Effective Automation in Chlorination and Water level System

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***Abstract*—On considering increasing water crises and existing method for purification of water by chlorination, led to move towards automation. The volume of water is sensed by the sensor and based on that volume of water, dosage of chlorine is done by the prescription and water pump is turned on/off automatically. The entire system is controlled (on/off) and monitored by Bluetooth controller. The temperature and humidity of bleach solution is significant so it is monitored through IoT (Thingspeak). The volume measurement is shown through a LCD display. This is done by Arduino UNO microcontroller. A Wemos D1 mini, an ethernet board which is use to upload data over internet.**

Keywords—Automation,Chlorination,Arduino, IoT, Thingspeak Wemos D1 Mini

I. INTRODUCTION

Our world is facing excessive water usage either for domestic or commercial purposes and it is a serious issue, which affects the sustainability of our environment. India is one among them. Due its huge population makes it very vulnerable when it comes to water shortage and scarcity. A recent study suggests that by 2040 there will be no drinking water in almost all of India. But we are having the lack of knowledge about saving the water. As water is needed for energy production, transportation and distribution of water. Therefore, energy and water are directly or indirectly related sustainability issues that may not be seen separately. An efficient use of water will contribute to the efficient use of the other resources. For utilization of water we are mostly using river, ponds, lakes, etc. In India we are having the practice of storing the water in overhead tanks. While transmitting the water from source to the tank, there may a chance of getting overflow of water when there is lack of monitoring. Since the overhead tanks are more in numbers, we cannot pay attention to each and everyone through humans. This is in one extreme. On the other hand, conservation of water is more significant. Since stagnant water leads to the many waterborne diseases like cold, malaria, cholera and viral fever. This stagnant water provides the favorable environment for the formation and development of pathogens. In order to eradicate that we are following various water conservation of water like filtration, distillation, chlorination. Out of these chlorination is a cheap and effective method used to treat overhead tank water. But there is a problem arises while handling the chemicals for chlorination. The chemicals include sodium hypochlorite, calcium hypochlorite, chlorine dioxide. Lot of precautions have to be taken while chlorinating the water. On considering the above issues two objectives were framed.

- Automatic pump control based on the low and high level of water in the tank.
- Automatic supply of bleach solution based on the various volume of water in a specified duration.

The existing system of chlorination involves human involvement, where workers have to climb up the tank and they have dose the water by bleach powder. This is a risky job

for them at the same time dosage of bleach inappropriate. Since, the workers are not much literate. Hence automation is required. Development of wireless technologies like IR, Bluetooth, IoT paved the way to ease of control. Hence with the help of Bluetooth the project can be turned on/off. This results in low power consumption and provides better lifetime. An IoT technology is used to monitor the physical properties of bleach solution. Because, nature of the chemical should be same throughout the chlorination process.

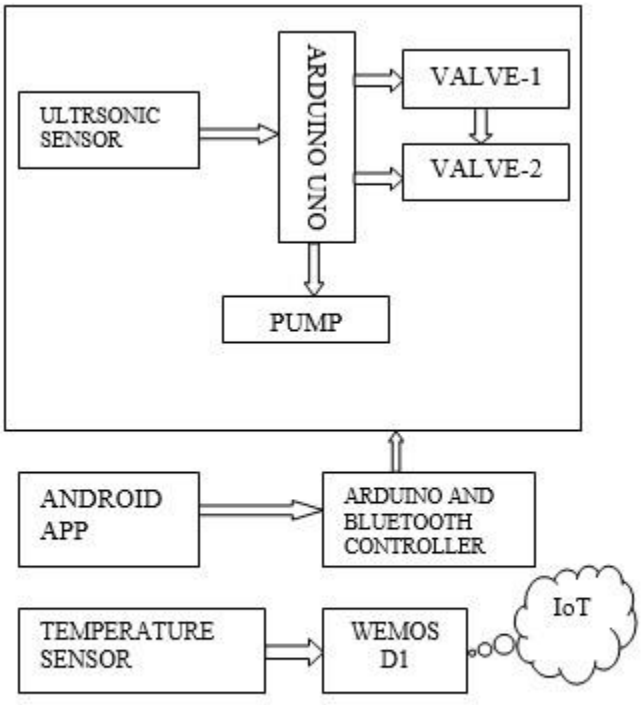

Fig. 1.Block diagram of the entire system

II. .Literature Review

A. *Existing system*

Water chlorination is the process of adding chlorine (Cl_2) or hypochlorite to water. This method is used to kill certain bacteria and other microbes in tap water as chlorine is highly toxic. In particular, chlorination is used to prevent the spread of waterborne diseases such as malaria, cholera and viral fever etc. The existing methodology involves the direct handling of bleach solution and passing the water over chlorine gas. This one is a tedious process. The transmission of water is done only by the human's control over pump.

B. *Chlorinating procedure*

According to the prescription provided from World Chlorine Council it is recommended that for 1000 litres of water 20 ml of sodium hypochlorite has to be added.

