VISIBLE SPECTROSCOPY BASED PORTABLE EMBEDDED SYSTEM DEVELOPMENT FOR WATER QUALITY ANALYSIS

Abstract: ***The visible spectroscopy has been widely used for characterizing and measurement of test samples and the entire spectrum will give huge amount of information. The visible portion is from 400 to 800nm. The visible (Vis) spectrometry system is increasingly employed recently for its significant advantages compared with regular standard chemical method in liquid/fluid quality analysis. This method is used due to its non contact type measurement nature when compared with other techniques. In this project, an investigation is undertaken to determine whether the sample color, physic-chemical parameters and also detecting the heavy metals in samples provide a good indication of the parameter. Parameters will be measured; extracted using the experimental data and soft computing techniques and information is stored. In order to observe the absorptive characteristics and explore the detection methods, we will sample the absorption spectra of artificial sample solutions of NO3, COD and turbidity. In the measurement of NO3, COD and TOC, the cross sensitivity between NO3 and organic substances are avoided by selecting the appropriate characteristic wavelengths using soft computing models. Turbidity and TSS (Total suspended solids) will be detected outside the spectral range around the absorption peak caused by sample color. The sample color is calculated to warn for harmful algal blooms. The feasibility of this instrument will be demonstrated by a series of experiments.***

Keywords: CC2640 Microcontroller, pH sensor, Conductivity Sensor, AS7262 detector. Visible Spectrum in Iron and Copper.

1. INTRODUCTION

Contaminated water serves as a mechanism to transmit communicable diseases such as diarrhea, cholera, dysentery, typhoid and guinea worm infection. WHO estimates that in 2008 diarrheal disease claimed the lives of 2.5 million people. The Millions of people are exposed to dangerous levels of biological contaminants and chemical pollutants in their drinking-water due to inadequate management of urban, industrial or agricultural wastewater. In addition, dangerously high concentrations of chemical hazards, such as arsenic and fluoride, originating from natural sources affect millions and cause conditions such as cancer and fluorosis. Inorganic arsenic is present at high levels in the groundwater of a number of countries, including Argentina, Chile, China, India (West Bengal), Mexico, the United States of America, and particularly Bangladesh where 20 million and 45 million people are at risk of being exposed to arsenic concentrations that are greater than the national standard of 50 µg/L and the WHO guideline value of 10 µg/L, respectively.

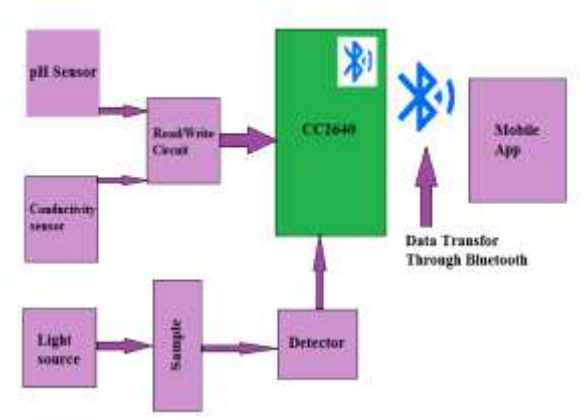
The United Nations General Assembly Resolution A/RES/64/292 (2010) recognized the right to safe and clean drinking-water as a "human right that is essential for the full enjoyment of life and all human rights". Subsequently, the Human Rights Council Resolution (2010) recognized that the right to water and sanitation is derived from the right to an adequate standard of living (A/HRC/RES/15/9), which is contained in several international treaties with references, inter alia, to the WHO Guidelines for Drinking-water Quality. In addition, new examine has built up a connection between water contamination and expanded psychological instability in youngsters. The outcomes propose that higher centralizations of water contamination, most importantly from activity, may increment diseases in kids and teenagers.

2. LITERATURE SURVEY

Yingtian Hu et al, (2016) ultraviolet–visible spectroscopy has been widely used for measurements of water quality in seawater, because full spectrum contains large amounts of information. NO3 can be detected in 220-230 nm, and chemical oxygen demand (COD) and total organic carbon (TOC) can be detected in 280-290 nm. In visible spectrum, water color, turbidity and total suspended solids (TSS) can be measured. We presented a water environmental multi-parameter sensor developed for the simultaneous measurement of these parameters. In order to research their absorptive characteristics and explore the detection methods, we sampled the absorption spectra of artificial seawater solutions of NO3, COD and turbidity. In the measurement of NO3, COD and TOC, the cross sensitivity between NO3 and organic substances was avoided by selecting the appropriate characteristic wavelengths of partial least squares (PLS) models, and the interference of turbidity was eliminated by using fourth derivative spectrum. Turbidity and TSS was detected outside the spectral range around the absorption peak caused by water color. The water color was calculated to warn for harmful algal blooms. The feasibility of this instrument was demonstrated by a series of experiments.

