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Research paper

Design and implementation of remotely Tigris river water monitoring system in Baghdad

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Abstract

Tigris River in Baghdad city that penetrate the rural and urban areas is polluted by many organic substances from different user activities including industrial, agricultural, and domestic purposes. Therefore to monitor and protect the river water from pollution, a remote monitoring system for Tigris river water in Baghdad is suggested. Different water quality parameters; Dissolved oxygen (DO), Electrical conductivity (EC), Total Dissolved Solids (TDS), and PH are measured from two areas near the Tigris River; oil refinery and power station. It show that wastes from these stations are polluted the river with their industrial wastes.

Keywords:*Arduino Uno; DO Sensor; EC Sensor; GPRS Sim900; PH Sensor; Remote Water Monitoring; Tigris River Pollution.*

1. Introduction

Water that occupies three quarters of the Earth's surface is essential for everything to grow and prosper [1]. Despite this, different activities of human are pollute water resources. The statistics said that approximately 5 million deaths per year are occurred due to water pollution diseases. Major environmental issues that threat the human life are occur due to the existing tendency of industrialization and urbanization whichresulting of poor quality of water due to the industrial effluents [2- 4].

In the last 20 years, water sources in Iraq have witnessed a significant deterioration from air pollution to soil and water pollution water sources due to lack of attention. The pollution took place for the following reasons: (1) a large number of pumping stations are discharging agricultural and sewage wastes directly into Tigris River near Baghdad; (2) some of the ancient drains that crossing through overcrowded areas are carry all kinds of effluent directly into the Tigris river; (3) there are a number of private agencies that discharging the sewage wastes from houses into the Tigris river [5]. Therefore due to these reasons, different types water pollution diseases are widespread such as Cholera that spread out during the hot summer months and leads to death if it left untreated. One of the World Health Organization (WHO) statistics showed that there are about 73 confirmed cholera cases in Iraq from April 28 to June 4, 2010, which is a higher number [6].

As it is mentioned before that for many reasons, the Tigris River polluted with different wastes when it is passing through Baghdad City, which makes monitoring system for river water, is an important thing. Therefore, in this paper, a new accurate, robust and real time monitoring system is proposed which continuously monitoring different water quality parameter and send the data to ARDUINO microcontroller which reads, processes and comparing sensing data with the standard values and then send a notification about the water quality status to the maintenance center via GPRS. Distributed sensors at different locations near the Tigris River in Baghdad are used to monitor the most common water pollution parameters of water. These parameters are:

1) Dissolved oxygen (DO) which is an important parameter for the monitoring of water quality [7]. In any aquatic system, if the rate of photosynthesis is high, then the value of DO is higher than when the rates of respiration and organic decomposition are high [8]. The amount of dissolved oxygen in the polluted water would be rapidly consumed which would affect the quality of the river water [9].
2) Temperature plays also an important role for the determination of water quality [10, 11]. Many of the chemical and biological processes of the rivers are affected by temperature parameter, also it affects on the plant growth, dissolved oxygen (DO), and the rate of the aquatic organisms metabolic. The geographic location, season, sampling time and temperature of effluent entering the stream also affect the temperature of the water [12].
3) Electrical Conductivity (EC) is a parameter that measured the concentration of ions that affect the quality of water [13]. Electrical Conductivity is an indication of how much total salt is dissolved in the water [14]. If the rate of total dissolved salt is high, then the conductivity is increase.
4) Total Dissolved Solids (TDS) is an indication for the organic and inorganic salts that dissolve in a solution in water [15].TDS can be measured from electrical conductivity (EC) through the equation below:

$$TDS\ (mg/L) = ke\ EC\ (\mu S/cm) \tag{1}$$

Where ke is the correlation factor varies between 0.55 and 0.9 [16].

PH: The pH value, which affects the water body biological and chemical reactions, represents the instantaneous hydrogen ion activity and [17]. There is a positive relationship between the pH level and the photosynthesis since photosynthesis

5) Consumes CO2 leads to arise in the pH values [18]. Many experiments conclude that for a sustainable aquatic life, the optimal range of pH is between 6.5 and 8.2 [19].

The monitoring values from the proposed system are comparing with Iraqi and WHO standard values for domestic and irrigation purposes to give an accurate decision about the quality of the water. The standard values for PH, EC, TDS and DO are shown in Table 1.

Table 1: Standard Values for Water Quality Parameters [20-21]

Parameter	Unit	Drinking		Irrigation	
		Iraqi	WHO	Iraqi	WHO
PH		8.5	8.5	8.6	8.5
DO	mg/L	5	5	5	-
EC	μs/cm	2000	1000	250	2000
TDS	mg/L	1500	500	2500	2000

The remainder of this paper is organized as follows: some related works will briefly illustrate in section 2. While in section 3, the proposed system will describe in detail. In section 4, the simulation results will be analyzed and compared with the standard. Finally, in section [5] conclusions will describe.

