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Liquid Quantity, Quality & Safety Analyser

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Abstract- *Nowadays, adulteration in liquids, which we use generally as our basic amenities is practiced everywhere like in milk, soft drinks, petrol etc. in sake of some profit vendors compromise on our health. Sometime vendors fools the customers in terms of quality, quantity and safety of the product which is commonly in practice everywhere. Our device has potential to give satisfactory results in order to check quantity of liquid, quality/purity of liquid, and safety in order to consume it. Here we have focused on three liquids those are mostly used or consumed. First is water, we will be measuring quantity, quality we will measure density and for safety we will measure pH value, same we will do for our second and third liquid, milk and petrol. We use reference data to compare the quality so our device can auto detect the liquid and its properties. Device will result the data in real time without wasting much of sample product and time. Our product has wide scope of advancements and it can be used by all age groups and classes of the society, pre-existing devices for the same purpose takes much time in order to fetch the results and is not in reach of common people, it is just available to government. In our device we are using ultrasonic sensor for quantity measurement, pH sensor for quality and safety measurement. Microcontroller is Arduino Nano in order to make device compact and power efficient and results are displayed on LCD display.*

Keywords: adulteration, density, pH, Arduino nano, LCD

1. INTRODUCTION

Quantity of Liquid delivered to the customer at petrol pumps, milk or water can vendors has become a trust issue, customer is cheated frequently as he is totally dependent on the server's commitments. There is need to create a system to assure the customer about quality, quantity and safety of liquid. In societies where water cans and milk is sold and customers believe that milk and water are pure and safe to drink without testing it they start consuming it and fall sick due to less purity and safety. Many dysentery diseases are caused by consuming bad water and milk. Due to bad quality of petrol car engine's health is also effected and thus they causes pollution and consumer remains unaware of the cause or get warned when it becomes too late. Our device plays a satisfactory role in order to take a step for the health of our body and our car's engine. This device is multipurpose hence helps daily to each member of the society. Our device provides results in real time and it has much further scope in order to calculate quantity, quality and safety of more liquids like juice, diesel etc. we are using ultrasonic sensor and pH sensor for solving our purpose, these sensors will provide good qualitative results in order to achieve our goal.

2. PRINCIPLE OF OPERATION

2.1 Quantity checking:

The system consists Ultrasonic Sensor, LCD to show the output. The system is controlled by using Arduino nano. Ultrasonic sensor shaving low cost and the possibility to use in any environment.

This sensor can measure a distance within 0.003-3 meter effectively and transform the data into impulse of different width. By using this pulse width, Liquid level in tank can measured. Liquid quantity measurement system is as shown in Figure 1 block diagram.

The whole block diagram consists of following parts:

1. Power Supply 9V
2. Ultrasonic sensor
3. Arduino controller
4. 16x2 LCD Display
5. Fixed dimension container

A. Power Supply: 9V supply given at the input.
B. Arduino: Arduino consists of both a physical programmable circuit board that runs on your computer, used to write and upload programs to the physical board.
C. Ultrasonic sensor: It is a type of trans receiver. Ultrasonic sensor works on the principle of echo. The ultrasonic waves are sent to an object and the reflected waves are received. Time required for the reflected waves is recorded and accordingly the distance is calculated by knowing the speed of transmitted waves. This principle is used here.
D. Display: Display units shows the amount of Liquid digitally.
E. Fixed dimension container is a cuboidal object with known dimension of base area 10x10 cm^2 and height of 25 cm. Liquid is filled in this container so that height of empty area can be calculated by Ultrasonic sensor.

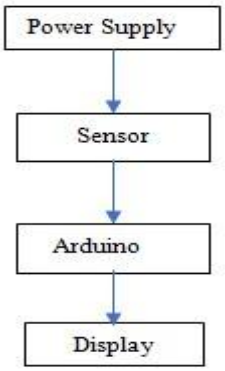

Fig -1: Liquid Quantity Measurement System

2.2 Quality and Safety checking:

Adulteration, defined as the introduction of a foreign substance into motor spirit / high speed diesel/petrol, impurities in water and water as adulterating substance in milk. Unauthorized with the result that the product does not conform to the requirements and specifications of the 9product Petrol, kerosene and high speed diesel is a mixture of organic volatile compounds, mainly hydrocarbons (83-87% of carbon and 11-15% of hydrogen).The petroleum fraction for petrol, kerosene and diesel Over the past it is seen that different methods and standards involving determination of physical and chemical properties are carried out for detection of adulterated petroleum products. As adulteration occurs mainly at some point of product delivery between refineries and Liquid stations. The American Society for Testing and Materials International (ASTM International) has developed and documented test methods for its detection including petroleum products. But such methods endure from limitations in terms of accuracy and sensitivity. Although different tests namely Density test, Evaporation test, Distillation test, Chemical test may be used to determine the adulteration.