Jian Zhang et al, (2014) this paper presents a short summary of ultraviolet-visible (UV-Vis) spectrometry system is increasingly employed in chemical oxygen demand (COD) predicting recently for its significant advantages compared with traditional standard chemical method. In this study, an investigation is undertaken to determine whether the physic-chemical parameters of samples provide a good compensation for prediction. Meanwhile, a feature selecting algorithm is employed to reduce the size of UV-Vis absorption spectroscopy provided as data input to the modeling algorithm. A high correlation of above 0.90 is obtained with the data using the stand chemical method, while less absorbance values are necessary to measure and a spectrometer with industrial wavelength resolution is adequate.

3. IMPLEMENTATION



3.1 Block Diagram of prototyping framework

The pH sensor and conductivity sensor sensing the values and connect to read/write circuit. The Read/write circuit used amplifiers and analog to digital converter. Amplifier is used as a increase strength of signal and ADC is used to convert analog values to digital values. The microcontroller cc2640 to access the data from ADC and send to mobile app using Bluetooth. In this block diagram to calculate the pH value and conductivity value. The values are standard compare to WHO (**World Health Organization**) is equal measurement values the water is drinking water. The source light passes through sample and detector (AS7262) detecting the values and stored the values in detector. The microcontroller CC2640 to access the data and send the data to mobile application using Bluetooth after that to compare the standard spectroscopy already available in market. This process is find heavy metals in water and also calculates the wavelength of metals.

4. RELATED WORK

The brief introduction of different modules used in this project is discussed below:

CC2640 Microcontroller

The CC2640 device d e s i g n e d around a Cortex-M3 processor core. The Cortex-M3 processor provides the core for a high-performance, low-cost platform that meets the needs of minimal memory implementation, reduced pin count, and low power consumption, while delivering outstanding computational performance and exceptional system response to interrupts.

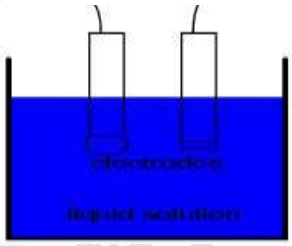
Features

- Cortex-M3 processor core
  - 48-MHz RC oscillator and 24-MHz XTAL oscillator with an internal doubler.
  - 32-kHz XTAL oscillator, 32-kHz RC oscillator or low-power 24-MHz XTAL derivate clock for timing maintenance while in low-power modes.
  - ARM Cortex SysTick timer
    - Nested vectored interrupt controller (NVIC).
- On-chip memory
  - Flash with 8KB of 4-way set-associative cache RAM for speed and low power.
  - System RAM with configurable retention in 4KB blocks

pH Sensor

Working Principle

pH probes measure pH by measuring the voltage or potential difference of the solution in which it is dipped. By measuring potential difference, hydrogen ion concentration can be calculated using the Nernst equation which gives the relationship between Hydrogen ion concentration and Voltage or Potential



The design and operational theory of pH electrodes is a very complex subject, explored only briefly here.

What is important to understand is that these two electrodes generate a voltage directly proportional to the pH of the solution. At a pH of 7 (neutral), the electrodes will produce 0 volts between them. At a low pH (acid) a voltage will be developed of one polarity, and at a high pH (caustic) a voltage will be developed of the opposite polarity.

Conductivity Sensor

Conductivity is measure in a wide range of industries and gives readout of total ionic concentration within the sample solution. In some industries the nature of the ions us known and may be present as one molecular species. In food manufacturing processes, the conductivity meter becomes a salt meter and is used for control measurement.

AS7262 6-Channel Visible Spectral_ID Device

The AS7262 is a cost-effective multi-spectral sensor-on-chip solution designed to address spectral ID applications. This highly integrated device delivers 6-channel multi-spectral sensing in the

visible wavelengths from approximately 430nm to 670nm with full-width half-max (FWHM) of 40nm. An integrated LED driver with programmable current is provided for electronic shutter applications.

