Monitoring and evaluation of the water pollution

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Abstract. The main purpose of this research is to control the water pollution through focusing on monitoring and evaluating of the water pollution. The components such as electronic device contains Arduino, sensors (total dissolved solids (TDS), temperature, and turbidity), liquid crystal display LCD, and electronic arm with servo motor have been employed to control the water quality. The evaluation of the water quality is paramount to the investigation and use of water and aiming to progress the realization of the phenomena which take place in the water environments. It is important to know the variables which affect the water bodies. This evaluation participates to the improvement of water quality and contribute to the fast and effective method for monitoring and displaying the water quality.

1. Introduction

The Water constitutes 75% of the earth exterior. The clean water is necessary for human-being, therefor the World Health Organization (WHO) records that about 80% of diseases are because of water pollution [1, 2]. Water pollution happens when chemicals or microorganisms substances contaminate river, ocean, lake…etc. effecting on the water quality and converted it harmful to the environment and humans [3]. The pollutants have negative effects on the environment and on human health, each chemical have different impacts, according to their positions and types [4]. Thus water is paramount for human health and safe-life everywhere [5].

Healthy ecosystems depend on a complex grid of animals, plants, microorganisms which interact, directly or indirectly, with each other. Harm to any of these organisms can make a series impacts, dangerous on the whole aquatic environment Therefore, the impacts of water pollution are diverted and according to the kinds of chemicals which are dumped and on the location of dumping [6, 7].

Water pollution is caused by many factors, including such as: uncontrolled construction locations, leaking sewage pipes, spills and leaks by accident [8, 9], wastes discharging, activities of mining, and so on.

The solutions of water pollution can be done in different ways. Much of the water we depend on every day for cooking, bathing, and other activities is provided from surface water sources [10]. Therefore, without current care and suitable protection and treatment methods, water resources are becoming more polluted and then excessive funding needed for improving the solutions of water pollution [11]. TDS is used to characterize the inorganic salts and small quantities of biologic materials in the water. In “clean” water, TDS is approximately equal to salinity [12].

In contaminated water, TDS may cover biological materials and salt ions. The concentrations of dissolved solid beyond the standard level may cause a cell to deform. So, this will have a
negative impact on aquatic life. Almost fresh water has 2000 ppm of TDS, and Dissolved solids are very necessary to aquatic life through keeping the balance of cell density [13]. The water is diffused in distilled water into an organism’s cells and this leads to swell them, and in contrary, the cells will shrink with the high TDS water. This phenomenon can effect the organism’s ability causing it to float or sink beyond its natural range [14]. Water taste is affected by TDS. According to World Health Organization (WHO), the TDS concentration of 1000 ppm is considered appropriate for water consumers, but this appropriate factor may differ as TDS concentration has an immediate effect on the water taste. Temperature beside its direct effect on water quality, it can both chemical and physical characteristics of water [15]. In this status, water temperature is to be considered when measuring: “Photosynthesis production and metabolic rates, salinity, conductivity, dissolved gas concentrations, dissolved oxygen, oxidation reduction potential (ORP), pH and water density”. When temperature of water increases, the water conductivity and consequently TDS will increase. For each one centigrade increase, the water conductivity increases by 2–4%. Temperature has significant effect on conductivity by increasing ion mobility and the dissolvability of different salts [16].

Turbidity is a visual limitation of water clarity which is decreased by unsettled solids and dissolved colored material. Turbid water has a great impact on the water appearance. Turbidity is normally employed as indicator measurements are used as an indicator of water purity in terms of the clarity and total suspended solids in the water [17].

The water turbidity is a function of rate of the light scattered by particles in the water. So, turbidity and total suspended solids are related. Turbidity is often used to show changes in the TDS concentration in the water without giving any guide to measure solids [18]. There are many factors affecting the transparency of the water such as sunlight, suspended particles in the water column, and solid materials like colored dissolved organic material (CDOM) [19, 20].

In this study, an electronic device contains Arduino, sensors (TDS, temperature, and turbidity), LCD, and electronic arm with servo motor was developed to control the water quality. A detailed analysis of water quality parameters was recorded [21].

2. Related works

Singh, et.al. 2019, the study focused on the importance of various parameters of water pollution [20]. In April 2017, Radhakrishnan et.al. demonstrated that the water quality is very dynamic during flooding [4].

Marina Salim, et.al. in 2019 found major differences between the sub-basins in terms of FCI concentration. [10]. Ioanna Zotou, et.al. in 2018 attempts to test the performance of seven different WQIs [12]. Nyanti et.al. in 2018 showed the possible adverse impacts of water quality decay and biological attack on the survival of Malaysian native fish in natural environment [22].

3. Methodology

To complete this research, several steps are followed for development and integration of the project. The first step, after studying several types of water pollution, which are used for different purposes, was to select the right components for the development process the project parts.

4. The Components and Characteristics

4.1. Arduino mega 2560

The Arduino Mega 2560 shown in Figure 1 is programmed using the Arduino software integrated development environment (IDE) common to the board [23].
The Arduino MEGA 2560 Characteristics are listed in Table 1.

