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Digital Fuel Meter

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ABSTRACT:

It's found out that a proper solution for indicating the accurate availability of fuel in the tank digitally. A sensor and a microcontroller is used to find out the fuel level which is economic and also accurate. This paper focuses on the study of various fuel level measuring sensors suitable for our project. Some issues with respect to the existing level measurement techniques are identified and so a better alternate digital sensing technology has been suggested, described and justified.

I.INTRODUCTION:

Petrol bunk frauds were very common in recent time. Many of the petrol bunks today manipulated pumps such that it displays the amount as entered, but in reality, the quantity of fuel filled in the customer's tank is much lesser than the displayed value. The pumps are cheated for the benefit of the petrol bunk owner. This results in huge profits for the petrol bunks, but at the same time the customers are being cheated. Majority of the two wheeler vehicles in India consist of analog meters which will not help to precisely know the amount of fuel currently in the vehicle and also it is not possible to cross check the quantity of fuel filled at the petrol bunk. Also in this modern and competitive world, products are being digitized owing to its benefits, user friendliness. So we are conducting a project named "design and development of a digital fuel level indicator for two wheelers". It consists of creating a digital display for the exact volume of fuel contained in the fuel tank.

The above furnished fact is considered in the project. In the recent times we are constantly hearing about petrol bunk frauds. Most of the petrol bunks today have manipulated the pumps such that it displays the amount as entered but the quantity of fuel filled in the customer's tank is much lesser than the displayed value. I.et the pumps are tampered for the benefit of the petrol bunks owner. This results in huge profits for the petrol bunks but at the same time the customers are cheated.

All the vehicles in India consist of analog meters hence it is not possible to precisely know the amount of fuel currently in the vehicle and also it is not possible to cross check the quantity of fuel filled in the petrol bunk. In this project we focuses on creating a digital display of the exact amount of fuel contained in the vehicles tank and also help in cross checking the quantity of fuel filled at the petrol bunk. Finally once the fuel is filled at a bunk the device also sends an SMS to the vehicle owner indicating the amount, quantity, and date, time etc. And also we can find the exact location of the vehicle.

Problem Statement

To design a fuel metering system that can report the exact amount of fuel in the tank. The amount should be reported in a digital readoutand should be in unit of either liters and in km's at average/current consumption.

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Vision and Mission

Up until now the accuracy of the fuel level measurement has not been of great importance. The purpose measuring the fuel level has been to present the information on the dashboard with a fuel level meter. Instead of accuracy the two most important things have been to avoid rapid changes in the fuel level displayed and the meter must indicate that the tank is empty when the fuel level is below a predefined level. This system is not capable to provide the exact value of fuel in the fuel tank. Also such system cannot protect us from getting cheated at petrol pumps and this cost more for less amount of fuel so filled. So it becomes necessary to develop such a system which gives exact (numeric) value of fuel in fuel tank.
As used in cars, the fuel gauge has two parts:-

- The sender unit
- The indicator

The sending unit usually uses a float connected to a variable resistor. When the tank is full, the resistor is set to its low resistance value. In addition, when the resistance is at a certain point, it will also turn on a "low fuel" light on some vehicles. Meanwhile, the indicator unit (usually mounted on the instrument panel) is measuring and displaying the amount of electrical current flowing through the sending unit. When the tank level is high and maximum current is flowing, the needle points to "F" indicating a full tank. When the tank is empty and the least current is flowing, the needle points to "E" indicating an empty tank.

A gauge (or gas gauge) is an instrument used to indicate the level of fuel contained in a tank. Commonly used in cars, it may also be used for any tank including underground storage tanks. The system consists of two important parts that is for sensing and indication of fuel level. The sensing unit usually uses a float type sensor to measure fuel level while the indicator system measures the amount of electric current flowing through the sensing unit and indicates fuel level.

There are various techniques to implement sensing and indicating systems.

• Traditional float type measurement technique
• Microcontroller based fuel measurement technique

Presently the most common and traditional fuel indicator system makes use of the resistive float type sensors to measure the level of fuel in the tank and this system consists of two units i.e., the sender unit responsible to measure the level of fuel in the tank, the gauge until responsible to display the measured fuel level to the driver. Another technique is known as the Smart fuel gauge system, which is similar to the traditional technique but also makes use of embedded systems such as microcontrollers or microprocessors for providing better accuracy.

