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Development of Water Level Controller with SMS Capability

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Abstract*: Water is considered a valuable resource and covers about 70% of the earth's surface. Tight schedule prevents regular checking of the domestic water tank level while refilling the used ones. This often leads to waste of water and increased monthly revenue payment to power utility company. Consequently, this paper presents a development of water level controller with SMS capability aimed at measuring water level smartly such that when tank is filled, message would be automatically transmitted as an alert to the owner using GSM for immediate response. The method involves interconnection of a water container that serves as tank with another open container serving as Bore-hole and a microcontroller-based device with its integrated development to generate a communication message. A flowchart that shows the procedural steps involved was developed. On completion of the prototype, components and sub-circuits effectiveness as well as experimental testing of the system effective operation were carried out. Some anticipated water level (AWL) were selected at interval of 2 centimeters (cm) starting from 3cm and the corresponding Message Operating water level (MOWL) were obtained with error deviations not greater than 0.17cm. Thus the average AWL, average MOWL and the error deviation are 11cm, 10.7cm and 0.1cm. The prototype device thus operated effectively.*

Keywords: *Microcontroller, Programming Code, Smart Water Level, Ultrasonic Sensor, Water Level Controller.*

1. INTRODUCTION

Smart technology is a new development that needs advanced technology and worldwide appreciation. The development of a water level controller with SMS capability is a typical illustration of a smart technology. Although, it is on record that 70% of the landmass is enthralled by water, yet, a huge failure of water coffers performing to frequent famines has been endured in some parts of the world. The society largely depend on the reserved water contained in tank popularly refers to as upper reservoir tank for daily activities. In recent time, this upper tank is made of Rubber which prevents algae growth and often covered with a cap to avoid dust, mosquito and other infestation. In most cases, water level such upper tank is not known. When an electric pumping machine is switched-on to pump water from bore-hole to upper reservoir tank, most owners or machine operators normally forget to switch-off the machine when the tank is filled-up. As a result of this, large volumes of water will be lost. This becomes a waste particularly in Nigerian environment where water scarcity is rampant both in rural area and urban centres. This scenario call for a need to substitute the pumping approach to a method that would automatically start and shut-off the electric motor when the tank is filled with water to the level desired. At this point, the propose device is expected to send a message to the owner via GSM sms message notifying the user that the tank is filled-up to the desired level. This approach assists to guarantee that the water in upper or storage tank is always available. The device is designed such that controller operate when the water level falls below a specified or preset level and turn-off when the water level get to the upper specified level.

One of the enterprises to palliate this problem is creating a procedure that will reduce the wastage of water in household, agrarian setups, and the industries. Certain hazards similar to the boiler bursts due to unforeseen lowering of the water position can be avoided through the control using this smart system. A GSM communication system is handy and makes the system user-friendly by furnishing a sms announcement to the user on their mobile phones. The GSM device is used to control the liquid position by giving sms alert of the chance of liquid filled into the desired level. An Arduino is a microcontroller that is programmed in any of these programmable languages i.e., C, C++, etc [1]. The Arduino is used in commanding other sub-circuits such as ultrasonic detector, GSM module, and other circuits.

Preethi *et al.* [2] measures water position with the help of ultrasonic sensor. It uses an automated, turning motor on/ off with the help of a relay which helps in controlling the redundant water inflow from overhead tanks and the water level is finally shown on LCD. Eltaieb and Min [3] carried out a computerized enhancement design of water level monitoring system which uncovers an efficient way of software application and tackling hardware that blends for the purpose of

interfacing. The device additionally makes use of advanced technology to descry the position of the water. The motor is controlled by Arduino and a relay. Different cables are connected at different junctions of the bucket used in this paper. When water is poured into the bucket, the cables come in contact with the water body and tell the position of the water in the bucket. Consequently, they present the position of water on the GSM and the relay is used to switch on and off the motor.

Smart technology is on the increase in usage. This advance technology reduces cost, user's interference, and time saving. Conventional method makes water tank overflow when water top cannot be controlled. Thus, during water pumping, it is frequently required that the tank owners put a stop to other activities until the water in the tank is full. This difficulty can be excluded by introducing a system that sense and present the water position so that the motor can be turned off at the applicable set duration so that electricity consumption is minimized; time is not un-necessarily wasted as well as achieving water wastage control. As a result, mechanized water position index and regulator using Arduino can be used on a massive scale base where manpower demand and the installation process are made easier [4].

Priya and Chekuri [5] proffer a simple water monitoring system with indicated different situations. Internet of thing (IoT) has potentially added a new dimension that enables smarter object communication (SOC).The paper signifies when the water position is above or below the demand stated. System design and armature are considerably bandied such that the system is cost-effective and simple in strategy to cover the water position system.

In Das *et al.*[6], a design and enhancement of mechanized water inflow cadence is presented. This research emphasized the need for a water level monitor in agrarian irrigation. This paper says that each crop needs a different quantum of water and this can be achieved by using an automated water position regulator which will as well help in reduction of wastage of water. This approach was a device to calculate the inflow rate of water available in the irrigation channel. This device makes use of Hall Effect sensor to measure the charge of inflow. G1/ 2 Hall Effect water inflow detectors were used as unit with an internally connected turbine rotor whose gyration velocity adjusted the difference in rate of inflow of water.

However, for authors that used electrode insertion in water body as part of their designs have the same limitation; i.e., the electrode is made of conductors and normally when the conductor stays long in the water body it causes corrosion and this leads to the impurity of the water which could cause the spread of diseases. Consequently, this paper presents a development of water level controller with SMS capability that exclude the use of electrodes by using the ultrasonic sensor to descry the position of the water and the GSM module to shoot communication and admit commands from the users to reduce the mortal intervention and water wastage. It also presents a more comprehensive algorithms and well packaged programing code that give a more accurate result. Furthermore, a result oriented experimental is setup to validate the research work.

