

Water Quality Measurement Using Hybrid Sensors

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Abstract: In this paper, describe Dissolved oxygen is probably the single most important water quality factor that pond managers need to understand. Oxygen dissolves in water at very low concentrations. The main aim of the project is to sense the water quality parameters such as dissolved oxygen (DO) and Temperature in a fish forms. The system is designed to collect DO and Temperature sensor information and process using the Micro Controller. The data is sent from sensor nodes through the connected GSM module to authorized person, when the sensors level is deviated from the irrespective threshold, thus allowing the person to monitor Dissolved oxygen content in the fish forms and can turn on the motor to pump fresh water into it. Dissolved oxygen (DO) is a measure of the quantity of free oxygen molecules in water. The concentration of DO is an important indicator of the health of an aquatic ecosystem. water level of the dissolved oxygen will be ranging from 0-20mg/l. Applications of dissolved oxygen include Field use, Fish keeping, Mixed aqueous/organic, Hydroponics, Environmental monitoring. So sensing of these parameters helps to improve the quality of water.

Keywords: Dissolved oxygen sensor, Temperature Sensor, Aerator, GSM Technology, Raspberry pi Board

1. Introduction

Dissolved oxygen is probably the single most important water quality factor that pond managers need to understand. Oxygen dissolves in water at very low concentrations. Our atmosphere is 20% oxygen or 200,000 ppm but seldom will a pond have more than 10 ppm oxygen dissolved in its' water. Dissolved oxygen concentrations below 3 PPM stress most warm water species of fish and concentrations below 2 ppm will kill some species. Often fish that have been stressed by dissolved oxygen concentrations in the range of 2 or 3 ppm will become susceptible to disease.

Oxygen dissolves into water from two sources: the atmosphere and from plants in the water. The primary source of oxygen for a pond is from microscopic algae (phytoplankton) or submerged plants. In the presence of sunlight, these produce oxygen through photosynthesis and release this oxygen into the pond water. At night and on very cloudy days, algae and submerged plants remove oxygen from the water for respiration. During daylight hours plants normally produce more oxygen than they consume, thus providing oxygen for the fish and other organisms in the pond

This paper is organized as follows: in Section 2 the related work about the Sensors. Section 3, 4 ,5 and 6 describes the proposed method. Flow chart is shown on section 7. Hardware implementation is shown in section 8. Experimental results are shown on section 9 and finally section 10 presents the conclusion and future scope.

2. Previous Work

In long history in developing and manufacturing sensors that measure dissolved oxygen in aqueous solutions and has had many firsts over the years including the invention and commercialization of the first portable dissolved oxygen instrument in 1963. This instrument utilized a membrane-covered Clark Paleographic sensor, commonly referred to as a Clark electrode, which was developed in 1956 by Dr. Leland Clark, a researcher at Antioch College who was working in collaboration with YSI scientists. Before the

introduction of the Clark electrode, methods for measuring dissolved oxygen were laborious, time-consuming and highly susceptible to interference. Today the world continues to benefit from Dr. Clark's invention as the Clark electrode is still used by many manufacturers and in several YSI instruments. In addition to the variety of Clark electrodes offered, YSI also manufactures optical based dissolved oxygen sensors for laboratory, spot sampling and long term monitoring applications

3. Overview of the Method

This chapter describes an entire project overview in brief. In this project, this system describe a real time water monitoring system is to sense the water quality parameters such as dissolved oxygen (DO) and Temperature in a fish forms. The system is designed to collect DO and Temperature sensor information and process using the Raspberry pi board. The data is sent from sensor nodes through the connected GSM module to authorized person. It continuously checks the dissolved oxygen levels in the water. If the dissolved oxygen is below the threshold level then it shows indications as indicator will be on, aerator will on and also it sends a message to the authorized person as a DO alert

