Design and Implementation of Petroleum Product Level Monitoring and Tracking System

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Abstract— Distribution of refined crude oil by road transport is characterised by numerous constraints like thefts and accident on the highways. The need to monitor and track the location of the trucks conveying the petroleum product can't be over emphases. This work is all about the design and implementation of petroleum product level monitoring and tracking system. The system incorporates GSM/GPS module, Ultrasonic sensor and PIC16f877A microcontroller for data acquisition and processing. The study is aimed at reducing theft and knowing were about of the vehicle conveying the petroleum product at a minimal cost. This paper presents a classy summary on technology-based methodology for determination the complicated chase system within the logistics and supply chain network. The ultrasound detects the change in volume of the petroleum product in the truck and the GSM/GPS module send the GPS location and volume to the administrator in a remote location.

Keyword: GSM/GPS module, Level, Microcontroller, Tracking, Ultrasonic sensor, Petroleum Product (eg. petrol, kerosene, diesel fuel oil).

1 INTRODUCTION

A lot of mishappenings occur on the road daily in the process of conveying petroleum products by truck to retail outlets. Therefore the necessity of security and watching is developed. To resolve such issues, this research was carried out using Ultrasonic sensor, GPS and GSM technologies.

Roads handle over 70% freight transport share in Nigeria. The highways within the country usually account for above 70% of the movement of products and persons within the country. The various modes of transporting refined products complement one another on various occasions, though in some cases they competition against each other. According to [7] road transport forms the major linkage between the depots and the bulk consumers and retails outlets. The cost per unit of transporting the products by road depends both on the road and vehicle in use. This is the major issues in freight transportation there are demand all over the world.

This system deploy Global Positioning System (GPS) which receive the coordinates from the satellites among other critical information. Tracking system is very important in modern world. This can be helpful in soldier watching, tracking of the theft vehicle and various other applications. The system is microcontroller based that consists of a global positioning system (GPS), global system for mobile communication (GSM) and ultrasonic sensor. This project uses only one GPS device and a two approach communication method is achieved employing GSM electronic equipment [6].

2 RESEARCH OBJECTIVE

The main objective of this research work design and implement an advanced Petroleum product tracking and level monitoring system in real time. When user sends a STATUS message from a cell phone and as soon as the GSM module gets the message, it will check for the user's authentication and if found to be valid, it will immediately send the details of the fluid level and location like the latitude and the longitude using GPS module with google map link. So the user can get to know the exact location of the vehicle and monitor the level [10][6].

3 LITERATURE REVIEW

The proposed method presents the researchers framework for achieving a more cost effective vehicle theft alert and fluid level sensing system.[14] The framework proposes the use of the GPS, GSM and the ultrasonic sensor. [14] Architecture of this research is shown in fig. 1.0

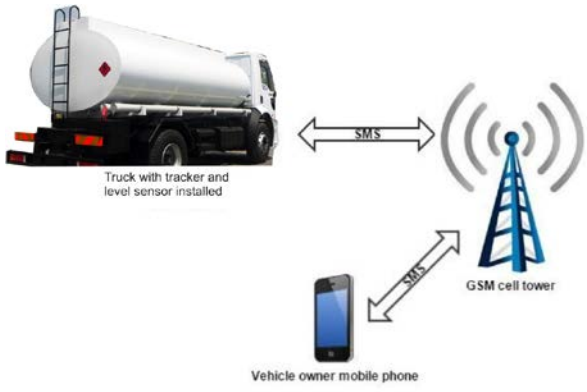


Fig. 1: The System Architecture

The system uses PIC16f877A microcontroller, A6 GSM/GPS module and ultrasonic sensor as the main component. The system can track and measure the level of the petroleum product. The gps location of the truck and measurement report is obtained upon requested SMS. The system block diagram can be seen in Fig. 1.1.

