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Research Article

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Liquid level Indication and Control System using Arduino

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Abstract

Overflow from Liquid tank is a common problem which leads to the wastage of Liquid. Though there are many solutions to it like ball valves which automatically stop the Liquid flow once the tank gets full. So a simple device has been created. This device allow to detect the Liquid level and will raise an alarm upon getting the Liquid tank full or a preset level show the level percentage on LCD, then controlling the process of turn pump on and turn it off operation.

Liquid level indicator is a modern way of measuring the liquid level using latest technologies like Arduino as as a programming unit and many different types of sensors like Ultrasonic, LDR,PIR, ……etc.

The main aim of the project is to calculate the Liquid level at any instant of time and to turn the pump on when the tank is empty or at specific level and turn it off if the tank is filled completely.

*As a result of this project the percentage of liquid's level has shown on a display unit (16*2 Liquid Crystal Display), and the fuel pump has been automatically controlled.*

Keywords: Overflow, Liquid, Ultrasonic Sensor, Fuel Tank, Pump

Introduction

The project has a simple circuit to control the pumps transferring fuel from the main tanks to the operating tanks (day tanks) automatically, without the need for operation or supervision by technicians, and this saves a lot of money and a lot of efforts, the use of this circuit also preserve the machine in the station.

The Idea came from observing the daily work of the technician at the generation station, as they were opening and closing the pumps to transfer the fuel from the main tanks to the operating tanks manually, and this process takes not less than 10minutes until the technician reaches the control panel of the pump and turn it on or off, one day there was overflow in the operating tank due the failure to stop the pump after the tank was full, which caused the loss of a lot of fuel, in addition to the damage that could have been caused to the machine and workers as a result of this.

Literature Review

Ananthan Sai MK 2019

This research dealt with the concept of measuring fluid level only in the same way used here ,which is the use of an ultrasonic sensor ,but it did not address the issue of pump control, as it was limited only to measuring and displaying the result.

Habbas, Sajjad Asghar and Shahi Qamar 2012

The research present the mathematical modeling of coupled-tank system and designing of sliding mode control(SMC) for liquid level control in system

The Problems

The time taken to open and close the pumps is very long.
The need to closely monitor the flow of fuel in the tanks and this process maybe cumbersome.

Overflow may put the machine and power plant's workers at risk
Loss of fuel when overflow occurs and that causes a loss of money

Objectives of the paper

The objective of this paper can be summarized in the following points
Reducing the time wasted in the process of opening and closing pumps manually.
Reducing the efforts required when turning on and off the pump manually
Ensure that the machine operate efficiently and without damage
Saving money that may be spent as a result of wasting fuel when overflow occurs.

Method of the project

Designing a circuit consisting of a control unit and sensor to read the fuel level and control the opening and the closing of the pump based on this reading, to transfer fuel from the main tanks to the operating tank without the need for human intervention.

Architecture of the system

The entire system can be divided into four basic blocks;

1- Sensor unit. (Ultrasonic sensor)
2- Processing Unit (Arduino board)
3- Display unit (Liquid crystal)
4- Control unit (12v Pump)

