Design Lab Project Report

Final Report

Project Title

A report submitted in part fulfilment Design Lab course

2nd Year (3rd Semester)in ECE

Supervisor: Supervisor's Name

Designed by: Harsh Surana(Roll No: 18uec185)

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Declaration

This report has been prepared on the basis of my own work and designs developed under Design Lab Course. Where other published and unpublished source materials have been used, these have been acknowledged.

Students Name:

Harsh Surana, Roll No:18uec185

Date of Submission:

Signature of Supervisor/ Supervisors: _____

Name of Supervisor/ Supervisors: Dr Deepak Nair

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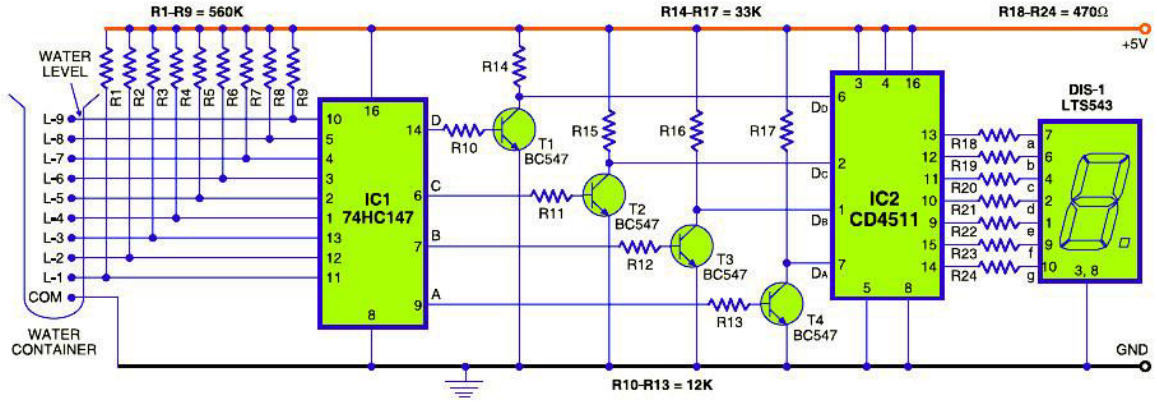
Abstract

Water tank overflow is very common problem which leads to wastage of water, it is of extreme importance to preserve water. In home based water tank, the one problem is very common to us that the control of water level of overhead tank, as a result the wastage of water is increasing day by day. But we all know water is very precious to us. This problem can be controlled by a simple electronic circuit consists with some cheap electronic components , that circuit is called 'Water Level Indicator'. The operation of water level controller works upon the fact that water conducts electricity. So water can be used to open or close a circuit. As the water level rises or falls, different circuits in the controller send different signals. These signals are used to switch ON or switch OFF the motor pump as per our requirements. Water Level Indicator is a simple low cost circuit. There the circuit is made with various components like transistors (BC547) Resistors, IC 74HC147 and IC CD 4511 etc. After we discussed that how to measure actual depth of the water using ultrasonic sensor and arduino.

Most water level indicators are equipped to indicate and detect only a single level. The Water Level Indicator implemented here can indicate up to nine such levels and display the level number on a seven-segment display. So, not only is the circuit capable of cautioning a person that the water tank has been filled up to a certain level, it also indicates that the water level has fallen below the minimum detectable level. This circuit is important in appliances such as the water cooler where there is a danger of motor-burnout when there is no water in the radiator used up. Also, most of the times there is a need to know the exact level of the liquid, in those situations where either empty or full is not the sufficient information, our count-based water level indicator will perform the required tasks and fulfil the requirements.

Project Specification



We have added more features in this and now the project works as follows Counter based water level indicator can detect 10 different levels, i.e. LEVEL 0 which refers to tank empty case, LEVEL1, LEVEL2, LEVEL3, LEVEL 4, LEVEL 5, LEVEL 6, LEVEL 7, LEVEL 8, and LEVEL 9, which represent tank full condition.

As this is a sensor-based project involving probes, various factors can cause problems at the probes like rusting or earthing of probes due to external factors. This could make this device to give false readings. For example, water is below LEVEL 2 but due to some earthing, the 9th probe gets grounded. In such cases, this device won't show the reading as 9, instead the seven-segment will start blinking and an error message will be sent through serial.

Chapter 1: **Introduction**

Every building where people live has a overhead tank System , for example ,waiting for tank to overflow have been rendered inefficient especially when there is acute shortage of water, 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 fresh water resources. there is need of an electronic system that can detect water tank levels. It has to be low cost specially because

- The market demand is huge and high cost product will very soon be replaced by better low cost products .
- There should be an easy way to replicate our devices because
  a) We can easily scale up production because of less capital cost.
  b) If we are to solve the water problem , we need a device that can be easily designed by anyone.

Water level indicator is used to show level of water in an overhead tank, this keeps the user informed about the water level at all time avoids the situation of water running out when it is most needed.

Water level indicator system is quite useful to reduce the wastage of water from any reservoir, while filling such reservoir. Water is most essential thing on earth. Safe drinking water is essential to human and other life forms even though it provides no calories or organic nutrients.

The project was implemented in two ways

1. **AnalogIn**: this implementation, the circuit was implemented using priority encoder IC, BCD to 7segment decoder IC, transistors and resistors.

2. **DigitalIn**: this implementation, the project was made using Arduino UNO (Atmega 328 based microcontroller) board.

Water Level Indicator Project Features:

- Easy installation.
- Low maintenance.
- Compact elegant design.
- Avoid seepage of roofs and walls due to overflowing tanks.
- Fully automatic, saves man power.
- Consume very little energy, ideal for continuous operation.
- Automatic water level controller provides you the flexibility to decide for yourself the water levels for operations of pump
- Shows clear indication of water levels in the overhead tank.

Chapter 2: **Component Required**

• Phase I : Analog Analysis:

COPMONENT REQUIRE

IC 74HC147

RESISTOR (470K, 33K,12K,470 OHMS)

IC CD4511

BJT BC547

7 SEGMENT DISPLAY

POWER SUPPLY

BRESDBORED

JUMPER WIRES

•IC 74HC147

The 74HC147 9-input priority encoders accept data from nine active LOW inputs (A0 to A8) and provide a binary representation on the four active LOW outputs (Y0 to Y3). A priority is assigned to each input so that when two or more inputs are simultaneously active, the input with the highest priority is represented on the output, with input line A8 having the highest priority. The devices provide the 10-line to 4-line priority encoding function by use of the implied decimal “zero”. The “zero” is encoded when all nine data inputs are HIGH, forcing all four outputs HIGH.

The 74HC/HCT147 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL).

They are specified in compliance with JEDEC standard no. 7A. The 74HC/HCT147 9-input priority encoders accept data from nine active LOW inputs (A0 to A8) and provide a binary representation on the four active LOW outputs (Y0 to Y3).