C. *Calibrations and Measurements*

The ultrasonic sensor reads only the height not the volume. To find out the volume of the tank we can use the following formulae,

$$V = \pi r^2 h, \quad (1)$$

where,

V - Volume of Cylindrical tank(cm^3)
r - radius of the tank(cm),
h - height of the tank(cm).

$$V = a^3 \quad (2)$$

where,

V - Volume of cubical tank(cm^3)
a - side of the cube(cm)

$$V = l\ b\ h \quad (3)$$

where,
V – Volume of cuboid tank
l – length of the tank
b – berth of the tank
h – height of the tank

Since, volume obtained is in cm^3 it has to be converted into litre. The second one is the calibration of solenoid valve on state. Preliminarily, the solenoid valve is kept open for allowing 20ml of bleach solution. This is done with help of a 20 ml beaker. It is seen that,
volume of bleach solution passed α ON period of solenoid valve

The calibrations are made to fed the data into microcontroller

III. Proposed System

The proposed work involves the automation of chlorination by sensing the volume of water by low cost microcontroller. Using the same controller to on/off the motor which draws water to the tank. Monitoring the volume of water and solenoid valve status via LCD display. Monitoring the temperature and humidity of the sodium hypochlorite(bleach) solution through IoT. Indication of volume of bleach through a buzzer. Controlling (on/off) the overall project kit through a Bluetooth.

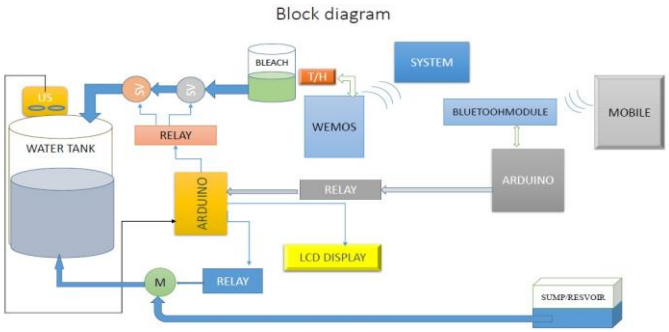

Fig. 2. Practical layout of the system

A. Working

Arduino is connected to two solenoid valves and which is present in between the water tank and bleach solution container. Arduino will turn on the motor when the water is not present inside the water tank. This is done by sensing the low level of water in the tank. After this, water gets raised gradually from bottom to top. When the water reaches 1000 litres first solenoid valve goes to ON state, another solenoid valve will be cascaded with the first solenoid valve. Second valve will be operated for about 10 seconds, this will ensure that 20ml of bleach solution is passed into the water tank. After that second solenoid valve goes to off state. But the first solenoid valve will still be in ON state. This switching operation of solenoid vale-2 will repeated at each 1000 litres of water. Once the tank is completely filled solenoid valve-1 and the motor will be OFF. No further the bleach and water will be added. Both device will be ON only when the water again goes to low level. The overall volume measurement is done through an ultrasonic sensor which is interfaced with the Arduino. When the source of water is absent then, there is no use of chlorination at that scenario. Hence with the help of Bluetooth module & mobile app the project kit can be turned OFF. The level of water such as low, medium and high can be indicated through LCD display. A temperature/humidity sensor is interfaced with Wemos d1 mini, an Ethernet board that will plot graph between temperature and humidity vs time in thingspeak online portal.

B. Hardware tools

1) Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

2) Wemos D1 mini

The Wemos D1 Mini is a small versatile card based on the ESP8266 (ESP-12). It is found for less than €5 direct from china. Very easy to use (programming via USB cable, there are many expansion cards (shields). Relay (250VAC / 10A or 30VDC / 10A), 64×48-pixel OLED display (SSD1306), LiPo battery charger (via micro-USB plug, charging in operation), micro-SD card reader, 7 to 24 VDC power supply, prototyping microplate, double socket, 2 x 15VDC driver, RGB light point based on the WS2812B controller. It is very easy to develop connected objects (IoT) with the Wemos D1 Mini using the Arduino IDE or ESP Easy and integrate them into a home automation software or Node-RED.

3) Ultrasonic sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. It has four pins, they are supply, ground, trigger, echo. Trigger sends the signal and echo receives the signal. We can the sensor data Arduino microcontroller unit.

4) Solenoid valve

A solenoid valve is electronically operated valve The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold. It is operated under 24 V D.C supply. Initially it is in closed state, when given supply it goes to open state.

5) Bluetooth module

A HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04 - External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

6) Relay

A relay is an electrically operated switch. Here we are using 4-channel relay which is used to control Arduino board, two solenoid valves, a motor. It has five pins common, positive terminal, negative terminal and normally open and normally closed.

7) DHT11 Temperature sensor

A DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component and connects to a high- performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

8) LCD Display

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

9) Power supply

A 12V-500mA adapter is used to power Arduino boards. A 24 V d.c supply is used to control two solenoid valves. A 9v battery is used to power the wemos d1 mini board.

10) Indication

The status for the perfect working of valves and motor are indicated through LEDs.

