1. Project : Liquid Level Management of Multiple Tanks & Motor Pump Station using Arduino UNO & 555 Timer IC

a. Introduction

Monitoring liquid levels can have numerous benefits and is a popular measurement for a number of different industries and organisations. Few of the benefits of implementing the system are as follows:

a. It prevents the wastage of liquid as it automatically turns on and off based on liquid levels on both the tanks thereby saving both money and energy
b. It is a completely automatic system so there is no need of manual monitoring.
c. The system is easy to install, requires very minimal maintenance, economical and compact in design.

In this project I have designed a system which is capable of maintaining the liquid level in a tank provided the liquid is present in the parent tank up to a certain level. The system will only work with conductive liquids.

b. Working Principle

The system works on the principle that liquids used in the system are conductive and allow the flow of electricity. When wires at different height are kept inside an empty container the circuit is not complete and therefore no current flows through it. When the container is gradually filled with liquid up to a level where both the ends of wires are immersed in liquid, the circuit completes and the current starts flowing through it. The liquid in the container acts as a switch.

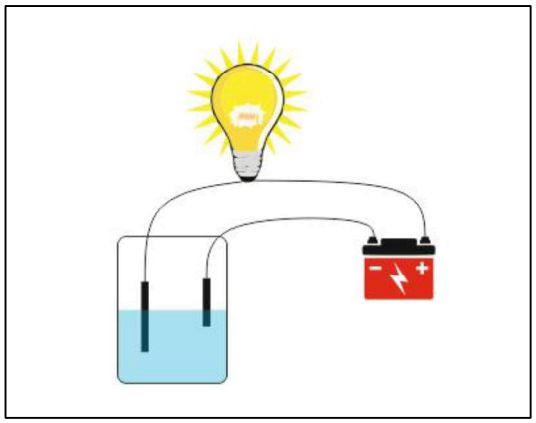


Fig 14: Conducting Liquid acting as a switch

c. Concepts Used

i. Pull Up Resistor

If a pin in an MCU is configured as an input and there is nothing connected to the pin then the pin will read a floating value i.e. the program will read either High or Low and is not fixed. To prevent this unknown state a pull – up resistor is used to keep the pin state to either High or Low, while using a low amount of current.

With a pull-up resistor, the input pin will read a high state when the button is not pressed. In other words, a small amount of current is flowing between VCC and the input pin (not to ground), thus the input pin reads close to VCC. When the button is pressed, it connects the input pin directly to ground. The current flows through the resistor to ground, thus the input pin reads a low state. The resistor value selected is of the order of 10kΩ.

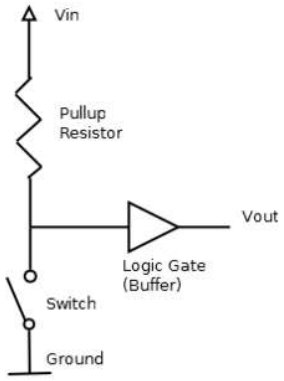


Fig 15: Pull Up Resistor

ii. Pull Down Resistor

Its application is similar to that of a pull up resistor. The only difference is that the pin state will read low when the button is not pressed and will read a value close VCC when the button is pressed.

