

Demand Based Water Level Indicator and Controller Using Internet of Things (IoT)

Sarjana Srivastava¹, Shiva Nand Singh² and Jayendra Kumar³

Department of Electronics & Telecommunication Engineering

National Institute of Technology, Jamshedpur, India

E-mail:- sarjana0204@gmail.com¹

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Abstract

In this paper, we present the idea of automatic and demand-based water level controller and indicator using Arduino. For the purpose of water level indication, we use the conducting property of water. There are wires placed at a different level in the tank, and no two wires touch each when water reaches a specific height, the water acts as conducting medium, and the wires get electrically connected. The water level is checked for both the source tank and the overhead tank. This is done to prevent dry running of the motor; the motor gets on only when the source tank is filled, else the motor does not start. There are two inputs taken using logic states ('0' and '1'). The user input determines the level to which the tank is to be filled (it can be one-fourth, half, three-fourth or full). Like on a day when consumption is too much, the user can fill the tank completely, and if the consumption on a particular day has to be minimal, the user can store water for one-fourth only. The motor gets ON only when the water level falls below one-fourth, i.e., LOW. The motor is connected to a relay switch (single pole double throw). The LCD screen is connected to the Arduino, which shows (i) status of the motor and (ii) the level of water, and if the sump is low, that also gets displayed on the screen. If there is any error in the connection of the circuit, then the buzzer starts to beep. So, the whole setup described above leads to the construction of an innovative, demand-based water level controller and indicator.

Keywords:- *Arduino; Arduino IDE, Conducting property, Water level indicator, Water wastage.*

INTRODUCTION

Water is a basic need of life. But water scarcity problem is rising day by day around the globe. The total amount of water available on Earth has been estimated at 1.4 billion cubic kilometers, enough to cover the planet with a layer of about 3 km. About 95% of the Earth's water is in the oceans, which is unfit for human consumption. About 4% is locked in the polar ice caps, and the rest 1% constitutes all freshwater found in rivers, streams and lakes, which is suitable for our consumption. A study estimated that a person in India consumes an average of 135 liters per day.

This consumption would rise by 40% by the year 2025. This signifies the need to preserve our freshwater resources. So, it is important to use water carefully and cautiously to avoid any wastage. [1, 2]

The conventional method used in residential areas to fill the water tank completely is to overflow the tank and switch off the motor manually only when

water starts falling from the overflow pipe. This method leads to too much wastage of water as well as electricity.

So, to monitor the level in the tank, one can use a water level indicator and switch off the motor manually once the tank is full. But it might happen that the operator is busy somewhere and he forgets to look at the indicator; then there might be unnecessary wastage of water, so to resolve the above problem, an automatic water level indicator and controller [4-7] is designed, which prevents wastage and doesn't require any human involvement.

In this system, we not just check the water level of the overhead tank but also for the source tank. The motor is started (when the overhead(sink) tank is low) only when the source tank is not empty.

If the source tank is empty, then the motor is not switched ON even when the overhead tank is low.

This prevents the motor from dry running. We can also design the same system using Raspberry pi, as it is used in many application [8-11]. But since Arduino is cheaper and easy to use, so we design the system here using it.

The most innovative feature of this designed system is that it is DEMAND BASED. It means, unlike other automatic water level controller that switches ON the motor only when the tank is FULL. This system can be used to determine the upperlimit of water level at $\frac{1}{4}$ th, HALF, $\frac{3}{4}$ th or FULL.

Depending upon the need for water on a specific day, the user can change the demand using the two logic states. Like for any weekday or working day, there is usually less consumption so the user can set the demand at $\frac{1}{4}$ th, and on weekends when there is high consumption (due to cleaning and washing), the user can set demand on FULL. Similarly, demand can be set at half or $\frac{3}{4}$ th. The logic state (input XY) is the demand status that is shown in Table 1.

Whenever there is some error in connection of the circuit, the buzzer starts beeping; this alerts the user to check the connection and rectify if there is any fault found. The LCD connected to Arduino shows the status of:

- 1) MOTOR ON/MOTOR OFF
 - 2) Level of water in the tank
- LOW SUMP (if the sump is empty)

Table 1: Logic state vs. demand Status

| Logic state | | Demand Status |
|-------------|---|------------------|
| X | Y | |
| 1 | 1 | FULL |
| 1 | 0 | $\frac{3}{4}$ th |
| 0 | 1 | HALF |
| 0 | 0 | $\frac{1}{4}$ th |

COMPONENTS REQUIRED

A. Arduino

This component is the “heart” of this designed system. Arduino is a microcontroller-based on 8-bit ATmega328P microcontroller. It has various components such as crystal oscillator, serial communication, voltage regulator etc. There are 14 digital pins (both input/output), out of these 6 can be used as PWM output pins. These can be configured to read logic 0 or 1. It has 6 analog pins (input only), a USB connection, a power jack barrel, an ICSP header and a reset button. The analog pins (A0 to A5) can read the signal from analog sensor like humidity sensor, temperature sensor etc. and convert it to a digital signal that

can be read by the microprocessor. Arduino IDE(Integrated Development Environment) software is used for writing and uploading programs on the Arduino board. [12-13].