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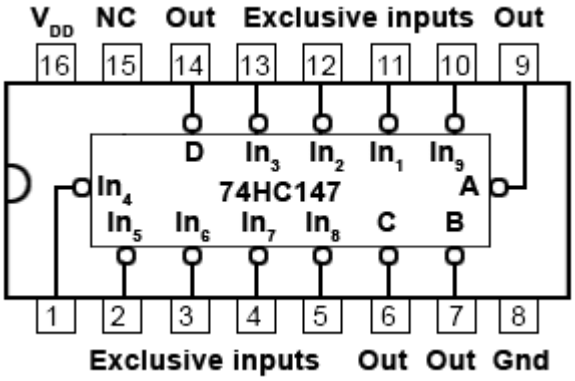


- Below is the Truth Table of IC74HC147

SN54/74LS147
FUNCTION TABLE

INPUTS									OUTPUTS			
1	2	3	4	5	6	7	8	9	D	C	B	A
H	H	H	H	H	H	H	H	H	H	H	H	H
X	X	X	X	X	X	X	X	L	L	H	H	L
X	X	X	X	X	X	X	L	H	L	H	H	H
X	X	X	X	X	X	L	H	H	H	L	L	L
X	X	X	X	X	L	H	H	H	H	L	L	H
X	X	X	X	L	H	H	H	H	H	L	H	L
X	X	X	L	H	H	H	H	H	H	L	H	H
X	X	L	H	H	H	H	H	H	H	H	L	L
X	L	H	H	H	H	H	H	H	H	H	L	H
L	H	H	H	H	H	H	H	H	H	H	H	L

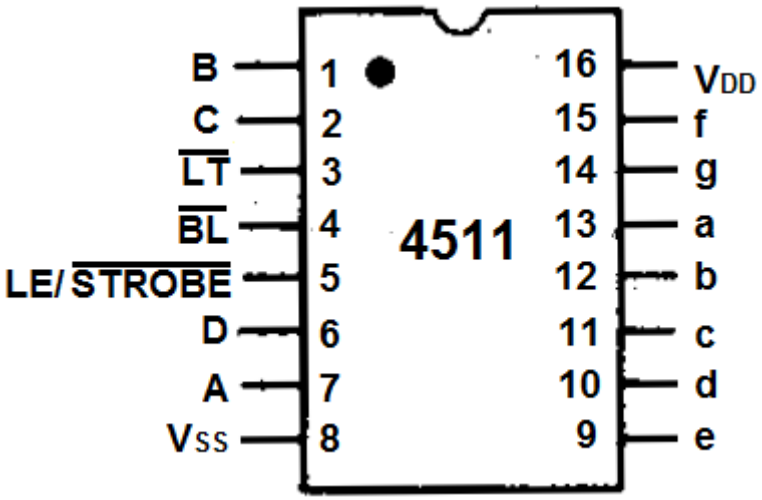
H = HIGH Logic Level, L = LOW Logic Level, X = Irrelevant

- **2.1.2 CD4511**

CD4511 7-Segment Driver IC. CD4511 is a BCD to 7-segment latch decoder driver IC formed with CMOS logic and NPN bipolar transistor output devices on an immovable structure. This IC is used where we need to driving common-cathode displays like 7-segment display, low voltage fluorescent display, and incandescent display.

Lamp Test (LT), Blanking (BL), and Latch Enable or Strobe inputs are provided to test the display, shut off or intensity-modulate it, and store or strobe a BCD code, respectively. Several different signals may be multiplexed and displayed when external multiplexing circuitry is used.

The CD4511B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).



- Pin diagram of CD4511.

Truth Table

Inputs							Outputs							
LE	BI	LT	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	B
X	0	1	X	X	X	X	0	0	0	0	0	0	0	
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	
0	1	1	1	0	1	1	0	0	0	0	0	0	0	
0	1	1	1	1	0	0	0	0	0	0	0	0	0	
0	1	1	1	1	0	1	0	0	0	0	0	0	0	
0	1	1	1	1	1	0	0	0	0	0	0	0	0	
0	1	1	1	1	1	1	0	0	0	0	0	0	0	
1	1	1	X	X	X	X				*				*

X = Don't Care

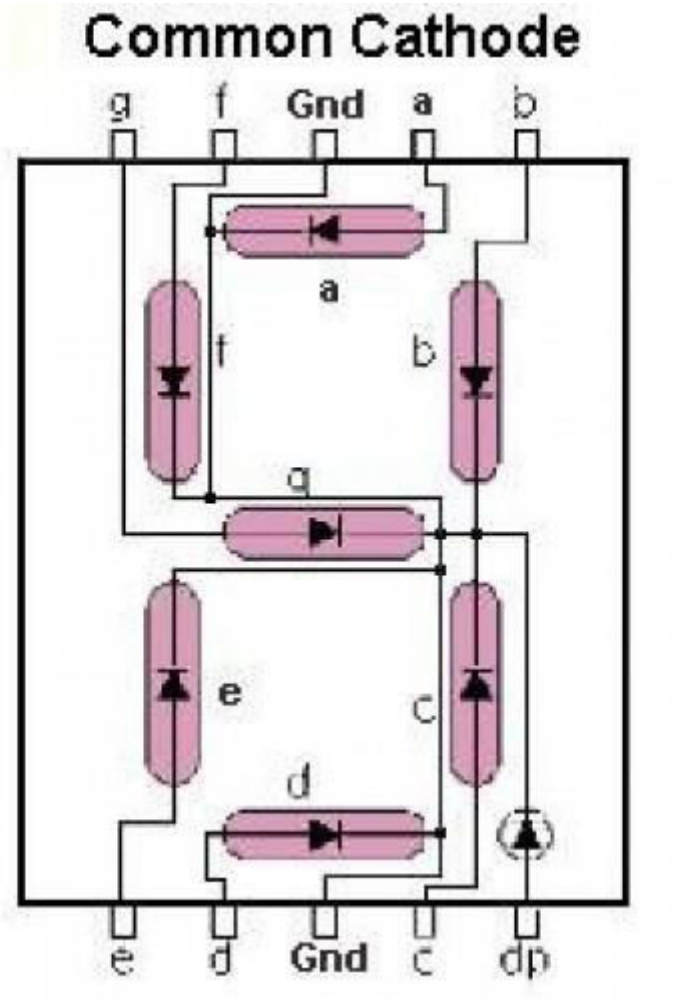
*Depends upon the BCD code applied during the 0 to 1 transition of LE.

2.1.3 BC547

BC547 is an NPN bi-polar junction transistor. A transistor, stands for transfer of resistance, is commonly used to amplify current. A small current at its base controls a larger current at collector & emitter terminals. BC547 is mainly used for amplification and switching purposes.