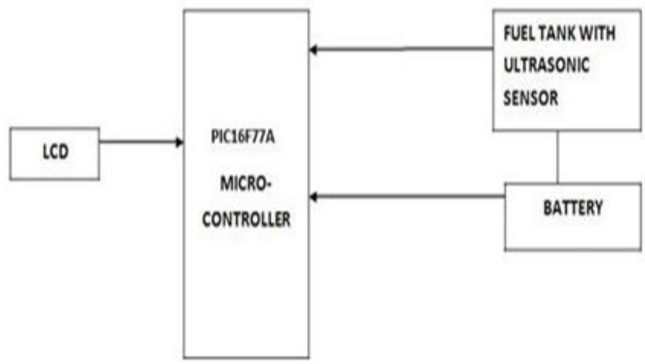

Fig 1: Block Diagram

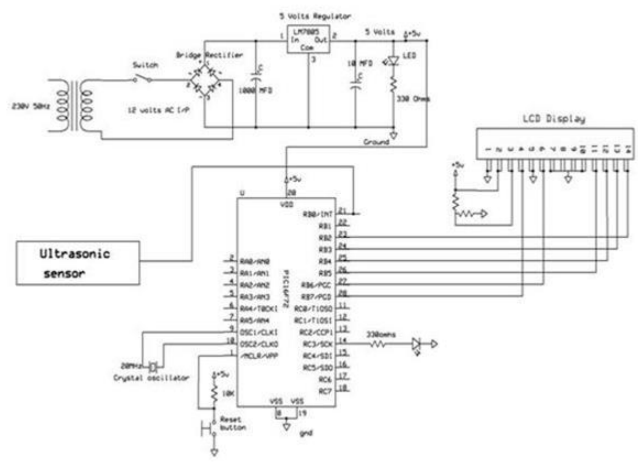

Fig 2: Circuit Diagram

II.EXISTING TECHNOLOGY

Introduction

Most of the vehicles in India consist of analog meters hence it is not possible to precisely know the amount of fuel currently in the vehicle and also it is not possible to cross check the quantity of fuel filled in the petrol bunk. The traditional fuel indicator consists of two units i.e. the sending unit and the gauge. The Fig 3 shows the commonly used traditional fuel measurement system. The sending unit is located in the fuel tank of the car and it consists of a float, usually made of foam, connected to a thin, metal rod. The end of the metal rod is mounted on a variable resister or potentiometer.

The variable resistor consists of a strip of resistive material over it which moves across the variable resistor changing the resistance and flow of current depending on the movement of the float with respect to the level of fuel present in the fuel tank. The Fig 3 shows that the fuel in the fuel tank is almost empty and the float has moved to the bottom of the tank moving the strip on the resistor thus increasing the resistance to maximum and current flow through the resistor becomes minimum thus displaying fuel empty on the gauge.

The gauge consists of a bimetallicstrip i.e. a strip made of different kinds of metal and whose thermal co-efficient of expansion differs from each other. When resistance is decreases current increases and thus the strip is heated during which one metal expands less than the other, so the strip curves and this bending action is what moves the needle move on the fuel gauge. As resistance increases, less current passes through the heating coil, so the bimetallic strip cools. As the strip cools, it straightens out, pulling the gauge from full to empty.

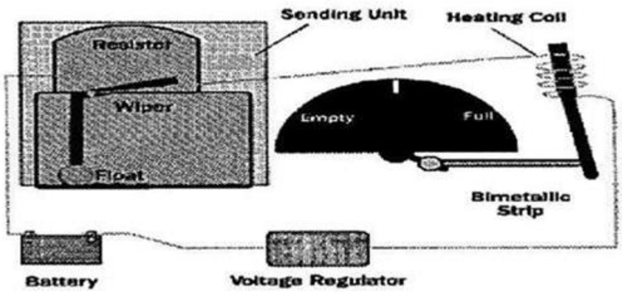

Fig 3: Traditional fuel measurement system

The smart fuel gauge system techniques has been implemented in some newer cars in which, instead of sending the current directly to the gauge, an intermediate microprocessor is used to read the output of the resistor and then communicate with the dashboard for displaying the fuel on the gauge corresponding to read output voltage from sending unit and these system actually help to improve accuracy of system.

III.COMPARISION OF EXISTING TECHNOLOGIES

The traditional float type resistive measurement technique has bad accuracy issues compared to that of the microcontroller based technique and the reason for this is its mechanism, it is noticed that the gauge tends to stay on full for quite awhile after filling up and this is because when the tank is full, the float is at its maximum raised position while its upward movement is limited either by the rod its connected to or by the top of the tank and therefore this means that the float is submerged and it won't start to sink until the fuel level drops to almost the bottom of the float, hence the needle on the gauge won't start to move until the float starts to sink.