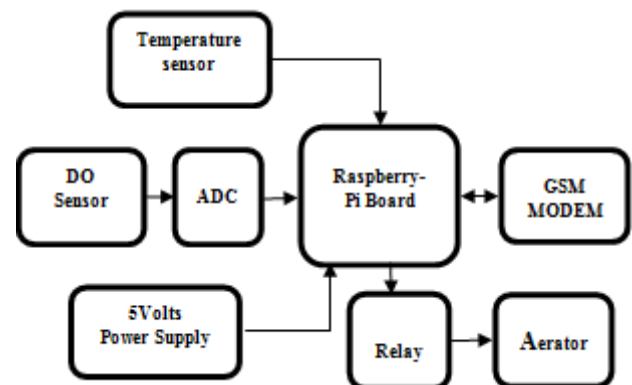


Figure 1: Overview of the project

3.1 Description of Block Diagram

In this project dissolved oxygen sensor is interfaced to raspberry pi board through adc. ADC converts dissolved oxygen sensor values from analog signal to the digital signal given to the raspberry pi board. Temperature sensor is directly interfaced to the raspberry pi board. Raspberry pi board is continuously monitoring the dissolved oxygen and temperature sensors value. When the threshold level is crossed. Raspberry pi sends a signal to GSM and it sends a message to the authorized person. If the dissolved oxygen sensor value is below the threshold level then the indicator will be on, siren is ON and sends a message to the authorized person and also Aerator will be on. If the dissolved oxygen sensor is above the threshold level then indicator, siren, Aerator will automatically turn OFF.

4. Dissolved Oxygen Sensor

Oxygen gas dissolved in water is vital to the existence of most aquatic organisms. Oxygen is a key component in cellular respiration for both aquatic and terrestrial life. The concentration of dissolved oxygen, DO, in an aquatic environment is an important indicator of the environment's water quality. Oxygen gas is dissolved in water by a variety of processes—diffusion between the atmosphere and water at its surface, aeration as water flows over rocks and other debris, churning of water by waves and wind, and photosynthesis of aquatic plants. There are many factors that affect the Concentration of dissolved oxygen in an aquatic environment. These factors include: temperature, stream flow, air pressure, aquatic plants, decaying organic matter, and human activities. As a result of plant activity, DO levels may fluctuate during the day, rising throughout the morning and reaching a peak in the afternoon, At Night photosynthesis ceases, but plants and animals continue to respire, causing a decrease in DO levels. Because large daily fluctuations are possible, DO tests should be performed at the same time each day. Temperature is important to the ability of oxygen to dissolve, because oxygen, like all gases, has different solubilities at different temperatures. Cooler waters have a greater capacity for dissolved oxygen than warmer waters. The amount of oxygen that a given volume of water can hold is a function of:

1. The pressure the atmospheric oxygen is exerting at the air-water interface.
2. The temperature of the water
3. The amount of other substances dissolved in the water.

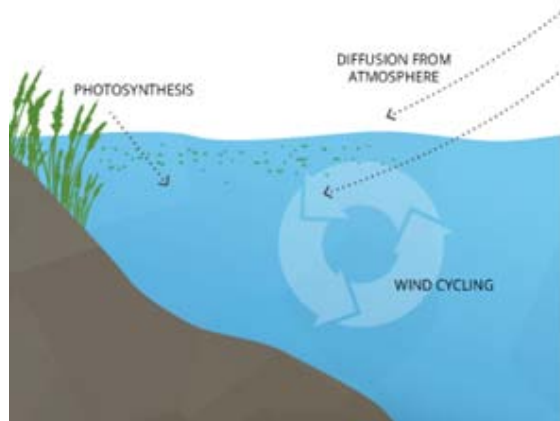


Figure 2: Dissolved Oxygen Enters Water

5. Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). The LM35 series are precision integrated-circuit 2 temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. Thus the LM35 has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55°C to $+150^\circ\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only $60\ \mu\text{A}$ from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 is rated to operate over a -55°C to $+150^\circ\text{C}$ temperature range, while the LM35C is rated for a -40°C to $+110^\circ\text{C}$ range



Figure 3: Temperature Sensor

6. GSM Technology

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial up modem, but it sends and receives through radio waves. In this work we are using SIEMENS MC55 tri-band GSM/GPRS engine that works on the three frequencies GSM 900MHz, GSM 1800MHz, GSM 1900MHz. This modem requires SIM card for a wireless carrier in order to operate and to control modem like sending and receiving messages/emails using AT commands. This GSM modem connected to base station through RS-232 for sending SMS using AT commands and receiving the messages.

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, the following operations can be performed:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low i.e., about 6 to 10 SMS messages per minute.

