WATER-SAFE PROJECT REPORT

TEAM MEMBERS
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Report

Abstract

The objective of our project was to build a portable, easy to handle and smart device of monitoring the status of your pool. The status includes temperature of water, pH (whether the pool water is acidic or basic) and the amount of disinfectant required to clean you pool water. Our project runs around three basic sensors communicating with a microprocessor which transmits data to cloud storage for further usage. It also keeps a record for the user to understand and keep his history clean. Our pool device is quite effective with respect to cost and efficiency and has an interface which could be handled by any layman. Conclusively, our project is a device which monitors the health of your pool and also keeps you and your family safe.

Introduction

The motivation behind this project was a commercial device being sold all over the world to user for monitoring their pool water's health. The commercial device isn't cost effective and although being a compact and ready-to-use device still doesn't meet user's requirements which include self-sufficiency and understanding of the product. In the same way, there are many other devices which are much complex and are not easy to handle and a major problem in these devices is the cost. They have a great amount and not everyone can afford it. Our device not only differs in technology but also market wise it is quite cheap and is understandable. It is efficient and easy to handle for the user. Our device can be operated by any personnel. Our device communicates with an allotted cloud space storing data regarding your water's health.

Why this work is important

Many people, all around the world use the facility of swimming pool for enjoyment and recreation. To keep this facility in better shape for humanity, research under this topic is quite necessary. There are a large number of diseases which are produced by harmful bacteria inside the swimming pool's water. These are called Recreational Water Illnesses (RWIs). RWIs include a wide variety of infections, such as gastrointestinal, skin, ear, respiratory, eye, neurologic, and wound infections. The most commonly reported RWI is diarrhea which affects thousands who

accidentally swallow infected pool water. In the past two decades, there has been a substantial increase in the number of RWI outbreaks associated with swimming. Keeping chlorine at recommended levels is essential to maintain a healthy pool. However, a 2010 study found that 1 in 8 public pool inspections resulted in pools being closed immediately due to serious code violations such as improper chlorine levels. When you swim, some water is going to get into your mouth. For the most part, that is OK. In recreational pools chlorine is used to kill germs although it can take its sweet time killing some of them.

Most swimming pool outbreaks go unrecognized and unreported. In the last decade, he estimates, pool outbreaks have affected 10,000 people.

In May of 2004, Opinion Research Corporation (ORC) conducted a survey of nearly 1,000 people over the age of 18. Among the findings:

- About 60% said that it is "not likely at all" or "possible but not likely" that a person could get sick from pool water.
- One-fifth said if you could smell the chlorine, the pool was safe (chlorine does kill germs, but some organisms die a slow death, lasting in a dangerous state for days). Also, a heavy odor means harmful chemicals have formed.

Keeping these points in mind one can conclude that a common man does not know how dangerous pool water can be if not taken care of on weekly basis. To make surety of safety of oblivious common man, one who does not know his pool stats, this device can be extremely helpful in determining pool parameters. These parameters will help in pool extreme care and will determine the required amount of disinfectant in pool along with temperature.

Scope of the problem

The scope of the problem is high. To ensure the complete solution, the device with determine pH, concentration of Chlorine in water and temperature of the pool to calculate the disinfection rate of the water in order to kill the bacteria present. It is to be noted that the disinfection percentage should be kept as high as needed to keep the safety all the time. The temperature should be kept around 25-30 degree centigrade which is the basic requirement of the human body.