2.1.4 Common-cathode 7-segment display

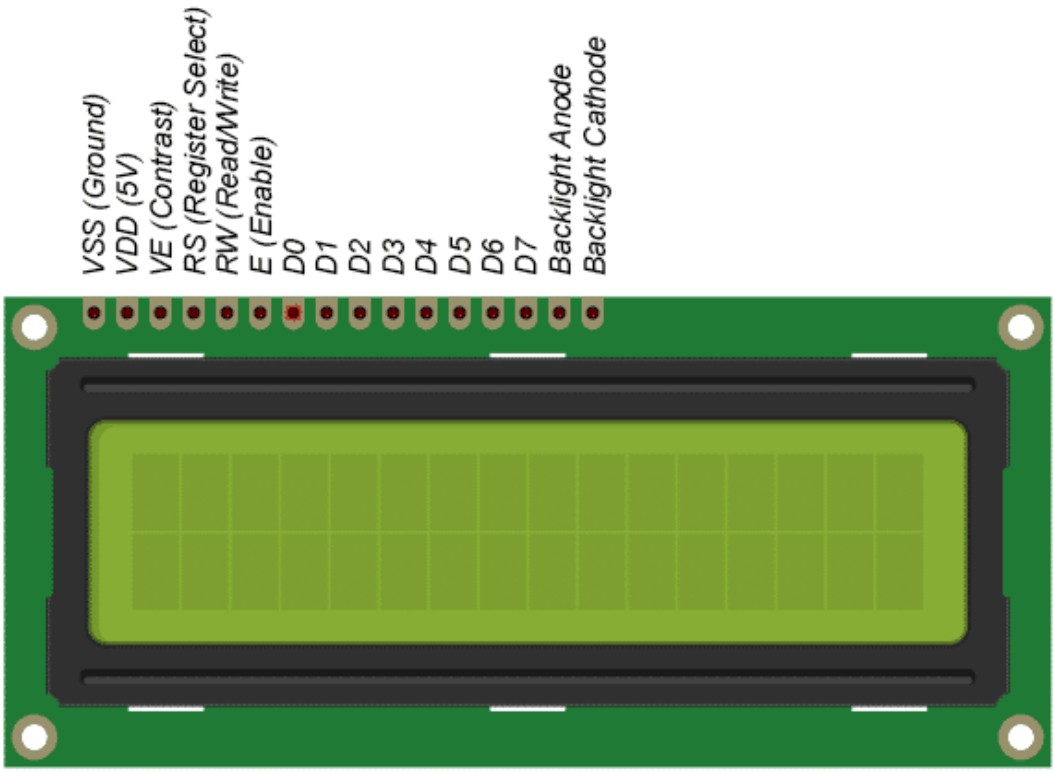
The 7-segment display, also written as “seven segment display”, consists of seven LEDs (hence its name) arranged in a rectangular fashion as shown. Each of the seven LEDs is called a segment because when illuminated the segment forms part of a numerical digit (both Decimal and Hex) to be displayed. The Common Cathode (CC) – In the common cathode display, all the cathode connections of the LED segments are joined together to logic “0” or ground. The individual segments are illuminated by application of a “HIGH”, or logic “1” signal via a current limiting resistor to forward bias the individual Anode terminals.



- **2.2 Phase II:Digital Analysis**

2.2.1 16x2 LCD display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. 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. Click to learn more about internal structure of a LCD.

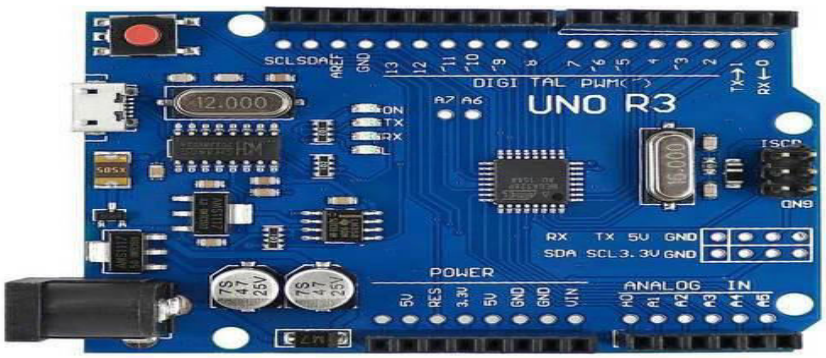


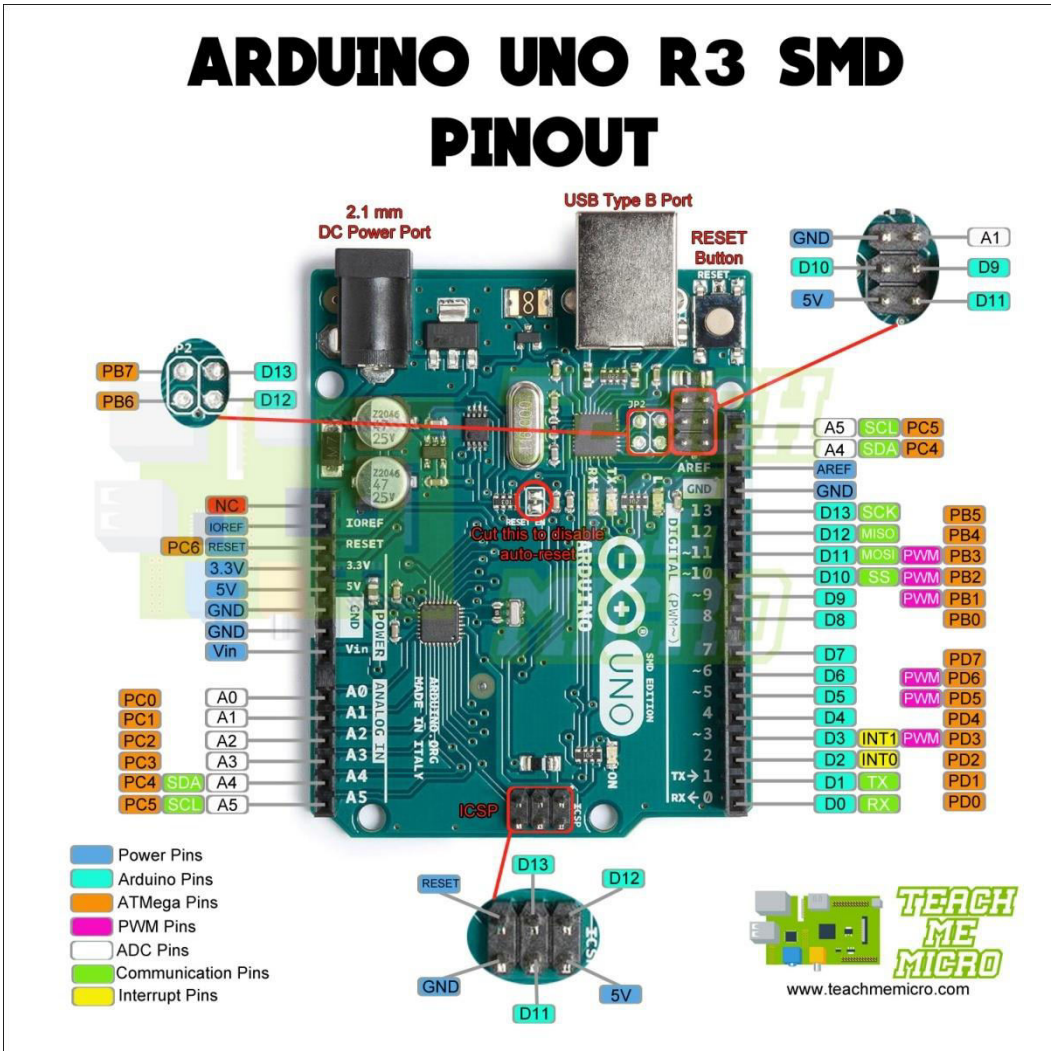
16x2 LCD display

2.2.2 Arduino UNO Board

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Atmel® picoPower® ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designer to optimize the device for power consumption versus processing speed.