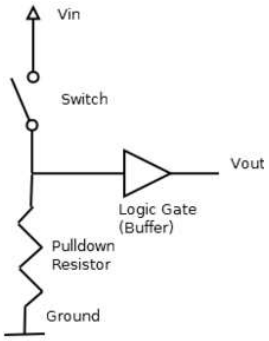


Fig 16: Pull Down Resistor

d. Developing Circuit using Arduino UNO

i. Brief about Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

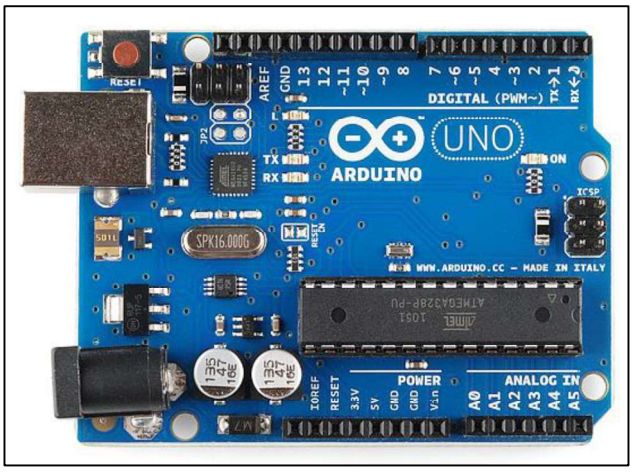


Fig 17: Arduino Uno Development Board

ii. Other Components Used

a. Connecting Wires
b. 1 x 5V Relay
c. 1 x Pump
d. 1 x power source for pump

iii. Circuit Diagram and Explanation

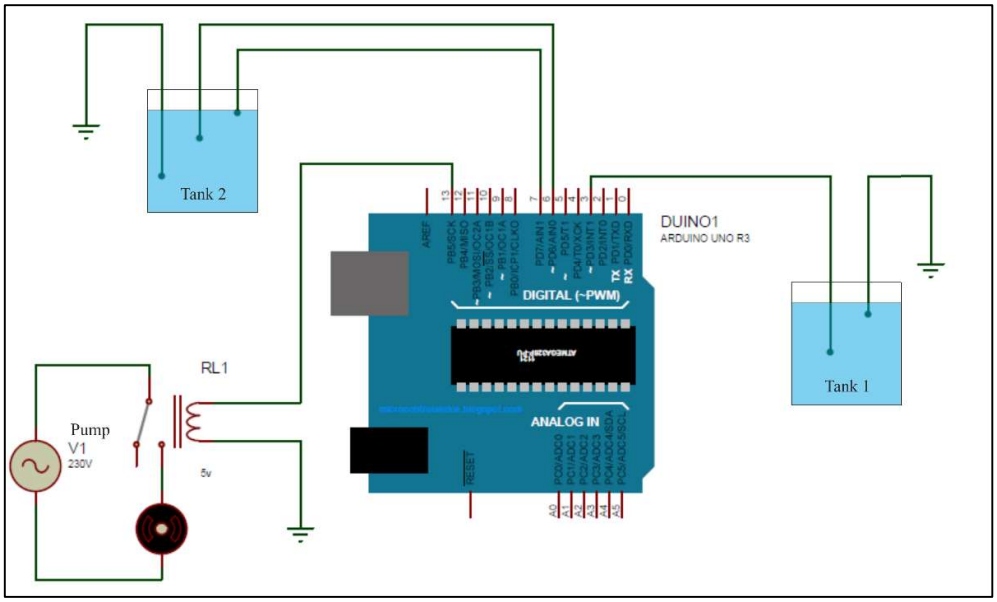


Fig 18: Circuit of Liquid level monitoring system using Arduino Uno

The circuit diagram shows that the pin 2 of Arduino Uno is used as a check pin for the lower tank (Tank 1), pin 6 is used as lower check pin in the upper tank (Tank 2), pin 7 is used as upper check pin in the upper tank (Tank 2) and the pin 13 is used as output and is used to activate the relay which further completes the circuit for the pump.

There are no separate pull up/down resistors used in the circuit as the Arduino Uno has a built in ability to use these functions.

iv. Code and Explanation

The code for the circuit is written, compiled and uploaded through Arduino IDE. The code is as follows:

```
int output = 13,ut_lowpin = 6,ut_highpin = 7, lt_checkpin = 2;
bool currentStatus = false;

void setup() {
  pinMode(ut_lowpin,INPUT_PULLUP);
  pinMode(ut_highpin,INPUT_PULLUP);
 pinMode(lt_checkpin,INPUT_PULLUP);
  pinMode(output, OUTPUT); }
void loop() {
```

```
        if(digitalRead(lt_checkpin) == LOW){

if(digitalRead(ut_lowpin) == HIGH && digitalRead(ut_highpin) == HIGH){
            digitalWrite(output,HIGH);
            currentStatus = true;

          }

if(digitalRead(ut_lowpin) == LOW && digitalRead(ut_highpin) == HIGH){
            if(currentStatus == true){
               digitalWrite(output,HIGH);
            } else {
              digitalWrite(output,LOW);
            }
        }
          if(digitalRead(ut_highpin) == LOW){
            digitalWrite(output,LOW);
            currentStatus = false;
          }
}else{
          digitalWrite(output,LOW);
          currentStatus = false;
}


        }
        // end of code
```