2. MATERIAL AND METHOD

There are numerous styles used in the design of water level control using switching devices. It is interesting to know that the styles go along with user's interventions. In this design, a smart water level controller is designed using electronic control to refill the water without the user's intervention.

2.1 Description of Major Circuit Component

2.1.1 Semiconductor Diodes

A Diode is an electronics component that allows the flow of current in a direction due to resistivity variation at both ends. In a diode, current moves from the anode to the cathode (asymmetric conductance) and it does not move in the other way. In many of its applications, diodes are used in rectification for converting alternating current (ac) to direct current (dc), extracting modulation from radio signals in radio receivers, and as temperature sensors [7, 11]. Light – emitting diodes is the commonest type and used for status indication in electronic systems.

Furthermore, diodes exhibit more complicated action than the ON and Off actions due to their non-linear current and voltage characteristics [12, 13]. The diode current/voltage characteristic is controllable during manufacturing of these products through selection of correct semiconductor materials. The aforementioned methods are often used in creating certain category of diodes which are capable of performing different functions. Such special purpose diodes include Zener diodes for voltage regulation, avalanche diodes for protecting circuits against high voltage surges, varactor diodes for tunning, gun diodes and Impatt diodes. The lastly mentioned three diodes are used for radio-frequency oscillation. Thus, diodes current/voltage curve is modeled by the following non – linear Equations [7]:

$$I = Io\ (e^{\frac{qV}{kT}} - 1) \quad (1)$$

Where

k = Boltzmann's constant in Joules/Kelvin
I = Diode net current flowing.
V = Terminal voltage of the diode
I_0 = Saturation Current (usually 10^{-12}A for silicon diodes)
q = Electron charges in coulombs.
T = temperature measure from absolute zero in Kelvin

And the thermal Voltage of the diode is expressed as [7];

[[[Thermal Voltage = kT/q (2)
At 27^0C, T = 27 + 273 = 300 K,
Therefore, terminal Voltage = 26Mv

Ideal diode equations:

As earlier discussed, the diode current and voltage characteristic (*i-v* characteristic) in diode is [7]

$$i(v) = I_S \left[e^{(\frac{v}{\eta})(VT)} - 1 \right] \qquad v \rangle V_Z \qquad (3)$$

where,

I_S = the reverse saturation current
V = the applied voltage
$V_T = \frac{T}{11{,}586}$ i.e., expressing voltage in terms of temperature
η = Emission coefficient
V_Z = The negative value of v on diode ideal curve
i = Flowing current from *p* to *n*

Therefore, when diode is in breakdown condition during which the diode equation does not apply, then V≤ Vz. Also, at the same voltage condition but with i = − ∞, ideal diode characteristic (i- v curve) is achieved. Meanwhile, the three commonly used diodes in practice are light emitting diode (LED), power diode and Zener diodes (ZD).

2.1.2 Diode bridge rectifier

Diode Bridge is a connection of four to six diodes which is often used in rectification of ac to pulsating dc voltage. For a full wave rectifier, it converts both halves of each waveform cycle into pulsating dc signal. This output current or voltage is purely dc or contains certain dc component. The merits derived in using full wave rectifier when compared to using half wave rectifier (HWR) technique. This includes [7 – 13];

1. Higher output voltage is achieved in full wave rectification than in half wave rectification.
2. The ripples contained in the output is less in full wave rectification than in half wave rectification, implying better production of a smooth output waveforms.

In a typical FWR circuit, four diodes are generally used with two diodes used on each half of the cycle. A typical full wave rectifier (FWR) circuit is shown in Figure 1.

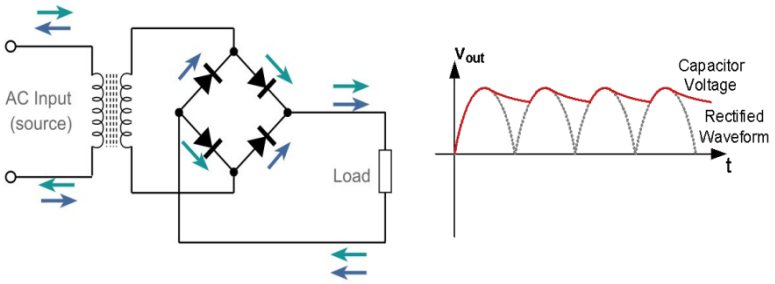

Figure 1: Circuit diagram of a bridge rectifier [14]

Full wave rectifier circuit (FWRC) with capacitor included in Figure1 above produces an output that is half cycle but such circuit couldn't give steady dc supply. Thus, full-wave bridge rectifier (FWBR) presents the dc value of 0.637 Vmax. This output frequency is twice the input frequency. Therefore, there is a general improvement in dc output and while the capacitors filter the output waveform. The capacitor is often connected in parallel with the load and because it is a storage device it increases the output. Limitations often encountered in FWRC includes; for a particular output required, a bigger transformer with secondary windings center – tapped is required and thus making the system very costly than FWBR circuit equivalent.

Bridge Rectifier Ripple Voltage: The ripples equation of a FWBR circuit is shown in equation (4) [15 - 17]

$$\boldsymbol{V}(ripple) = \frac{Idc}{2fC} \qquad (4)$$

Where,

I_{dc} = Load current (A).
f = Ripple frequency (Hz).
C = Capacitance (F).

The merit of a FWBR includes;

1. Have a small AC ripple value for a given load.
2. Often use a small smoothing capacitor in comparison with an equivalent HWR rectifier.

This implies that the fundamental frequency of ac supply voltage is (50 Hz) is half of the frequency of the ripple voltage (100 Hz). That is, for the HWR, it is exactly equal to the supply frequency (50Hz).