UNO R3
DIGITAL PWM~
POWER
ANALOG IN


ARDUINO UNO R3 SMD
PINOUT
2.1 mm
DC Power Port
USB Type B Port
RESET
Button
Cut this to disable
auto-reset
ICSP
Power Pins
Arduino Pins
ATMega Pins
PWM Pins
ADC Pins
Communication Pins
Interrupt Pins
www.teachmemicro.com

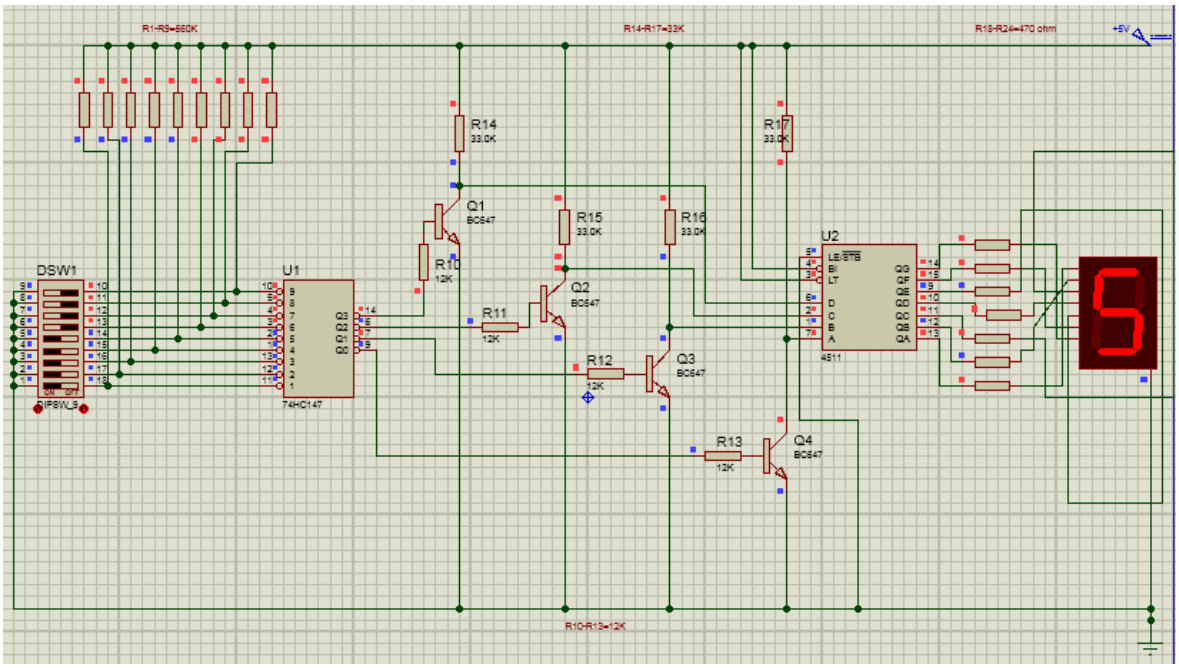
Chapter 3: Count Base Water Level Indicator

Concept of water level indicator involves metallic probe sensors to be placed at different levels. One common ground pin is kept at the lowest position.

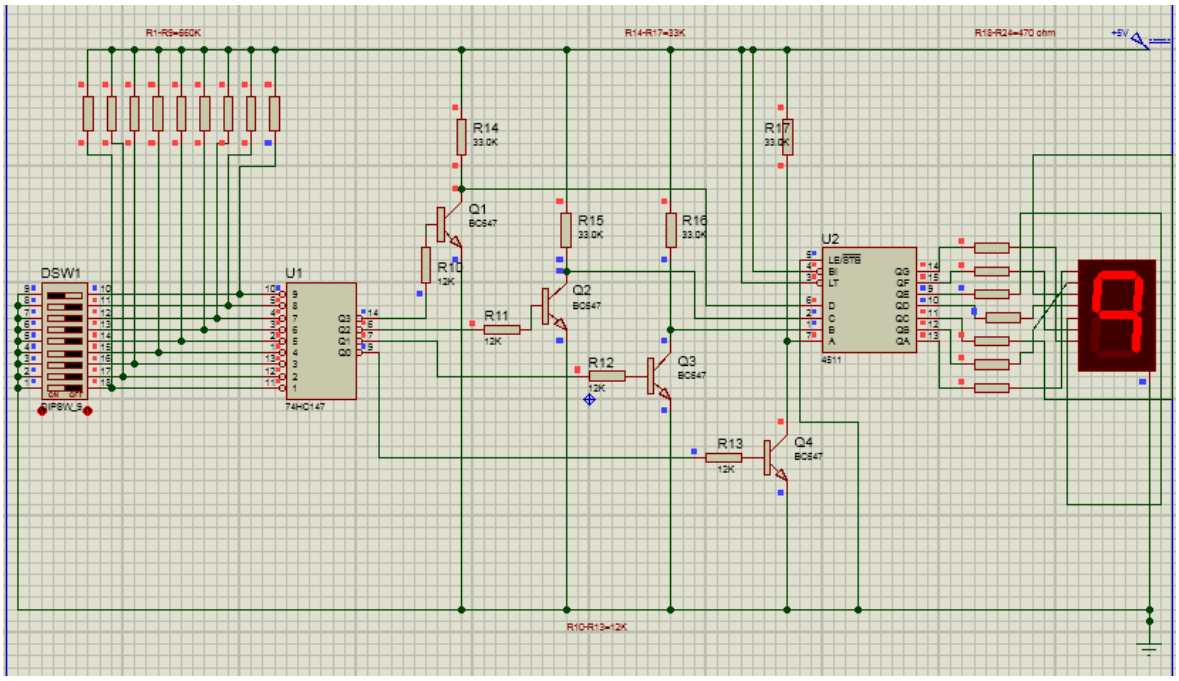
As the water rises, and touches the probes, the circuit between the ground probe and that probe gets completed due to conductivity of water. Hence the corresponding level number is displayed on the 7-segment display.