5. RESULTS

5.1 Results for the pH Sensor

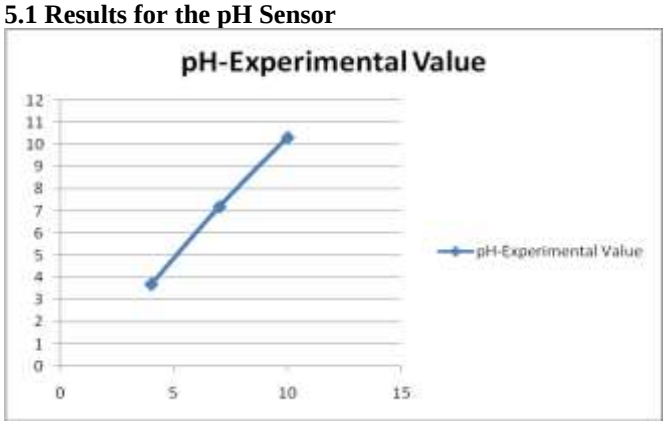


Figure 5.1 pH values graph

5.2 Results for the Conductivity Sensor

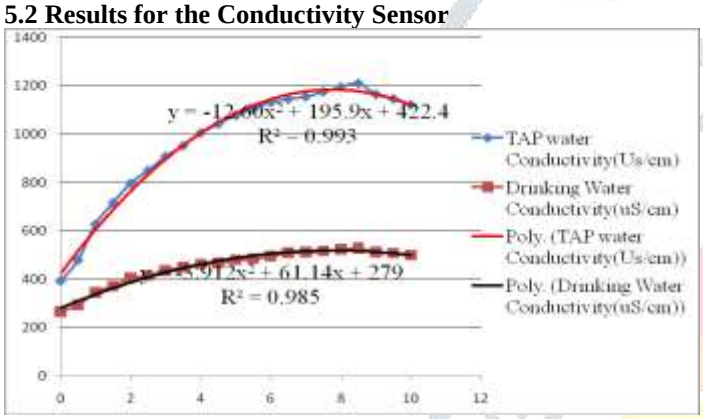


Figure 5.2 Conductivity values graph

5.3 Developed Visible Spectrum

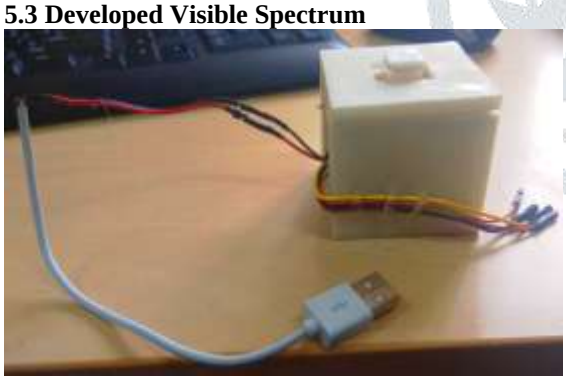


Figure 5.3 AS7262 Module with CC2640

5.4 STANDARD Spectrum

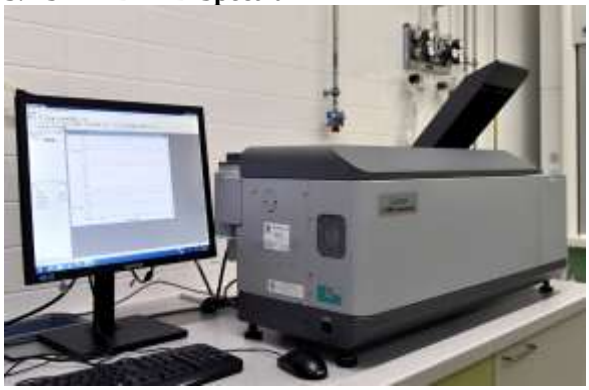


Figure 5.4 Standard Spectrum

5.5 Comparison of Standard Spectrum and Development Spectrum

5.5.1 IRON Samples

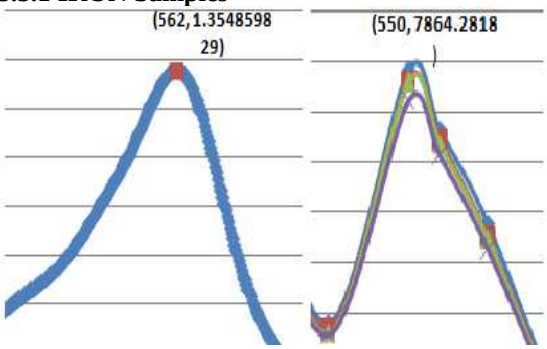


Figure 5.5 Iron with standard Iron sample

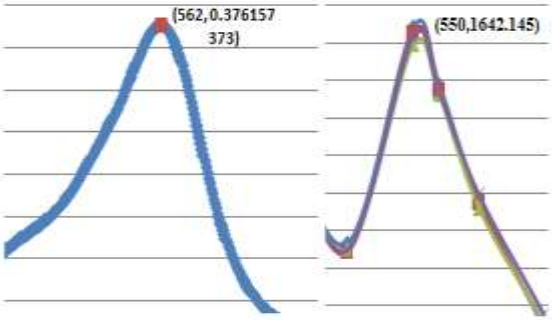


Figure 5.6 Iron with DI water sample

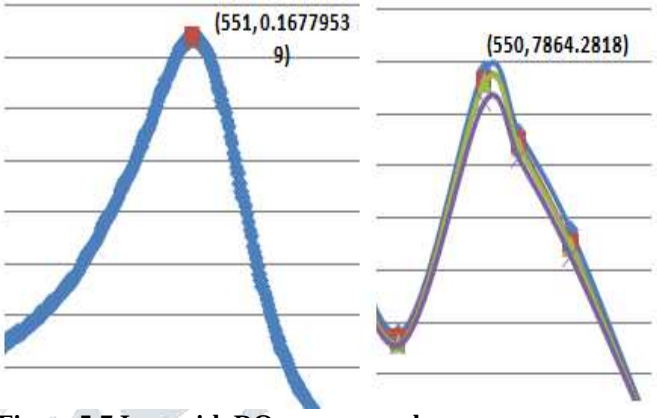


Figure 5.7 Iron with RO water sample

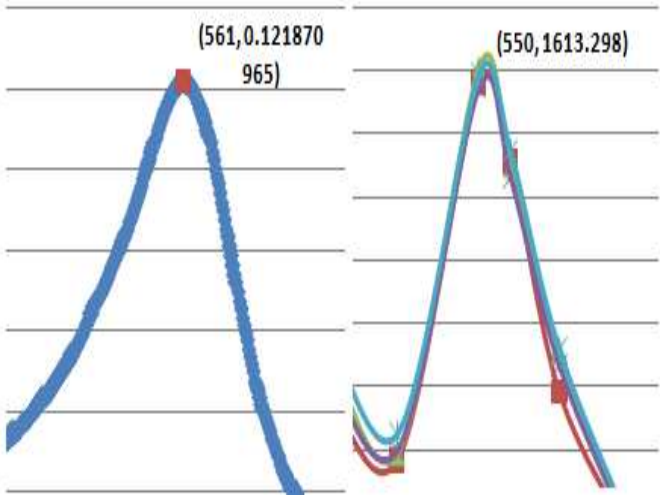


Figure 5.8 Iron with TAP water sample

5.5.2 COPPER Sample

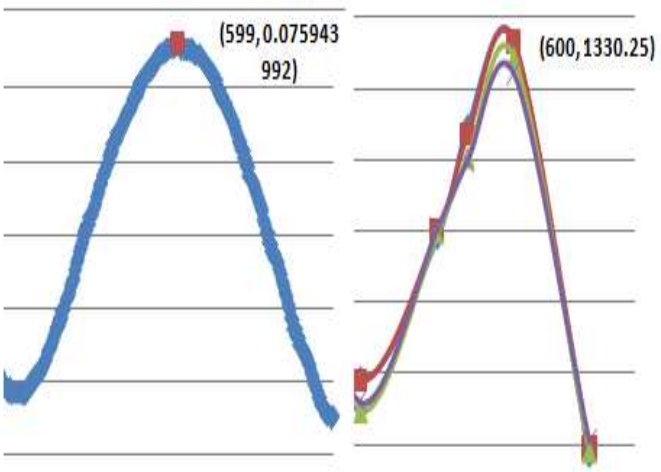


Figure 5.9 Copper with DI water sample

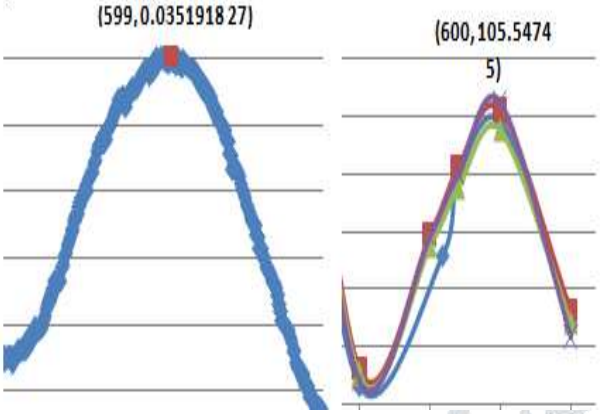


Figure 5.10 Copper with RO water sample

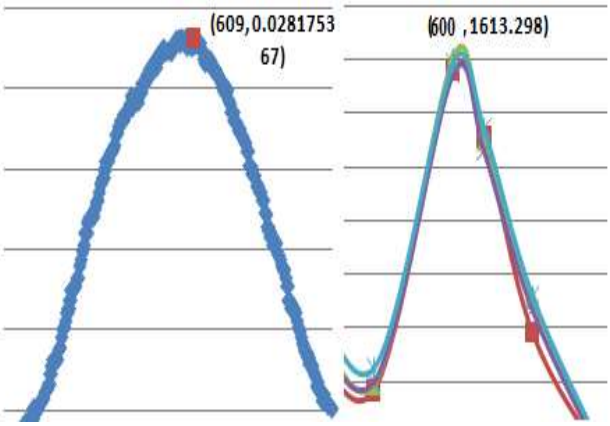


Figure 5.11 Copper with TAP water sample

6. CONCLUTION

In this study, inexpensive and accurate Visible spectrometric method has been developed for determination of COD in the waste water treatment facility. The results from this work have permitted to conclude that the developed system could monitor and estimate the accurate COD concentration