Table -1: Density Table

Petrol/Petrol+Kerosine	Density 260 C
Pure petrol	719
Up to 5%	725
Up to 20%	751
Up to 21-30%	768
Up to 31-40%	774
Up to 41-50%	791
Up to 51-55 %	783
Up to 56-60%	802
10% adulterated	725
20% adulterated	783
Kerosene	795

The Parameters like density, Distillation, Hydrocarbon Composition Stability Octane Number, Multifunctional additive dosage are conducted for Gasoline. We are going to identify the adulteration by checking the density. Density according to the percentage of adulteration is shown in Figure 2 table above. The table gives information about the density of petrol at respective percentage adulteration of kerosene with the petrol on basis of this table we can identify the quality of adulteration into the petrol. The setup consists of 200ml Beaker having mesh on upper side. The electronic flow valve is attached at bottom of beaker, so that the Liquid from beaker is released using gravitational force. The whole arrangement is placed on load cell. The load cell and the electronic flow valve are connected to Arduino and are controlled using program.

Second is our milk in societies of rural areas , both the places some local milk vendors claims to give pure milk but there is no parameter to test them, as they offer such claims they need to be tested so, where water is mixed or due to stagnation pH value of milk changes which make it harmful to consume it can cause much dysentery diseases to old and infants mainly. Results of pH will also be displayed over the LCD in real time before consuming it.

Third liquid is our water, in societies water can business is popular which provides water in plastic can and customers don't know if the water is pure or not , even from how long it is stagnate in that bottle, or if that bottle wash properly distilled or not. So to keep a check is necessary.

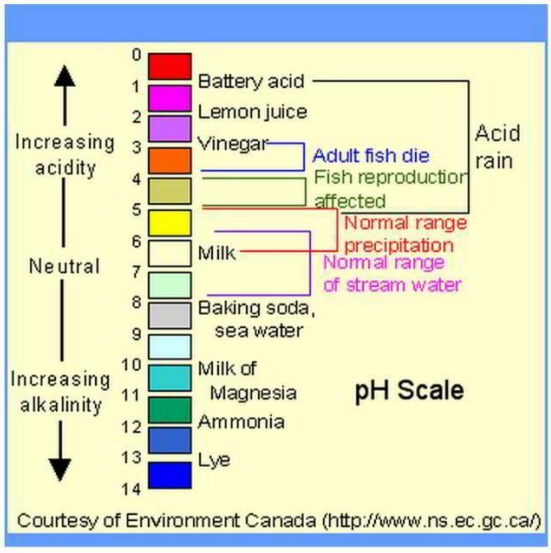

Fig -2: pH Table

2.3 Working:

Here our pH sensor is basically a hydrometer and hydrometers use Archimedes principle, Archimedes principle also you are familiar with from your school days. A partially floating body will sink to that explained till the weight of displays liquid equals the weight of the body. I repeat, a partially floating body will sink to that extent till the weight of displays liquid equals the weight of the body, does a hydrometer will sink to different depths in liquids of different densities. This is a schematic of hydrometer so, it has some weights here which are let us sorts as shown here, and this is air filled glass bulb. You have the stem here, and there is a graduated scale eastern the stem. Now, if I dip this hydrometer into a full of liquid depending on the density of the liquid it will sink to a particular depth.

So, when this hydrometer is depth in say liquid one, it can sink to it can sink say up to one particular depth, but if I know take this hydrometer and put it some other liquid with different density it will sink to some other depth. So, this scale can be used to indicate the density. So, we can perform proper calibration,

We can perform calibration using liquid some known density, and can note up to what depth this hydrometer sinks. And then can use the hydrometer to find out the density of unknown liquid. Like here if you look at the scale, the different densities in gram per ml is indicated on this scale. So, they all corresponding to different liquids, density gram per densities represented in gram per ml; so when it when it is one it is distilled water one point 0 to 0 brackish water so on and so forth. So, basically a hydrometer consists of a weighted cylindrical float with an arrow 15 centimetre to 14-centimeter-long stem graduated in any unit. The float and steam are made of plastics or glass so, from the scale; that is, they are on the stem of the hydrometer, and we can measure the density of the liquid. This equation tells you the mass mg which is mass of the hydrometer is equal to the mass of the liquid that is displaced.

