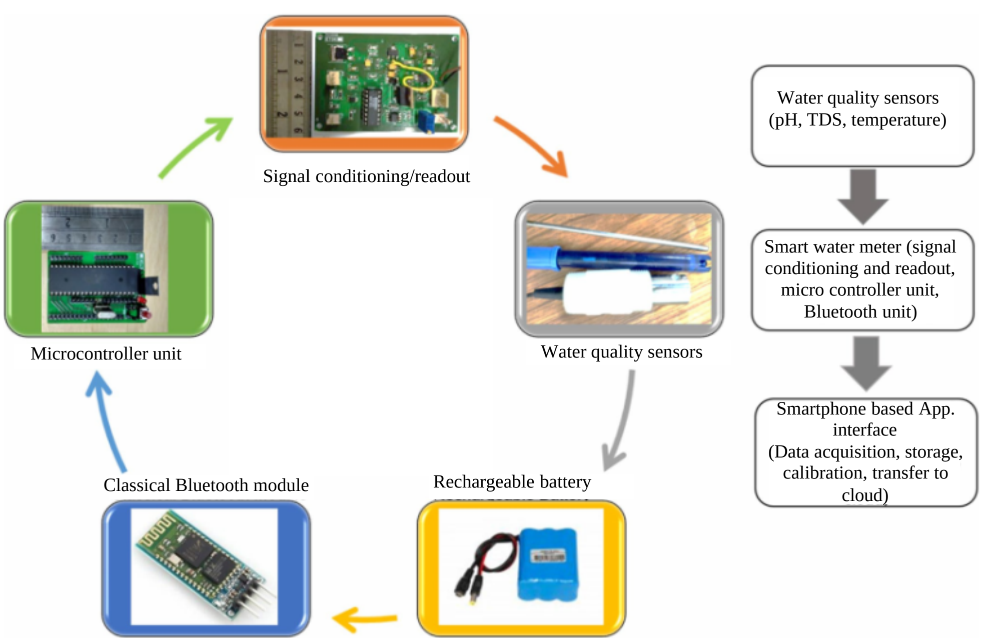

Fig. 1: a) Diagram of intelligent water meter prototypes and various components and b) Integration scheme of smart WQ

accepts the information and processes the information gathered by the sensors through the GSM module. The analysis of data is processed by the microcontroller in the Arduino module and transmitted to the central server via. the GSM/Wi-Fi module using the data communication module. Collection of generous data will be displayed in real time. The Arduino microcontroller is based on real-time support for embedded tracking and simulation. It is considered to be the main requirement for extended application control for consumer's access and consumes low power.

Internet of Things (IoT): The basic concepts behind the technology of the internet of Things (IoT) are implemented in that the device integrates with the virtual world of the Internet and interacts with it by tracking and monitoring the sensor of the object and its environment. For this reason, the global network of smart devices that can sense and interact with their environment using the internet to connect to and interact with users and other systems (Da Silva Junior *et al*., 2016; Cloete *et al*., 2016; Ranjbar and Abdalla, 2017; Robert *et al*., 2016).

ThingSpeak API: ThingSpeak is an open source application for the Internet of Things (IoT) Application Programming Interface (API) to store and retrieve data from things using HTTP protocol over the internet or over a local network. It allows ThingSpeak to create applications to register the sensor data and the applications to track the locations and the social network of things with status updates (Santos *et al*., 2016; Chandrappa *et al*., 2017).

Hardware components (Sowmya *et al*., 2017; Das and Jain, 2017) pH sensor: The pH sensor (SKU: SEN0161) is a sensor to detect the value of the pH of the water. The term "pH" starts from the Latin and is an abbreviation for "potential hydrogen "or" power of hydrogen". The pH is the concentration of hydrogen ion in aqueous solutions indicating the acidity and alkalinity in a solution.

A measure of the pH is a logarithmic scale that ranges from 0-14 and a neutral point is 7. The normal range of pH is 6-8.5. A value >7 is for an alkaline solution and values below 7 are indications of the acidic solution as shown in Fig. 2.

