ARDUINO-BASED DETECTION OF WATER QUALITY BY TURBIDITY SENSOR AND PH LEVEL SENSOR

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Abstract: *The system is detected the turbidity and PH level of water. The system is controlled by Arduino Uno board between two input sensors and the output liquid crystal display. The turbidity sensor is determined the water quality by using photometric technique. The PH level sensor is tested the acidity and alkalinity of a solution. The results are displayed on Liquid crystal display screen. The program is written by Arduino programming language.*

Key Words: *Arduino, PH sensor, Turbidity Sensor.*

1. INTRODUCTION:

Basically, the PH value is a detection how water is hard or soft. The pH of pure water is 7. Liquid with a pH lower than 7 is acidic, and with a pH greater than 7 is basic. Alkalinity is a measure of the ability of the water to resist a change in pH that would tend to make the water more acidic. The measurement of alkalinity and pH is needed to control the corrosiveness of the water. Turbidity is the cloudiness of a fluid caused by large numbers of individual particles that are generally invisible to the uncovered eye, similar to smoke in air. The measurement of turbidity is a main test of water quality.

1.1 Scope of Work

The system is constructed for measuring water turbidity and PH level. The system consists of three main parts. The input section consists of PH Electrode E-201 BNC sensor and MJKDZ Turbidity module. The output voltage PH electrode sensor is directly proportional to PH level. The output voltage of sensor is determined by Analog to digital converter A0 of Arduino. The turbidity sensor uses LED optical technology and its output voltage automatically varies the light penetration. The output of turbidity sensor is determined by analog to digital converter A1 of Arduino. The output display section is used by 16×2 line liquid crystal display. The block diagram of the system is shown in figure below.
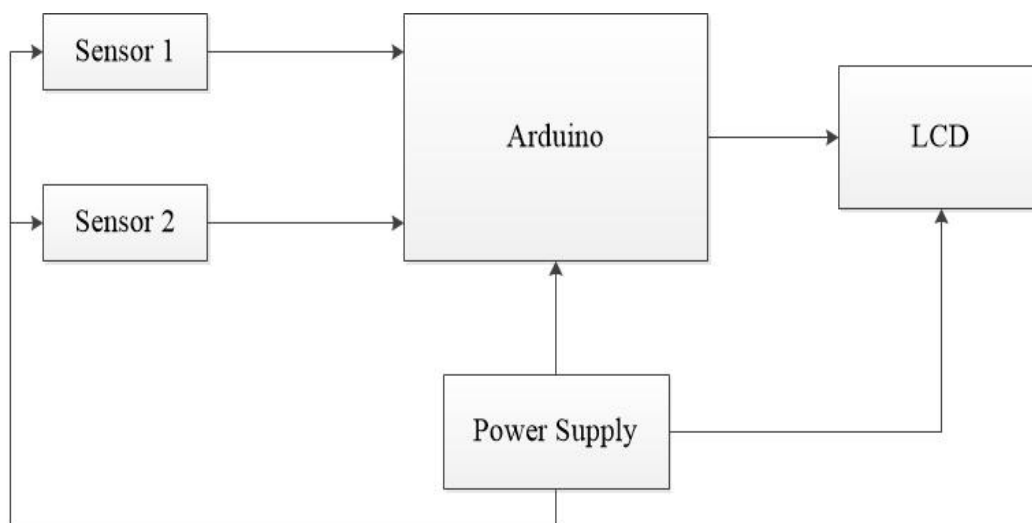