So, mass of the hydrometer is mg and V is the liquid that is displaced. So, V into rho into g is the mass of the liquid that is displaced. So, this equation tells you that this V into rho will be different for different liquid. Because mg is fixed so, when different liquids, I am take if I take different liquids this is V into rho will be different.

So, this is basically this rho will be different. So, this is rho is since this is rho is different, since this rho is different, it has to sink to different depths. So, let me clarify this 0.1 more time. Mg represents the mass of the hydrometer which is fixed. Now when you depict into a liquid of density rho, it displaces a volume of water which is b vol volume of the liquid is V that is displaced. So, n g has to be equal to V into rho into g. So, if I put it into different liquid now, this has to sink to different depths. So, from the scale that is attached to this stem can be used to indicate densities. The span that can be covered is 0.05 to 2.1 specific gravity.

2.4 Operation:

The following flow chart is explaining the operation of our device. Fixed dimension container is a cuboidal object with known dimension of base area 10x10 cm^2 and height of 25 cm. Liquid is filled in this container so that height of empty area can be calculated by Ultrasonic sensor. Then the empty height is subtracted from total height which is known, so that we have result as height of the liquid.

The pH sensor senses the concentration of H+ ions in the liquid so that density of the liquid can be measured that is the measurement of the Quality of the liquid. The density value is qualitatively measured via reference value.

The pH sensor also senses the pH value of the liquid directly so that we can determine that is it safe to consume or not.

All the values are displayed over 16 x 2 bit LCD using the microcontroller Arduino.

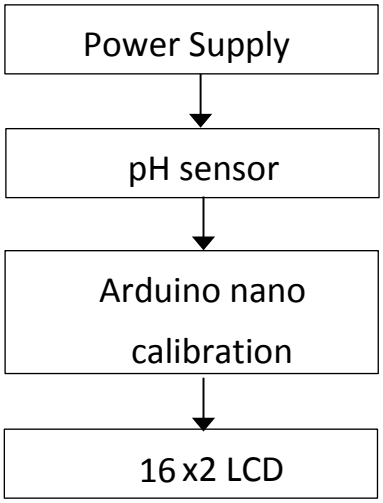

Fig -3: Operation Flow Chart

3. COMPONENTS INCLUDED

3.1 Arduino:

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P; offers the same connectivity and specs of the UNO board in a smaller form factor. The Arduino Nano is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline. Arduino Nano has similar functionalities as Arduino. The Nano is inbuilt with the ATmega328P microcontroller, same as the Arduino

UNO.T he main difference between them is that the UNO board is presented in PDIP form with 30 pins and Nano is available in with 32 pins. The extra 2 pins of Arduino Nano serve for the ADC functionalities, while UNO has 6 ADC ports but Nano has 8 ADC ports. The Nano board doesn't have a DC power jack as other Arduino boards, but instead has a mini-USB port. This port is used for both programming and serial monitoring. The fascinating feature in Nano is that it will choose the strongest power source with its potential difference, and the power source selecting jumper is invalid.

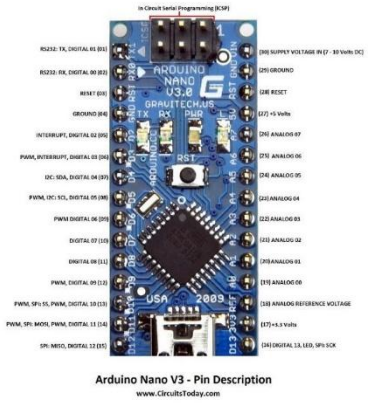

Fig -4: Arduino Nano

3.2 Ultrasonic sensor:

An Ultrasonic sensor is a device that can measure the distance of an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and by receiving the reflected sound wave. The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back.

Fig -5: Ultrasonic sensor

The sensor has two openings on its front. One opening transmits ultrasonic waves, the other receives them. The distance can be calculated with the following formula:

L = 1/2 × T × C

Where,

L-Distance

T-Time between the emission and reception

C- The sonic speed.

C=331.5+0.607t (m/s)

Where, T-Temperature

(The value is multiplied by 1/2 because, T is the time for go and return distance)

3.2.1 Working of ultrasonic sensor:

STEP-1: Make 'TRIGGER' pin of sensor high for some duration. This will initiate sensor cycle.