7. System Flow

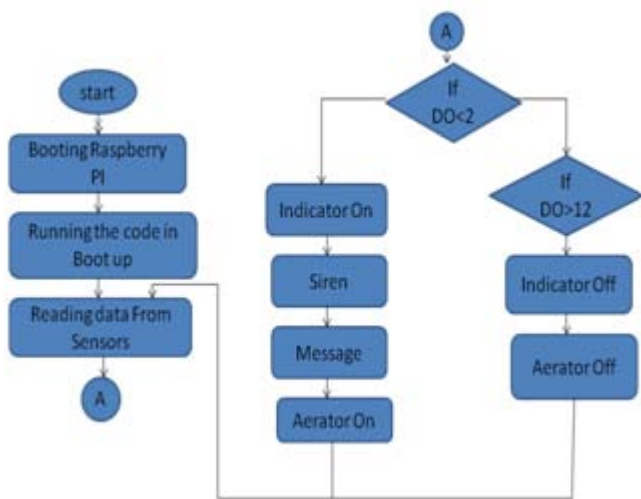


Figure 4: System Flow

Flow chart of the Project is shown in the Figure 2

The Flow Chart shows that

STEP 1: Start

STEP 2: Booting the raspberry pi

STEP 3: Running the code in Boot up

STEP 4: Reading the data from the sensors

STEP 5: If the dissolved oxygen sensor value is below the threshold value 2 then the indicator turns on and gives a siren and aerator turns on and the message is sent to the authorized person.

STEP 6: If the dissolved oxygen sensor value is above the threshold value 12 then the indicator, aerator will be automatically turnoff.

8. Hardware Implementation



Figure 5: Raspberry Pi Board

The **Raspberry Pi** is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egomania. These companies sell the Raspberry Pi online. Egomania produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red colouring and lack of FCC/CE, marks. The hardware is the same across all manufacturers. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage.

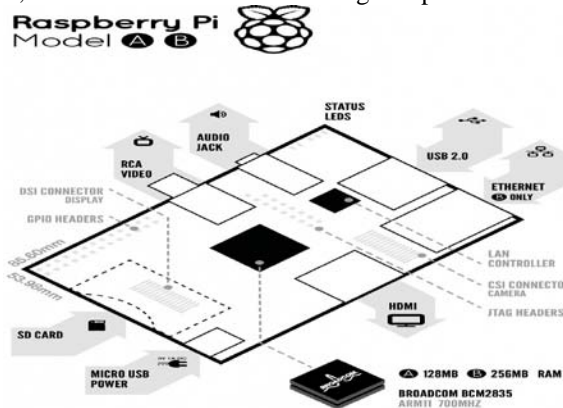


Figure 6: Board Overview

The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, Java and Perl [8]. No matter what operating system we are going to use for the installation process, we have to download the Debian image from the official download site. We can download it using HTTP or via Torrent. After the download has finished, we should have a file named 2014-07-15-wheezy-raspbian.zip on your local hard drive then we need to extract the file. First insert the SD card and plug in the power supply. When you boot Raspbian for the first time, it starts a configuration program named

Raspi-config. When you boot Raspbian for the first time, it starts a configuration program named Raspi-config. It helps you configure the most important aspects of the Linux system. We're probably used to control user interfaces with mouse, but we have to control Raspi-config with our keyboard.

9. Experimental Results

Design and implementation of water quality measurements using hybrid sensors was implemented successfully. The dissolved oxygen sensor, GSM, Speakers are interfaced to raspberry pi and keyboard devices are interfaced with raspberry pi board through USB ports. Figure 7 shows the hardware setup of the Raspberry pi board with connections and µSD card.



Figure 7: Dissolved oxygen sensor, GSM, Speakers are interfaced to raspberry pi

Led will glow when the threshold level of dissolved oxygen in water is less than the value 2, which is shown as in the below Figure 8

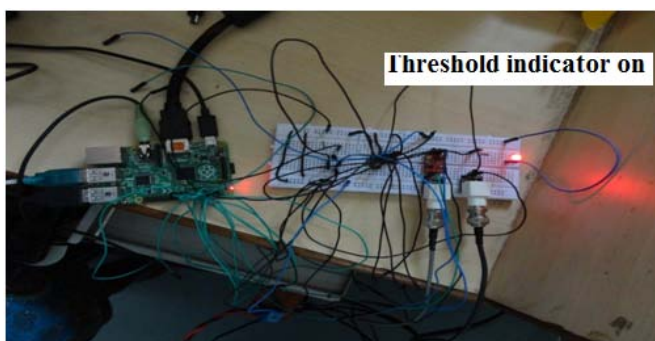


Figure 8: Threshold Indicator

Alert Sound Produced at the time of Threshold value is below 2 which is shown in the Figure 9 as “PLAYING WAVE, 8000Hz STEREO”

