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Automation of Fuel Tank Level Monitoring and Measurement

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ABSTRACT
Fuel is one of the most essential commodities in the market and it plays a key instrument in the economy of every country, hence measuring and monitoring fuel to check the quantitiesof fuelin the tank is important.
Over the years fuel stations inKoforidua, Ghanause the traditional way of monitoringand measuring the fuel levels in storage tanks, known as manual system.
The use of manual system of dipping a graduated stick into fuel tanks is time consuming and often gives inaccurate quantities of fuel in the tanks.There are other fuel tank monitoring systems in the market, however they are extremely expensive to purchase.

KEYWORDS: Arduino Mega Board, Ultra Sonic Sensor, Temperature Sensor, Fuel Tank, Fuel

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I. INTRODUCTION

A fuel tank monitoring system is automatic device that provides high precision measurement of fuel quantities in a tank. The most popular fuel monitoring system in Koforidua, Eastern Region, Ghana currently is the manual system where a graduated rode is used to measure the amount of fuel quantities in a tank.

The manual systemhas been in existence for a long period of time and is highly inaccurate. Also,the quantities of fuel obtained during the manual measurement is influenced by the temperature of the fuel tank.

The Digital Fuel Tank Monitoring System will inculcate Arduino mega board, a micro controller which will coordinate all the activities of all other components of the system.

These components include: ultra-sonic sensor,temperature sensor and LCD screen.

The Arduino Board will process and execute the computer programming codes that will determine how the temperature and ultra-sonic sensors will function.

1.1 PROBLEM STATEMENT

Fueltank levelmeasurement using manual systemis inaccurate and inefficient.

1.2SIGNIFICANCE OF STUDY

The digital fuel tank monitoring system will enable accurate quantities of fuel to be determined in the fuel tank.

1.3 OBJECTIVES

1. To automatically provide precisemeasurement of fuel quantities in the tank
2. To provide a less expensive fuel tank monitoring system
3. To provide efficient method of gauging fuel quantities in the tank

II. LITERATURE REVIEW

Related works were thoroughly studied and the gaps discovered in those literatures will be addressed in this study. The method of using graduated measuring stick to gauge the quantities of fuel in the tank is expensive and time-consuming(Ward and Haskins, 2014)

It is actual problem in the oil industry to monitor quantity of fuel remained in a tank. Long stick is good enough such as the one used in some Russian industries but this method gives inaccurate measurement (Ibragimov,2014).

2.1 ARDUINO MEGA BOARD

ARDUINO HOME SECURITY SYSTEM

This a Home Security System that uses Arduino Mega 2560. It is activated or triggered an alarm when any door is opened or any movement is detected in the room (Abedi, 2017).

2.2 DIGITAL THERMOMETER USING LM35 TEMPERATURE SENSOR

Thermometers are very useful in terms of temperature measurement. In this study, thermometerwhich measures and output present temperature on liquid display device will be used. This device is used in offices and many other places to measure the temperature. TheArduino basedsystem alsoinvolvestemperature **sensor** and an LCDunit.

Hardware components of the digital thermometer mentioned above include the followings:

- LM35 temperature sensor
- UNO Arduino
- LCD Display

The digital thermometerconsists of 3 hardware components, which include, LM35 temperature sensor, UNO Arduino and the LCD Display which helps to determine the temperature of a particular environment(Saddam, 2015).

The digital fuel tank monitoring system will inculcate the use of a temperature sensor which is able to detect the fuel tank temperature because the quantities of fuel in the tank can be inaccurate as a result of high temperature.

2.3 SMART WIRELESS WATER LEVEL MONITORING AND PUMP CONTROLLING

The smart water level monitoring system controls water pump without human interfacing (Santra, Sanjoy, Sibasis, and Kanushik, 2017)and the components include the followings:

- Ultra-sonic level sensor
- Arduino board
- LCD

III. METHODOLOGY

A qualitative research approach was adopted and used in this study; data gathering was done using interview.