Figure 1: Arduino UNO board top view
Source: <http://distrelec.biz>.

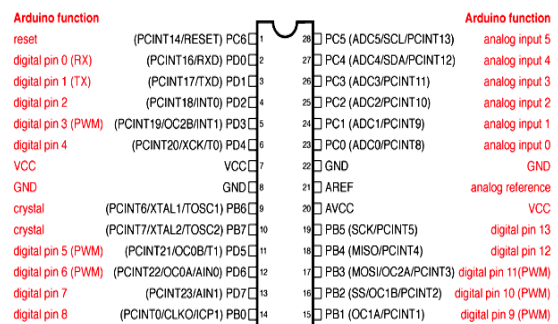


Figure 2: Pin mapping of Arduino Uno [9]

B. Liquid Crystal Display (LCD)

Here we use 16X2 LCD (16 columns and 2 rows) to display the desired characters. It has data pins 0 to 7 that can be connected to a microcontroller to send 8-bit data. To setup communication between Arduino and LCD module, we include the build-in library <LiquidCrystal.h>. [14 - 15].



Figure 3: 16X2 LCD Display
Source: www.indiamart.com

C. Single Pole Double Throw (SPDT) Relay

A relay is an electromechanical device that opens or closes a circuit. It has an electromagnet, a movable armature and contact. When current passes through the electromagnet (coil), it attracts the armature (metal piece); this movement of armature is used to make or break a connection. SPDT is a relay with one common terminal and two switching terminals.

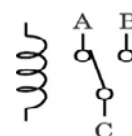


Figure 4: Single Pole Double Throw relay switch. [16]
Source: https://www.homofaciens.de/technics-base-circuits-relay_en.htm

D. Other components

- Motor
- Diode (IN4007) – 1
- NPN transistor (2N2222)-2
- Battery (DC supply)-5 V, 12 V, 24 V.
- Potentiometer (10kΩ) [17]
- Resistors- 10 kΩ (5 units), 100 Ω (2 units)
- Buzzer
- Logic States (key)
- Aluminium wires.

CIRCUIT DIAGRAM

The circuit diagram of the demand-based water level controller and monitor is shown above. Here we use the conductive method to measure the level of water, both in the source tank and sink tank; for the sink tank, it has four aluminum wires arranged at one-fourth, half, three-fourth, and full level. The dry ends of these wires are connected to A1, A2, A3 and A4, the analog input pins of Arduino. The fifth wire is placed at the bottom of the sink tank, and its other end is connected to a +5V DC supply. The resistors R6 to R9 are used here as pull-down resistors. Whenever the water reaches a particular level, the wire end at that level gets electrically connected to a 5V DC supply (here, we have used a manual switch to show that connection for simulation purpose). This results in current flowing through the probe. This current gets converted to a proportional voltage by the resistors R6 to R9, i.e. the pull-down resistor. The voltage dropped across each resistor is read by Arduino; this helps in determining whether water is present at a particular level or not. This same method is employed in the sump/source tank (R10 as pull-down resistor) connected to A0.

Digital pin 7 is connected to the transistor Q1, which further drives the buzzer. Resistor R3 limits the base current of this transistor. Digital pin 8 is connected to transistor Q2, which is connected to diode D1 (freewheeling diode), which drives the relay. The relay is connected to the motor. Resistor R1 limits the current to the base of Q2. To adjust the contrast of 16 X 2 LCD screen, a potentiometer R2 is used. The digital pin 10 and 9 are connected to logic state X and Y, respectively. The values in these keys, X and Y are used to set the demand. (00 -- 1/4th, 01 – half, 10 -- 3/4th and 11 – full). See Figure 5.

WORKING OF THE CIRCUIT

The logic states X Y are set as per the need of the user (say 10 for 3/4th level). As soon as the water level falls below the 1/4th mark in the overhead tank, the water level in the sump is checked. If the sump is not empty, then the motor is turned ON; else, the motor is OFF. The LCD displays the ON/OFF status of the motor –MOTOR ON/ MOTOR OFF and level in source/sump tank is also displayed throughout the simulation process. When the sump is empty, then “Low Sump” gets displayed on LCD.