STEP-2: Eight pulses of 40 KHz are transmitted from transmitter part of sensor. After this is done, 'ECHO' pin goes high from low state

STEP-3: After the transmission, transmitted signal gets reflected from the nearby object and returns back to the sensor.

STEP-4: When the ultrasonic sensor detects reflected wave, 'ECHO' pin of sensor goes low.

STEP-5: The time duration when ECHO pin is high will provide distance between sensor and detected object.

STEP-6: The ultrasonic sensor is programmed in such a way that if no object is found then ECHO pin remains high for some time and will go low again

3.3 pH-4502c sensor Sensor:

PH is a measure of acidity or alkalinity of a solution, the pH scale ranges from 0 to 14. The pH indicates the concentration of hydrogen [H] + ions present in certain solutions. It can accurately be quantified by a sensor that measures the potential difference between two electrodes: a reference electrode (silver / silver chloride) and a glass electrode that is sensitive to hydrogen ion. This is what form the probe.
We also have to use an electronic circuit to condition the signal appropriately and we can use this sensor with a micro-controller, such as Arduino.
As we can see that there are two potentiometers in the circuit. Which it is closer to the *BNC* connector of the probe is the ***offset regulation***, the other is the ***pH limit***.

- **Offset:** The average range of the probe oscillates between negative and positive values. The 0 represents a pH of 7.0. In order to be able to use it with Arduino this circuit adds an offset value to the value measured by the probe, so the *ADC* will only have to take samples of positive voltage values.

- Therefore we will force a pH of 7.0 by disconnecting the probe from the circuit and short-circuiting the inside of the BNC connector with the outside. With a multimeter measure the value of ***Po pin*** and adjust the potentiometer to be 2.5V.
- **PH Limit:** This potentiometer is to set a limit value of the pH sensor circuit that causes the red *LED* to light up and the ***Do pin*** signal to turn *ON*. In addition we have to calculate the voltage conversion that will give us the pH sensor so we will need two pH reference value and measure the voltage returned by the sensor on the ***pin Po***.
- The best thing to do is to use a calibration solution in powders, there are also in liquid but it is easier to preserve the powders. These solutions are sold in different values but the most common are pH 4.01, pH 6.86 and pH 9.18.

3.3.1 PH Probe Sensor Pinout:

1. TO – Temperature output DO – 3.3V Output (from ph limit pot)

2. PO – PH analog output ==> **Arduino** Gnd – Gnd for board (can also come from Arduino GND pin) **==> Arduino GND**

3.VCC – 5V DC (can come from Arduino 5V pin) **==> Arduino 5V pin**

4. POT 1 – Analog reading offset (Nearest to BNC connector)

5. POT 2 – PH limit setting

Fig -6: pH-4502c

Fig -7: probes

3.4 16x2 bit LCD:

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

Operating Voltage is 4.7V to 5.3V

- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

Fig -8: 2x16 LCD

4. RESULT

4.1 For Quantity check up

Data obtained by the ultrasonic sensor, the exact quantity of poured Liquid is measured and displayed on display. Fixed dimension container is a cuboidal object with known dimension of base area 10x10 cm^2 and height of 25 cm. Liquid is filled in this container so that height of empty area can be calculated by Ultrasonic sensor.

4.2. For Quality check up

According to the percentage of adulteration is shown in table above. The table gives information about the density of petrol at respective percentage adulteration

From this table we can identify the quality of adulteration into the petrol.

Table -2: Result Density Table

Petrol/Petrol + Kerosene	Density
Pure Petrol	718-722
Petrol+10%Adulteration	730-735
Petrol+20%Adulteration	738-742
Kerosene	798-802

Fig -9: Test Results of Adulteration.

5. CONCLUSION

Irrespective of the challenges encountered, we were able to measure the pumped Liquid inside the tank using ultrasonic sensor. The quality of liquid like milk and water is tested satisfactorily by the pH meter as we have calibrated it to density also and safety is measured by pH scale the data is displayed over the LCD which will help many common people in consuming a safe and healthy liquid as promised by their trusted vendors. This device is multipurpose hence helps daily to each member of the society. Our device provides results in real time and it has much further scope in order to calculate quantity, quality and safety of more liquids like juice, diesel etc. we are using ultrasonic sensor and pH sensor for solving our purpose, these sensors will provide good qualitative results in order to achieve our goal.

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