

# Prototype of Water Turbidity Monitoring System

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**Abstract.** Along with the increasing use of water by the community, the quality of water needs to be considered, especially for human consumption. Water quality is determined based on the value of turbidity of water. This project develops an Arduino Uno-based water turbidity monitoring system, which is aimed to measure water level and water turbidity levels. The turbidity sensor consists of a photodiode and infrared LED. Measurements of water turbidity using principles of light scattering in the water. The turbidity sensor to detect the intensity of light passing through the scattering of particles and the results of the analog signal voltage. The signal entering Arduino Uno of the ultrasonic sensor and the turbidity sensor will be processed. The measurement results is converted to NTU (Nephelometric Turbidity Units) and liter, then are shown on the LCD display 2x16. The turbidity measurement limits on this system are designed between 0 NTU to 40 NTU. This system can potentially help PDAM in monitoring water tanks and it is hoped that water quality monitoring system can be applied online.

## 1. Introduction

Turbidity is one of the parameters in determining water quality. Turbidity is caused by organic materials and inorganic particles that are suspended in the water [1]. High water turbidity levels can cause health problems if the water is continually consumed. Water turbidity standards are set between 5-25 NTU (Nephelometric Turbidity Unit) [2].

Water-treatment plant station as a provider of clean water in Indonesia needs to pay attention to water quality that will be distributed to society [3]. Monitoring of water turbidity is required in the water treatment process to ensure water quality, so that water is suitable for use in subsequent processes [4].

The research aim to design a prototype system of monitoring the level of water turbidity. Water turbidity is measured based on the principles of light scattering [5]. Water that has a high turbidity levels will be added chemicals to assist in the deposition of particles in water [6].

Turbidity sensors are designed by using components a photodiode as detector and infrared led as light sources. This system is controlled using Arduino Uno microcontroller. The measurement results of the turbidity sensor in the form of ADC value is converted to units of NTU and is shown on the LCD display 2x16.

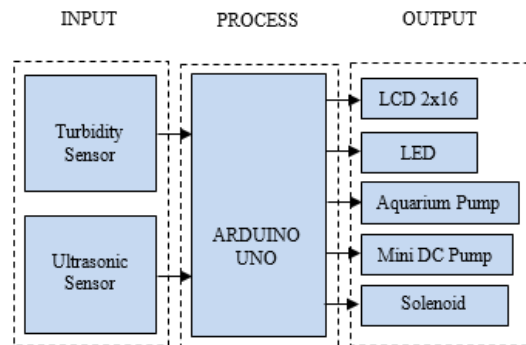
## 2. Methods

The prototype design of this turbidity monitoring system begins with the system general design. The system design consists of interconnected devices that is hardware design and software design.



### 2.1. General System Design

General design of this system include turbidity sensor and ultrasonic sensor as a signal provider, microcontroller Arduino UNO as the signal processing of the measurement and LCD 2x16 for display output.



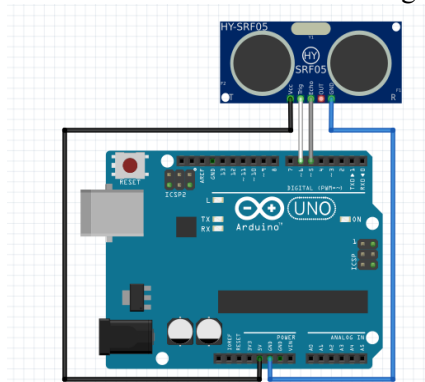
**Figure 1.** System Block Diagram.

This system is used to monitor water volume and water turbidity in tank. The ultrasonic sensor is used to measure the volume of water and turbidity sensor is used to measure of water turbidity. If the water was turbid be added chemicals such as calcium hypochlorite ( $\text{Ca}(\text{ClO})_2$ ) as the lowering of the water turbidity adjusted with the volume of water in tank. This condition is done to know and produce a decent water quality. The measurement results of ultrasonic sensors and the turbidity sensor is processed by a microcontroller Arduino UNO, then shown on the LCD display 2x16.

### 2.2. Hardware Design

The hardware design consists of pump, ultrasonic sensor, turbidity sensor, mini dc pump, solenoid valve, lcd, and led. Design of this hardware is simplified into the design of ultrasonic sensors, design of turbidity sensor and 2x16 LCD design.