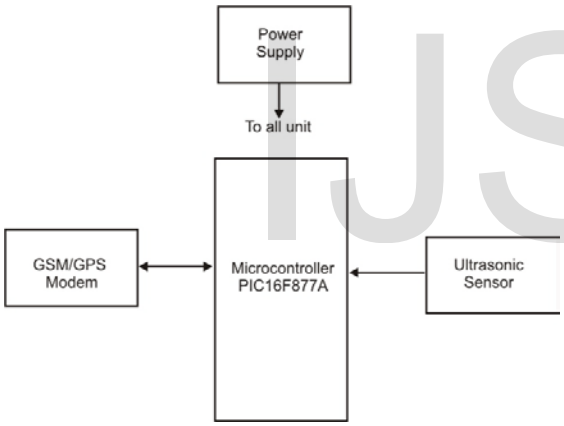


Fig. 2: block diagram of monitoring and tracking of petroleum product system

3.1 Power Supply Unit

5V DC supply is needed for the operating voltage for the microcontroller unit, GSM/GPS module and the ultrasonic sensor.[10] And since the truck is not station there will be no need for a power supply conversion. The needed 5V can be gotten from the vehicle battery and regulated using a 5V regulator. A 7805 IC is used as a voltage regulator which gives 5V DC from 12V DC voltage. [10]

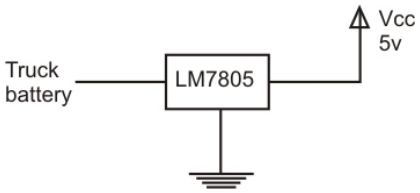


Fig. 3: 5V Regulator circuit

3.2 Global Positioning System (GPS)

All the notifications that are needed to be given are based on this module. The GPS reference station normally operates without break, 24 hours a day. We should have knowledge of the coordinates of this station before we will begin using GPS on any of our machines. First a proper website for the reference station is to be selected, so a GPS survey is carryout to obtain the known coordinates[1]. This is sometime done as a part of the installation, either by the installation team or other. [1]Once it is installed, the GPS reference station perform 2 functions time:

a. Receive data from the satellites

b. Broadcast GPS data to the rovers in the mine

3.3 Global System For Mobile (GSM)

GSM networks consists of the following substations SS-the switching system, BSS-Base Station and the operation and support system for GSM systems. GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL TTL Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5VDC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600-115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver

and Transmitter) feature [1][2][3][4][5] (serial communication).

3.3.1 GSM Commands

Commands always start with AT (which means Attention).[1]

i. Dial command D

a. Eg :"ATD+33146290800;"

ii. Hang-Up command H

a. Command syntax: ATH

iii. Answer a call A

a. Command syntax: ATA

iv. Redial last telephone number ATDL

a. Command syntax: ATDL

v. Read message +CMGR

a. Syntax : Command syntax:

AT+CMGR=<index>

vi. Send message +CMGS

a. Syntax:AT+CMGS= <length><CR>

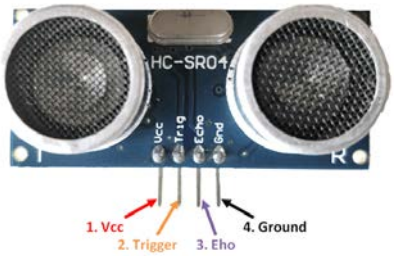
vii. Delete message +CMGD

a. Syntax :Command syntax:

AT+CMGD=<Index> [,<DelFalg>]

3.4 Ultrasonic Sensor

The basic principal is based on the speed of ultrasonic waves in open air. The microcontroller used in this research work is PIC16F877A to transmit and receive ultrasonic waves through 40 KHz ultrasonic receiver and transmitters MODULE. By measuring the time required to travel the unknown distance by ultrasonic waves in air we can find out the distance between two points. The distance measured is sent alongside with the location coordinate via sms to the administrator. Some applications of ultrasonic waves include measurement of distance, speed, flow etc. Ultrasonic also find many application in medical instrumentation.



Fig, 4: Ultrasonic Sensor Module

Operating voltage: +5V
Theoretical Measuring Distance: 2cm to 450cm
Practical Measuring Distance: 2cm to 80cm
Accuracy: 3mm
Measuring angle covered: <15°
Operating Current: <15mA
Operating Frequency: 40Hz

HC-SR04 Ultrasonic Sensor – Working: The module has two sensors (ultrasonic transmitter and Receiver). The sensors work with this simple formula: Distance = Speed × Time The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module[13].