Figure 1.1. The basic block diagram of the system

2. OBJECTIVES:

- To determine the PH value in liquid
- To determine the turbidity in liquid

3. GENERAL DESCRIPTION OF THE CONSTRUCTED SYSTEM:

3.1 Arduino Uno Board (Control Unit System)

This is the latest modification of the basic Arduino USB board. It ties to the computer with a standard USB cable and has everything else you need to program and usage the board. Arduino Uno Board is a microcontroller board based on the ATmega328P (datasheet). Arduino has 14 digital input/ output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. Arduino Uno has everything needed to support the microcontroller; connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.
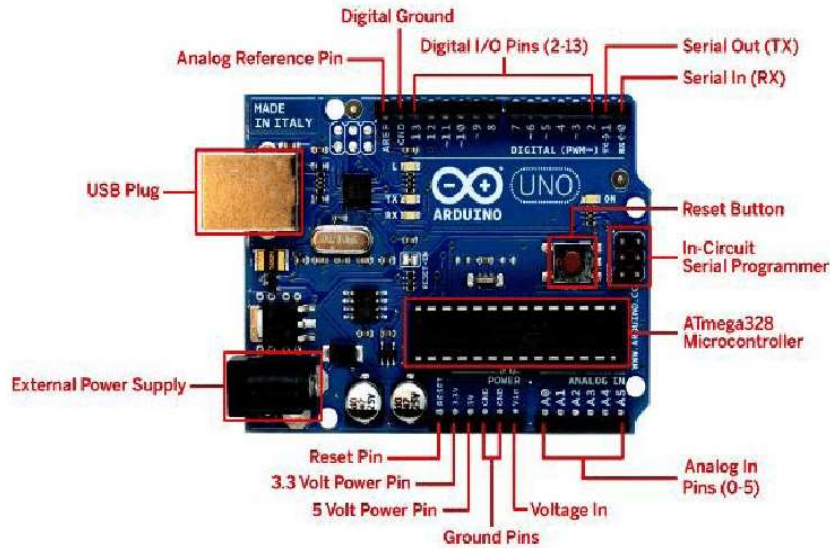

Figure 3.1 The photograph of Arduino Uno board

3.2 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic demonstration module. Liquid crystal module modules are preferred over seven segments and other multi segments LEDs. LCDs are used in an extensive range of applications including computer monitors, televisions, mobile phones, and signage. The **16×2 LCD** is called because of it has 16 Columns and 2 Rows. This LCD has two registers, **Command and Data.** The register is used to switch from one register to other, RS=0 for command register, whereas RS=1 for data register. The LCD module runs 4-bit or 8-bit parallel interfaces and writes data directly.

Figure 3.2. Pin configuration of the 16×2 module

3.3 PH Electrode E-201-BNC Sensor

The pH sensor module consist of PH sensor, so called as PH probe and a Signal Conditioning Board which gives an output which is usually proportionally to the PH value. The PH sensor is combined into device called a combination PH electrode. The electrode is glass and quite fragile. The preamplifier is a signal conditioning device. The preamplifier takes the high impedance pH electrode signal and changes into the low impedance signal which the transmitter can accept. It makes less electrical noise.

Figure 3.3. The photograph 0f PH Electrode E-201-BNC Sensor

3.4 MJKDZ Turbidity module and sensor

The sensor functions on the principle that when the light is passed through a sample of water, the amount of light transmitted through the sample is dependent on the amount of soil in the water. If the amount of solid increases, the amount of transmitted light decreases. The Water Turbidity Sensor Module detects water quality by determining the levels of turbidity. The turbidity module uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the total suspended solids increases, the liquid turbidity level increases. Turbidity sensors with module are used to measure water quality in rivers and streams, wastewater and effluent measurements.

Figure 3.4.The photograph of the MJKDZ Turbidity module and sensor

4. DESIGN AND CONSTRUCTION OF SYSTEM:

The pH E-201 pH sensor and SEN-01809 Turbidity sensor are analog output sensors. These sensors are inputted to Arduino Uno board to measure the pH value and water turbidity.

Increasing in acidity of solution has greater H^+ ions and then the output voltage of turbidity sensor increases. For the alkali solution, the output voltage from the sensor decreases. Analog to digital converter (ADC) A1 pin of sensor converts analog voltage to digital counts and then the actual pH value is calculated using the equation $y = -5.7 \times (voltage) + 21.34$.