2. Literature survey

Traditional monitoring system for water quality involves three steps namely water sampling, testing and investigation. The scientists do these manually. This technique is not fully reliable and gives no indication before hand on quality of water. For resolving the problem adopted from the traditional analytical method, a remote system for monitoring the quality of water is proposed.In [22] a number of sensor nodes are distributed in different locations to measure and monitor the water quality, to increase the efficiency and to reduce the power consumption these nodes enter the sleep mode when it does not collect the data.Another monitoring system based on WSN platform developed by "Smart Coast" [23], this system used a Zigbee communications for power consumption and used to measure and monitor number of parameters like conductivity and pH. Reference [24] described the development of a continuous and real-time monitoring system for the Lee Co. Cork River in Ireland with multi-sensor for water quality. Tigris River has a high level of interesting from the Iraqi environment researchers due to the high effect of pollutants on it. Researchers in [25] and [26] monitor the quality of Tigris water in many selected sites to measure the pollution effects on it. Also the authors in [27] evaluate the pollution of drinking water and its effects in human health in Baghdad, Iraq. Finally assessment of water quality of Mahrut Riverin Diyala region in Iraq is evaluated in [28].

3. Methodology

The proposed monitored system consists of four parts; the sensing, controlling, transmitting and receiving parts. The first one contains four types of sensor; Electrical conductivity (EC), Temperature, PH and Dissolved Oxygen (DO) sensors. Theses sensors connected through solenoid valve to tap water for automatically taking river water sampling. The second part contains Arduino microcontroller which process and analyze the sensing data received from sensors. The third part is the transmission part that transmits a report based on measured values to the maintenance center via GSM module. Finally, the receiving part which consists of GSM module and mobile phone of the monitoring pollution center receive the measured water quality information and based on these information an action must be taking in case of river water pollution.Fig. 1 shows an overall picture for the proposed water quality monitoring system.

3.1. Proposed system hardware design

In the following sections a brief description about the main parts of the proposed system are illustrate:

3.1.1. River water controlling and analysing part

Firstly, an Arduino microcontroller is send a signal to relay and then a sample from the river water is taking through a solenoid valve. These samples will sense by three sensors; Electrical conductivity (EC) sensor to calculate the dissolved solid in water, pH sensor to measure the pH level of water and Dissolved Oxygen (DO) sensor to measure the dissolved oxygen. The sensing information is then analysed by the Arduino to take the correct action. Fig. 2 and 3 show the connection between the Arduino, relay, solenoid valve and the three sensors.

3.1.2. The sending part

In this part, a GSM SIM900A module is used for transmit a brief report about the measuring water quality parameters from the Arduino to the maintenance center mobile as shown in Fig. 4.

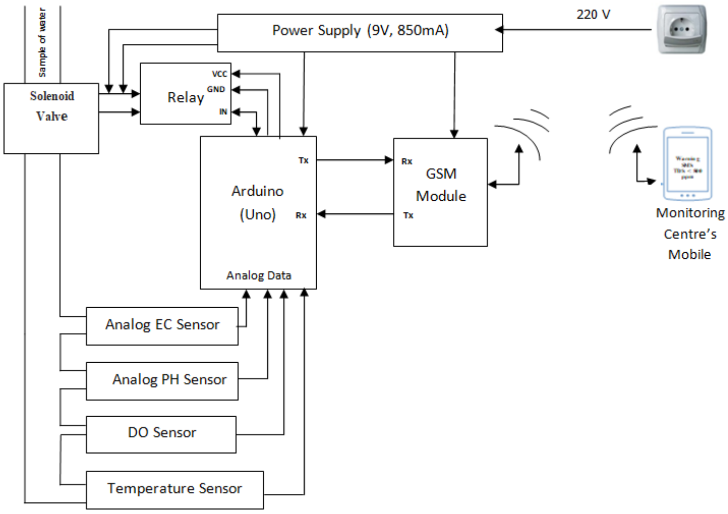

Fig. 1: Block Diagram of Proposed Monitoring System for Tigris River Water.

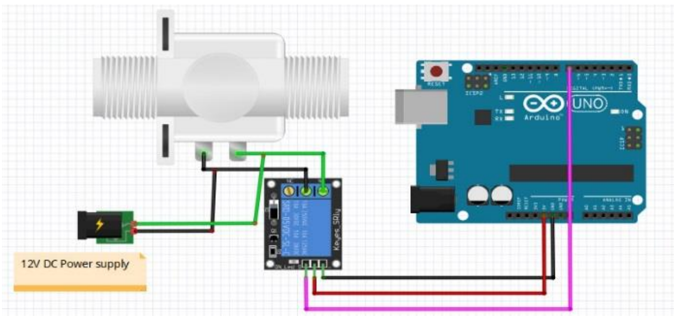

Fig. 2: Relay Solenoid Valve and Arduino Components.