in wastewater treatment plant. The developed system comes with a smart algorithm, which is capable to automatically identify maximum sensitive spectral region and wavelength for COD content in the waste water system. It was possible to conclude that Visible spectrometer system can probe in raw waste water sample and distinguish between solutions with different composition. The COD concentration obtained from the system was validated using traditional method. The developed system showed accurate result with very small error range. Finally, it is possible to conclude that the developed system can estimate the COD content accurately and instantly without performing any sample preparation like traditional technique.

ACKNOWLEDGEMENT

We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

REFERENCES

1. L. L. Wang, X. H. Liu, X. X. Shi, Y. R. Lu, Y. Qi, and M. Y. Wang, "Study on Real-Time Monitoring of Seawater COD by UV-Vis Spectroscopy, ," Advanced Materials Research, vol. 726-731, pp. 1534-537, 2013.
2. A. Torres, and J. L. Bertrand-Krajewski, "Partial Least Squares local calibration of a UV-visible spectrometer used for in situ measurements of COD and TSS concentrations in urban drainage systems", Water. Sci. Technol., vol. 57, pp. 581-588 April 2008.
3. Jian Zhang, Dibo Hou (*), Huang Ping-jie, Guangxin Zhang, Leilei Dai, Jiachen Li, Tianlong Lu, Shu Liu " Multi-sensor Fusion and Feature Selection in Ultraviolet-Visible Spectrometry System for Predicting Chemical Oxygen Deman" pp. 904-907 june 2014.