Objectives

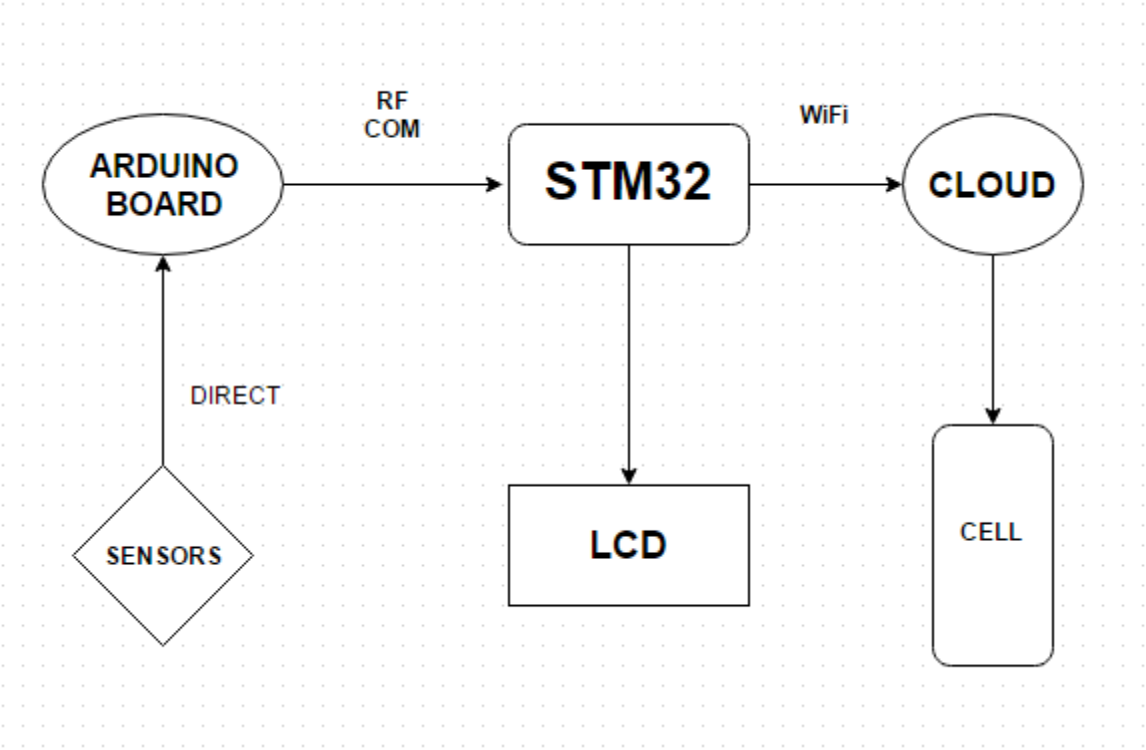
Objectives of the project are as follows:

- Accurate results of pH of the water.
- Approximate concentration of chlorine in water which is highly important as chemicals can do harmful damages with presence of excessive amount.
- Temperature of water accurate as possible to ensure the use does not catch cold with the use of water. Also temperature of water has effects on chemical reactions happening inside but the effect is negligible as long as the temperature difference is not too high which is obvious in case of pools.

Customer Needs Assessment

- Portable
- Able to tolerate high weather
- Highly Economic
- Safe
- Adaptable to unsafe pH ranges and temperature
- Durable
- Easy to operate
- Light
- Small footprint
- Less reading response time
- 24 hours battery life

Working Principle



BLOCK DIAGRAM

The working of the project is shown in above diagram. The number of modules are:

- Sensors (Conductivity sensor, temperature sensor, pH sensor)
- Arduino UNO Board
- STM32 F103RB
- Cloud (Thingspeak)
- LCD Monitor

Sensor

The most challenging part of the project was working of sensors. Sensors are usually highly sensitive and technical and even one error would lead to wrong results from the sensors outputs. To ensure the correct results, the sensors had to be calibrated at accurate outputs in order to achieve minimum error results. Three sensors are used in the project.

pH Sensor:

pH sensor is used to calculate pH of any solution. The sensor requires high care with use of different chemicals. Before change of chemical for use, the probe has to be washed with distilled water.

pH Probe

The output of the pH probe gives an analog signal which has a central value at pH = 7.0. This value deviates up and down depending on the pH deviation of the solution. This value is in mV and is given an input to pH probe adapter which translates the input in order to give it as an input to Arduino board. The Arduino board translates the voltage reading to a certain pH with logic based on experimental values of pH sensor readings done in a chemical Lab.

pH Probe Adapter

Conductivity Sensor:

Conductivity Sensor is used to measure the conductivity of a solution. The unit of output is Siemens/cm. The conductivity sensor works in the same fashion as pH probe. It delivers a certain voltage based on the current resistance of the solution it is dipped in. The conductivity sensor used in the project is based on the same principle and is hand-made with cost efficiency of 50 times less price than the industrial conductivity sensor available on amazon.com and such sites.