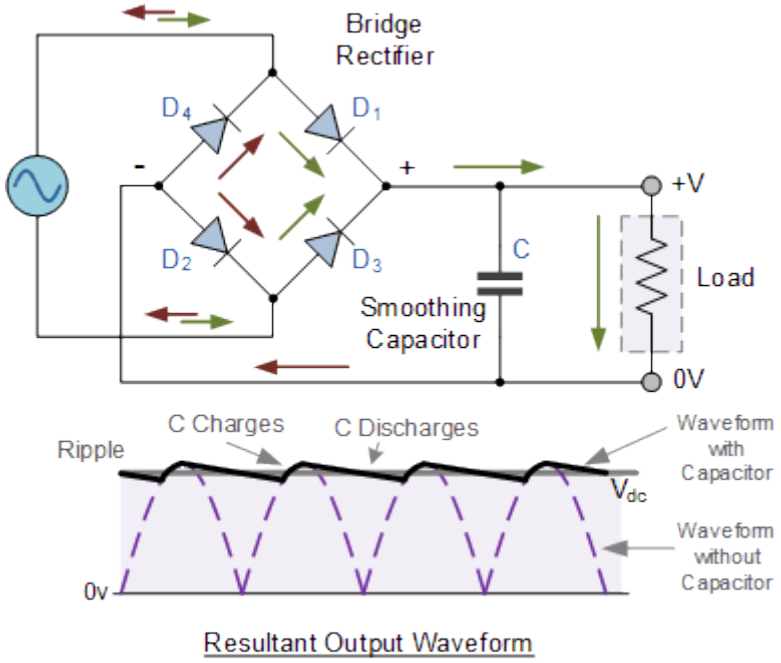

Figure 2: Full -wave rectifier with Capacitor [14]

2.1.3 Voltage regulator

Voltage regulator also described as a "controller" is used for regulating and control of voltage. It has just three pins and seems like a simple device but it is indeed a certifiably complicated circuitry or IC. It is used to converts changing input voltages to produces a more stable "regulated" output voltage. Voltage controllers are accessible in different ranges of output. The two last integers in the name denote the output voltages as shown in Table 1 [15].

Table 1 Voltage Regulator Output Voltages

NAME	VOLTAGE
LM7805	+5V
LM7809	+9V
LM7812	+12V
LM7905	-5V
LM7909	-9V
LM7912	-12V

2.1.4 Capacitor

A capacitor is an electronics component that comprises of two terminals which are separated by a distance occupied by dielectric or vacuum. It stores energy by holding apart pairs of opposite charges. Capacitors are manufactured in different forms. Applying a potential across the capacitor makes one of the plate positive with respect to second plate. Current flows through the capacitor from its positive to negative terminal. The field between the terminal plates is depending on the charges provided to the conducting terminals. Thus, Equation (5) relates that the potential difference (V) varies directly with the electric field [14].

$$C = \frac{Q}{C} = \frac{dQ}{dV} \quad (5)$$

where,

C = Capacitance
Q = Electric Charge
$\frac{dQ}{dV}$ = Incremental changes define as the capacitance [9].

While, the stored energy (E) in Capacitor is defined as [14]

$$E = \frac{1}{2} CV^2 = \frac{1}{2}\frac{\varepsilon A}{d} \quad (6)$$

d = Separation distance between the plates

A = Cross-sectional area of the capacitor plates

The charging and discharging of capacitor follow the equations expressed in (7a) and (7b) respectively.

$$V_C = V_S * (1 - e^{-(t/RC)}) \quad (7a)$$

$$V_C = V_S * (e^{-(t/RC)}) \quad (7b)$$

where

V_C = Capacitor terminal voltage

t = Time

CR = Time constant

V_S = Source Voltage

2.1.5 Relays

The relays are frequently used to control the pump. There are three layouts of a relay, namely; Common Connection (COM), Typically Closed Connection (NC), and Typically Open Connection (NO) [10]. In this paper, NO configuration was selected and used because of its function as a switch. Also, since this configuration is open, implying no connection for NO and COM. However, activating relay module, it connects COM via electromagnet within relay. Therefore, electricity is supplied to the load which will in turns switch the alarm OFF [16, 17].

2.2 Methodology

In this research, an ultrasonic sensor, Arduino, and GSM module were used for controlling and watching water level in an overhead tank will be employed. Smart water level controller using SMS module will use GSM to transmit current water level position in overhead reservoir from 0 – 100 percent the proprietor's mobile. The research uses the ultrasonic sensor in determining the exact water position present in overhead reservoir and sends the exact water level in tank using probability of 0 – 100 percent by just transmitting an SMS alert to the user's phone incontinently. Arduino is used as the brain box of this research; ultrasonic sensor replaces the old strategy of electrode insertion into water due to its capability to quantify the water level using water echo and send exact values without any physical contact with the water body. Figure 2 summarized the subsections involved in carrying out the research.

2.2.1 Microcontroller (Arduino Uno)

Arduino Uno was used as controller of the system. Connection is established between the Tx and Rx of the GSM board and that of the Arduino board as well, and the establishment of connection between the two modules. Echo pin and Trigger pin of ultrasonic sensor are connected to pin 3 and 2 of Arduino respectively. The diagram Arduino Uno showing the pins is shown in Figure 3 while the descriptions of the configured pins are show on Table 2.

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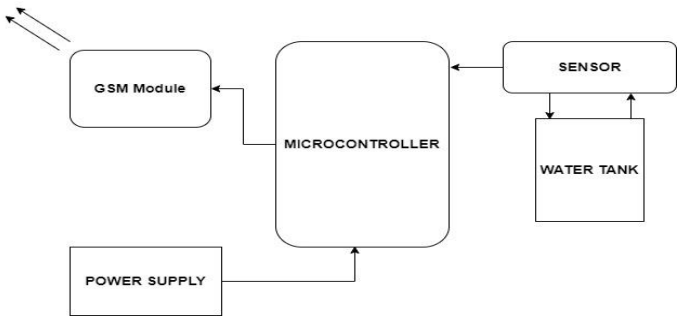