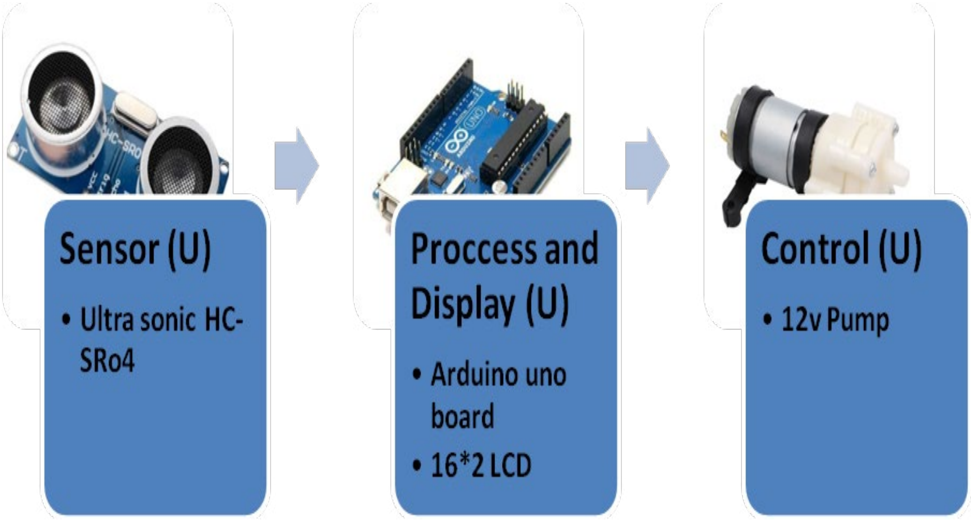

Figure 1: system architecture

Ultrasonic Sensor

As the name implies, ultrasonic sensors use ultrasonic waves to measure distance. The sensor head emits ultrasonic waves and receives the waves reflected from the target. Ultrasonic sensors degree the gap to a goal through measuring the time from transmission to reception. An ultrasonic sensor is a tool that makes use of sound waves to degree the gap to an object. Distance is measured by emitting sound waves at a specific frequency and monitoring the sound waves to bounce off. The distance between the sonar sensor and an object can be calculated by recording the elapsed time from the generation of sound waves to the bounce. Sound is known to travel through the air at about 344 m / s (1129 ft / s), so take the time it takes for the sound waves to return and multiply by 344 meters (or 1129 ft) to get the overall roundness. can do. Decision. The distance traveled by the sound wave. Round trip means that the sound wave traveled twice the distance to the object before it was detected by the sensor. This includes a "journey" from the sonar sensor to the object and a "journey" from the object to the ultrasonic sensor (after the sound wave hits the object and bounces off). To find the distance to the object, simply split the outer and return distances in half.