3.2 Phase I : Analog Analysis

3.2.1 Circuit Explanation

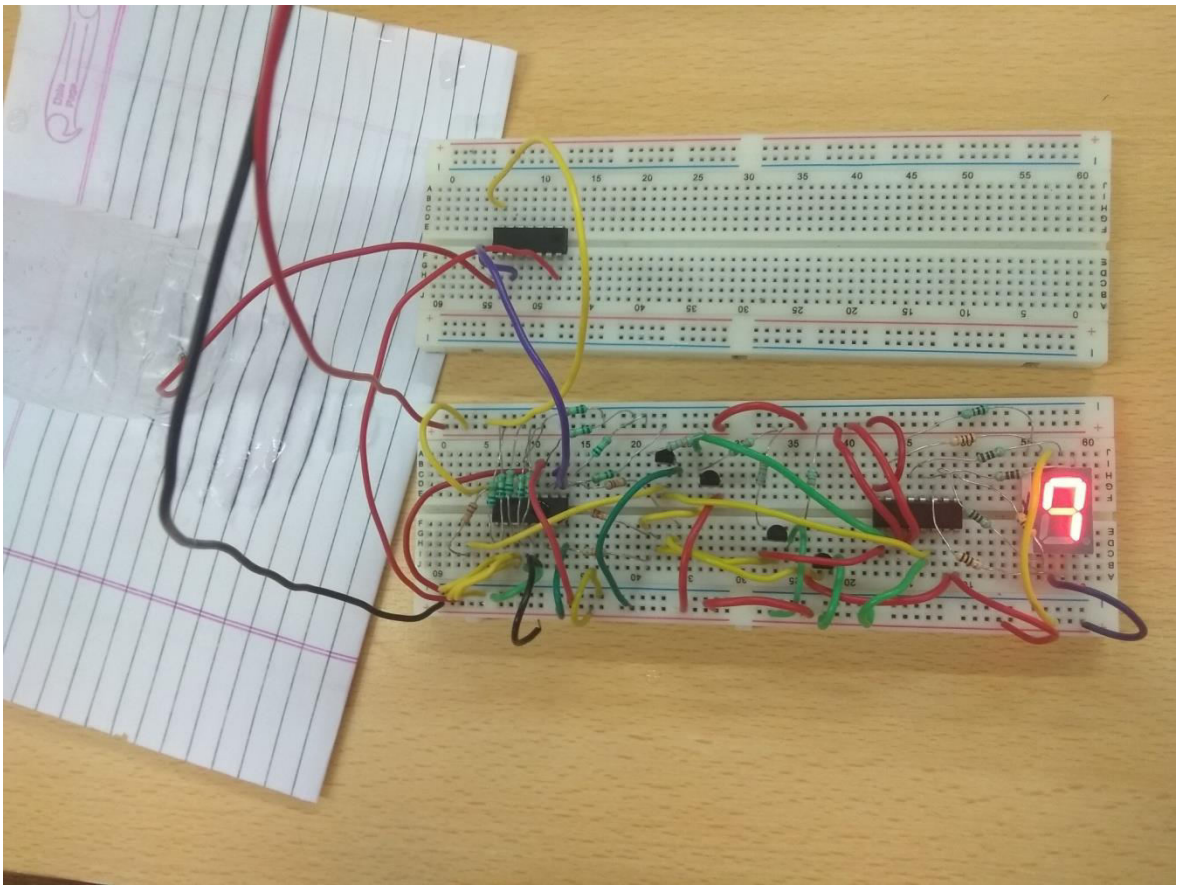


Implementation In Proteus



This is the analog analysis of The Counter based Water level Indicator. In this, we are using 74HC147 Priority encoder which encodes the input lines based on priority into the corresponding BCD code.

This in turn switches a particular transistor OFF, giving a HIGH output on the corresponding pin of IC 4511 which is a BCD to 7-segment display decoder. This IC drives the 7 -segment display to light up the corresponding LED of the display making it print the required number. Below are the screenshots implementation of the circuit on the breadboard.



3.3 Phase II: Digital Analysis

3.3.1 Source Code

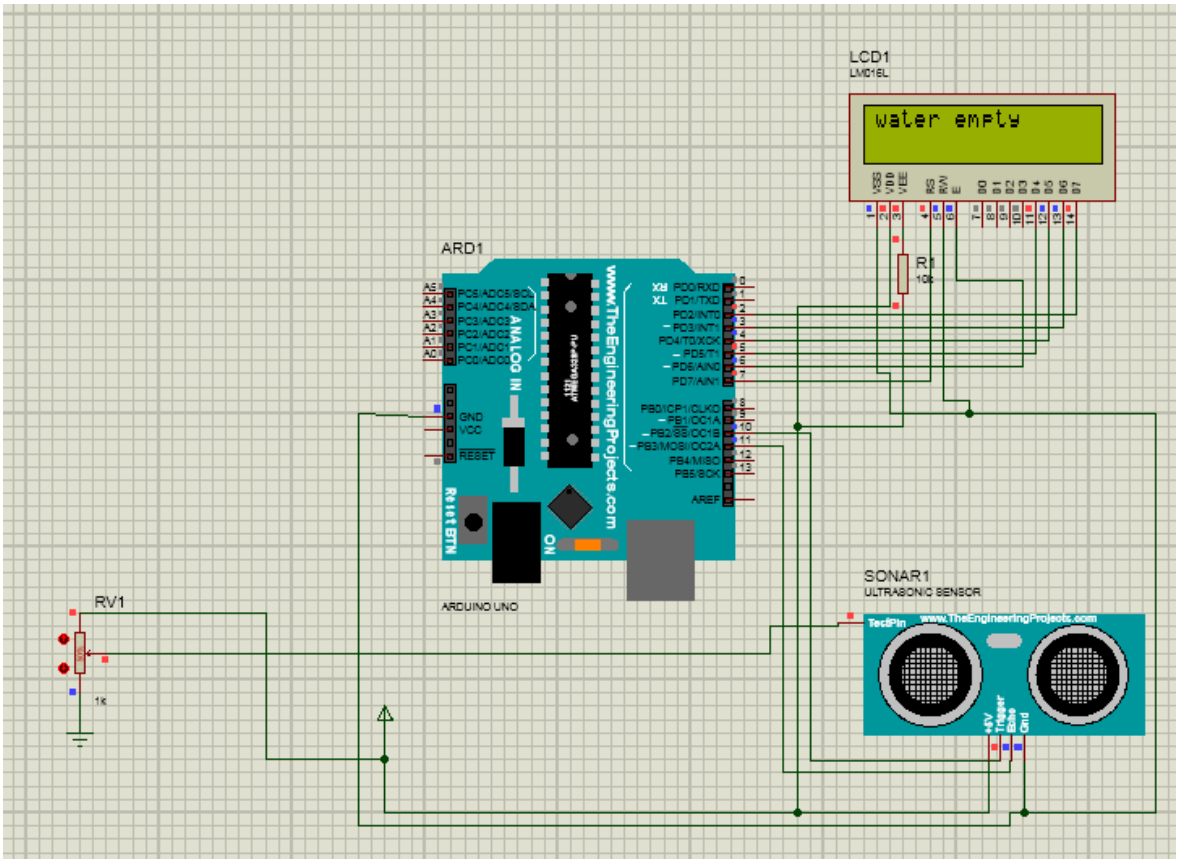
```
/*here is the basic implementation of water level indicator using microcontroller and lcd display.*/

#include<LiquidCrystal.h>

#define trigger 10

#define echo 11

LiquidCrystal lcd(7,6,5,4,3,2);

float time=0,distance=0,h=30;

void setup()

{

 lcd.begin(16,2);

 pinMode(trigger,OUTPUT);

 pinMode(echo,INPUT);

 lcd.print("  Water Level ");

 lcd.setCursor(0,1);
```

