LabVIEW Based Water TDS Monitoring System

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Abstract

The water TDS (total dissolved solids) monitoring system is designed and constructed by using Keyestudio TDS sensor, chipKIT Uno32 microcontroller board and LabVIEW programming software. The TDS sensor used in the present research is the analog output type sensor. The output voltage of the sensor changes according to the TDS value of the water. The output voltage of the TDS sensor ranges from 0 to 2.3 V. The corresponding TDS values are from 0 to 1000 ppm. The TDS value of the water is usually expressed in ppm (parts per million). The sensor output is fed into the ADC (analog to digital convertor) circuit of the chipKIT Uno32 board. Analog to digital conversion, data processing and interfacing with PC are done by using LabVIEW software. The measured TDS values are displayed in graphical format as well as in numerical format. Therefore, the changes in TDS values of water can be monitored simultaneously while the measuring of the TDS is done.

1. Introduction

Total Dissolved Solids(TDS) indicates that how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids dissolved in water, and the less clean the water is. Measuring the TDS value in the water is to measure the total amount of various organic or inorganic substances dissolved in water, in the unit of ppm or milligrams per liter (mg/l). TDS electrode can measure conductive materialsin water. In the study by the World Health Organization (WHO), a panel of testers came to the following conclusions about the preferable level of TDS in water and it is shown in Table 1[1]. However, a very low concentration of TDS has been found to give a flat taste, which is undesirable to many people.

Table 1. Level of TDS

Level of TDS (milligram/liter)	Rating
Less than 300	Excellent
300 - 600	Good
600 - 900	Fair
900 - 1200	Poor
Above 1200	Unacceptable

The water TDS measurement can be done by using Arduino Uno and serial monitor in the Arduino IDE [2] or using LCD module [3]. In this research work, the water TDS will be measured and monitored by using chipKIT Uno32 and LabVIEW. The functional block diagram of the system mainly consists of five parts and it is shown in Figure 1.

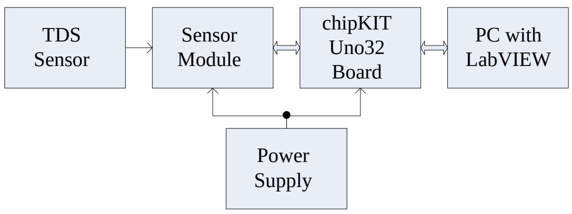

Figure 1. Functional block diagram of the water TDS monitoring system

2. Electronic Devices Used in the Research

The electronic devices mainly used in this work are TDS sensor, sensor module, chipKIT Uno32 microcontroller board and 7805 voltage regulator IC. LabVIEW software is used to control the whole system.

2.1. TDS Sensor and Module

TDS sensor used in this work is Keyestudio TDS sensor.It consists of TDS sensor (probe) and associated module.TDS probe has two small needle to sense water TDS. It is a small device and has a total length of about 83 cm including signal cable connector. The probe is made water proof to be able to insert into water. The photograph of the TDS probe is shown in Figure 2. The TDS module is the small circuit board which is operated with 5 V power supply. It has two connectors. One connector has two pins and it is used to connect with the TDS probe. Other connector has three pins: 5 V power pin, ground pin and analog signal output pin. The output voltage of the TDS module ranges from 0 to 2.3 V for the TDS value of 0 to 1000 ppm.The TDS measurement accuracy of the device is ± 10 % at 25°C water temperature. The photograph of the TDS module is shown in Figure 3[4].

Figure 2. Photograph of the TDS sensor

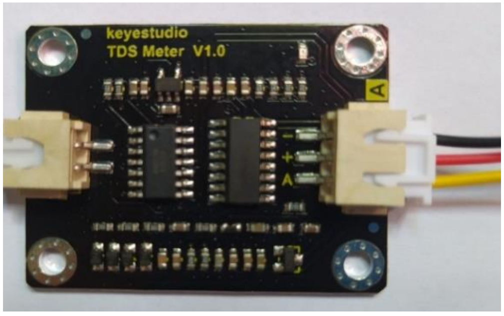

Figure 3. Photograph of the TDS sensor module

2.2. The chipKIT Uno32 Microcontroller Board

The chipKIT Uno32 is an open-source hardware prototyping platform with 32 bits capability by using the Microchip PIC32 microcontroller. The Uno32 is the same form factor as theArduino Uno board and is compatible withArduino shields. It has the features: a USB serial port interface for programming and powered via USB or an external power supply. It uses powerful 32-bit PIC32MX320F128 running at 80 MHz, 128K of flash program memory and 16K of SRAM data memory.