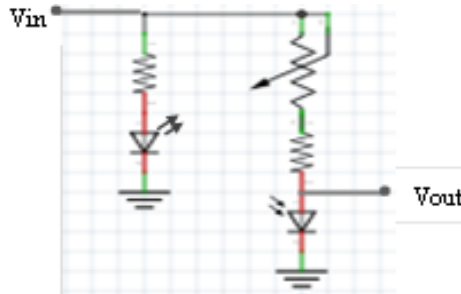
**2.2.1. Ultrasonic Sensor Design.** SRF05 ultrasonic sensor is a sensor measuring the distance an object has a range that can be detected between 3cm to 300cm. This sensor has 5 pins Vcc pin, Trigger, Echo, Out, and Gnd, and 2 transducers that function as transmitter and receiver [7]. The interface circuit to connect the ultrasonic sensor to the arduino UNO can be seen in Figure 2.



**Figure 2.** Ultrasonic Sensor Interface Series Srf05 with Arduino Uno.

How ultrasonic sensor work on this tool to measure the volume of water in the tank and a pump switch. Distance measurement is converted to volume, so that the output of the unit water volume (liters).

**2.2.2. Design of Turbidity Sensor.** Turbidity sensor circuit is made of a photodiode and infrared led. A photodiode is used as detector [8] and infrared LED as a light source. Infrared led has a wavelength of 960 nm [9]. Photodiode and an infrared LED arranged in parallel, so that forming a 90 ° angle position between the two components.

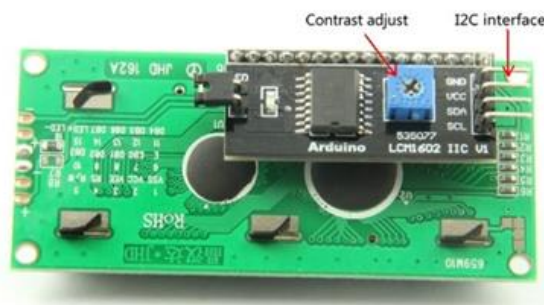


**Figure 3.** Turbidity Sensor Circuit Scheme.

This sensor utilizes the principle of light scattering by passing water between the detector and the light source. Infrared led will emit light that is partially transmitted and partially dissipated by particles in the water. Photodiode will detect the intensity of light scattered by the particles and converted into a voltage signal [10].

Turbidity sensors are used to measure the turbidity of the water in the tank. The level of turbidity > 25 NTU then mini dc pump will flash to add chemicals and levels of  $\leq 25$  NTU turbidity then open the solenoid valve to drain the water.

**2.2.3. LCD 2x16 Design.** LCD 2x16 connection with Arduino UNO using the I2C module to reduce the use of LCD pin on arduino UNO. I2C has a contrast adjust that can be used to adjust the brightness and contrast of characters displayed on the LCD. I2C consists of 2 channels that is SDA (Serial Data) and SCL (Serial Clock) [11]. SDA and SCL pins on the I2C associated with analog pins 4 and 5 on the Arduino UNO.

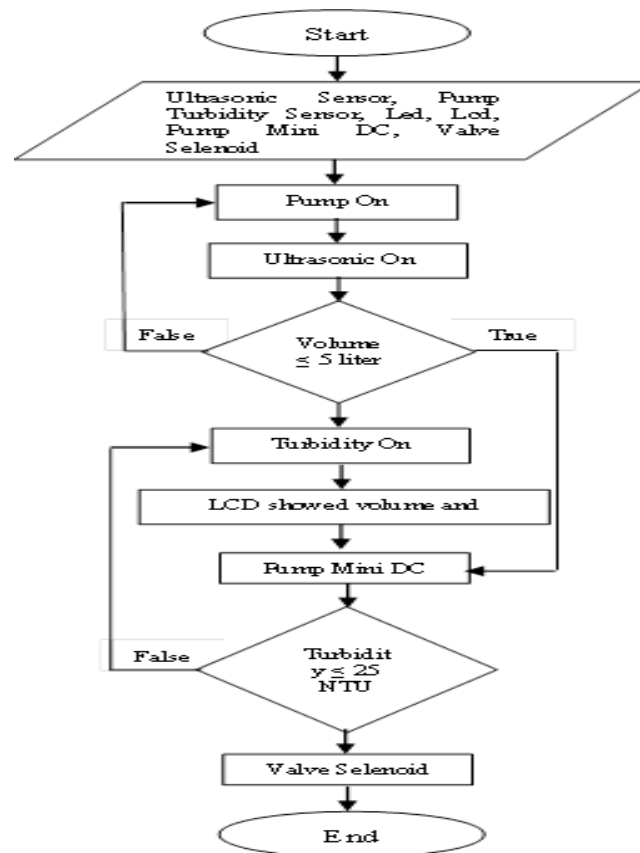


**Figure 4.** 2x16 LCD Connected With I2C Module.

### 2.3. Software Design

Design and manufacture of software is used to process the signal changes of the measurement of ultrasonic sensors and the turbidity sensor. Analog signal processing of the sensor is converted into digital data in the form of ADC value. The ADC value is converted to the value of voltage to be processed on the Arduino UNO microcontroller [12]. The final result of the Arduino UNO processing a value of volume and a value of turbidity that shown on the LCD display.