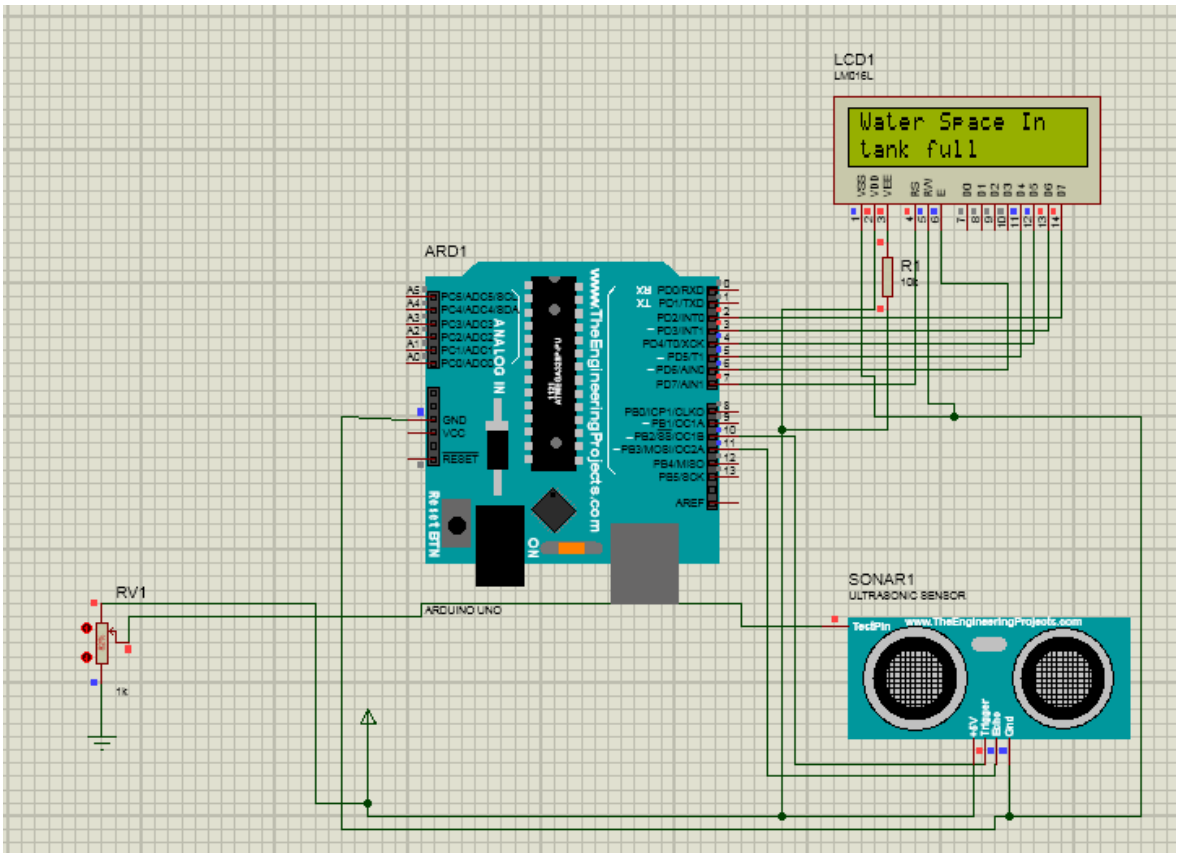
```
 delay(2000);
}

void loop()
{
 float time=0,distance=0,h=0;
 lcd.clear();
 digitalWrite(trigger,LOW);
 delayMicroseconds(2);
 digitalWrite(trigger,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigger,LOW);
 delayMicroseconds(2);
 time=pulseIn(echo,HIGH);
 distance=time*3.4/2;
 distance=distance/1000000;//now distance is in cm
 h=2*distance;
 lcd.clear();
 lcd.print("Water Space In ");
 if(h==0)
 {
  lcd.setCursor(0,1);
  lcd.print("water  empty");
 }
 else if(h>0 && h<100)
 {
  lcd.setCursor(0,1);
  lcd.print(h);
  lcd.print("Cm ");
```

```
 }
 else if(h>=100)
 {
  lcd.setCursor(0,1);
  lcd.print("tank full");
 }
 delay(2000);
}
```

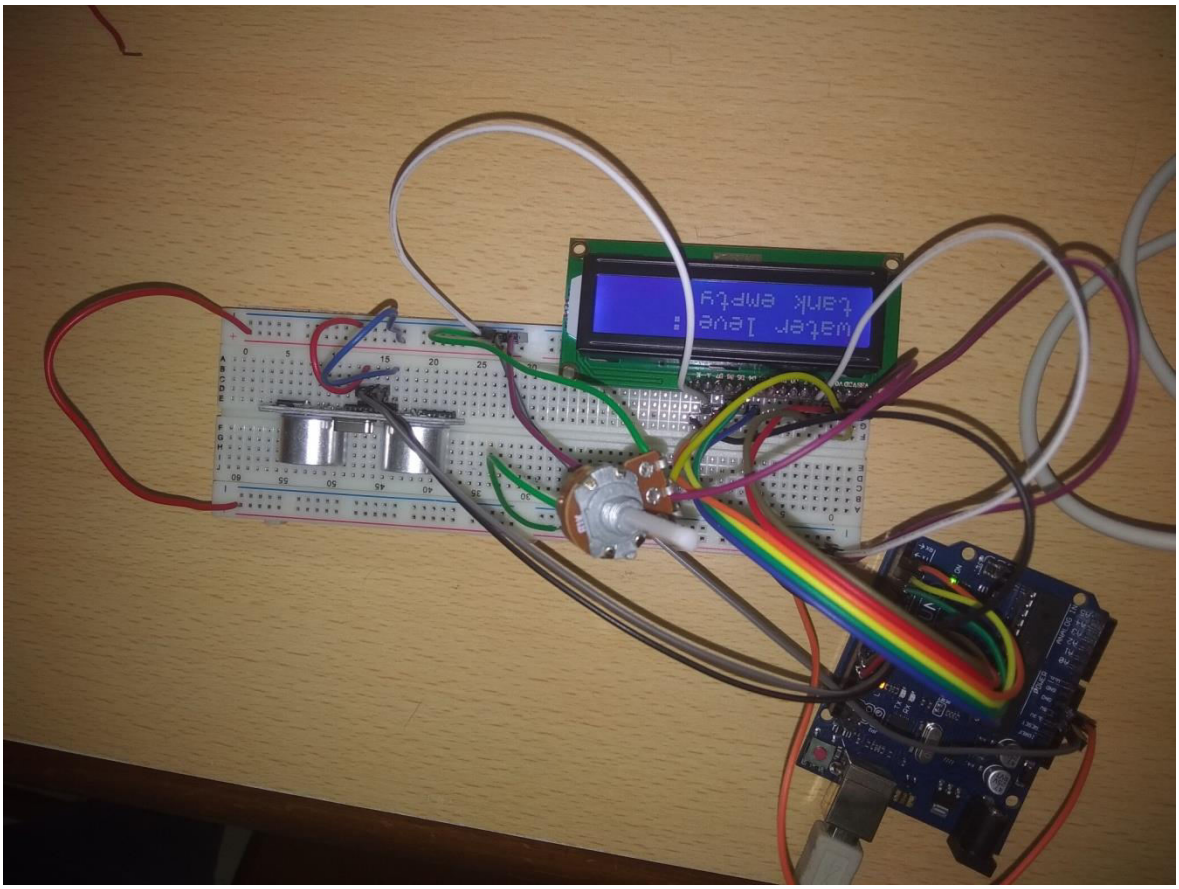
This is the digital analysis of the Counter based Water Level Indicator. In this analysis we are using Arduino UNO board, and the 7-segment display with a resistor. The code is written in such a way that according to the inputs at the LEVEL sensor probes, the corresponding pins of lcd display are turned HIGH and the required number is displayed.

