Advanced Water Quality Monitoring Using Microcontroller

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Abstract

This research aims to make an efficient portable device which can be monitoring the quality of water and make aware the consumer or user about the water they are going to drink or use. The contamination in water supply is biggest problem right now in world. Rural area's water supply system is not stronger as compare to urban locality. Rural area population is blindly depended on water filter system because they don't have any testing module under their budget limit. In this, the main water parameters are going to be carried out like TDS, Turbidity, hardness, and conductivity and monitored with help of microcontroller and different sensors. Innovation Challenge to develop 'portable devices' for testing drinking water quality.

Key Words: ***Portable, TDS, Turbidity etc.***

1. INTRODUCTION

Pollution of water bodies affects the ability of the body of water to provide the ecosystem services. Water bodies consist of for example like lakes, rivers, oceans, aquifers, reservoir and groundwater. Pollution is caused by polluting water bodies in such a way that negatively affects its legitimate uses.

In this project, the main parameters that define water quality are monitored and monitored. To monitor all parameters of water all measured parameters are compared with threshold values which defines the highest purity. Once the parameters are measured, they are sent to the display panel in the form of alert news for informational purposes

1.1 Problem statements

It aims to develop 'portable devices that can be used at the household level to test the drinking water quality'. Several types of portable devices may be developed. We can propose to develop portable devices for one or two or all three types of water testing kits.

A] a device with ability to test all parameters.

B] A device with ability to only detect the presence of bacterial contamination.

C] a device which test one or more parameters with portability.

1.2. LITERATURE REVIEW

Md. Galal Uddin Stephen *et al.* [1] (2021). The water quality index (WQI) model is a popular implement for evaluating surface water quality. Globally, the WQI model has been applied to evaluate water (surface water and groundwater) based on local water quality criteria. This paper presents a comparative analysis of the most commonly used models as well as issues affecting model accuracy.

S. P. Gordel et al [2] (2011) For the assessment of water pollution status of the water bodies, the following water quality parameters were analysed: (1) pH (2) Specific Conductance (3) Temperature (4) Total dissolved solid (TDS) (5) Total Solids (TS) (6) Total Alkalinity (7) Dissolved oxygen (DO) (8) Chemical oxygen demand (COD) (9) Biochemical oxygen demand (BOD) (10) Total Hardness. Parameters that may be tested consist of temperature, pH, turbidity, salinity, nitrates and phosphates, etc. An assessment of the aquatic macro invertebrates can also provide an indication of water quality.

Mr. Sensin Zhaho *et al* [3] (2011). This paper presents the Water Quality Monitoring System for Inland Lakes (WQMSIL) that aims to make it convenient for the experts to make a further decision-making and the public to participation. Remote sensing data, combined with ground-based observation data provide a variety of information to reflect the problems of water quality of inland lakes. The improvement of the system in the future is also presented in the paper.

Anna F Rusydi *et al.* [4] (2021) studied the Correlation between conductivity and total dissolved solid in various type of water These two parameters are correlated and usually expressed by a simple equation: TDS = k EC (in 25 0 C). The process of obtaining TDS from water sample is more complex than that of EC. Earlier research results have found that the connection between TDS and EC are not at all times linear. The ratio is not only strongly prejudiced by salinity inside, but also by materials contents. In addition, the examination of TDS concentration from EC value can be used to give an impression of water quality. For more exactness, TDS concentrations need to be analyzed using the gravimetric method in the laboratory.

2. METHODOLOGY

There are two major types of methodologies usually used

• Continuous method in this method the sensor is always submerged under the water to transfer the readings to user.

• Intermittent method in this method the sensor is programmed to give reading at specific time interval.

As the project is to make device portable, we have chosen Intermittent Monitoring Approach. The benefits of this approach are that less power consumption which leads to the longer battery life, less thermal issues like overheating, no need for extra cooling fans which continuous method uses. Low cost of manufacturing.

Following are the steps

1. Sensing: To sense the parameters like Hardness, Turbidity, and Total Dissolved Salt (TDS) we are using TDS sensor and Turbidity Sensor Module both are analog in nature.

2. Computing and Controlling : to compute and control the input data from the sensor we use ATmega328 the high-performance Microchip 8-bit AVR® RISC-based microcontroller combines 32 KB ISP Flash memory in the company of read-while-write ability, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters by means of compare modes, internal and external interrupts, serial programmable UART, a byte-oriented Two-Wire serial interface, SPI serial port, 6-channel 10-bit A/D converter.