3.5 Microcontroller

A microcontroller usually abbreviated MCU, it could be a single computer chip integrated circuit that executes a user program normally for the aim of controlling some device thence the name microcontroller. Microcontroller includes several thousands of transistors stored into one chip, with addition of external peripherals such as memory input-output lines, timers built into it.

3.5.1 PIC16F877A Microcontroller and Features.

PIC16F877A is a class of 8-bit microcontrollers of RISC architecture. It has the following features as shown in the table below

Table 1.0 FEATURES OF PIC16F877A

Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F877
Operating Frequency	DC - 20 MHz
RESETS (and Delays)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	8K
Data Memory (bytes)	368
EEPROM Data Memory	256
Interrupts	14
I/O Ports	Ports A,B,C,D,E
Timers	3
Capture/Compare/PWM Modules	2
Serial Communications	MSSP, USART
Parallel Communications	PSP
10-bit Analog-to-Digital Module	8 input channels
Instruction Set	35 instructions

Flash program memory: This is used for storing a written program, it is an 8K x 14 words memory which can be programmed and cleared more than once, it makes the PIC16F877A suitable for device development.

EEPROM: it is a memory used for storing important data that must not be lost if power supply suddenly fails. The PIC16F877A is made up of up to 256 x 8 bytes of EEPROM data memory. For instance the EEPROM stores the personal identification number which is compared with the user input so as to activate the port to which the door relay is connected.

RAM: it contains data used by a program during its execution. The PIC16F877A consists of up to 368 x 8 bytes of data memory (RAM).

Pin Description

PIC16F877A has a total of 40 pins which consist of the following;

Port A (6-pin); its pin RA4 functions as a timer; others have no additional function.

Port B(8- pin); its pin RB0 functions as an input interrupt, RB0 functions as "clock" line in program mode. RB7, 'Data' line in program mode.

Port C (8-pin) its pins are used for transmitting and receiving data from peripheral components.

Port D (8-pin): all pins are use for parallel slave port with external peripherals.

Port E (3-pin): enable port, can be used as chip select CS.

Vcc (2-pin): use for supply of +5V dc to the microcontroller.

MCLR (1 pin): reset input and Vpp programming voltage of microcontroller.

GND (2-pin): use for grounding the supply to the microcontroller.

OSC 1 & OSC2: assigned for oscillator connection, for clocking and clock out respectively.

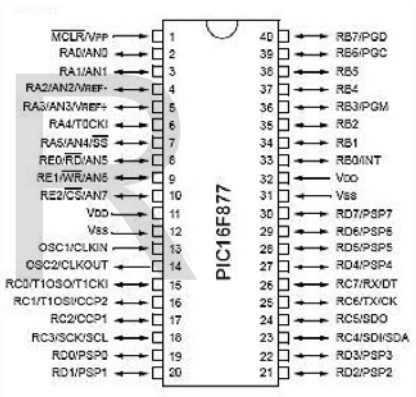


Fig. 3.4.2 Pin Description of the PIC16F877A

The clock is microcontroller's main starter, and is obtained from an external component called an "oscillator" the clock is divided into four; Q1, Q2, Q3 and Q4. The four together makes up an instruction cycle during which one instruction is executed.