Figure 3: Block Representation of water level controller with SMS capability

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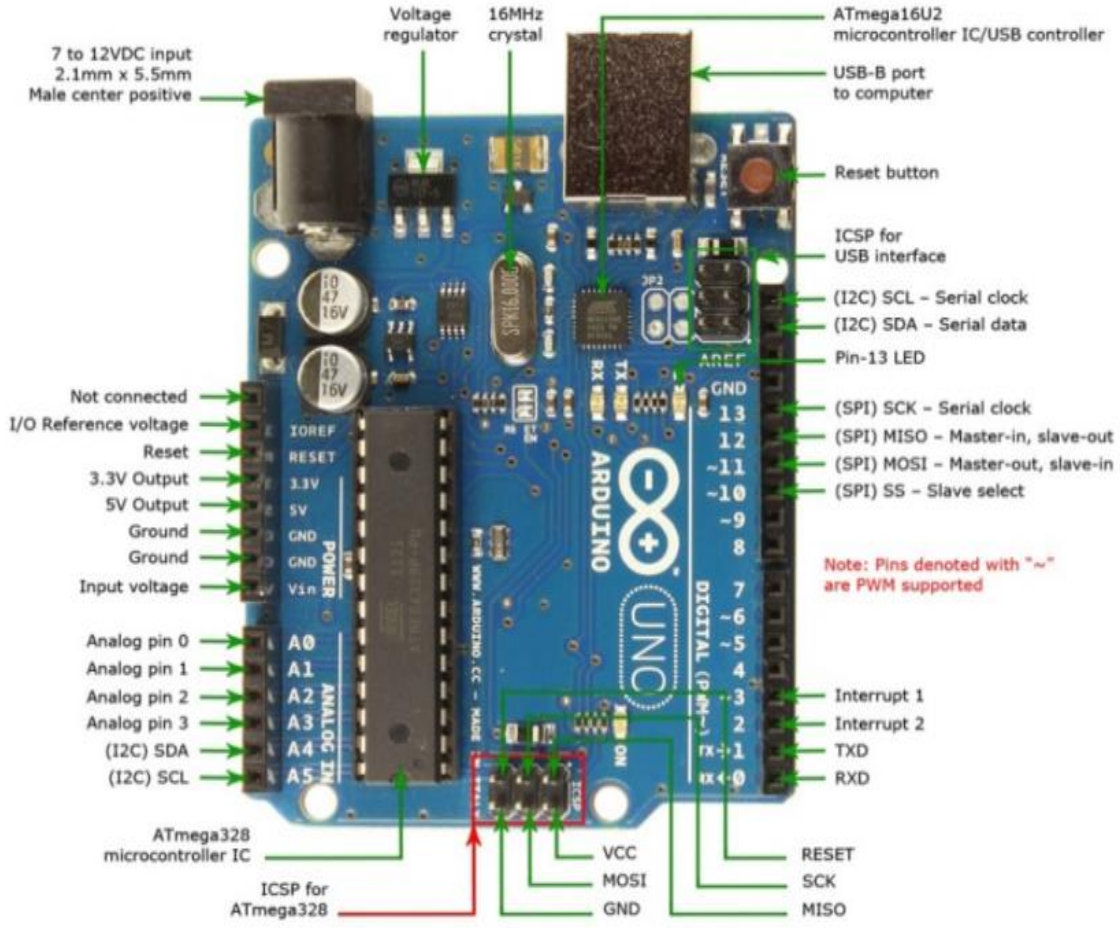

Figure 2: Diagram of Arduino UNO [4]

Table 2**:** Arduino Uno configuration pins

Section	**Pin description**	**Pin Usage**
Power Supply	Vin	Arduino input voltage with usage of external power source.
	5V	Voltage regulator for perfection of input voltage to equipment like microcontroller and other 5V rated components.
	3.3V	Voltage regulator for other on-board components. Permissible current draw is 50mA.
	Pin designated GND	This is a ground pin connection,
Reset	Pin designated reset	Resetting Microcontroller
Analog pins	Pin designated $A_0 – A_5$	Provides analog input between 0 - 5v
Input/output pins	Pin designated digital Pins 0 – 13	These pins are used either as input or output.
Serial	Rx tagged 0, Tx tagged 1	Used in receiving and transmission of TTL serial data
External interrupter	Pin 2 and 3	Used in triggering an interrupt
PWM	Pin 3, 5, 6, 9 and 11	They are used for provision of 8-bit PWM output
SPI	Pin 10, 11, 12 and 13	Used for SPI communications
LED	Pin 13	Used to turn ON the in-built LED
TWI	Pin A4 and A5	Applied for TWI communications
AREF	Pin AREF	Provides reference voltage as input.

2.2.3 Sensor circuit

HC- SR04 Ultrasonic sensor senses water position in the reservoir. Vastly sensitive ultrasonic sensor is powered by the operating voltage of the output pin of Arduino Uno. The ultrasonic sensor generates exact, non-contact interval measures of about 0.8 to 120 inches. Ultrasonic sensor transmits low spurts of sound and listening to this sound to echo off. Therefore, the frequency of this sound is altitudinous for human-beings to catch (i.e., it is ultrasonic). An ultrasonic sensor measures the duration of flight of the sound burst. A user also computation of the distance to an object exploits this flight duration and as well as the speed of sound (ft./s). Ultrasonic sound is of a high pitch which is difficult for human being to hear. This particular detector transmits ultrasonic sound with frequency of around 40 kHz [10]. The sensor also uses ultrasonic sound to measure distance. The HC- SR04 ultrasonic sensors have four pins and these pins 'configurations are epitomized as follows.

i. Pin 1 (Vcc): Makes available a 5V supply to the sensor.
ii. Pin 2: Input pin that transmit ultrasonic waves via keeping the pin high for 10us.
iii. Pin 3: Output pin that goes high for some time and substitutive to time duration which waves take to return to sensor.
iv. Pin 4: Pin through which connection to ground (GND) is made.