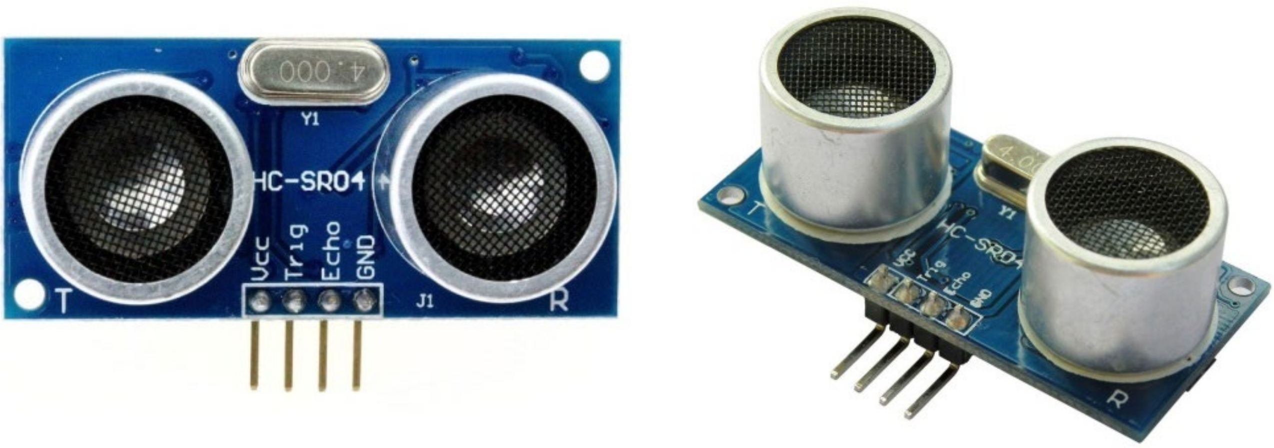

Figure 2: Ultrasonic sensor

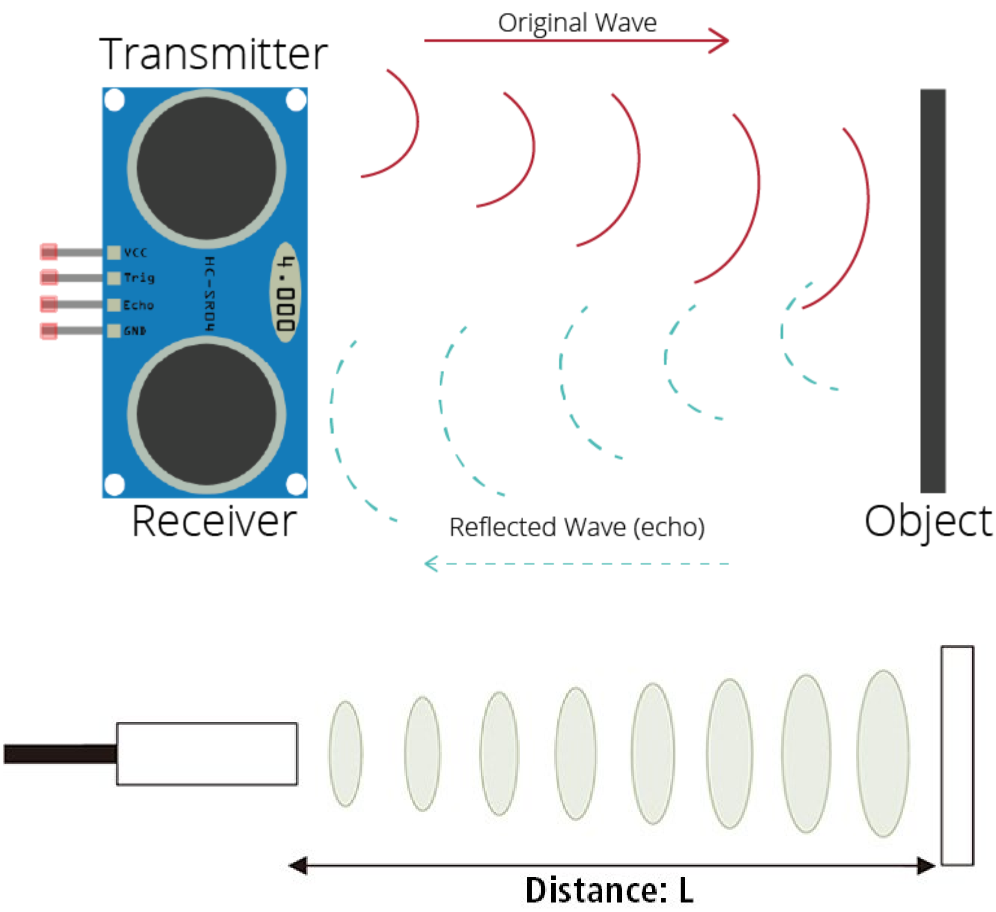

Figure 3: Ultrasonic sensor transmitter and receiver

Optical sensors have transmitters and receivers, but ultrasonic sensors use a single ultrasonic element for both transmission and reception. In a reflective ultrasonic sensor, one oscillator sends and receives ultrasonic waves alternately.

Distance Calculation

The distance can be calculated using the following formula:

Distance L = (1/2 × T × C) ....(1)

Where L is the distance, T is the time from emission to reception, and C is the speed of sound. (T is the round-trip time, so multiply the value by 1/2.)

Experiment

I connected the ultrasonic sensor to the Arduino control board and from the Arduino output I connected the relay, which in turn controls the opening and closing of the pump. The figure below explain the connection of system.