TDS sensor: The dissolved solids are all the minerals, salts, metals that are dissolved in the water. The Total Dissolved Solids (TDS) include organic salts (primarily calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter dissolved in water. The TDS sensor kit is compatible with IoT devices when plugged and played

Fig. 2: pH sensor

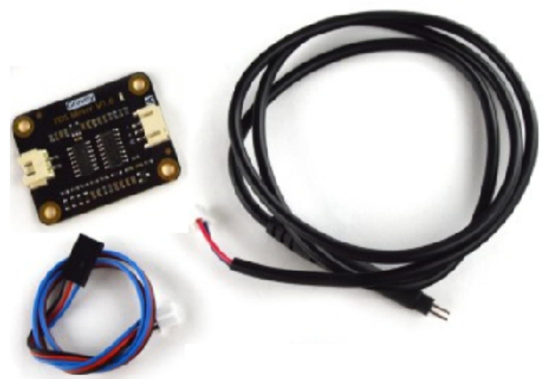

Fig. 3: TDS sensor

and can easily be used to build a detector of TDS measuring the value of TDS of the liquid as shown in Fig. 3. The sensor supports 3.3~5.5 V wide voltage input and 0~2.3 V analog voltage output, making it compatible with 5 or 3.3 V control system or circuit board. The measurement range of the TDS sensor is 0~1000 ppm.

Temperature sensor: The temperature sensor (DS18B20) was used to measure the temperature of the water. When a precise measurement is required, you should always look at the temperature. An increase in the temperature of the water increases the rate of ionization. Changes in the value of pH and turbidity vary with temperature. The pH is related to the temperature and as temperature increases, the ionization rate increases and vice versa. The temperature plays a crucial role in the measurement of the quality of the water.

The temperature is a key factor to determine other applications for the analysis of the quality of the water. We used the DS18B20 to measure temperatures between -55 and 125°C. This temperature probe digital sealed accurately measures temperature in a humid environment as shown in Fig. 4.

Fig. 4: Temperature sensor

RESULTS AND DISCUSSION

The system uses three sensors: A temperature sensor (DS18B20), a pH sensor (SKUSEN0161) and a turbidity Sensor (SEN0244). Temperature and turbidity sensors were directly connected to the microprocessor. The pH probe had a very high resistance and was also susceptible to noise. Then our goal was to select an op-amplifier (TL072) that would be sufficient to prevent the probe from loading and a buffer circuit separated the probe's high impedance from our low impedance of microprocessors (Fig. 5 and Table 1).

Temperature and turbidity sensors provided digital input connected to Arduino digital contacts. The pH probe connected to the pH circuit provided an analog