We chose qualitative approach over quantitative because it is less rigorous. The research method adopted in the study was also quantitative. Interview was used to collect data because is a communication based qualitative research method.

3.1 DATA COLLECTON

Data were collected fromtendifferent fuel stations in Koforidua, Eastern Region and these are:

i. Shell fuel station (Poly junction),
ii. Total 1 fuel station
iii. Total 2 fuel station
iv. Goil fuel station (Charley Junction)
v. Total 3 fuel station (Zongo Junction)
vi. Total 4 fuel station (Nkurakan),
vii. Frimps oil fuel station (Koforidua-Nsutam Rd)
viii. Total 5 fuel station (Koforidua,Suhum Rd)
ix. Petrosol Fuel Station
x. Finest Fuel Station

3.2 INTERVIEW QUESTIONS

i. Is it inconvenient and time consuming using the manual system to gauge fuel quantities in a tank?
ii. How many times in a day do you measure fuel levels?
iii. Do you take into consideration the temperature of tank environment when measuring fuel levels?
iv. What is your opinion about The Digital Fuel Tank Monitoring System?

IV. PROPOSED SYSTEM

The digital fuel Tank Monitoring System is made up of three major components which are explained below with block diagrams.

3.3 ARDUINO MEGA 2560

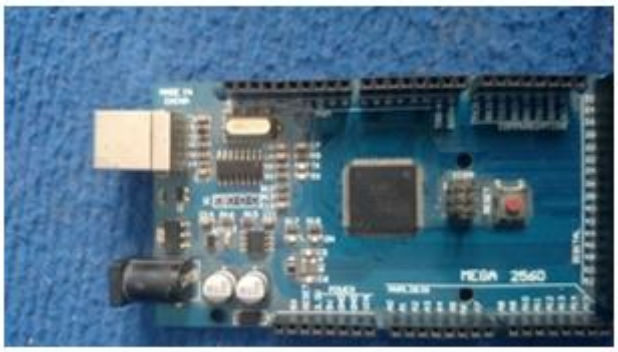

FIG.1 Arduino Mega 2560 (microcontroller)

It acts as the brain of the entire circuit. It is able to receive and send digital and analog signals and also do basic low-level computations

3.4 LIQUID CRYSTAL DISPLAY (LCD)

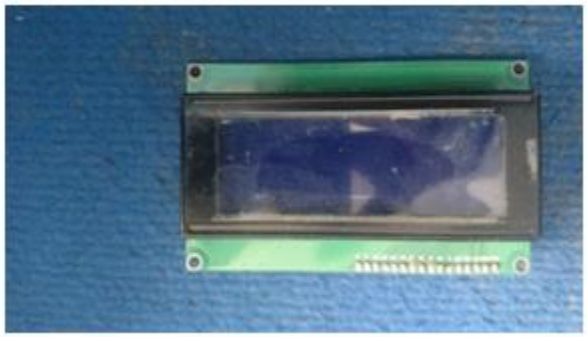

FIG. 2 20x4 i2c Liquid Crystal Display (LCD)

It displays alphanumeric characters and also custom-made characters in 20 rows and 4 columns array. It uses the i2c interface type, which has two wires to transfer data from the microcontroller to LCD.

3.5 ULTRASONIC SENSOR

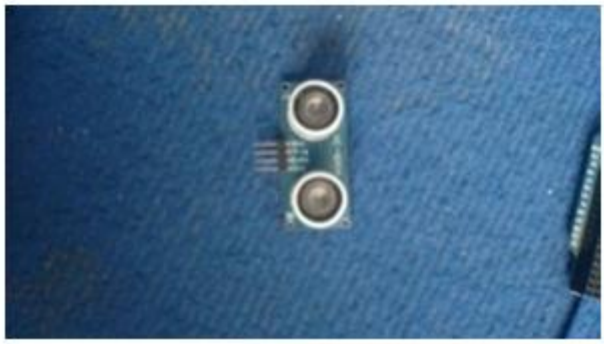

FIG 3. HC-SR04/ Ultrasonic sensor

It has two protruding cylindrical shaped metallic casing which houses a transmitter and receiver responsible for sensing objects.