Something similar can happen when the float nears the bottom of the tank.Often, the range of motion does not extend to the very bottom as shown in Fig (1), so the float can reach the bottom of its travel while there is still fuel in the tank. This is why, on most cars, the needle goes below empty and eventually stops moving while there is still gas left in the tank. The newer cars have a microprocessor that reads the variable resistor in the tank and communicates that reading to another

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microprocessor in the dashboard thus displaying the fuel level and a fuel light indicator signal with respect to the fuel level such as a red light when low on fuel and green light when tank is full. In this technique, the Car makers can tinker with the gauge movement a little while compensating for the shape of the tank by comparing the float position to a calibration curve and this curve correlates the position of the float with the volume of fuel left in the tank. This allows the gauge to read more accurately, especially in cars with complicated gas-tank shapes The microprocessor can also provide some damping to the needle movement i.e.

when the car goes around a turn, or up a hill, the fuel can slosh to one side of the tank and quickly change the float position and if the needle were to respond quickly to all of these changes, it would be bouncing all over the place, instead the software calculates a moving average of the last several readings of the float position. This means that changes in needle position occur more slowly; therefore this may have been noticed when filling up car tank that the tank is fulfilled long before the needle reaches full, however the cost of implementing this technique is more expensive and complex compared to that of the traditional technique, therefore the trade off in the microprocessor based technique is the cost and complexity for gaining accuracy and its vice versa for the traditional technique i.e trade off accuracy for reducing cost of development and complexity of the system.

IV.CAPACITIVE LEVEL SENSING

In a capacitive fuel level sensing system, the capacitive sensors have two conducting terminals electrodes and the gap between the two rods is fixed the fuel level can be found by measuring the capacitance between the two conductors immersed into the fuel as shown in the Figure.

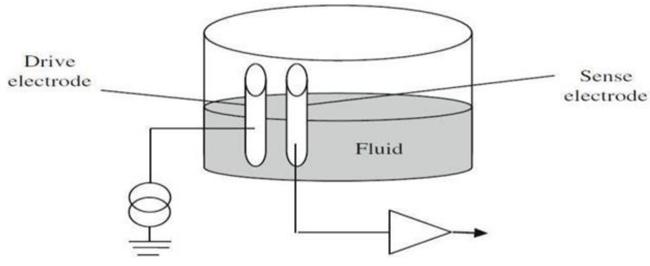

Fig 4: Capacitive level sensing

Since the capacitance is directly proportional to the dielectric constant between the parallel rods or plates, therefore the fuel rising between the two parallel rods leads to increase or change in the net capacitance value of the measuring tankas a function of fluid height. If the dielectric behaves even slightly as a conductor then this can reduce the performance of the capacitor. The dielectric material used should ideally be an insulator while chemically fuel will have other contents mixed in it increasing the conductivity of electrons to some extent; therefore a common method used to overcome this problem is placing an insulating layer on each of the rods in order to preserve the performance of the measuring system. Capacitive type fuel level measurement system can make use of multiple capacitors or multi-plate capacitors which has an advantage of an increased capacitance value and accuracy.Multi capacitor systems share the common dielectric constant, which is essentially the fluid itself in capacitive type fluid level measurement systems. If a capacitor is constructed with ‘n’ number of parallel plates, then the overall capacitance will be increased by a factor of (n-1)

Advantages of capacitance

• Cost effective
• Fast speed of response
• Interface measurement

V.SPECIFICATIONS

Introduction to Specifications

- Microcontroller (PIC16F77A)
- Display Unit
- Permanent Data Storage unit

- RS232
- Regulator (7805)
- Rectifier
- Proximity sensor
- LCD

Brief on all specifications

Microcontroller (PIC16F77A)

An 8051 architecture microcontroller is used as the microcontroller unit. The 8051 is an 8 bit Reduced Instruction Set Computer (RISC) microcontroller. It has four 8 bit ports, total 32 I/O lines. Different peripherals of the meter are connected with its ports as shown in Fig6.1. It has 64KB of program memory and 256 byte of RAM. The Driver Layer contains protocols for accessing different hardware peripherals such as LCD, EEPROM, RTC, LR, GSM modem, etc.

On the top of the Driver Layer, the Application Layer contains routines for load calculation, bill calculation, data SMS frame creation, etc. Application Layer calls different routines of the Driver Layer to access hardware peripherals. This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices.

The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-

Display Unit

A 16 x 2 character LCD (HD44780) is interfaced with the micro-controller port using 4 data wire mode. Different meter readings like current month kWh, total kWh, voltage, current, date, time, etc. are sequentially displayed here.