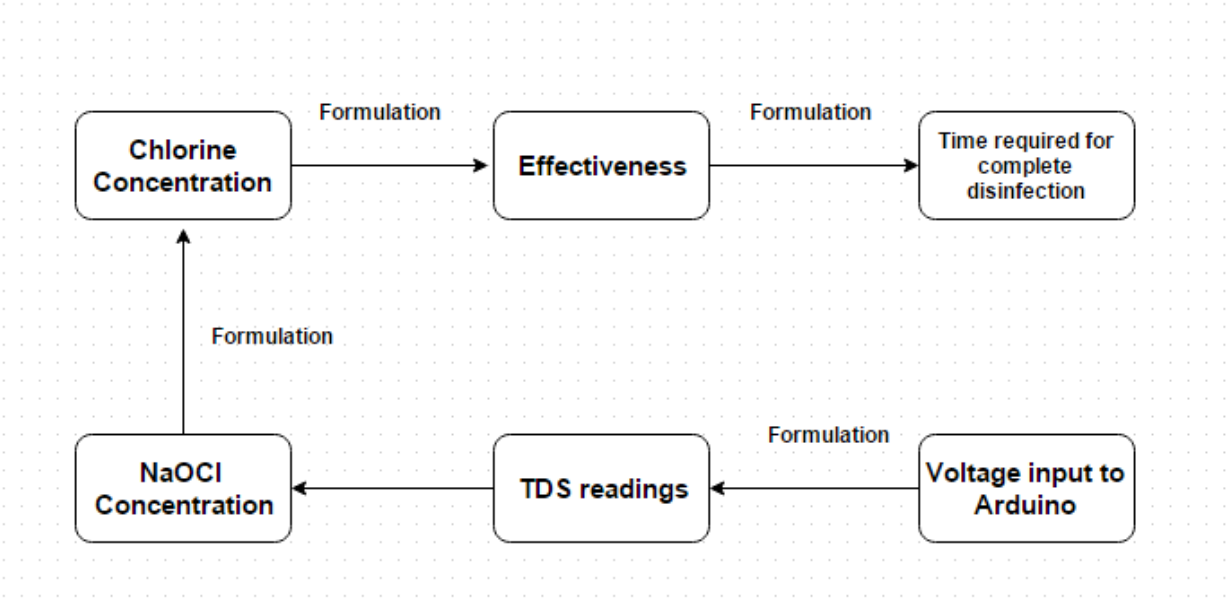
Home Made Conductivity Sensor

The construction of the conductivity sensor requires following components.