### Table 1. Characteristics Arduino MEGA 2560

| Parameter                      | Value                                           |
|--------------------------------|-------------------------------------------------|
| Microcontroller                | ATmega2560                                      |
| Operating Voltage              | 5V Input Voltage                                |
| Input Voltage (recommended)    | 7-12V                                           |
| Input Voltage (limits)          | 6-20V                                           |
| Digital I/O Pins               | 54 (of which 14 provide PWM output)             |
| Analog Input Pins              | 16                                              |
| DC Current per I/O Pin         | 40 mA                                           |
| DC Current for 3.3V Pin        | 50 mA                                           |
| Flash Memory                   | 256 KB of which 8 KB used by bootloader         |
| SRAM                           | 8 KB                                            |
| EEPROM                         | 4 KB                                            |
| Clock Speed                    | 16 MHz                                          |

### 4.2. Turbidity sensor

The turbidity sensor Figure 2 detects water quality by measuring the turbidity value. It is able to detect suspended particles in water by measuring the light transmittance and diffusion rate, which related with the amount of total suspended solids (TSS) in the water. When the TSS increases, the liquid turbidity level increases too. This turbidity sensor has both analog and digital signal output the process. Table 2 illustrate the characteristics of turbidity sensor [16].
4.3. TDS sensor

TDS sensor Figure 3 is an Arduino-convenient the TDS sensor for measuring TDS value of the water to reflect the purity of the water. It can be applied to the water quality testing. TDS refers to that amount of soluble solids in milligrams dissolved in one liter of water. In general, the TDS value increase when the soluble solids dissolved in water increase, and the less purity of the water is. Therefore, the TDS value could be used as one of the signals for reflecting the purity of water. Table 3 shows the characteristics of the TDS sensor [24].
4.4. Temperature sensor (DS18B20)
Temperature sensor (DS18B20) Figure 4 is the 1-Wire digital temperature sensor from Maxim IC. With 9 to 12-bit accuracy, accounts degrees in Celsius from -55 to 125 (+/-0.5). Each sensor has a unique 64-Bit Serial number- allows for a large number of sensors to be applied on one data bus [25]. Table 4 shows the characteristics of temperature sensor.

![Temperature sensor (DS18B20)](image)

**Figure 4.** Temperature sensor (DS18B20)

| Parameter                  | Value                                      |
|----------------------------|--------------------------------------------|
| Power supply range         | 3.0V to 5.5V                               |
| Measures temperatures      | from -55°C to +125°C (-67°F to +257°F)+0.5°C |
| Thermometer resolution     | from 9 to 12 bits                           |
| Converts temperature       | To 12-bit digital word in 750ms (max.)     |

4.5. LCD display
LCD display Figure 5 from Winstar Company (16 characters x 4 lines, transflective, positive STN). Table 5 shows the characteristics of LCD display [20].
Table 5. Characteristics of LCD display

| Parameter                       | Value                                      |
|---------------------------------|--------------------------------------------|
| Model No.                       | WH1604A                                    |
| Character LCD                   | 16x4                                       |
| includes cursor                 | 5x8 dots                                   |
| Built-in controller             | (ST7066 or Equivalent)                     |
| power supply                    | (+5V Also available for +3V)               |
| optional for +3V power supply   | WG16032D3                                  |
| duty cycle                      | 1/16                                       |
| LED can be driven by            | PIN1, PIN2, PIN15, PIN16 or A and K        |
| Interface                       | 6800, option SPI/I2C (RW1063 IC)           |

4.6. Resistors (Potentiometer)
Potentiometer Figure 6 is a three-depot resistor with a sliding or rotating connect that forms an adaptable voltage divider. This measuring instrument is basically a voltage divider applied for measuring voltage (electric potential), the component is an application of the same base, hence its name [26].

4.7. Board and wires
Board Figure 7 is one of the generality essential pieces to build circuits by using wires [16].
Figure 7. Board and wires

4.8. Arm Robot
This arm as shown in Figure 8 was intended in a way that’s suitable to the system on which it works and based at the top of the basin and has the ability to move up and down [27].

Figure 8. Arm Robot

5. System design
The method of connecting sensors is shown in Figure 9.

(A) Temperature connecting
6. Flow chart of the Project.
The flow chart of the research is demonstrated in Figure 10.

7. Results
The system was operated to detect the TDS, turbidity, and temperature and the ratios that appeared according to the water sensors and sending the ratios to the Arduino and then to the display LCD screen. This system works by connecting sensors which are operating simultaneously and transmit the results of water analysis to be displayed on LCD screen.

The system tested different types of water to demonstrate the degree of purity. It was focused on three samples. It was measuring salts dissolved in water and the ratio of pure water to less than 50 and the average water from 70 to 100 and when the TDS in water was over 100, it was highly salted water.

Temperature Sensor (DS18B20) measured the water temperature to test its permeability for using in drinking, industries, or even for irrigation purpose. Turbidity Sensor is used to measure the water clarity, the measurement of the percentage to determine the turbidity of the water when approaching 5 but can be used in irrigation.
8. Conclusion

The main conclusion that draws the attention from this study can be summarized as follows:

- In principle, the system was designed to control the water pollution, so that research paid its' interest in monitoring and evaluating the water pollution.
- Under the conditions studied, An electronic device contains Arduino, sensors (TDS, temperature, and turbidity), LCD, and electronic arm with servo motor were used in this study.
- A different types of water were tested in different conditions in order to analyze the water quality.
- This system could be applied by using more advanced sensors for detecting the water pollution in the future work.

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