The Uno32 can be programmed using theMulti-Platform Integrated DevelopmentEnvironment (MPIDE), an environment basedon the original Arduino IDE modified to supportPIC32. In addition, the Uno32 is fully compatible withthe advanced Microchip MPLAB® IDE and thePICKit3 in-system programmer/debugger.

The Uno32 provides 42 I/O pins that support anumber of peripheral functions, such as UART,SPI, and I2C ports and pulse width modulatedoutputs. Twelve of the I/O pins can be used asanalog inputs or as digital inputs and outputs [5]. The photograph of the chipKIT Uno32 microcontroller board is shown in Figure 4.

Figure 4. Photograph of chipKIT Uno32 microcontroller board

2.3.The 7805 Voltage Regulator IC

The LM7805 is the fixed-voltage integrated-circuit voltage regulator which produces regulated + 5 V at its output. It has three terminals: input, ground and output terminals. It is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. The regulator can deliver up to 1 A of output current [6].

2.4. LabVIEW

LabVIEW is short for Laboratory Virtual Instrument Engineering Workbench. It is a powerful and flexible instrumentation and analysis software development application created by National Instruments. LabVIEWis a major player in the area of testing and measurements, industrial automation, and data analysis.

LabVIEW programs are called Virtual Instruments or VIs in short. LabVIEWis different from text based programming languages (such as FORTRAN and C) in that LabVIEW uses a graphical programming language, known as the G programming language, to create programs relying on graphic symbols to describe programming actions. The LabVIEW program contains three main components: the front panel, the block diagram and the icon and connector pane [7, 8].

3. Design and Construction

The constructed water TDS monitoring system mainly consists of circuit construction or hardware (tangible electronic devices) section and program implementation or software section. Each parts of the system will be described in this section.

3.1. Circuit Construction

The complete circuit diagram of the water TDS monitoring system is shown in Figure 5. The TDS probe is attached to the TDS module. The signal output of the TDS module is connected with the analog input pin A0 of the chipKIT Uno32 microcontroller board. The power and ground pins of the TDS module are connected with the 5 V and ground pins of the voltage regulator circuit. The chipKIT Uno32 board connects with PC through the USB cable. The USB cable not only supply power but also communicates data to the chipKIT Uno32 board from the PC. The voltage regulator circuit produces regulated 5 V for the TDS module from the small 9 V battery. The whole process of water TDS monitoring is done under the control of the LabVIEW program.

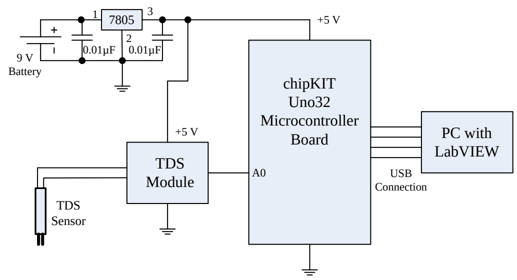

Figure 5. Complete circuit diagram of the water TDS monitoring system

3.2. Program Implementation

The LabVIEW is the main control software in this research work. LabVIEW 2014 (64-bit) version from the National Instruments Corporation is used. The LINX toolkit software is installed to properly interface with PC and chipKIT Uno32 via USB connection in the LabVIEW application. LINX is an open source project by Digilent and is designed to make it easy to develop embedded applications using LabVIEW. LINX includes VIs for over 30 of the most common embedded sensors as well as hardware agnostic APIs for accessing peripherals like digital I/O, analog I/O, PWM, I2C, SPI, and UART.

The LINX firmware wizard is obtained from the tool menu of the LabVIEW program. The chipKIT Uno32 is selected as the microcontroller board to be connected with the program. Then the front panel of the LabVIEW program for the TDS monitoring system is created by using the required controls and indicators. The print screen of the front panel of the LabVIEW is shown in Figure 6. Three controls are used to select serial port, analog channel and for the stop function of the program. The serial port is selected with the baud rate of 9600. The analog channel 0 (A0) is selected. The stop control is use to stop or abort the program. Three different indicators (number display, vertical progressive bar and waveform graph) are used to display and monitor the TDS values.