Arduino IDE application is used as a software in the design and manufacture of programs. A software that is used to program the Arduino is application Arduino IDE. Application Arduino IDE is used programming language C ++ [13].



**Figure 5.** Flowchart Software Design.

### 3. Results

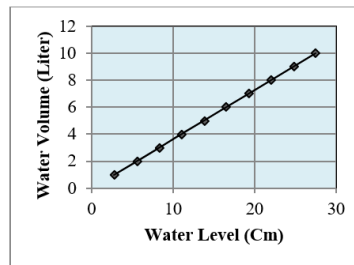
After designing and manufacturing water turbidity monitoring system prototype is completed, then taken the data with tool testing methods. Tests conducted to determine the ability of tools that have been made to work and function in accordance with the designed. Testing is divided into 2, namely ultrasonic sensor testing and turbidity sensor testing.

#### 3.1. Ultrasonic Sensor Testing

The test is performed on the ultrasonic sensor to determine the height of the sensor against the barrier and to know the response to changes in water volume. The data taken in the form of the height value from the sensor measurement that is converted to water volume unit (liters).

**Table 1.** Ultrasonic Sensor Test Result Data.

Water Level (cm)	Water Volume (liter)
2,75	1
5,5	2
8,3	3
11	4
13,8	5
16,5	6
19,3	7
22	8
24,8	9
27,5	10



**Figure 6.** Graphic of Ultrasonic Sensor Characteristics.

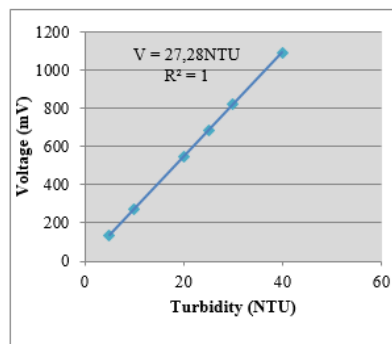
### 3.2. Turbidity Sensor Testing

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**Table 2.** Turbidity Sensor Test Result Data.

<b>Turbidity (NTU)</b>	<b>Voltage (mV)</b>
5	136,4
10	272,8
20	545,6
25	682
30	818,4
40	1091,2

Samples of water used is mineral water, toren, and water mixed with soil. Variations of turbidity concentration in water samples can be a reference to observe the effect of turbidity on the sensor output voltage.



**Figure 7.** Graphic of Turbidity Sensor Characteristics.

## 4. Discussion

Figure 6 shows that the volume of water approaching the linear value of the value of water level as measured by the ultrasonic sensor. The higher the water, the greater the volume of water and the less water the lower the volume of water. Ultrasonic sensor measurement results are used as a comparator in adding calcium hypochlorite chemicals ( $\text{Ca}(\text{ClO})_2$ ) as a decrease in turbidity of water. Ultrasonic sensors are designed to measure the volume of water with a maximum limit 12 liter.

Figure 7 shows that the sensor output voltage is increasing and turbidity increases. In contrast, the sensor output voltage decreases and the turbidity value decreases. From the graphic of the relationship

between of turbidity sensor output voltage with the turbidity level obtained the linearity equation is  $V = 27.28\text{NTU}$ . The value of the output voltage of turbidity sensor represented  $V$ . The water turbidity level represented NTU. linear regression coefficient ( $R^2$ ) that is 1. The sensitivity of turbidity sensor as big as  $27.28\text{ mV / NTU}$ . The sensor output voltage is converted to water turbidity value of the Arduino UNO using the linearity equation. This turbidity sensor measurement limit is between 0 NTU to 40 NTU. Turbidity sensor has a stable measurement capability without being affected by light around the room.

## 5. Conclusions

Based on the results of tests that have been done can be concluded ultrasonic sensors used ultrasonic sensors SRF05 which has a range of distances that can be detected between 3cm to 300cm. The chemicals used to decrease water turbidity are calcium hypochlorite ( $\text{Ca}(\text{ClO})_2$ ). Turbidity sensor consists of a component designed as a photodiode detector and infrared LED as a light source. Infrared led has a wavelength of 960 nm. The turbidity sensor uses light scattering principle. Limit measurement of turbidity sensor between 0 NTU to 40 NTU. The sensitivity of this turbidity sensor is  $27.28\text{ mV / NTU}$ . Measurement of turbidity sensor that has been made is not affected by the light conditions that exist around the room. This system can potentially help PDAM in monitoring water tanks and it is hoped that water quality monitoring system can be applied online.

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