2.2.4 GSM module (SIM900)

GSM Module (SIM900) is considered the most available and very cheap among modules for GSM/GPRS communication. It is often used with Arduino and microcontrollers in most of the enrooted operations. The use of a mobile sim for communication is provided by the GSM/GPRS technology. It involves the use of 900 and 1800 MHz frequency bands which allow users to admit/ transmit calls and SMS. The display interface, keypad, modes, command mode (CM) and data mode provide opportunity for the inventors to perform the customize operation. However, each country's GPRS/GSM has different frequencies/protocols to operate. CM assist inventors in modifying the dereliction settings based on their essentiality. GSM for wireless communication constantly uses periodical communication to interface with the microcontroller system and needs AT commands for its operation. These commands are transmitted by the microcontroller. This module requires a SIM card just like mobile phones and likewise has an IMEI number analogous to a mobile phone [10]. The arrangement is made on printed circuit board (PCB) as illustrated in Figure 4.
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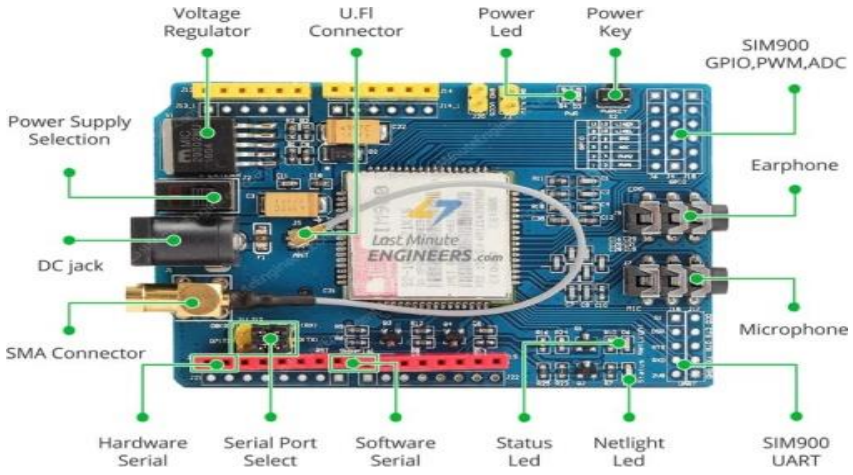

Figure 3: Illustration of GSM module components [1]

2.2.5 Power supply unit

A 220/12V transformer found its application in stepping down the ac input voltage 220V to 12V, diodes were used in full wave rectification of the stepped down 12V ac, capacitor was used for filtering the AC ripples and 7809 regulator was used to further regulate and stabilize the output voltage to 9V DC supply. Block diagram of this arrangement can be seen in Figure 5 while the power supply subsection circuit is show in Figure 6.

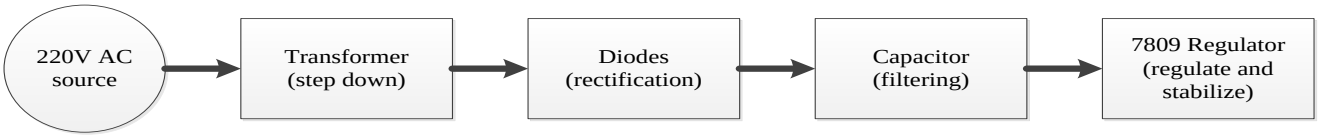

Figure 5: Block diagram of power supply

2.3 Algorithm

1. Begin
2. Carryout design of sectional unit of the expected prototype device.
3. Construction of the device prototype
4. Confirm the correctness of the device construction by testing for open and short circuit in all subsections of the circuit. If all is well then
5. Transfer the construction to printed circuit board.
6. Upload the micro-controller (Arduino) code
7. Carryout the device system test to ensure that
   i) Ultrasonic sensor senses water in overhead tank
   ii) Microcontroller calculates the percentage of water inside the tank to check if the level of water is low or high.
   iii) If water level in the tank goes down then micro-controller proceed on instruction to start the motor. Appropriate message displayed.
   iv) If the water level is at adequate level, then micro-controller turns off the motor automatically. Appropriate message displayed.
   v) If 7(i) to 7(iv) is not satisfied then GO TO Step 8
8. Check error and go back to step 3
9. Couple the device
10. End

This algorithm is summarily presented in the flowchart displayed in Figure 6

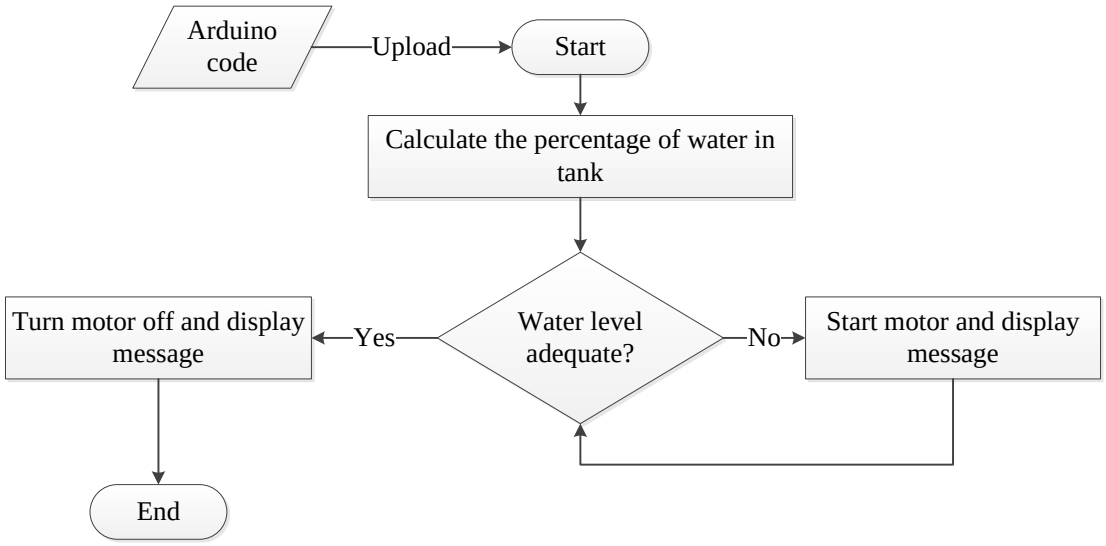

Figure 6: Flowchart of smart water level controller using SMS module

2.4 Interconnection of Device Sub-circuits

Conceptual design of the project is designed to know how the circuit will look like and how each component used will function to the best of their capacity. The design gives an overview of the roles of the major block, how they are integrated, and the information flow arrangement. After the design has been made, the construction of the circuit begins; the microcontroller used is established on the circuit design with minor hardware connection and flexibility. The other component such as the GSM module, ultrasonic sensor and a power supply pack were used for the construction of the hardware part. The set-up of power supply pack or circuit is shown in Figure 7