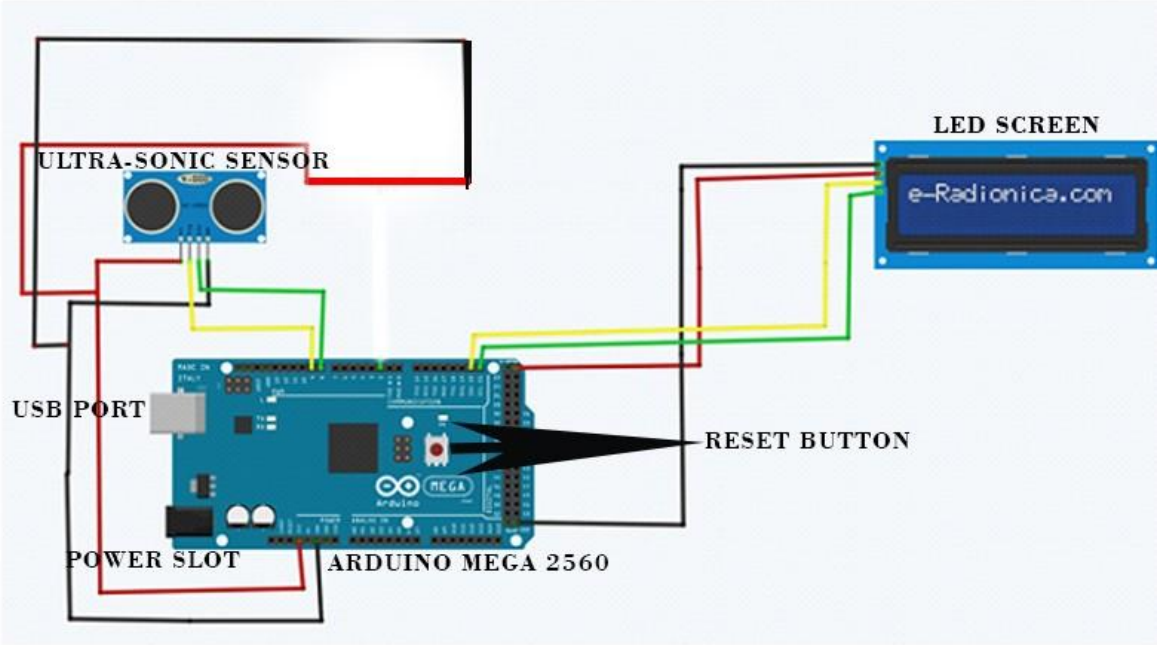

FIG.4 COMPLETE PROJECT ARCHITECTURE OF THE DIGITAL FUEL MONITORING SYSTEM

The above block diagram is a complete system which is the integration of ultra-sonic sensor, led screen and Arduino mega 2560.

3.6 PROGRAM SOURCE CODES

The below codes written C++ programming language were developed to make the hadware function.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>
#include <Adafruit_Sensor.h>

#define DHTTYPE DHT11

LiquidCrystal_I2C lcd(0x27,20,4);  // set the LCD address to 0x27 for a 16 chars and 2 line display

uint8_t DHTPin = 2 ;
DHT dht(DHTPin, DHTTYPE);

int trig = 9;
int echo = 8;

float Temperature;
float Humidity;

//TANK DIMENSION
float d = 21.3; //diameter in centimeters
float h = 19.4; //height in centimeters

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600) ;
pinMode(trig,OUTPUT);
pinMode(echo,INPUT);
pinMode(DHTPin, INPUT);
```