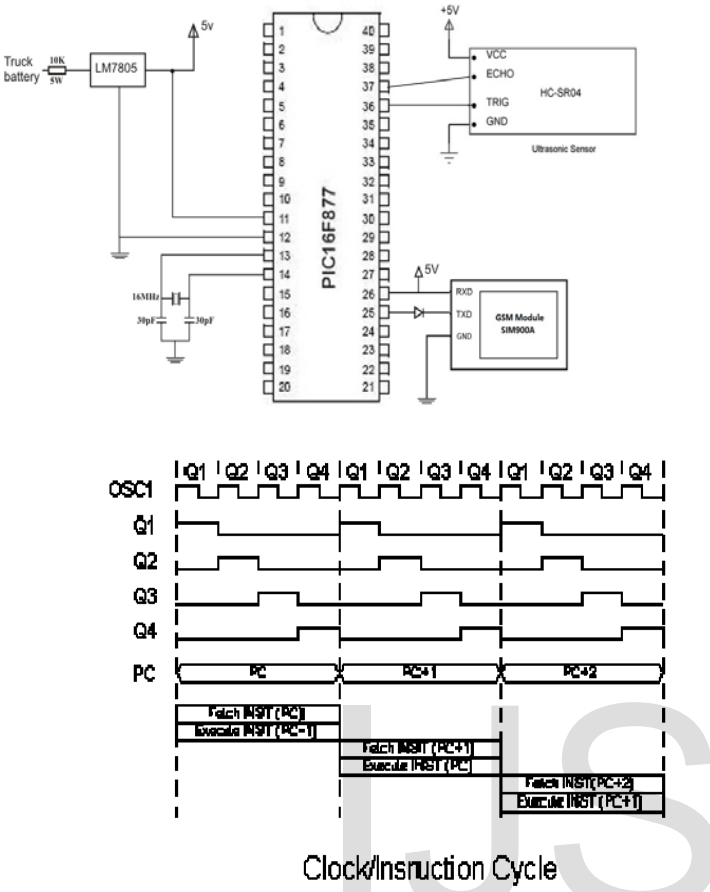


Fig.5: Clock/Instruction Cycle.

3.5.2 Application of PIC16F877A

Its applications include the design and implementation of electronic lock with display controlling home appliances, remote sensors and several safety devices. It is also used in systems where permanent storage of various parameters is needed due to its EEPROM memory; this system includes codes for transmitters, motor speed, receiver frequency etc.

4 CIRCUIT DIAGRAM

Fig.5: Working Circuit diagram

5 DATA ANALYSIS/ FINDINGS

The prototype system of petroleum product level monitoring and tracking system was tested for performance and accuracy. The fluid levels determination is done by electronically converting the time of arrival of echo as recorded by the receiver of the ultrasonic sensor from incident waves from transmitter.

Observation: There are some instances where the truck is not on a plane ground due to topography of the road or porthole the ultrasonic sensor will senses a wrong value.

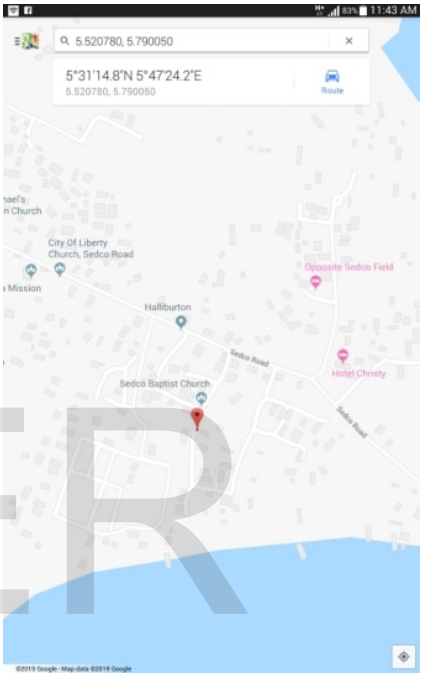


Fig.6: location on Google map

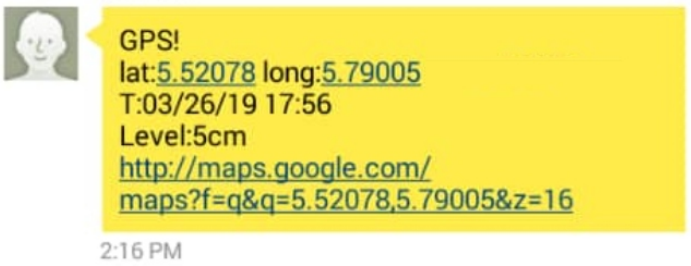


Fig. 7: SMS containing product location and level

6 CONCLUSION

This research addresses the way to minimize theft of petroleum product en-route for distribution to filling stations. The result shows that the system can measure the volume of the

petroleum product and as well as send the google map link with coordinate of the position of the vehicle conveying the product. The system is actualized by line of instruction embedded in the microcontroller

Acknowledgment

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