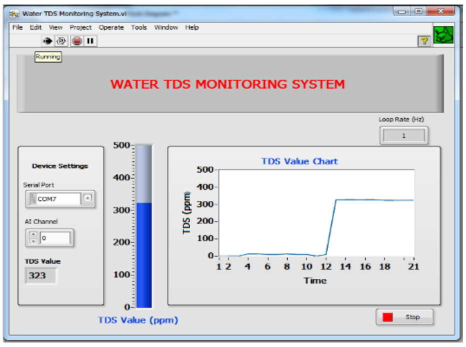

Figure 6. The front panel of the LabVIEW

The block diagram contains the graphical source code of the front panel. Front panel objects appear as terminals on the block diagram. Three VIs for the LINX toolkit are used in the block diagram. Open serial VI is used to initialize or to open the program. Analog read VI is used to read analog voltage for the analog channel specified by the user in the front panel of the program. Close VI is used to close the program. The analog read VI is enclosed within the while loop. Therefore the analog read process from the chipKIT Uno32 is done until a specific condition (i.e. pressing the stop button) is occurred. The delay time between each reading is set to about 1500 milliseconds. The block diagram of the LabVIEW is shown in Figure 7.

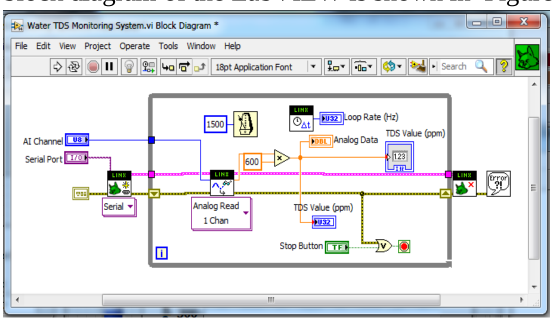

Figure 7. The block diagram of the LabVIEW

4. Results and Discussion

In this research, the water TDS monitoring system had been designed and implemented based on TDS sensor, chipKIT Uno32 microcontroller module and LabVIEW. The photograph of the complete system is shown in Figure 8.

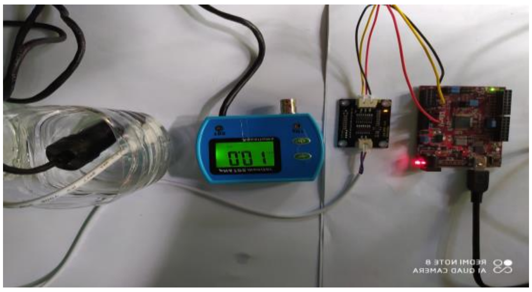

Figure 8. The photograph of the complete system under testing condition

In this research work four water samples, pure water samples and tap water samples are tested. The results are then compared with the aquarium pH and TDS meter.

Table 2. TDS values for some water samples

Sr.	Water Sample	Constructed System	aquarium TDS meter
1	Sample 1	12 ppm	10 ppm
1	Sample 2	10 ppm	10 ppm
1	Sample 3	323ppm	330 ppm
1	Sample 4	354 ppm	350 ppm

Water sample 1 and sample 2 are purifying water samples from Ye NanDaw (Banmaw region) and A2M2 from Amarapura (Mandalay region), respectively. Sample 3 and sample 4 are tap water fromBanmaw University and from Amarapura, respectively. The discrepancies of reading between these two devices are not too much. Therefore the constructed water TDS monitoring system can be used in testing and monitoring the TDS values of the water samples. The measured TDS values are displayed in graphical format as well as in numerical format on the front panel. The changes in TDS values of water can be monitored continuously while only the last updated TDS valuecan be seen in LCD based systems.

5. Conclusion

The constructed water TDS monitoring system used the TDS sensor probe and module with the measurement accuracy of ± 10% full scale. More precise sensor should be used to obtain more accurate TDS reading. Moreover, the quality of water depends not only on the TDS value but also on the pH level, turbidity, conductivity and so on. Therefore the system can be extended to capture other quantities of water quality by usingappropriate sensors, to log the data for later analysis or to monitor received data in real time applications.

Acknowledgements

First of all, we would like to thank our respective families. This research work would not have been carried out without their physical and mental supports. We also wish to express our sincere appreciation to all of our teachers from the primary level until now. Finally we are grateful to all people who have helped us with this research.

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