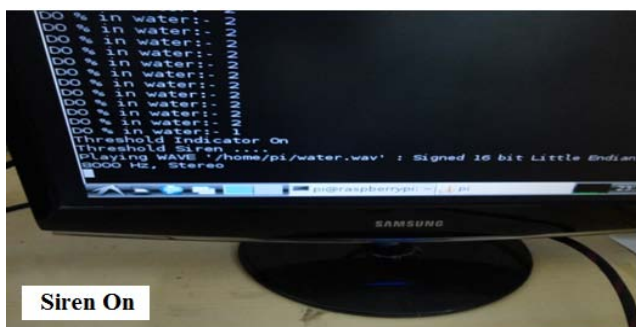


Figure 9: Alert sound

The aerator in the Test Aquarium Setup will be on when threshold level is below the value 2 which is shown in the Figure 10

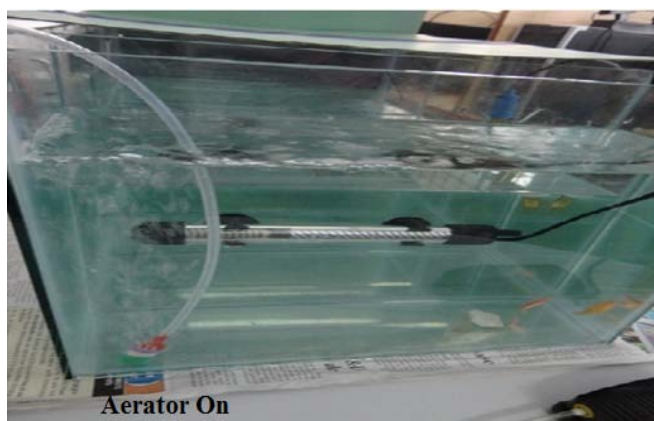


Figure 10: Aquarium Setup

Message Alert to the authorized person when the dissolved oxygen is below the value 2 which is shown in the Figure 11

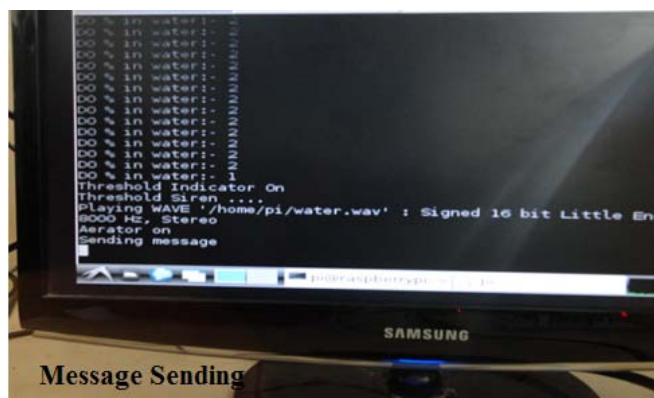


Figure 11: Message Alert

GSM module sending message to authorized person which is shown in the Figure 12

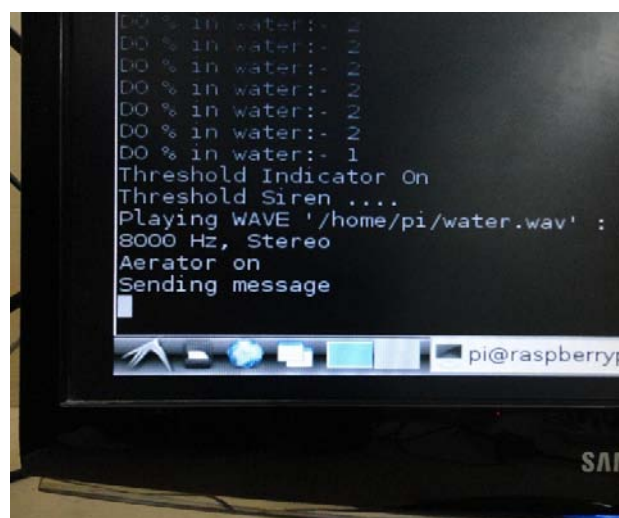


Figure 12: GSM Module sending message

Authorized person getting “DO Alert” message to the Mobile which is shown in the Figure 13



Figure 13: Authorized Person Mobile

10. Conclusion

The project based on water quality measurement using hybrid sensors has been successfully designed and implemented. It is useful in conservation of water quality which is the most essential need for living beings. Raspberry Pi board is used which is an ARM based personal computer for implementation. The system designed provides an efficient way of improving Dissolved oxygen levels in the water which will be very useful for the aquariums and can be applied in variety of industries and applications where accurate measurement and control is required to improve and optimize processes. For example cell culture in biotechnology, sewage treatment etc.

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