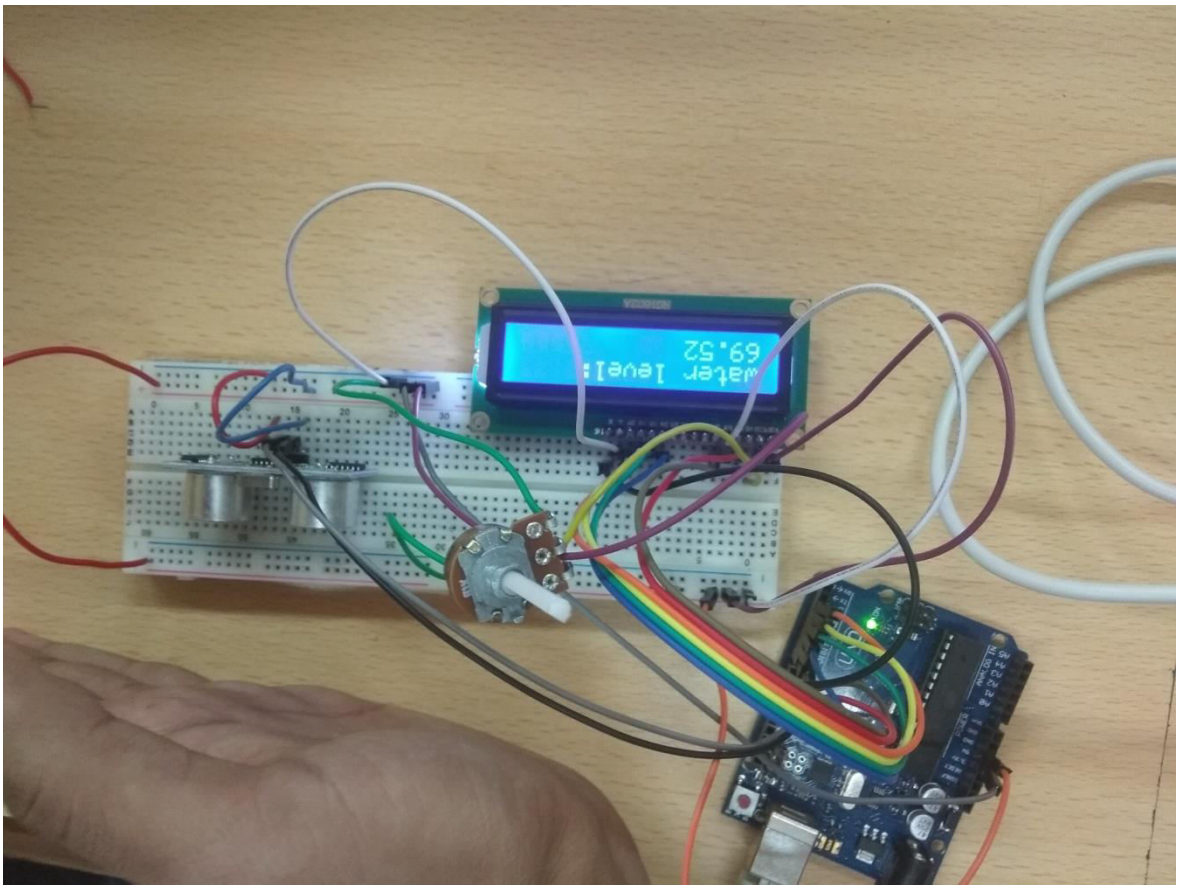
Here is the schematic of circuit on proteus