C. Software tools

1) Arduino IDE

The open-source Arduino Software (Integrated Development Environment) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

2) Eclipse

Eclipse is an integrated development environment (IDE) used in computer programming, and is the most widely used Java IDE. This is platform where coding for the Bluetooth controlling app is developed.

3) Thingspeak

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. With a given profile the values of temperature and humidity can be monitored in ThingSpeak portal.

IV. Programming Logic

For 5000 litre capacity tank the following flow graph is constructed.

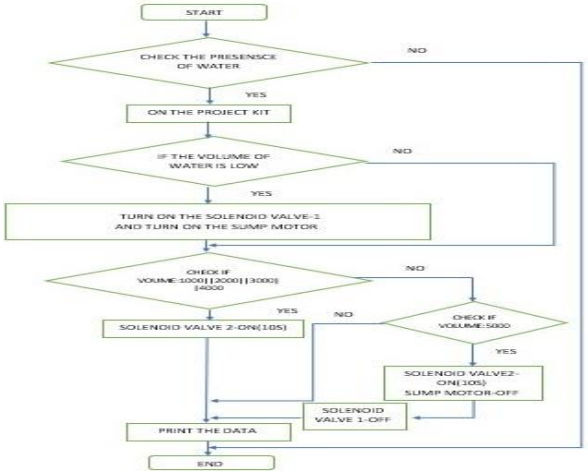

Fig. 3. Logic diagram of the project

V. Result and Discussion

1) Output

The following image shows the overall circuit of the project, that produced a perfect expected output.

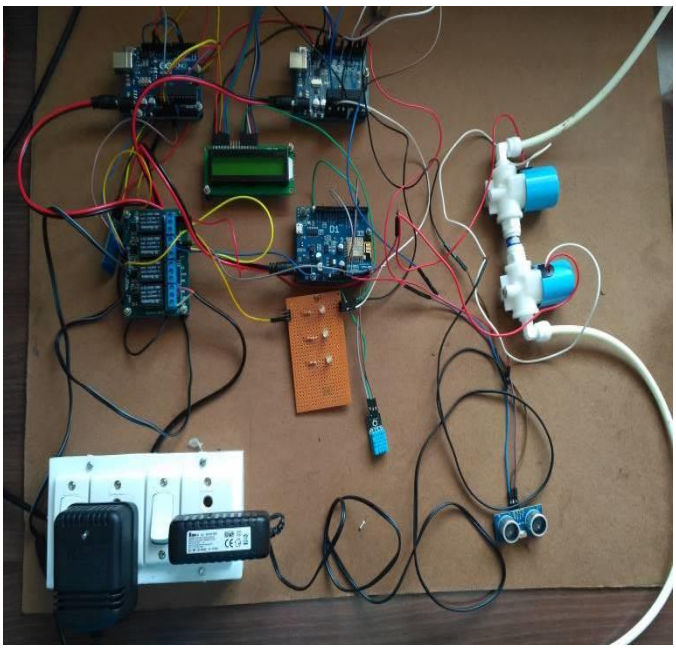

Fig. 3. Prototype of the project kit

The output is tabulated as follows,

VOLUME	PARTICULARS			
	UPSTREAM		*DOWNSTREAM*	
	VALVE-1	VALVE-2	VALVE-1	VALVE-2
1000	ON	ON/OFF	ON	ON/OFF
2000	ON	ON/OFF	OFF	ON/OFF
3000	ON	ON/OFF	OFF	ON/OFF
4000	ON	ON/OFF	OFF	ON/OFF
5000	OFF	ON/OFF	OFF	ON/OFF

VOLUME	PARTICULARS	
	UPSTREAM	*DOWNSTREAM*
	MOTOR	*MOTOR*
1000	ON	ON
2000	ON	OFF
3000	ON	OFF
4000	ON	OFF
5000	OFF	OFF

Table. 1. Tabulation of obtained results

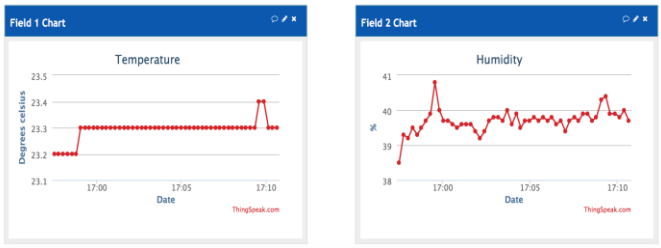

Fig. 4. Graph showing the temperature and humidity of bleach.

The above graph will intimate the properties of the bleach solution through mobile app as well as website.The temperature and humidity of bleach solution with respect to time is obtained perfectly.Thus the objectives of the project is completely achived.

VI. Future Scope

The implementation of this project in India will have a positive impact saving the water. It will create new trend for chlorinating the water by creating the automation. Due to its economical, compatible, upgradable advantages, it can be implemented any means. Since the controllers used for the project are upgradable features we may consider further water quality parameters like pH, turbidity, total dissolved solvents, and we can monitor and bring some minor updates based on those parameters. The future objective is to utilize this project for developing the rural agriculture of India by improving the features of the project.

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