The buzzer starts to buzz when the sump is low or if there is any error in the sensor assembly of the tank. When the water level reaches the demand level (3/4th in this case), the motor gets OFF automatically. In the course of water running into the tank, the level of water is displayed on LCD. The buzzer starts to buzz when the sump is low or if there is any error in the sensor assembly of the tank. When the water level reaches the demand level (3/4th in this case), the motor gets OFF automatically. In the course of water running into the tank, the level of water is displayed on LCD.

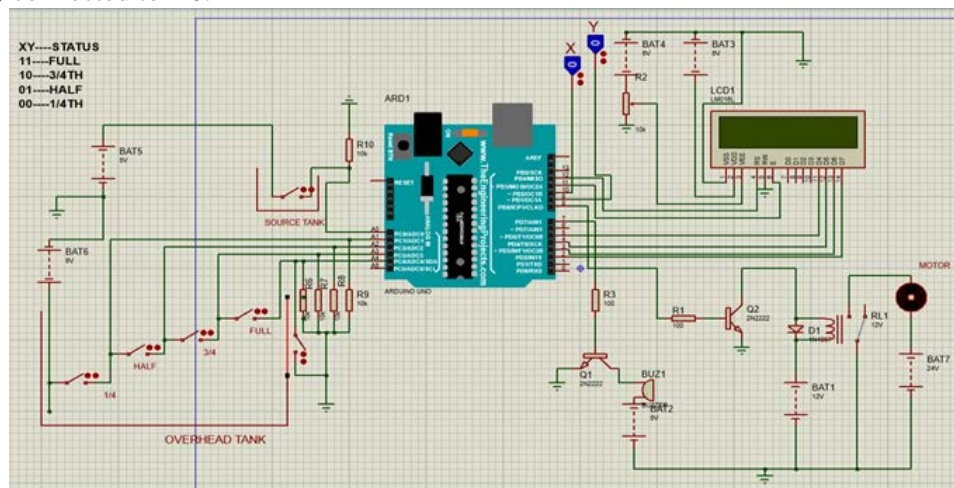


Figure 5: Circuit of the system designed using Proteus Software. Switches are used to establish connection between the wires, only for purpose of simulation. Practically these connections will be made by water in the tank when it touches a specific probe.

APPLICATION

This project can find its use in several sectors. This can be implemented in the water management system of a house, hotels, hostels, hospitals, factories, commercial complexes etc. It can This

project can find its use in several sectors. This can be implemented in the water management system of a house, hotels, hostels, hospitals, factories, commercial complexes etc. It can also be used in tanks to indicate the level of fuel and oil.