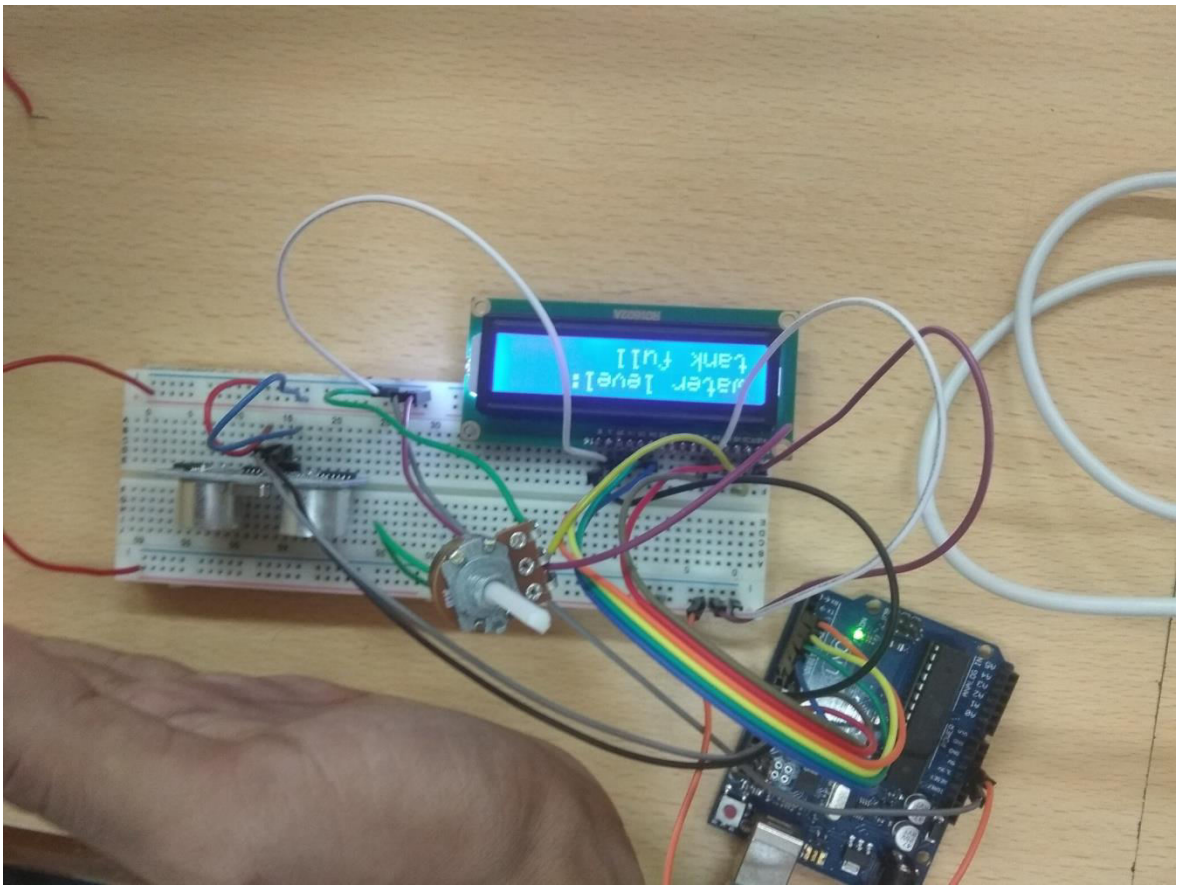


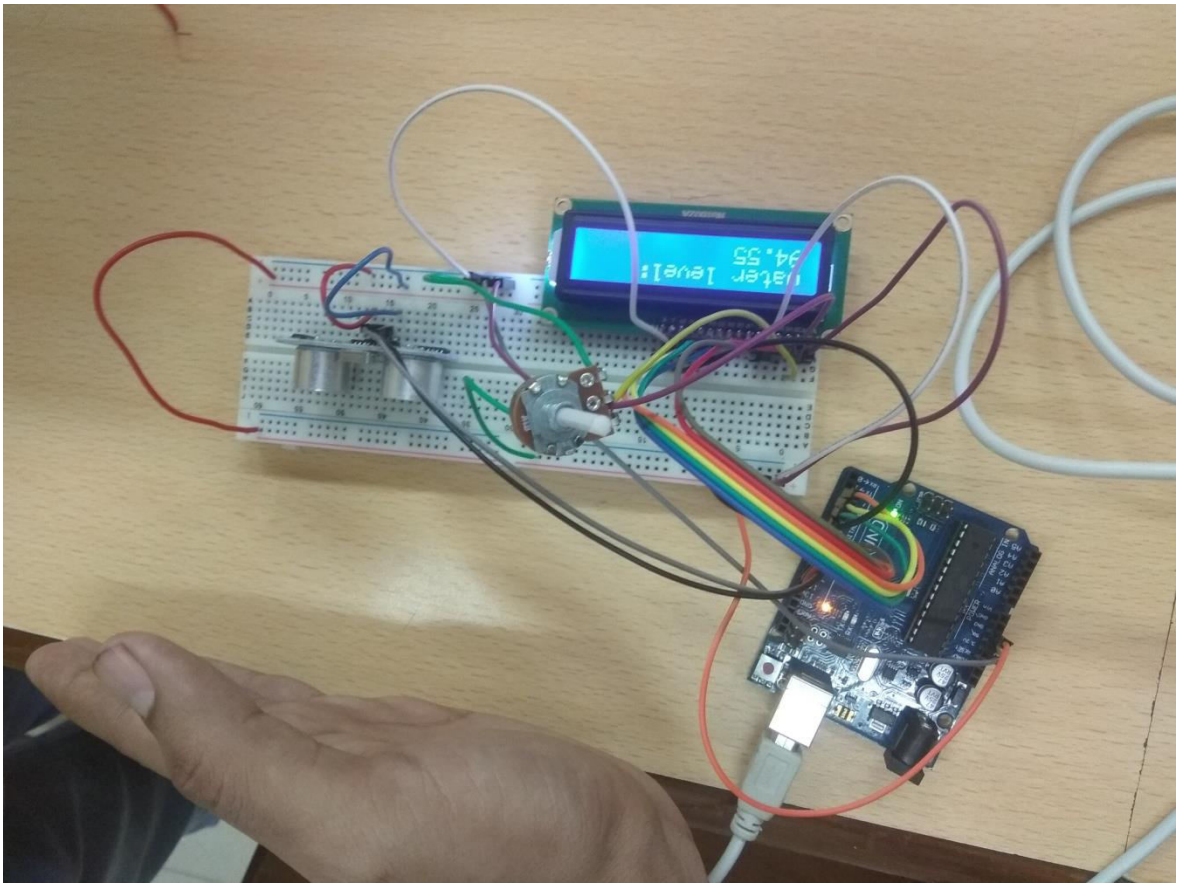


Below are the screenshots of circuit implement on breadboard.




Water level:
69.52


Water level:
Tank full


Water level:
94.55

Chapter 4: **Total Cost of basis components**

4.2 Analog Circiut

COPMPONENT	**PRICE**
IC74HC147	Rs.55.00
CD4511	Rs.21.00
24 Resistors	Rs.120.00(approx)
BC457	Rs.15.00
Jumper Wires	Rs.20.00
7 Segment Display	Rs.15.00
TOTAL	**Rs.256.00**

4.3 Digital Circuit

COPMPONENT	**PRICE**
Arduino UNO	Rs.355.00
Ultrasonic sensor	Rs.120.00
16x2 LCD display	Rs.115.00
Probes	Rs.20.00
Total	**Rs.610.00**

Chapter 5: **Conclusion**

There are several advantages as well as disadvantages of this water level indicator

Advantages-

➢ It is fully Automatic device.

➢ It ensures Maximum water stored in our storage tanks.

➢ It will save power by preventing unwanted running of water pumps.

➢ It will save water by preventing overflow of water after the tank is full.

➢ It provides comfort by reducing the stress of checking the water tank's water level.

➢ It also provides information on our mobile devices.

Disadvantages-

We came across several disadvantages, some of them we overcame, like false readings from damaged sensors. While some were not possible to full remove. These are-

➢ The sensor probes are made of metal, as we know, the probes will be immersed inside water for a quite long period. This will start developing rust over the probes.

➢ Also due to electricity being passed, electrolysis occurred at the tips of the probes.

➢ Electrolysis and rusting will decrease the conductivity of the probes and soon they will stop taking the readings.

➢ In order to increase the durability of the probes, they need to be cleaned constantly increasing the efforts in place of reducing them.

➢ If we will use high-quality stainless-steel probes, it will increase the cost but still they will too get rusted after some time.

➢ In case of any electric circuit failures, as the water is being used by us, a risk of chemicals due to rusting of probes or poor circuit might result in fatal conditions as well.

Chapter 6: **Biblography**

[1] Deepak Nair, Santosh Shah and Saumitra Debnath. Design Lab Project – Rules and Guidelines. The LNMIIT, Jaipur, 2019.

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