The second turbidity sensor detects the suspended solids water. It detects light intensity from scattering of particles and the results are generated the analog output voltage. The sensor module consists of a sensor and amplifier board. The VCC, GND and signal output pins in module are connected +5V pin, ground pin and analog to digital converter (ADC) A_2 pin from Arduino
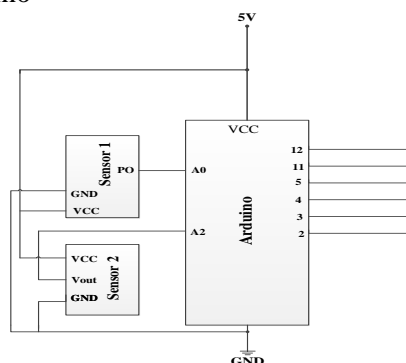

Figure 4.1. Input sensor with Arduino

4.2 Construction of Arduino and output LCD display

The 16×2 line liquid crystal display is used to display the information from the Arduino. It is used as the output device for the system. The power pin of LCD is provided the power. The contrast pin (pin 3) is controlled the brightness of LCD using 10k variable resistor. Register select pin control the writing data where in memory. Read/Write pin is connected to ground to write the data on LCD. Enable pin enable writing to register. The data pin (D_4 to D_7) are used to transfer the data as 4 bit data mode. The last two pins are backlight LED pins which are connected to ground and supply via resistor. The LCD pins are connected to arduino pin shown in Figure 4.2.
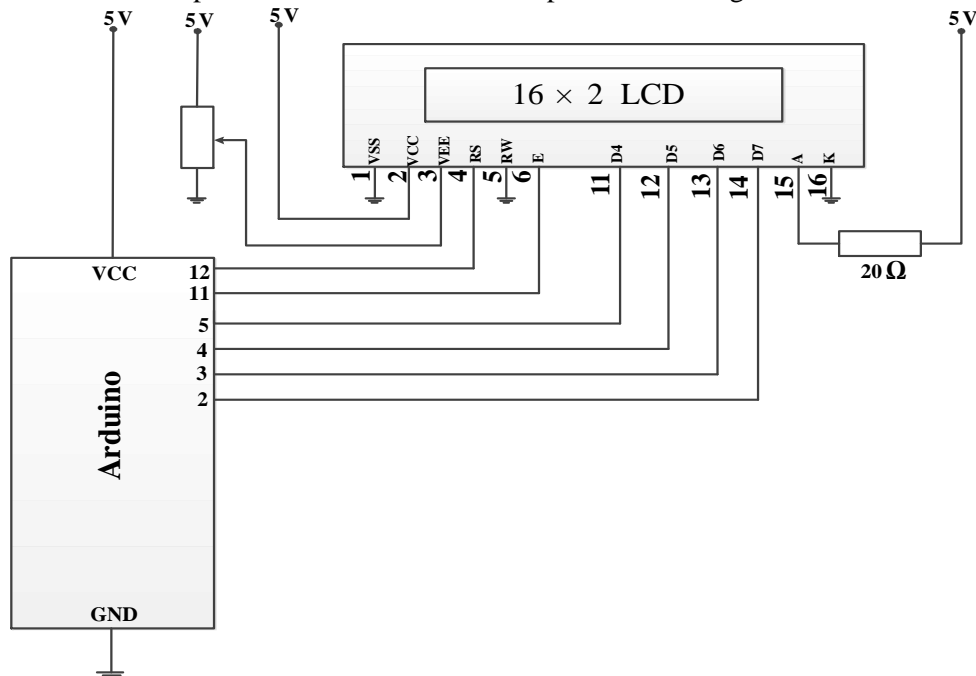