- Nichrome Wire
- Copper Wire
- Pen body
- Tape

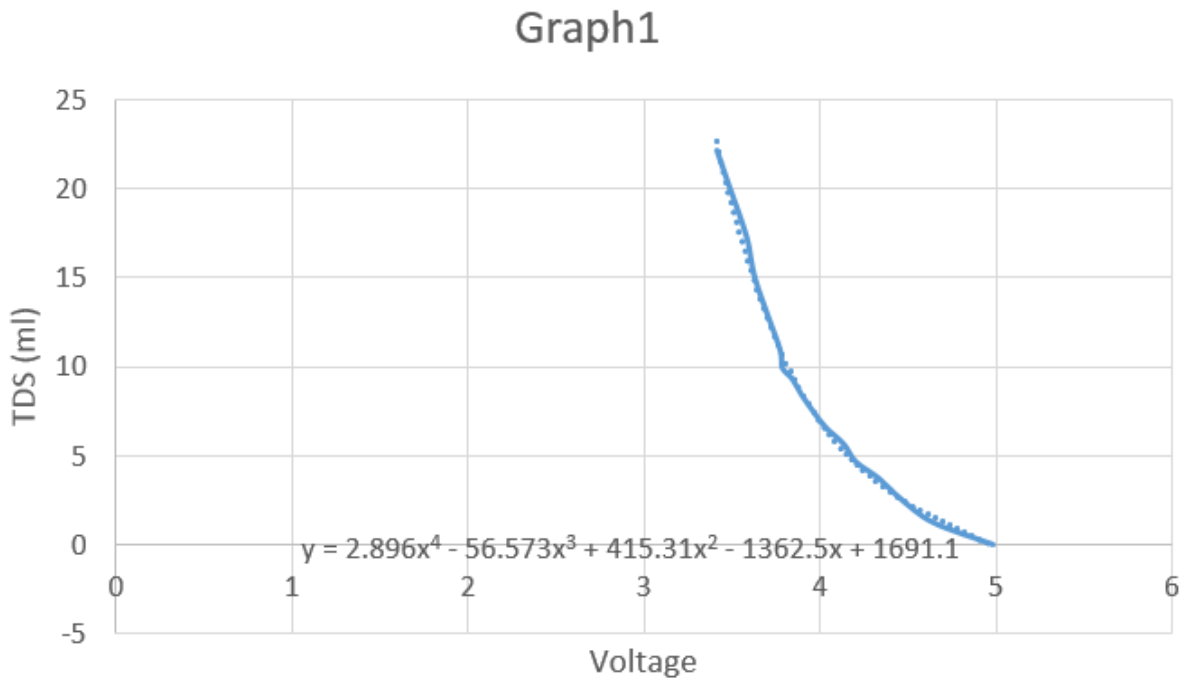
- Resistances
- 5V constant supply

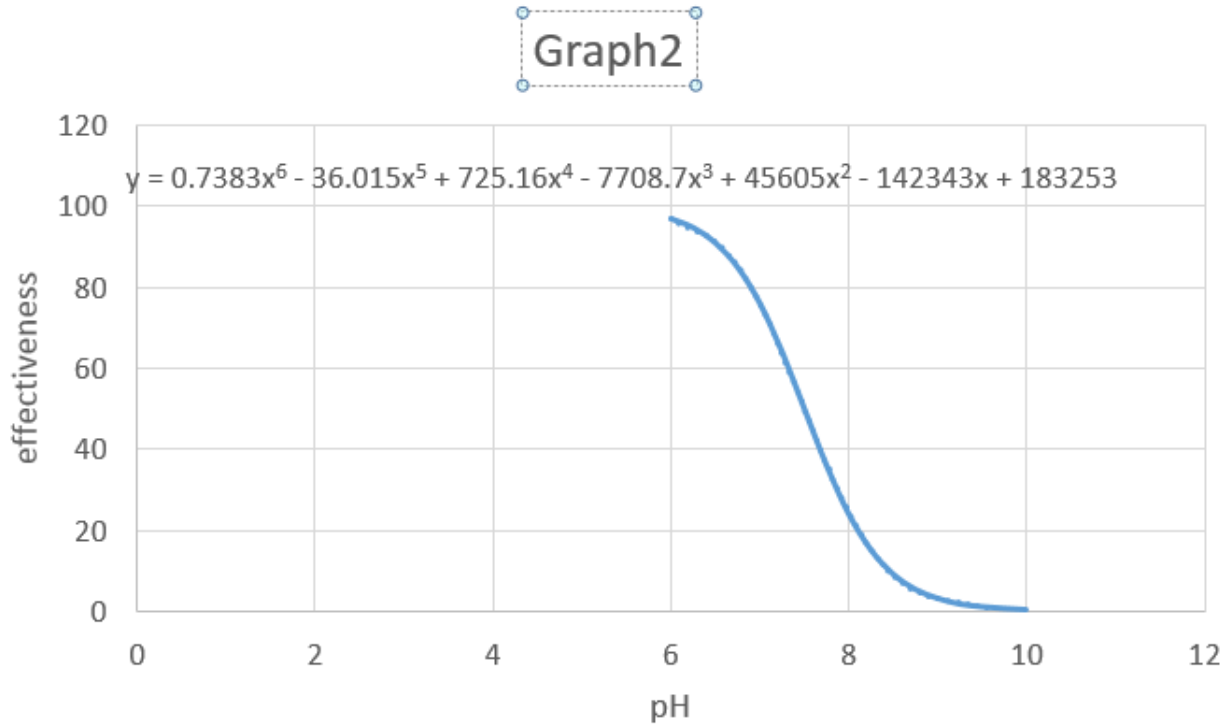
The 5V constant supply is given to the copper wires on one end. The other end of the copper wires are joined to nichrome wire and the connection between the nichrome wire is kept open. The wires are suspended in the solution and the resistance of the solution determines the voltage drop on output. This voltage drop is measured via Arduino. The next steps are as follows:

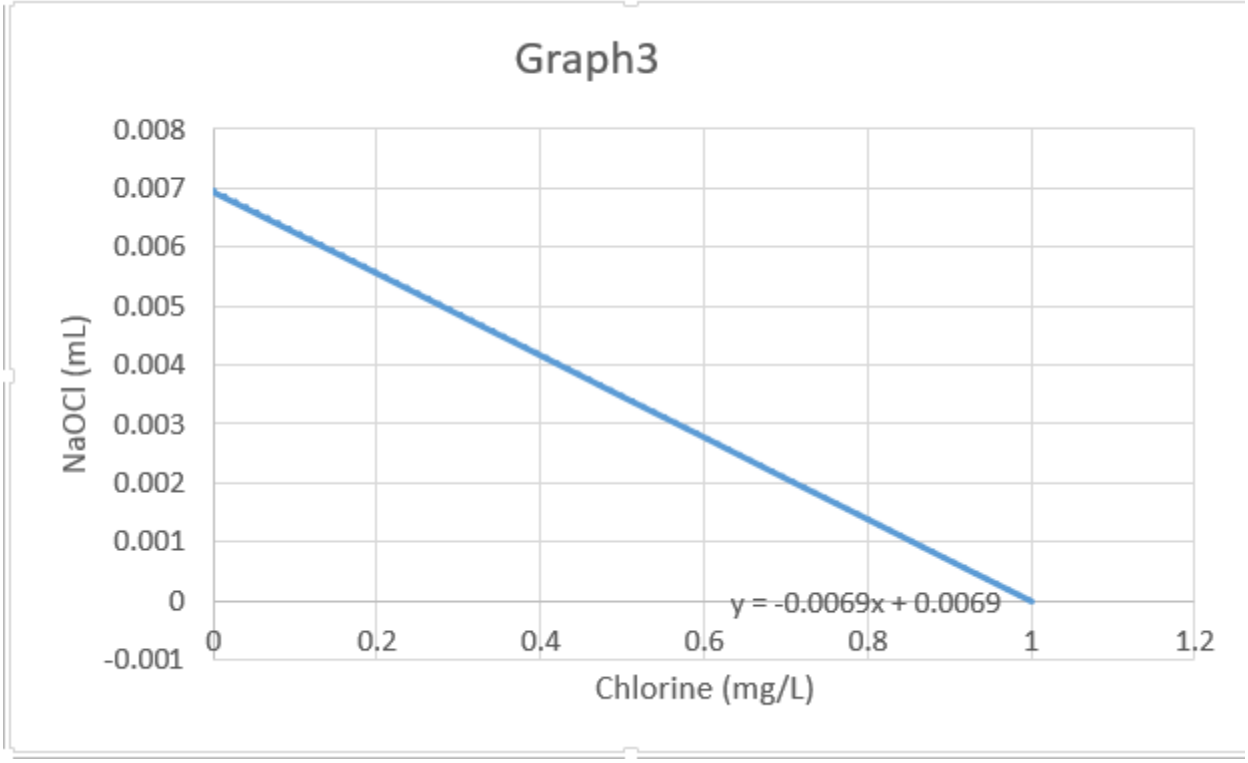


BLOCK DIAGRAM

The following graphs give the formulation for each step in sequence from right bottom to right top.


Graph1
25
20
15
10
5
0
-5
TDS (ml)
y = 2.896x⁴ - 56.573x³ + 415.31x² - 1362.5x + 1691.1
0
1
2
3
4
5
6
Voltage


Graph2
120
100
80
60
40
20
0
effectiveness
y = 0.7383x⁶ - 36.015x⁵ + 725.16x⁴ - 7708.7x³ + 45605x² - 142343x + 183253
0
2
4
6
8
10
12
pH



All the formulation logics are based on experimental readings taken from Chemical Labs. The final output is the time requirement for complete disinfection of the pool on certain amount of chemical input in the pool.

Temperature Sensor:

The sensor used for temperature is DS18B20. It gives a voltage output which is translated by the pH probe adapter and is given input to the Arduino Board. The input determines the temperature value.

Temperature Sensor

Arduino UNO Board

Arduino Board which is being used in our project is a model called UNO. Arduino Board is being used to communicate with the three sensors being used. Three input pins are connected which are taking input regarding the following sensors.

1. pH sensor (probe)
2. temperature sensor
3. conductivity sensor

PH sensor and conductivity sensor provides a level of voltage to the analog pin of the Arduino which is then translated through a specific relation (given by graphs). The temperature sensor is a digital sensor and is being used on a digital pin. The temperature sensor when dipped in a solution provides an accurate value of the solution.

Arduino board also communicates with the STM32 board through nRF transceiver of a frequency range of 2.4GHz. the data being sent is received by another nRF transceiver placed at the STM32 board which in turn transmits data to the cloud using a Wi-Fi module. These latter terms will be explained in the following section.

STM32

The STM32 is a high performance board which provides all the functions of Arduino Uno but is not cost effective. The STM32 in our project uses an nRF transceiver and a Wi-Fi module for communicating with Arduino Uno and the cloud. The STM32 also communicates with an LCD placed right across it displaying the run time values of all the sensors. This provides the user with all the run time details of their pool.

LCD

The LCD displays the values of all the sensors so that the user who is providing the recreational facility can show to his customers and satisfy them accordingly.

Thingspeak Cloud

Thingspeak cloud is a server which provides or allots a space to the user for storing and accessing data wherever and whenever the user wants it to. Thingspeak also provides the user with an ongoing app which displays the stored data on your smart phone. The user can view the history of the parameters of the swimming pool from time to time and analyze the performance of the pool.

Improvement Suggestions

The project works properly but the results of the device output can be made as accurate as possible by calibrating them in the perfect environment of chemicals. The voltage outputs can be made smoother with RC circuits which would help in achieving better values over time. The battery source of the device can be changed to solar battery source which doesn't need recharging from time to time.

References

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