```
dht.begin();
lcd.init();
lcd.backlight();

lcd.setCursor(8,0);
  lcd.print("FUEL");
lcd.setCursor(7,1);
  lcd.print("LEVEL");
lcd.setCursor(5,2);
  lcd.print("MONITORING");
lcd.setCursor(7,3);
  lcd.print("SYSTEM");
delay(3000);

}

void loop() {
  // put your main code here, to run repeatedly:

digitalWrite(trig,LOW);
delayMicroseconds(2);
digitalWrite(trig,HIGH);
delayMicroseconds(10);
digitalWrite(trig,LOW);

float duration = pulseIn(echo, HIGH);
float distance = (duration/2)/29.1;


if ( distance< 0) {
  distance = 0;
  }
if ( distance> h) {
  distance = h;
  }
/*if ( level< 0) {
  level = 0;
  }
if ( level> 100) {
  level = 100;
  }*/
float tankVolume = ( 3.142 * ( d * d ) * h ) / 4;              //cubic centimeters
float tankLitres = tankVolume / 1000;                          //total tank capacity in Litres
float fuelVolume = ( 3.142 * ( d * d ) * distance ) / 4;       //cubic centimeters
float fuelLitres = fuelVolume / 1000;                          //Litres
float actualLitres = map ( fuelLitres, 0.00, 6.50, 6.50, 0.00 );
float fuelPercentage = ( fuelLitres / tankLitres ) * 100;      //
float actualPercentage = map( fuelPercentage, 0.00, 100.00, 100.00, 0.00);

  Temperature = dht.readTemperature(); // Gets the values of the temperature
  Humidity = dht.readHumidity(); // Gets the values of the humidity

Serial.println(distance);
lcd.clear();
lcd.setCursor(7,0);
  lcd.print("Temp:");
lcd.setCursor(7,1);
  lcd.print(Temperature);
```