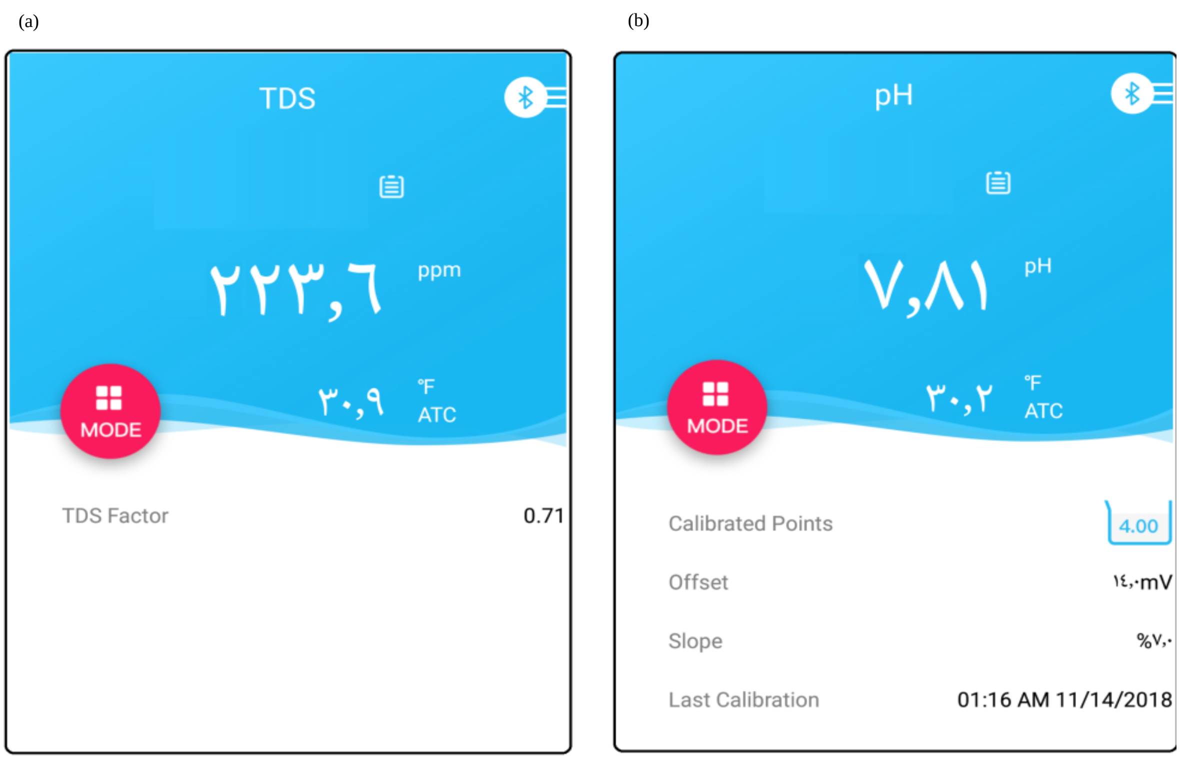

Fig. 5: Desktop application showing real-time: a) TDS and temperature readings and b) pH and temperature readings of River Shatt Al-Arab

Table 1: Summary of the physical / chemical characteristic of the Shatt Al Arab River water and standard value per WHO requirements

Parameters	Minimum	Maximum	Average	SD	Standard permissible value (Sn)
pH	7.1	8.1	7.634	0.214	8.5
Ca (mg.L^{-1})	144.3	504.0	289.061	111.676	75
Mg (mg.L^{-1})	240.3	863.0	463.645	153.422	50
Total hardness (mg.L^{-1})	381.0	1455.5	763.095	248.139	500
SO^4 (mg.L^{-1})	191.0	994.5	451.248	172.062	250
Cl (mg.L^{-1})	427.1	1498.7	839.481	254.188	200
TDS (mg.L^{-1})	1060.0	3670.0	2062.139	651.988	500
EC (µsec/cm)	2016.1	11723.3	5602.160	2298.326	1000

output, so, it is that was connected to the analog pins of Arduino Uno. All data collected were wirelessly transmitted to smartphones. In order to facilitate this transmission, we used the receiver of the WiFi transmitter that was connected to Arduino.

To test the preparation of the environment, the prototype was tested and the temperature was displayed in terms of the degree of temperature, turbidity in terms of volts and pH in terms of pH level. This data was downloaded wirelessly and displayed in terms of graphics as shown in Fig. 5 and Table 1.

CONCLUSION

Internet of Things (IoT) and its services have become part of our daily lives forms of work and business. IoT is changing the future of technologies through which one can access any type of information. A real-time water quality monitoring system was tested in real-time, efficiency and inexpensiveness. The level of contamination in the bodies of water was governed and sudden warnings were sent to the public through messages and alarms. This system could provide the necessary warning and protection about the diseases caused by the presence of metals and contaminants in water. So that, severity level of pollutants in Basra's rivers can be taken immediately. The monitoring task can be done using less trained people and the installation of the system can be done easily when it is close to the destination area.

RECOMMENDATIONS

Advantages:

- Automatic operation will reduce the time to measure the parameters
- Low maintenance costs
- Prevention of water diseases

In general, the quality of the water of the River Shatt Al Arab is not in good condition for the purpose of drinking and showing all the chemical agents considered that the quality of the water in all the control stations is unsuitable for consumption due to the high levels of concentration of pollutants. It showed that most of these contaminants is in a growing trend which means an increase in the focus levels. Further studies, are needed to study the origin of contaminants in order to avoid any deterioration in the water quality of the Shatt Al-Arab River. In the year under study, it showed higher levels of focus on most of the chemical parameters. The values calculated on water during the study period are found not valid which means that the water quality is not good and not suitable for drinking and other uses.

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