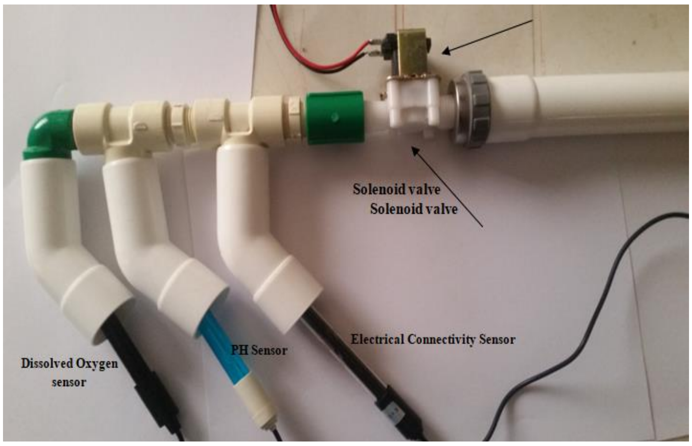

Fig. 3: EC, PH and DO Sensors with Relay, Solenoid Valve Components.

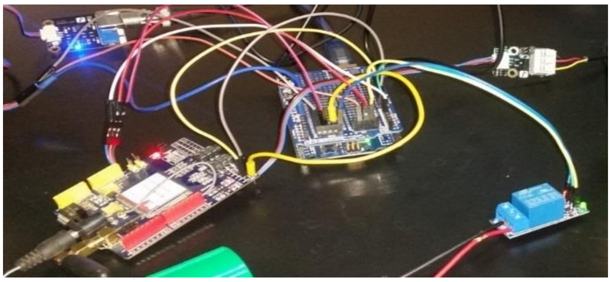

Fig. 4: Arduino Microcontroller Connected to GSM SIM900A Module.

3.1.3. The receiving part

In the last part, a notification message about the quality of the river water is send periodically from the sending control part to the authorized maintenance control station. After the receiving of the measured values by the authorized persons in the maintenance station, these values will analyze and save with the location from which is send depending on a phone number that implanted in GSM module in the sending part.

3.2. The software design of the proposed monitoring system

In the proposed Tigris River water monitoring system, an Arduino Uno is programming with the Arduino software to communicate with three types of sensors (PH, TDS and DO) and GSM SIM900A module to transmit the monitoring data to the maintenance center. Fig. 5 shows the proposed monitoring system in detailed steps.

4. Results and discussions

4.1. Study area

The two study areas that selected overlooking the Tigris River in the city of Baghdad is the Dora near the oil refinery and another region near thermal power plant. These areas suffer from the dumping of oil and thermal wastes in the river. A Google map picture for the two study areas is shown in Fig. 6 and 7.

4.2. Sampling

The samples of the water in study areas are collected from four different points of the Tigris River where a sample before Dora oil refinery area and a sample after it; another sample before Dora power station and last sample after it.

4.3. Result and discussion

The measured water quality parameters of Tigris River from the proposed system and comparison of measured values with the existing standards are show in Table 2 and 3, respectively. The water quality parameters that measured from Tigris River investigated in this study are: dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS) and pH. It can notice from Table 2 that the wastes from the oil refinery and power station areas are increasing the acidity of Tigris water (from 8.1 to 5.5 in oil refinery area and from 8.2 to 5.8 in power station area) which makes the water unsuitable for irrigation and drinking purposes. Also the total dissolved solids (TDS) in two areas are increase from 509 to 735 mg/L (in oil refinery area) and from 509 to 588 mg/L (in power station area).