The hardware part construction includes the connection of ultrasonic sensor, GSM module, establishing the ground connection between the boards, writing a 'programming code' in line with expected functionality of the system, the uploading of the Arduino code by downloading the Arduino environment, connecting the USB to the board and finally testing the code to see if it run accordingly without any mistake or code error.

In case of no error in the uploading of the code and hardware connection part, then the project can be coupled. Thus, Figure 8 shows the implementation diagram of the entire device system in question.

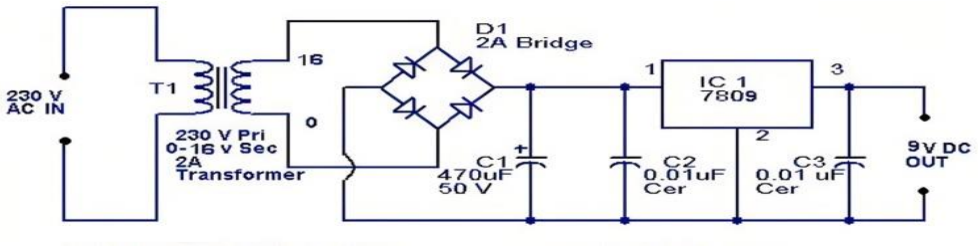

Figure 7**:** Diagram of Power Supply Circuit

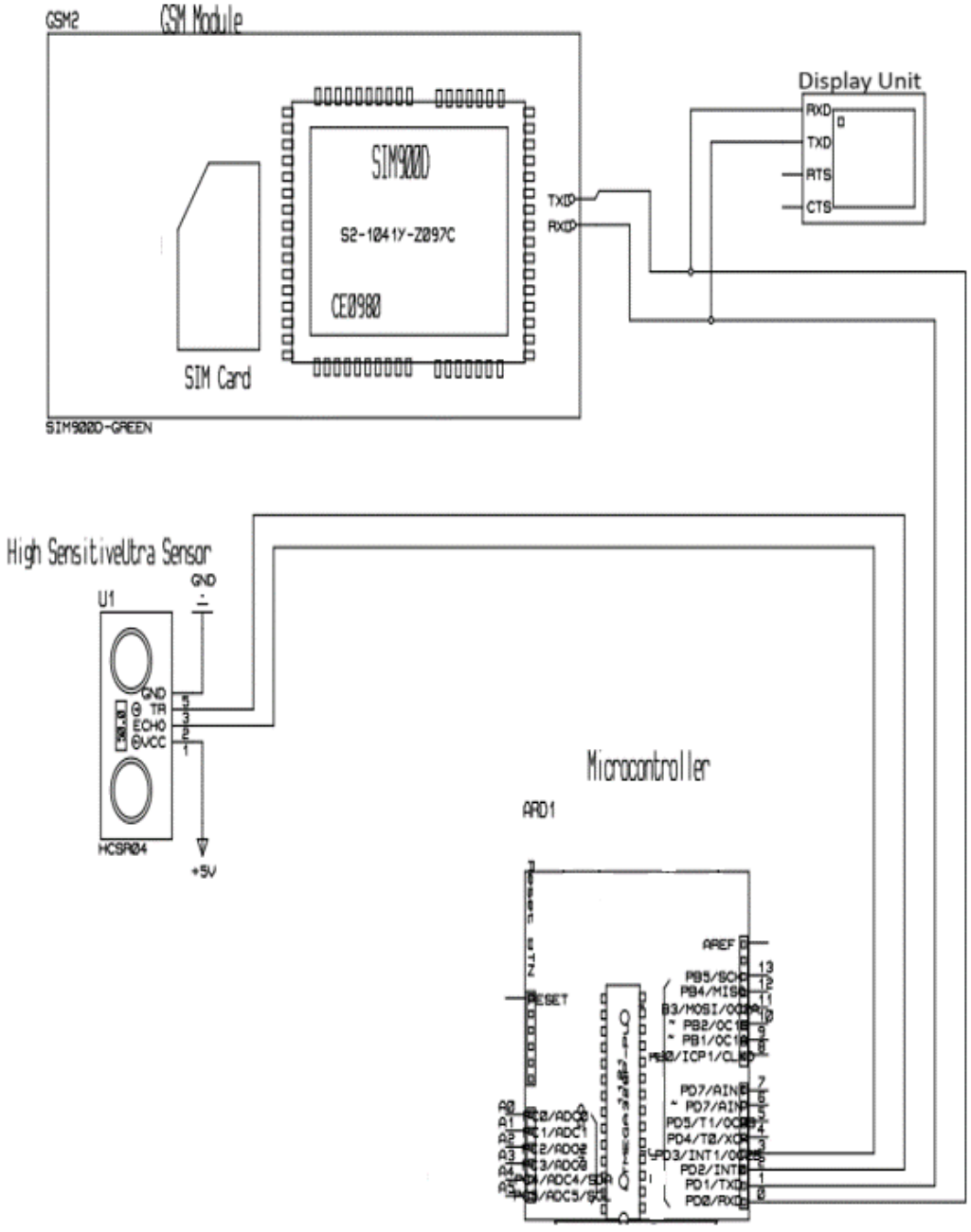

Figure 8: Circuit diagram of the water level controller with SMS capability

2.5 Experimental setup for Water Level Measurement

An experiment is performed to obtain the real water level measurements using the device prototype setup shown in Figure 9. In this approach, the system block diagram in Figure 2 is modified by connecting a laptop or personal computer (PC) to Micro-controller. The system is operated at different values of set anticipated (desired) water level during in order to measure the efficacy of the developed device. A calibrated overhead tank in centimeter was used as upper water reservoir. Selected as anticipated (desired) water level on the overhead tank ranged from 3 to 20 cm in step of 2. At each trial, the reading scale at which the message is released on thank being full is recorded. This is termed message operating water level. Thus, the difference between these two readings gives the percentage accuracy of the prototype device. The lower the error difference the more accurate the device is. The experimental result is shown on Table 3.