3. Displaying or communicating: for display of computed data, we are using 1.8 Inch SPI 128x160 TFT LCD Display 1.8 display has 128160 color pixels. Not like the low-priced Nokia 6110 and similar LCD displays, which are CSTN type and thus have deprived color and slow refresh, this display, is a true TFT. The TFT driver (ST7735R) is able to display full 18-bit color (262,144 shades). And the 1.8 Inch SPI 128160 TFT LCD Display Module which come up to with the similar driver chip so there are no doubts that our code will not work. It features a micro-SD card holder so we can simply fill the full color bitmaps from a FAT16/FAT32 formatted micro-SD card.

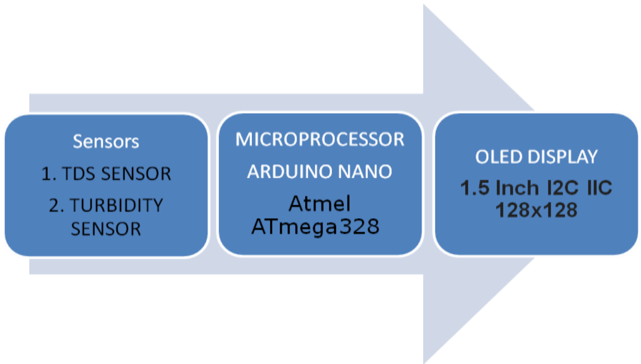

Figure -1: Flow chart of Methodology

3. COMPONENTS USED

3.1. Arduino UNO: Arduino Microcontroller is an open source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

Fig -2: Arduion UNO

3.2. TDS sensor: TDS sensor the commonly used TDS testing equipment is a TDS pen. Although it is inexpensive and easy to use, it cannot transmit data to the control system, do long-term online monitoring, and analyse the water quality. by means of a special instrument, although the data can be transmitted, the accuracy is high, but the price is very costly. To this end, we have particularly introduced the Arduino-compatible TDS sensor, which can be used to measure the TDS value of water after connecting to the Arduino controller.

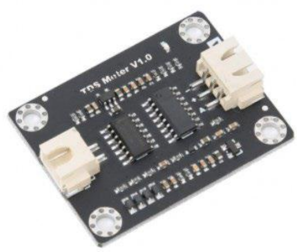

Fig -3: TDS meter

3.3. Turbidity sensor: The Arduino turbidity sensor can detect and check the water quality by performing a turbidity measurement. Turbidity measurements can be confirmed using digital or analog signals next to the corresponding pins on the associated electronic module. The turbidity sensor emits infrared rays at its edges. It is imperceptible to the human eye and can detect particles floating in water and measure light transmission and dispersion that change with the amount of TSS (total suspended solid) change.

Fig -4: Turbidity sensor

3.4. LCD display: Waveshare 2 inch LCD display module. A general purpose LCD display module with IPS screen, 2 inches diagonal, 240 x 320 resolutions, embedded controller, and communication via SPI interface. It supports Raspberry Pi, STM32, Arduino, etc.

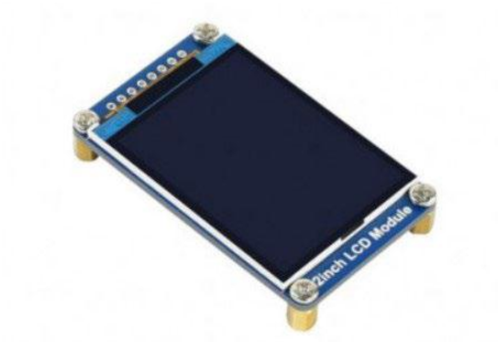

Fig -5: LCD screen

4. SPECIFICATION OF COMPONENTS

4.1. For TDS module

Gravity: Analog TDS Sensor TECH SPECS

Signal Transmitter Board

- Input Voltage: 3.3 ~ 5.5V
- Output Voltage: 0 ~ 2.3V
- Working Current: 3 ~ 6mA
- TDS Measurement Range: 0 ~ 1000ppm
- TDS Measurement Accuracy: ± 10% F.S. (25 °C)
- Module Size: 42 * 32mm
- Module Interface: PH2.0-3P
- Electrode Interface: XH2.54-2P

TDS probe

Number of Needles: 2

Total Length: 83cm

Connection Interface: XH2.54-2P

Color: Black

Other: Waterproof Probe

Other Requirements

- Hardware
- DFRduino UNO R3 (or alike) x 1
- Analog TDS Sensor x 1
- TDS Probe x1
- Jumper Wires x3
- tested liquid x1
- Software: Arduino IDE version: V1.0.x or V1.8.x