Figure 4.2. Arduino with output display and LED display

4.3 The complete circuit of the whole constructed system

Figure 4.3. is the complete circuit diagram for the whole system. The arduino controls between the input two sensors and the LCD output display. The analog data from the sensors are calculated then the datas are displayed on 16×2 line liquid crystal display. The two analog to digital pin (A_1 and A_2) are converted the analog voltage to digital count.
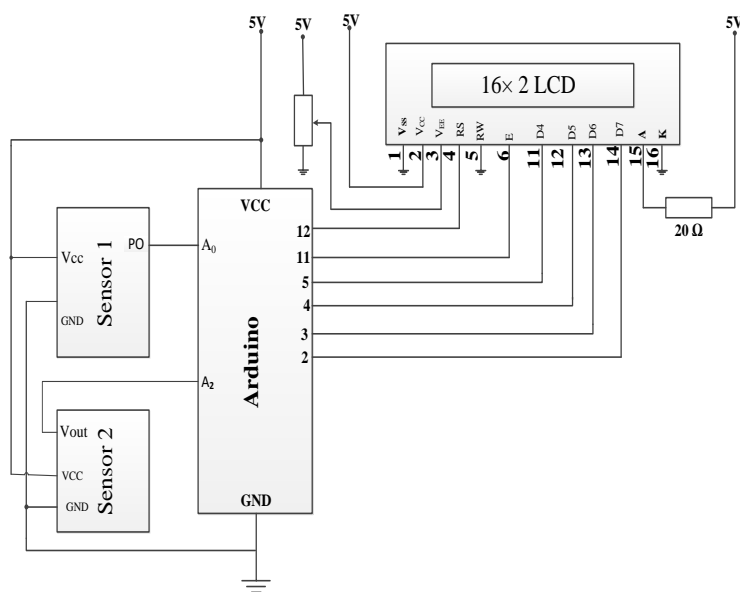

Figure 4.3.The complete circuit of the whole constructed system

4.4The flowchart for programming section

At the beginning of the program, LCD is initialized. A_1 and A_2 pins are assigned as input analog pins, pin 12 and11 as register select pin and enable pin, pin 2,3,4,5 are as data pins. Then read the pH sensor value and then calculate

the pH value. The result is displayed on LCD. After that read the turbidity sensor value and calculate the turbidity value in NTU units. The turbidity value is displayed on LCD. The flowchart for the system is shown in Figure 4.4.