Explanation:

The code begins with defining the variables with respect to the digital pins. The output variable is 13, lower tank check pin is declared as lt_checkpin and its value is 2 and upper tank check pins are declared as ut_lowpin and ut_highpin and their values are 6 and 7 respectively. A Boolean variable known as currentStatus is also declared to compare the current value with the previous value.

The first function is the setup function which runs only once therefore it declares the various pin modes used. The check pins are of type 'INPUT_PULLUP' to use them as input pins with

inbuilt pull up resistor logic. The output pin is declared as OUTPUT.

The next function is the loop function which runs continuously in a loop. This function will continuously check the liquid level in both the tanks and will turn on or off the pump accordingly. The function checks each possible cases and compares it with the previous value to give the desired output.

e. Developing Circuit using 555 Timer IC

i. Brief about 555 Timer IC

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide two (556) or four (558) timing circuits in one package.

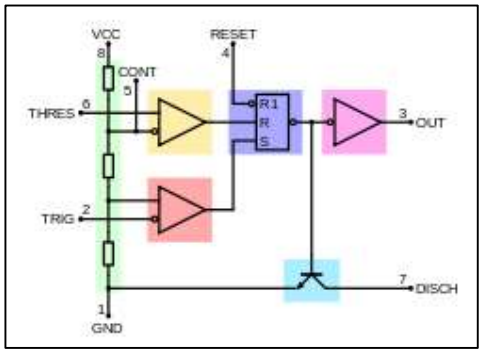


Fig 19: Internal Block Diagram of 555 IC

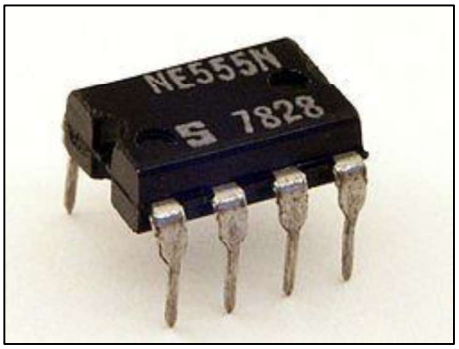


Fig 20: 555 Timer IC

The 555 IC has 3 operation modes:

- Astable Mode: In this mode the 555 can operate as an electronic oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation and so on. The 555 can be used as a simple ADC, converting an analog value to a pulse length. The use of a microprocessor-based circuit can then convert the pulse period to temperature, linearize it and even provide calibration means.
- Monostable Mode: In this mode, the 555 functions as a "one-shot" pulse generator. Applications include timers, missing pulse detection, bounce-free switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) and so on.

- Bistable Mode: the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce-free latched switches.

In this project we will be using the 555 IC in Bistable mode as by using flip flop we can create the required system.

ii. Other Components Used

- 2 x 500Ω Resistors
- 2 x 10k Resistors
- 2 x 1MΩ Resistors
- 1 x 750Ω Resistor
- 1 x 0.01µF Capacitor
- 1 x Relay
- 1 x Pump
- 1 x Power Source for Pump
- Connecting Wires