4.2 For Turbidity module

Working voltage	DC 5V
Working current	30Ma (max)
Response time	<500 msec
Insulation Resistance	100M Ω(Min)
Operating temperature (^{0}C)	-30~+80
Length (mm)	33
Width (mm)	20
Height (mm)	12
Weight(gm)	55
Shipment weight	0059 kg
Shipment Dimensions	8×5×5 cm

4.3 For Arduino UNO

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- PWM Pins: 6 pins
- UART: 1
- I2C: 1
- SPI: 1
- Analog Input Pins: 6

• DC Current per I/O Pin: 20 mA

• DC Current for supply 3.3V Pin: 50 mA

• Flash Memory: 32 KB of which 0.5 KB

• SRAM: 2 KB

• EEPROM: 1 KB

• Clock Speed: 16 MHz

• Length: 68.6 mm

• Width: 53.4 mm

• Weight: 25 g

• ICSP Header: Yes

• Power source: DC Power Jack & USB Port

4.4 Display Unit

General 2 inch IPS LCD Display Module 240×320 resolution, Brand: Waveshare

• Operating voltage: 3.3V/5V (Please make sure that the voltage of power supply and logic voltage are consistent, otherwise it will not work properly)

• Interface: SPI

• LCD type: IPS

• Controller: ST7789V

• Resolution: 240(V) x 320(H)RGB

• Display size: 30.60（H）x 40.80（V） mm

• Pixel size: 0.0975（H）x 0.0975（V） mm

• Dimension: 58 x 35(mm)

4.5. Pin Configuration

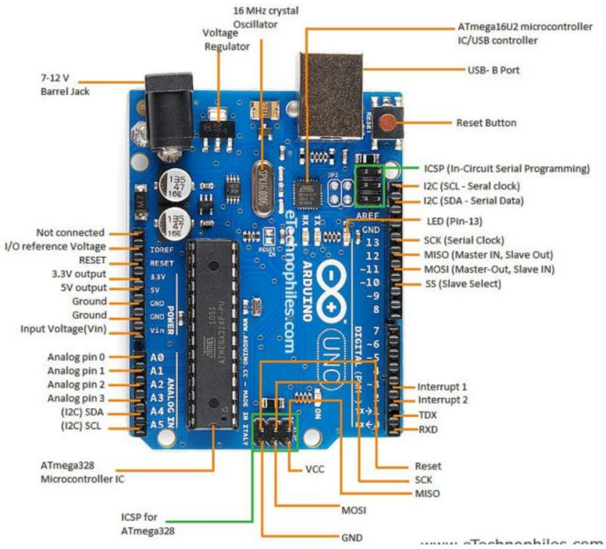

Fig -6: pin configuration

General pin configuration

• LED: Built-in LED driven by digital pin 13. If the pin is high, the LED will be on, and if the pin is low, it will be off.

• VIN: The input voltage to the Arduino or original board when using an external power supply. Power can be supplied through this pin or, if powered through ad power jack, access it through this pin.

• 5V: This pin outputs a regulated 5V from a regulator on board. The board can be powered from either the DC jack (7-20V), the USB connector (5V), or the board's VIN pin (7-20V). Applying a voltage through the 5V or 3.3V pins bypasses the regulator and can damage the board.

• 3V3: The 3.3 volt of power supply is generated by onboard regulator. The maximum current consumption is 50mA.

• GND: Ground pins.

• IOREF: This pin on the Arduino / Genuino board provides the voltage reference used by the microcontroller to operate. A well-configured shield reads the IOREF pin voltage and selects the appropriate current source or allows the output voltage converter to operate at 5V or 3.3V.

•Reset: Usually used to add a reset button to a shield that blocks the shield on the board.

Special pin configuration

Some pins have specialized functions:

• Serial /UART: pins 0 (RX) and 1 (TX). Employs to receive (RX) and transmit (TX) TTL serial data. These pins are linked to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.

• External interrupts: pins 2 and 3. These pins can be configured for generate an interrupt on a low value, an edge which is rising or falling, or a change in values.

• Pulse Width Modulation (PWM): pins 3, 5, 6, 9, 10, and 11. Can offer 8-bit PWM output along with the analog Write () function.

• Serial Peripheral Interface (SPI): pins 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).

• Two-Wire Interface (TWI)/I2C: Pins are SDA (A4) and SCL (A5). Hold up TWI communication by means of the Wire library.

• AREF (analog reference): it is reference voltage in support of the analog inputs.

5. CONCLUSIONS

The purpose of this study is to analyze the actual functionality of the device and its effectiveness. In order to reach the goal, a detailed investigation of water parameters and their measurements will be carried out in all possible aspects.

It concludes that device successfully delivering expected results without any lag in reading varying. It is easy to handle and as it is portable so any external connections need.

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