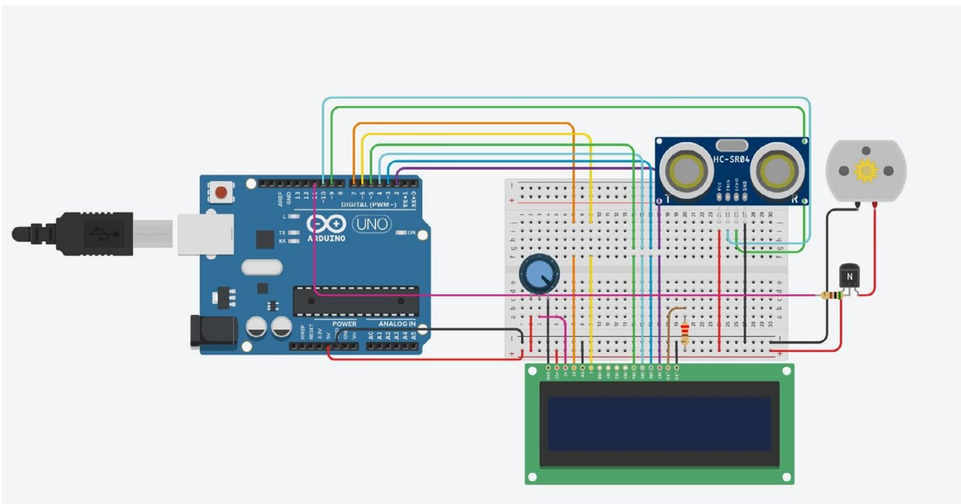

Figure 4: System connection

Working of this project is very simple Ultrasonic sensor module has been used which sends the sound waves in the Fuel tank and detects reflection of sound waves that is ECHO. First of all the ultrasonic sensor module is need to been trigger to transmit signal by using Arduino and then wait to receive ECHO. Arduino reads the time from triggering ECHO to receiving it. The speed of sound is about 340 m / s. Therefore, the distance can be calculated using the following formula: Distance = (travel time / 2) * speed of sound   Where speed of sound is approximately, 340 m per second.

By using this method we get distance from sensor to Fuel surface. After it we need to calculate Fuel level.

Now I need to calculate the total length of Fuel tank. As we know the length of Fuel tank then we can calculate the Fuel level by subtracting resulting distance coming from ultrasonic from total length of tank. And I will get the Fuel level distance. Now I can convert this Fuel level in to the percent of Fuel and can display it on LCD.

After calculating Fuel tank's level now I go to next stage using previouse result in control operation, independs on the result the pump turned on or turned off, here in my experiment the tank hight is (22cm) and the working values of system are shown in table below:

Table 1: Operation system values

Fuel tank hight (H) cm	Pump state
H=5	ON
H=20	OFF
5 =< H < 20	ON

Software Implementation

The sensor collects the data and sends it to the Arduino and then it gives the desired signal to the pumps. I can set our given level from the code. If the level crosses the given threshold the pump in the tank is given a signal and it starts to pump the fluid out of the tank until its under the threshold. When the level drops below the threshold above, the pump in the reservoir will start pumping the liquid to the tank. Only the tank and one pump are used.The flow chart below explain the process of software steps and the code which I need .