iii. Circuit Diagram and Explanation

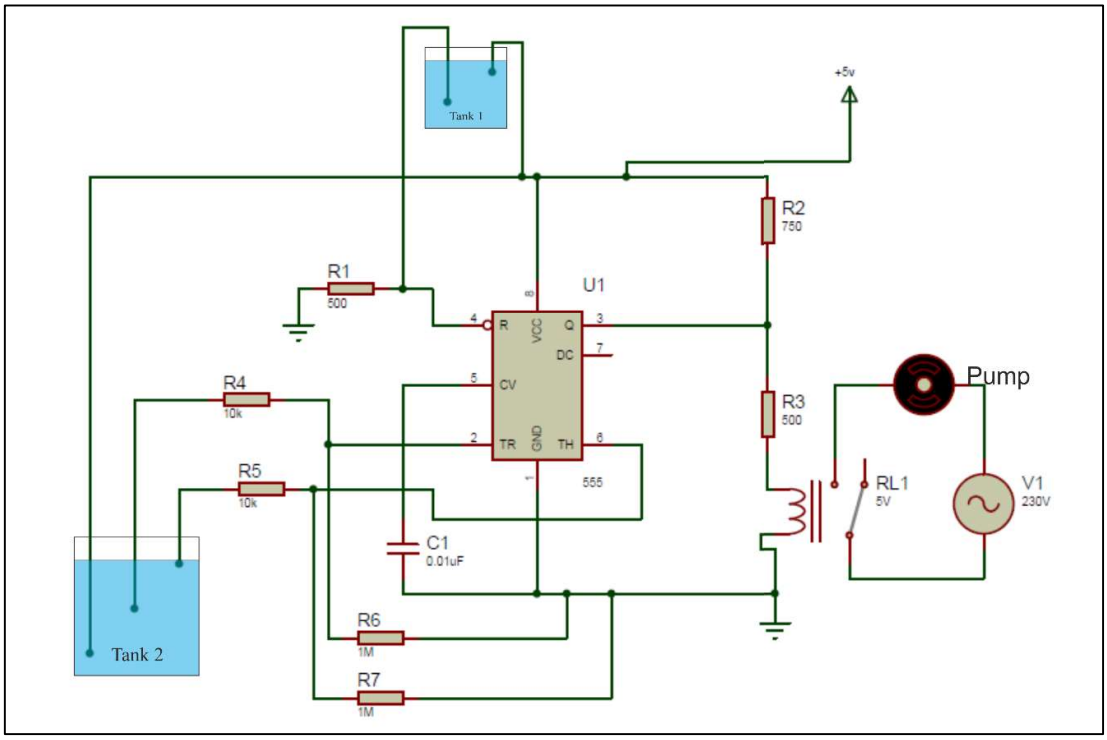


Fig 21: Circuit of Liquid level monitoring system using 555 IC

A 5V supply is given to the IC with pin 7 left unconnected and pin 5 connected to the ground along with a capacitor of 0.01μF. Pin 1 and 8 are connected to ground and VCC respectively.
As there is only one check pin in the lower tank (Tank 1) and it is superior to the other tank therefore the reset pin (Pin 4) is used to check the status of lower tank. A pull down resistor of 500Ω is used to maintain the distinct condition i.e. either HIGH or Low that is completely based on the liquid level.

As in the bistable mode the 555 IC is used as a flip-flop therefore we can connect pin 2 and 6 to the input of flip-flop. The SR flip-flop changes its state when both its input are different i.e. one is High and another is Low. There is no change of state when both are high.
Inside the 555 IC pin 6 is connected directly to the positive pin comparator whereas pin 2 is negated and connected to the negative side of the comparator. Therefore now the flip flop changes its state when status of both the pins are same i.e. the output will retain its state when status of Pin 2 and 6 are different.
The pin 2 i.e. the trigger pin has an input impedance of 2MΩ, pin 6 i.e. the threshold pin has an impedance of 10MΩ. Therefore by using the concept of pull down resistor the resistors are connected as shown above.
The output pin is Pin 3 and it can sink and source current. This means that two devices can be connected to the output so that one is on when the output is low and the other is on when the output is high, the diagram shows two LEDs connected in this way:

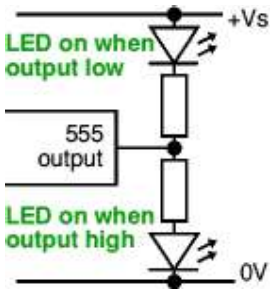


Fig 22: Output from 555 IC

Therefore the pump is connected to the 555 IC through the relay. The relay triggers when the pin is a source for current.

f. Summary and Conclusion

This is how a simple multi tank liquid monitoring system can be designed. It is easy to use, easy to install, economic and safe to use system. This system can also be improved to show the current water level status at both the tanks by just adding LEDs corresponding to every liquid level. This project can be developed by using almost any MCU.