Figure 9: Image of the sections of the system (constructed device, water tank and bore-hole representation)

3. RESULTS AND DISCUSSION

Testing and integration are done to make sure that the design is performing duly as anticipated there by allowing one or truly aimed users for which the design was targeted for, treasure its performance and inversely approaches exploited in the design and integration of several modules of the construction. Nonetheless, this involves checking to make certain that all the various units and subsystem work appropriately, also there has to be quality interface existing between the output and input unit subsystems. All the components/modules were connected together, and a device was created. All component and section performed as defined in the design. Tests such as component test, transformer test, ultrasonic sensor test, GSM module test and live test were carried out. Component like resistor, capacitor, LED, regulator, diode, relay used in the project are tested. The result of the testing is provided in Table 3.

Table 3**:** Experimental Results of water level Measurements

S/N	Anticipated Water Level A (cm)	Message Operating Water Level B (cm) (cm)	Error A – B = C
1.	3	2.94	0.06
2.	5	4.88	0.12
3.	7	6.89	0.11
4.	9	8.93	0.07
5.	11	10.91	0.09
6.	13	12.85	0.15
7.	15	14.86	0.14
8.	17	16.94	0.06
9	19	18.83	0.17

Average Anticipated water level (AAWL) = 11 cm
Average message operating water level (AMOWL) = 10.9cm

Average Error = AAWL - AMOWL = 0.1 cm
Percentage Water Level Accuracy = 10.9/11 = 99.1 %
The circuit components were tested using standard electrical equipment and while continuity test was carried out with the help of a digital multi-meter. All components tested OK as presented in Table 4.

Table 4: Results of tested components used

S/N	Components	Test performed	Status
1.	Resistor	Continuity test and resistance test	Okay
2.	Diode	Continuity test and voltage drop test	Okay
3.	Capacitor	Charging and Discharging test	Okay
4.	Regulator (LM7809)	Continuity test	Okay
5.	Relay		Okay
6.	LED		Okay
7.	Arduino	Pins testing	Okay

The rating of the transformer as expected was 220V/12V, 1000mA. From the AC mains power supply, the primary windings receive 220V input; and the output was scaled to be 16.75 using the formulas stated above. Test data on transformer has it that the resistances of the primary windings for step down transformer is greater than that of the secondary side these were established.

When performing an ultrasonic test, recall that the ultrasonic sensor has 4 pins. There is a ground connection established between Arduino and sensor, the GND and VCC pins of the sensor are connected to the GND of Arduino. Echo and Trigger pins of the sensor are connected to the Pin 3 and 2 of the Arduino. When the trigger pin of the sensor is applied, an ultrasound wave was transmitted from the transmitter through the echo pin, the reflected signal was observed. After all tests are performed, the sensor was deemed okay to be used.

For the GSM module test, the module was tested for proper SMS functionality, this is done by uploading the test code to Arduino. After the code has been uploaded, an SMS was sent to the mobile indicating that the GSM modem is working fine. During the test mistake such as incorrect TX/RX/GND connection was avoided and the Tx and Rx of the GSM was removed before the upload of the code to avoid error.

On completion of the prototype, live test which involves electrical power supply and Gasoline generator were used to power the device at different time. Each time this is done, the device sent a message through the GSM module to the mobile phone indicating that the system is ready to receive command as it is shown in Figure 10. The ultrasonic sensor calculates the percentage of water inside the overhead tank to check if water level is low or high. Figure 10 and Figure 12 shows the message displayed when the circuit was low and it was high and the command given to the relay (either to turn on the motor which is the pump or turn off the pump), the message displayed was sent to the mobile phone through the GSM module as shown in Figure 13. However, after draining some amount of water from the overhead tank, a message is sent to the device to check for the percentage of water left in overhead tank and the ultrasonic sensor calculates the water level remained in the overhead tank and sends such message to the designated mobile phone via the GSM module displayed in Figure 12. After all the tests have been done, it's evident that the device performed according to the given command and to satisfaction. The behavior of the components and the behavior of the device were observed and noted ok.
The significance of this study can be summarily itemized as follows:

i. The generated prototype device is works automatically.
ii. With this developed system, wasting of domestic, commercial and industrial could be minimized.
iii. Cost of unit production is relatively cheaper since discrete components and integrated Circuit (IC) are involved.
iv. Electronics components and ICs are protected from damage due to overheating because the system operates within the specified task given.
v. Since the system operates automatically, implies human or user's interaction is completely removed.

4. CONCLUSION

An average living being on planet earth survival depends on water as it is one of the most treasured resources on earth. Sadly, a substantial amount of water is wasted because of an unrestrained usage and deliberate wastages by children. Although, certain methods of controlling and monitoring water level have been recommended, yet, these methods still have one or two disadvantages. Efforts were made to overcome these disadvantages and to apply an efficient system. This paper has put in place a system that can solve the water wasting problem and provide a hygienic environment for all water users. The paper also implements a user-friendly system which has now been achieved.