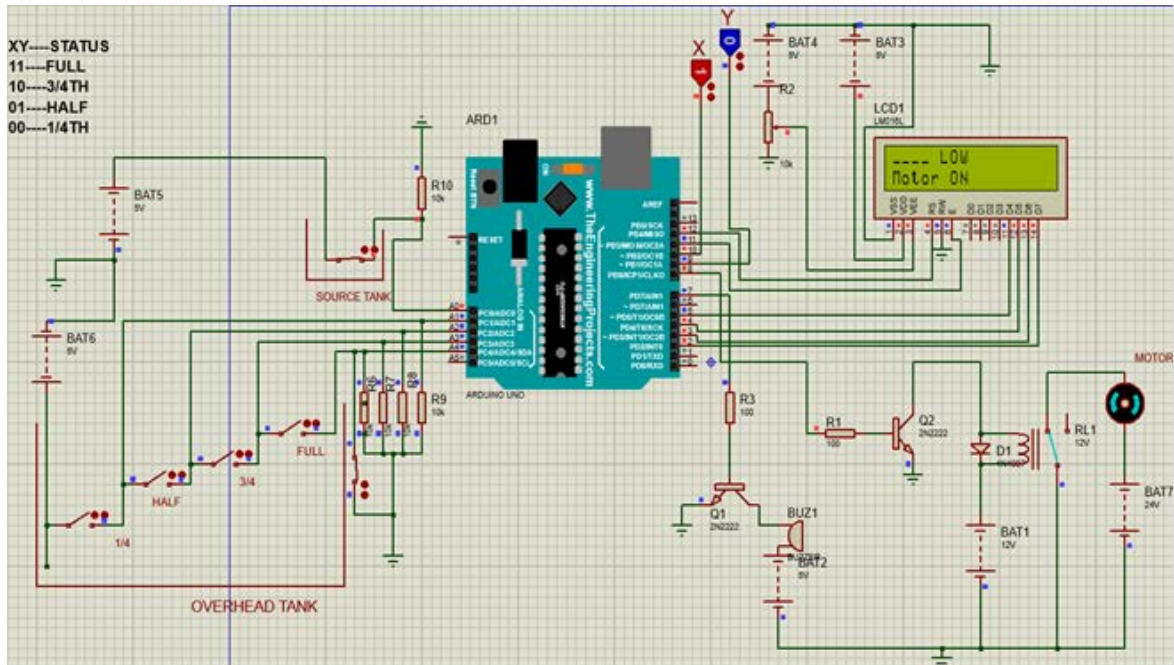


Figure 6: The demand is set as 3/4th (XY = 10). The overhead tank is empty (shown by open switches) and source tank is not empty (shown by closed switch in the tank). When this design is simulated the motor gets started, the LCD displays MOTOR ON and water-level as LOW

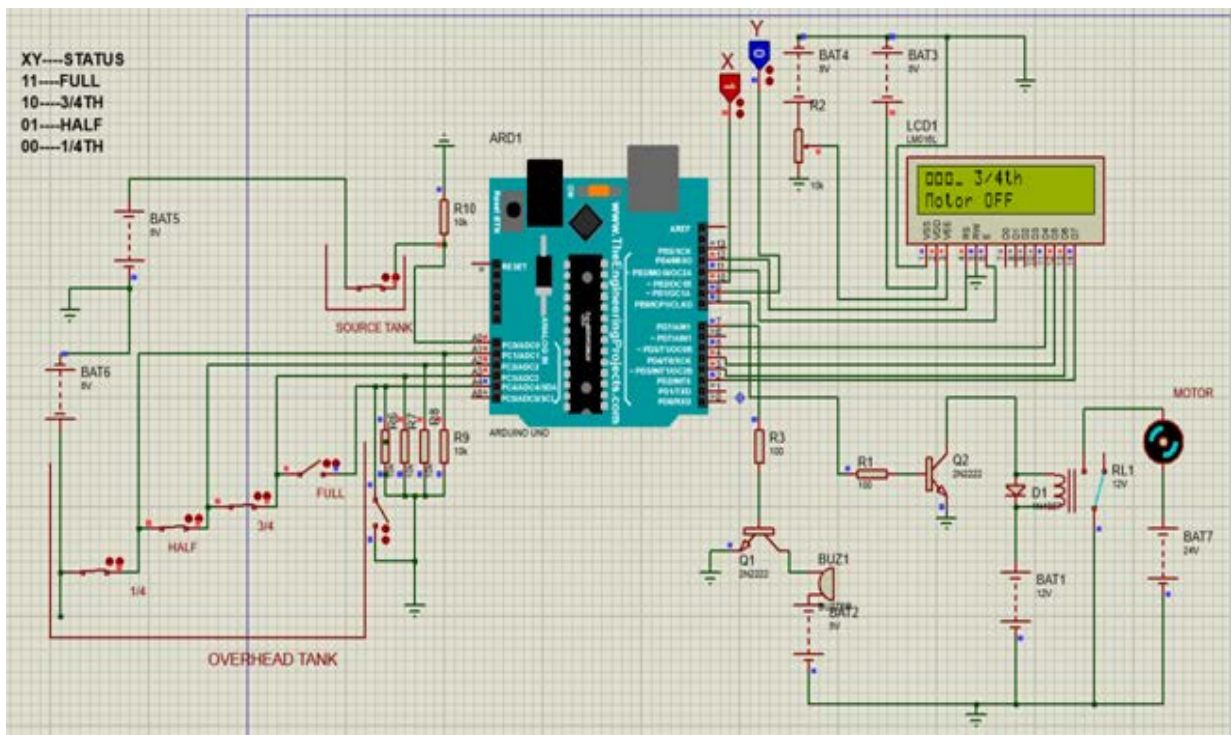


Figure 7: Three switches (at 1/4, HALF, 3/4th) in the overhead tank are closed, schematically showing water present at that specific level. In this figure the water-level reaches 3/4th (the demand), the motor is switched OFF automatically and LCD displays MOTOR OFF and water-level as 3/4th.

CONCLUSION

The main aim of this project was to design a simple and cost-effective demand-based water level indicator and controller. The maximum water level in the tank is selected by the user as per his/her need. Here only four levels can be selected using two logic states. This selection could be made out of more than four states using more than two logic states, say three logic states can make maximum 8 levels and so on.

In future, this design can be modified to make a web-based water level indicator and controller. A GSM module can also be integrated to get the current status on users' cell Phone via SMS.

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