A0 -PH Sensor
A1 -Turbidity

```
        ┌─────────────┐
        │    Start     │
        └─────────────┘
               │
        ┌─────────────┐
        │  Intial:0    │
        │    LCD       │
        └─────────────┘
               │
        ┌─────────────┐
        │ Assign I/O pins │
        └─────────────┘
               │
        ┌─────────────┐
        │  Read PH     │
        │ Sensor Value │
        └─────────────┘
               │
        ┌─────────────┐
        │ Calculate PH │
        │    value     │
        └─────────────┘
               │
        ┌─────────────┐
        │ Display on   │
        │    LCD       │
        └─────────────┘
               │
        ┌─────────────┐
        │ Read Turbidity │
        │ sensor value │
        └─────────────┘
               │
        ┌─────────────┐
        │ Calculate    │
        │ Turbidity value │
        └─────────────┘
               │
        ┌─────────────┐
        │ Display on   │
        │    LCD       │
        └─────────────┘
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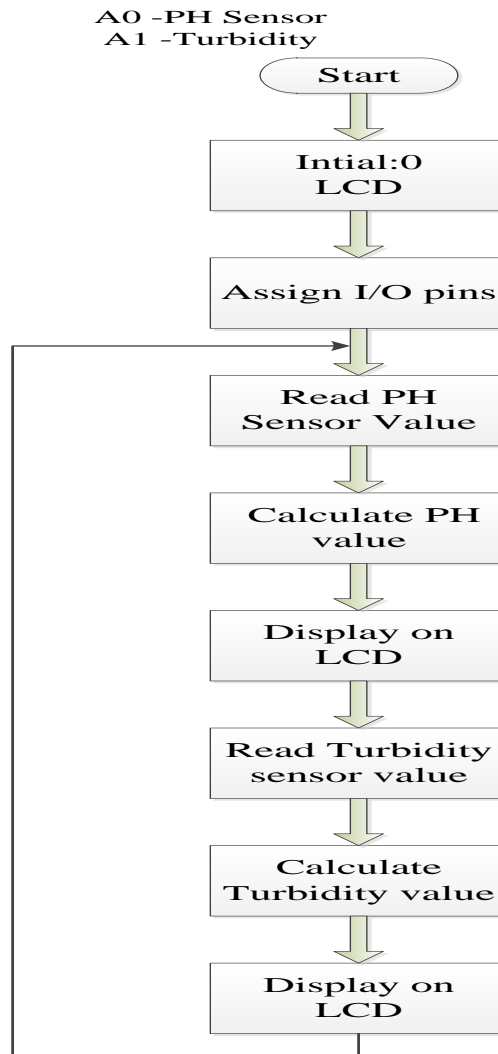
Figure 4.4. The flowchart for the system

5. RESULT AND DISCUSSION:

The hydrogen concentration in acid solution is greater than the alkali solution. The pH electrode measures H^+ ions is tested solution. The ranges of pH are from 1 to 14. The pH 7 is the neutral solution. In acid solution, the H^+ ions is more than the pH 7 solution and it gives pH value is less than 7. The pH value is greater than 7 in alkali solution. The potassium chloride neutral solution is contained in pH probe. The pH probe is submerged is tested acid solution, the H^+ ions is more than inside potassium chloride neutral solution. The output potential difference between two solution gives the pH value. In this research, the pH E-201 sensor is measured the pH value. Firstly, the potentiometer to give the 2.5 voltage is pH 7 solution. In measurement of acidity solution, the output voltage is given than the 2.5V and in alkalinity solution, the sensor output voltage is less than 2.5V. The analog output Po from the pH probe is connected to the analog to digital converter A_2 pin of arduino. The formula for measured voltage from the sensor and the pH value is associated

(pH value) = -5.7 (output voltage) + 21.34

The pH value of the solution is calculated using the above equation. The constructed system measures the lemon juice, organic juice, beer, coffee, tea, milk and then the results are less than pH 7. The soap and sea water gives the pH value greater than 7. The analog turbidity sensor SEN-1809 in research system measures suspended particles solution. The turbidity sensor directs the light beam into water and the reflecting light beam is measured from photo detector in turbidity sensor. The light intensity detected from sensor is proportionally to the turbidity of measured water. By measuring the light transmitted and scattering rate, it is observed that the liquid turbidity increases if the amount of suspended solids increase. The analog output of turbidity sensor is proportional to level of turbidity in liquid. The sensor contains transmitter and receiver. The suspended solids increase, the light scattering is minimum and the receiving light is increased. The output sensor voltage is decreased. It is observed that the output voltage is maximum 2.5V in clear

water. The analog output voltage is measured from analog to digital output A_0 pin of arduino and then the turbidity is calculated and displayed the results in NTU (Nephelometric) units liquid crystal display (LCD).

Figure 5.1.The photograph of circuit connections between printed circuit board,

Figure 5.2 The photograph of measuring turbidity values on various solutions by turbidity sensor

Figure 5.3. The photograph of measurement turbidity values(NTU unit) for various solutions

Figure 5.4 The photograph of results of pH value for measuring on various solution

6. CONCLUSION:

A pH meter gives a result solution as how acidic or alkaline in liquid. Turbidity sensor is useful for measuring water quality measurement in effluent measurement, sediment research, laboratory research in river , streams, sea, and waste water. Turbidity sensor consists of a photodiode detector and infrared LED as a light source. Limit measurement of turbidity sensor is between 0 NTU to 3000 NTU. Turbidity sensor is not affected by light around the room.

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