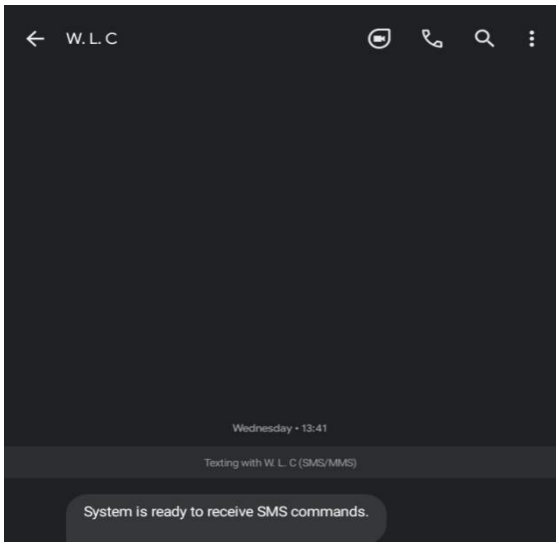

Figure 10: Diagram of the command received when powered up

Figure 11: Displayed image of when the tank is low

Figure 12: Displayed image of when the tank is high

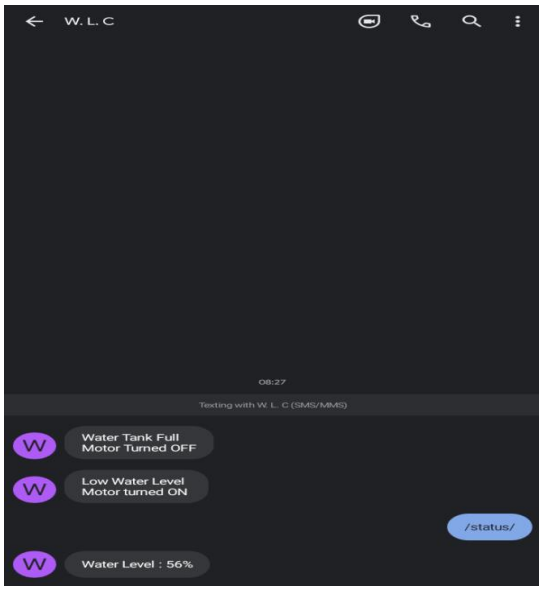

Figure 13: Diagram of the message received at each command

REFERENCES

[1] Pudasaini, S., Pathak, A., Dhakal, S. & Paudel, M. (2014). Automatic water level controller with short messaging service (SMS) notification. *International Journal of Scientific and Research Publications*, 4(9), 1-4.

[2] Preethi, D., Anusha, J., Sravani, M.V., Puviarasi, R. & Bala, M. S. (2015). Automatic water level controller, *Int. J. Appl. Eng. Res.*, 10(33), 26581–26587.

[3] Eltaieb, A.A. M. & Min, Z. J. (2015). Automatic Water Level Control System. *Int. J. Sci. Res*, 4(12), 1505-1509.

[4] Pooja, K., Kusumavathi, M., Pavithra, M., Nishmitha, M. & Shetty A. D. (2020). Automatic Water Level Indicator and Controller Using Arduino. *International Research Journal of Engineering and Technology (IRJET),* 7(5), 5342-5346

[5] Priya, J. & Chekuri, S. (2017). Water level monitoring system using IoT. *International Research Journal of Engineering and Technology (IRJET)*, 4(12), 1813–1817.

[6] Das, S., Dhar S., Deb, P. B. & Mujamdar, P. S. (2017). Microcontroller Based Water Level Indicator and Controller. *Asian J. Appl. Sci. Tech*., 1(5), 181-187.

[7] Ajao, L. A., Abisoye, B. O., Agajo, J., Ajao, A. O., Muazu, M. B. & Salami, A. F. (2019). Automated Multiple Water Tanks Control System Using Atmega and Fpga Technology. *IEEE Mac 2019*, 347-353.

[8] Big-alabo, A. & Isaac, C. (2020). Automatic Water Level Control System Using Discretized Components. *Journal of Applied Sciences and Environmental Management*, 24(10), 1781-1785.
[9] Asha, T. & Srija, V. (2020). Design and Implementation of Wireless Based Water Level Monitoring Using Arduino and Bluetooth. *International Research Journal of Engineering and Technology (IRJET)*, 7(1), 745-749.
[10] Barbade, G. M., Shreyas, C., Vedant, S., Vaibhav N. & Umesh, P. (2021). Automatic Water Tank Filling System with Water Level Indicator. *Indian Journal of Microprocessors and Microcontroller (IJMM)*, 1(2), 1-7.
[11] Getu, B. N. & Attia, H. A. (2016). Automatic water level sensor and controller system. *In 2016 5th International Conference on Electronic Devices, Systems and Applications (ICEDSA), IEEE*, 1-4.
[12] Das, S., Dhar, S., Deb, P. B. & Mujamdar, P. S. (2017). Microcontroller Based Water Level Indicator and Controller. Asian Journal of Applied Science and Technology (AJAST), 1(5), 181-187.
[13] Shrenika, R. M., Chikmath, S. S., Kumar, A. R., Divyashree, Y. V. & Swamy, R. K. (2017). Non-contact water level monitoring system implemented using lab view and Arduino. *In 2017 international conference on recent advances in electronics and communication technology (ICRAECT) IEEE*, 306-309.
[14] Bird, J. (2003). Electrical Circuit Theory and Technology, 2nd Edition, Routledge. Access online on 16th December, 2023 at https://doi.org/10.4324/9780080505169.
[15] Neverova, V. P. & Semanov, B. A. (1981). Voltage Regulator. *Instrum. Exp. Tech.*, 24(6), 1478 - 1484.
[16] Shankar, S. & Dakshayini, M. (2018). IoT-Mobile Enabled Smart Water Level Controlling System to Regulate Water Wastage. *In 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI), IEEE*, 2045-2048.
[17] Li, X., Li, J. & Shi, L. (2008). Modeling and simulation of water level system", in *Proceedings of the IEEE International Conference on Automation and Logistics, ICAL 2008*, 2856–2859.