4. Yingtian Hu, Yizhang Wen, and Xiaoping Wang "Detection of Water Quality Multi-Parameters in Seawater based on UV-Vis Spectrometry" published in june 2016.
5. B. Tang, B. Wei, D. C. Wu, D. L. Mi, J. X. Zhao, P. Feng, et al., "Experimental Research of Turbidity Influence on Water Quality Monitoring of COD in UV-Visible Spectroscopy," Spectroscopy and Spectral Analysis, pp. 3020-3024, 2014.
6. N. D. Lourenco, C. L. Chaves, J. M. Novais, and et al. "UV spectra analysis for water quality monitoring in a fuel park wastewater treatment plant E-7258-2011", chemosphere, vol. 65, pp. 786-791, May 2006.
7. A. Charef, A. Ghauch, P. Baussand, and et al, "Water quality monitoring using a smart sensing system", Meas., vol. 28, pp. 219 224, March 2000.

Author's Profile

ORUGANTI RAKESH KUMAR REDDY 1, SAI KRISHNA VADDADI M.Sc. Tech 2, D SONY M. Tech 3.

1 M. Tech, Department of Embedded Systems, Geethanjali College of Engineering and Technology (UGC Autonomous), Cheeryal (V), Keesara (M), Medchal District, Hyderabad, Telangana, India.

2 Scientist, Signal Analytics Group – CPS, CSIR-CEERI, Pilani, Rajasthan, India.

3 Assistant Professor, Department of Electronics and Communication Engineering , Geethanjali College of Engineering and Technology (UGC Autonomous), Cheeryal (V), Keesara (M), Medchal District, Hyderabad, Telangana, India.