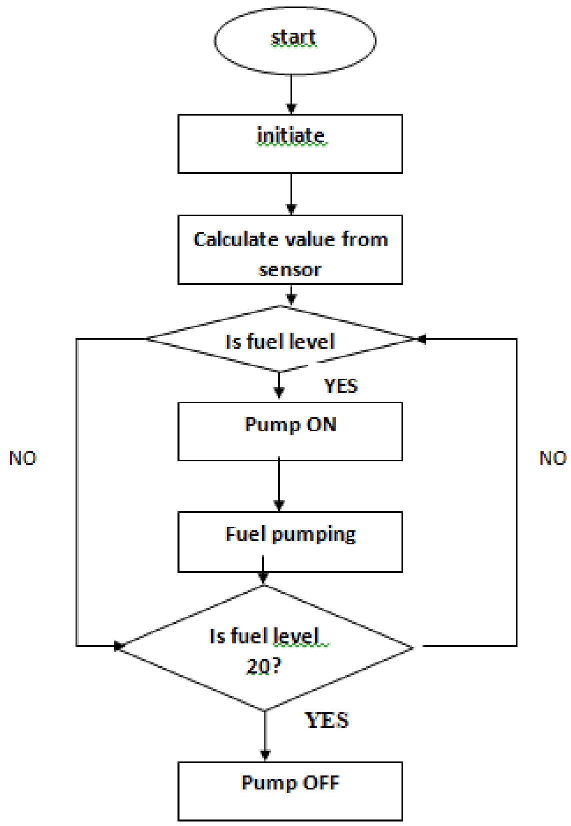

Figure 5: Flow chart

```
#include
 <LiquidCrystal.h>
int pos=0;
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
const int trigPin = 9;
const int echoPin = 10;
const int buzz=6;
const int P=7;
long duration;
int distance;
int FTH = 30;
void setup()
{  lcd.begin(16, 2);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
Serial.begin(9600);
lcd.setCursor(0,0);
lcd.print("FUEL TANK H=");
lcd.print(FTH);
lcd.print("CM");
}
void loop()
{
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance= duration*0.034/2;
int h= FTH-distance;
Serial.println(h);
delay(500);
lcd.setCursor(11,1);
lcd.print(h);
lcd.print("CM ");
int x=h;
if(h<=10&&h>=5)
{
 analogWrite(buzz,200);
 digitalWrite(P,HIGH);
 lcd.setCursor(0,0);
 lcd.print("FUEL TANK H=");
 lcd.print(FTH);
 lcd.print("CM  ");
 delay(1000);
 Serial.println("PUMP ON");
 lcd.setCursor(0,1);
 lcd.print("PUMP ON ");
 analogWrite(buzz,200);
 digitalWrite(P,HIGH);
}
else if(x==10)
{
 for(x=10;x<=27;x++)
 {
   lcd.setCursor(0,1);
 lcd.print("PUMP ON ");
 }
 digitalWrite(P,HIGH);
}
else if(h>10&&h<27)
{
 analogWrite(buzz,0);
}
else if(x==27)
{
 for(x=25;x>=10;x--)
 {
   lcd.setCursor(0,1);
 lcd.print("    ");
 }
 analogWrite(buzz,0);
}
else if(x==27)
{
 lcd.print("PUMP OFF");
 analogWrite(buzz,200);
}
else if(h>=27&&h<=30)
{
 analogWrite(buzz,200);
 digitalWrite(P,LOW);
 lcd.setCursor(0,0);
 lcd.print("FUEL TANK H=");
 lcd.print(FTH);
 lcd.print("CM ");
 delay(500);
 Serial.println("PUMP OFF");
 lcd.setCursor(0,1);
 lcd.print("PUMP OFF");
}
}
```

Results and Discussion

Screen Shot

The figure below shows the first fuel level representation by the ultrasonic and the arduino interface to turning pump ON automatically.

Figure 4: First fuel level at H=5cm

Figure (5) shows the second fuel level representation by ultrasonic and arduino interface to turning the pump OFF automatically.

Figure 5: Second fuel level at H=18~20

Result

Living in countries that suffer from shortage of sources where we need to be more conscious of the energy that we use, a liquid level indicator is ideal at saving power. Normally, regulating Fuel levels can consume electricity and waste Fuel. However, with automatic controllers, the electricity usage is limited as well as less Fuel needed to regulate a supply.

A liquid level controller helps save money by limiting the waste of Fuel and electricity. These devices accurately regulate how much energy is used to protect against any unnecessary Fuel/ electricity usage. Over time, the money saved is quite substantial.

Eliminating manual operations with a timer switch, the frustrations of manual monitoring Fuel tanks is minimized. Fuel levels are maintained at the appropriate levels thanks to the automatic operations of these devices.

Disadvantages

Fuel level controls need to be replaced every 3 years.
The rust, foul and deteriorate
Electronics are usually built separately
More difficult installation

Applications & Uses

The uses of a liquid level indication include the following applications:
Can be used in liquid tanks to control liquid levels
Automatically turn ON/OFF pumps
Oil tank level control

High & low-level alarms
Pool liquid level control
Life station switches
Leachate level control
Cooling tower water level control
Sewage pump level control
Remote monitoring liquid
Water level control
Pump controller
Stream level monitoring
Sump pump
Tsunami warning and sea level monitoring
Process batch control & monitoring
Irrigation control

Benefits

There are many benefits of Liquid (Fuel) level indicator and controller including:
Easy installation
Minimal maintenance
Sends an alert to let you know Fuel is too high or too low
Low & High alarms
Compact design

Conclusions

After designing and operating this circuit and obtaining excellent results compared to manual operation although there are some drawbacks the benefits are much more.

The time it takes to open and close the pump is greatly reduced.
The process of transferring fuel from the main tanks to the operating tank is now automated.
The risk on machine and worker due to overflow has been avoided.
Money wasted due to fuel overflow has been saved.

Recommendations

Therefore I recommend activating automated systems always because they save a lot of effort and money and work very efficiently times the efficiently that the most skilled workers can work with.

Finally through experience I found that the design is feasible from one side and can be used after adapting to different working conditions.

Declarations

Availability of Data and Materials

The experiments and results of this paper were carried out at the University of Kordofan, Faculty of Engineering and Technical studies, Sudan. The data used and analyzed during the current study will be available from the author upon reasonable request. This work is original and has not been published elsewhere and is not currently being considered for publication elsewhere.

Competing Interests

The author declare that he has no competing interests.

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Author Contribution

The author read and approved the final manuscript.

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Not applicable.

List of Abbreviations

Not applicable.

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