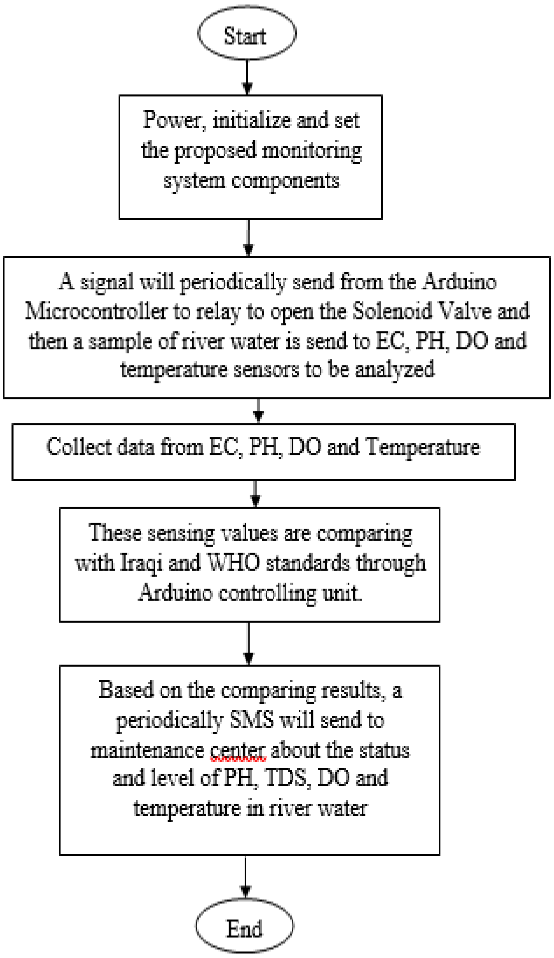

Fig. 5: Flowchart for the Proposed System.

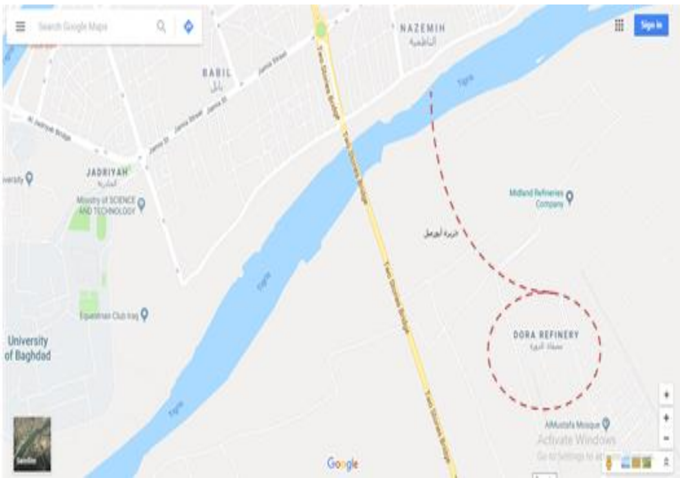

Fig. 6: Google Map Picture for Dora Oil Refinery.

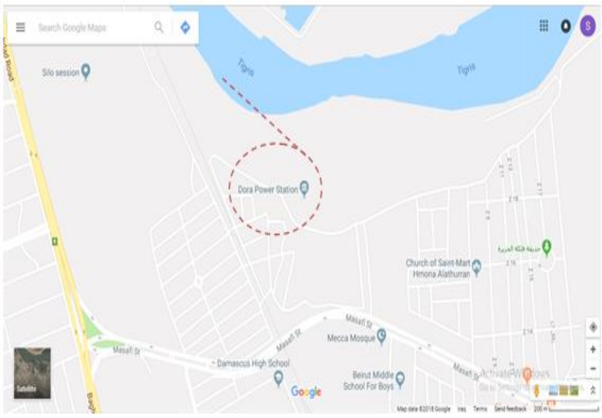

Fig. 7: Google Map Picture for Dora Power Station.

Table 2: Measured Values for the Monitoring Water Quality Parameters in the Tigris River

Study Area	Water quality parameters	Sampling points	
		Before	After
Dora refinery	PH	8.1	5.5
	EC (µS/cm)	727	1050
	TDS (mg/L)	509	735
	DO (mg/L)	6	6
	Temperature (C^o)	28	28
Dora power station	PH	8.2	5.8
	EC (µS/cm)	727	840
	TDS (mg/L)	509	588
	DO (mg/L)	6	5.5
	Temperature (C^o)	28	28

Table 3: Comparison the Measured Values from the Proposed System and the Standard

Water quality parameters	Drinking standard		Irrigation Standard		Present study			
					Dora refinery		Dora power station	
	Iraqi	WHO	Iraqi	WHO	Before	After	Before	After
PH	8.5	8.5	8.6	8.5	8.1	5.5	8.2	5.8
EC (µS/cm)	2000	1000	250	2000	727	1050	727	840
TDS (mg/L)	1500	500	2500	2000	509	735	509	588
DO (mg/L)	5	5	5	-	6	6	6	5.5

5. Conclusion

One of the major environmental problems of Tigris River is the industrial waste discharge. Therefore in this paper, a remote real time multi-sensor monitoring system based on GSM is proposed to measure the effect of industrial wastes on Tigris water. The most important parameters for the water quality; dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS) and pH are measured in two areas near the Tigris River (Dora oil refinery and Dora power station) through implanted sensors in these areas.The sensing data are processed through Arduino, which compared these measured values with the standard and if the measured quality values are above the standard, then a warning message is send to the authorized maintenance center. Also the sensing values are sent periodically to the maintenance center.The results measured from these areas are showed that industrial wastes are effected the level of PH ,TDS and EC and make the Tigris water unsuitable for drinking and irrigation purposes as compared with the standard levels.

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