```
  //lcd.setCursor(12,1);
  //lcd.print("C");
  //lcd.setCursor(0,3);
  //lcd.print(Humidity);
lcd.setCursor(0,2);
  lcd.print("Fuel%:");
lcd.setCursor(0,3);
  lcd.print(actualPercentage);
lcd.setCursor(13,2);
  lcd.print("Ltrs:");
lcd.setCursor(13,3);
  lcd.print(actualLitres );
delay(500);
  Serial.println(distance);
//lcd.clear();
}
```

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The data collected from the respondents in 10 different fuel stations through interview revealed the following results:

All the ten fuel station attendants that were interviewed stated that it was inconvenient using manual system of measuring the level of fuel in a fuel tank.Six out of the ten fuel stations attendants said that they measured their fuel levels thrice in a day while the other two mentionedtwice a day.Eight out of the ten fuel stations attendants were not aware that temperature affects the quantities of fuel in a tank while the other respondents were completely aware of it.All the ten fuel station attendants were so delighted about the digital fuel tank monitoring system because of its associated benefits.

The Arduino mega board 2560 was used as the micro-processor for the digital fuel tank monitoring system, the c++ programming language was also used to program the micro-processor to coordinate the functions of the other components i.e. ultra-sonic sensor, temperature sensor and the LCD screen.The c++ programming language was used because it is compatible with the Arduino mega board 2560.

5.1 TESTING AND VALIDATION

Both the unit and integration testing were done to ensure the reliability of the system.

5.2 UNIT TESTING

i. ARDUINO MEGA BOARD

We tested the Arduino megaboard to verify whether it was working reliably. Programs developed were uploaded unto the backend of the of the Arduino mega and it was confirmed that the codes executed successfully using virtual system.

ii. ULTRA-SONIC SENSOR

The ultra-sonic sensor as a unit was tested by connecting it to the Arduino mega board and fixed on top of the fuel container and then liquid was poured into the container to find out whether the ultra-sonic sensor could detect the level of liquid in the fuel tank accurately. The result of the test conducted showed that the liquid level was detected with accuracy.

iii. TEMPERATURE SENSOR

The temperature sensor was connected to the Arduino Mega Board and tested so to find out whether it was able to read the exact temperature of the environment and the result was successful.

iv. LCD SCREEN

The LCD screen was connected to Arduino Mega Board and the test performed was successful also. The fuel level in the container in litres as well as the temperature in degree Celsius were displayed on the LCD screen.

5.3 INTEGRATION TESTING

The Arduino Mega Board as earlier stated above is the brain of the entire system and all the other components are connected to it to enable the system function as a complete system. It contains all the programming codes that instructs each component to work efficiently and reliably.

The ultra-sonic sensor was connected to the Arduino Mega Board using thin copper cables. The Arduino Mega Board instructs the ultra-sonic sensor through codes to read the level of the fuel tank in litres.

Temperature Sensor was also connected to the Arduino mega using thin copper cables also. It measures temperature of the fuel tank monitoring environment in Degree Celsius with the aid of the codes in the Arduino Board.

The LCD screen was also connected to the Arduino board to display the various outputs of the various components of the Digital Fuel Monitoring System. The outputs displayed on the LCD screen was done via the codes in the Arduino mega board.The LCD Screen is integrated with the entire system using thin copper cables.

And it was tested to display the various outputs i.e. fuel level and temperature of the fuel tank environment with all the other components interconnected through the Arduino Mega Board

5.4 SYSTEM TESTING

To verify that the digital fuel tank monitoring system works effectively and efficiently, we did a full-time demonstration including a third party who is our colleague in class and the fuel station employee since the system will be used mainly at fuel stations.

Step 1

The Arduino Mega Board, LCD unit, ultra-sonic sensor and temperature sensor that wereassembled together as a single unit was placed on top of the liquid container.

Step 2

Four(4) litres of liquidwas poured into the liquid container to verify if the ultra-sonic sensor can read the exact amount of liquid in the container.

Step 3

The output of the ultra-sonic sensor was displayed on LCD screen and it was exactly 4liters.

V. CONCLUSION

In conclusion, we have been able to design and implement digital fuel tank monitoring system which monitor and measure fuel tank levels. Using both hardware and software to build and develop the system successfully as shown in the results above, it is also confirmed from the responses of all the respondents that manual system of gauging fuel level is inaccurate and time consuming.

VI. RECOMMENDATION

It is recommended that the digital fuel monitoring system should be used in the ten fuel stations in Koforidua, Easter Region, Ghana including other stations in different regions which are already using the expensive fuel monitoring systems. This is because, the developed system in this study is not only cost effective topurchase but it saves time and gives accurate measurement when compare to manual system.

REFERENCES

[1]. Abedi, H. (2017). Arduino Home Security System.*ResearchGate*. Retrieved on March 3rd 2020 from https://www.researchgate.net/publication/319621288_Arduino_Home_Security_System

[2]. Saddam (2016, June 16). Digital Thermometer using Arduino and LM35 Temperature Sensor.*CircuitDigest.* Retrieved on March 3rd, 2020 from https://circuitdigest.com/microcontroller-projects/digital-thermometer-using-arduino

[3]. Santra,M.,Sanjoy, B., Sibasis,B., Kanushik, P. (2017).Smart Wireless water level Monitoring & Pump controlling System.*International Journal of Advances in Scientific Research and Engineering, volume03*(4), page 186-196

[4]. Ward, I., Haskins,R. (2014, February 27). United States patent application publication ward et al. Retrieved on March 3, 202 from https://patentimages.storage.googleapis.com/74/50/ba/339e0d2791d991/US20140053645A1.pdf

[5]. Ibragimov,R. (2014, February 17). National Research University of Electronic Technology. Retrieved on March 3, 2020 from https://www.researchgate.net/post/What_methods_can_be_applied_to_measure_quantity_of_fuel_remained_in_a_big_industrial_container_about_50_m3

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