Permanent Data Storage Unit

If power fail occurs, the content of the RAM must be stored in EEPROM so that when power is back, the meter can start from its last state. An I2C EEPROM (AT24C64) of 8KB size is used for this purpose. Also, different billing slabs containing rates for peak and off peak hour, meter ID etc. are stored here.

RS232

RS-232 is simple, universal, well understood and supported but it has some serious shortcomings as a data interface. The standards to 256kbps or less and line lengths of 15M (50 ft) or less but today we see high speed ports on our home PC running very high speeds and with high quality cable maxim distance has increased greatly. The rule of thumb for the length a data cable depends on speed of the data, quality of the cable.

Regulator (7805)

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload.

Rectifier

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals.

Proximity sensors

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target.

Proximity sensors are commonly used on smartphones to detect (and skip) accidental touchscreen taps when held to the ear during a call. They are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large steam turbines, compressors, and motors that use sleeve-type bearings.

LCD

We are using a high quality 16 character by 2 line intelligent display module, with back lighting, Works with almost any microcontroller.

Features
- 16 Characters x 2 Lines
- 5x7 Dot Matrix Character + Cursor
- HD44780 Equivalent LCD Controller/driver Built-In
- 4-bit or 8-bit MPU Interface
- Standard Type
- Works with almost any Microcontroller
- Great Value Pricing

VI.SYSTEM DESIGN

PIC16F/18F Evaluation Board

The PIC16F/18F Evaluation board is specifically designed to help students to master the required skills in the area of embedded systems. The kit is designed in such way that all the possible features of the microcontroller will be easily used by the students. The kit supports in system programming (ISP) which is done through USB port.Microchip's PIC (PIC16F877A), PIC16F/18FEvaluation Kit is proposed to smooth the progress of developing and debugging of various designs encompassing of High speed 8-bit Microcontrollers.

LCD (Liquid Crystal Display)

Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose. A liquid crystal display (LCD) is a flat panel display that uses the light modulating properties of liquid crystals (LCs). LCD Modules can present textual information to user.

Interfacing LCD

Fig 5 shows how to interface the LCD to microcontroller. The 2x16 character LCD interface card with supports both modes 4-bit and 8-bit interface, and also facility to adjust contrast through trim pot. In 8-bit interface 11 lines needed to create 8-bit interface; 8 data bits (D0 – D7), three control lines, address bit (RS), read/write bit (R/W) and control signal (E).

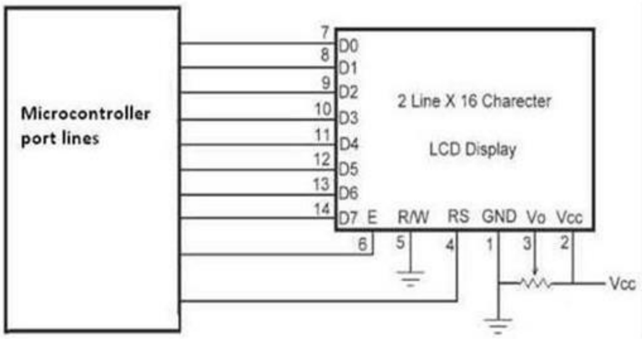

Fig 5: Interfacing LCD with PIC16F877A

We now want to display a text in PIC16F/18F Evaluation Board by using LCD module. In PIC16F/18F Evaluation Board contains the LCD connections in a single header. The PIC16F/18F Evaluation board has eleven numbers of LCD connections, connected with I/O Port lines (PORTE.0 – PORTE.3 && PORTD.0 – PORTD.7) to make LCD display.

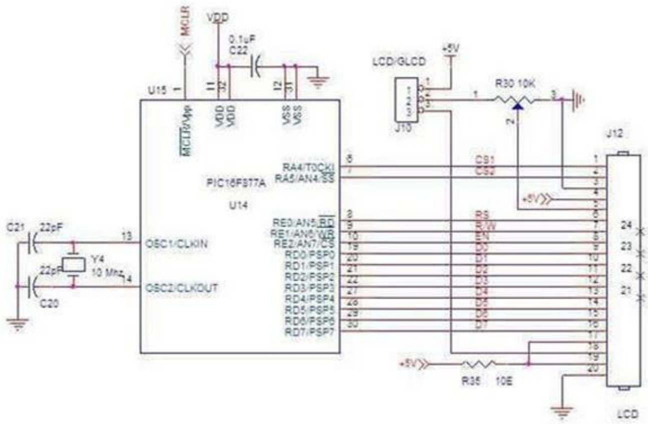

Fig 6: Circuit Diagram to Interface LCD with PIC16F877A Microcontroller

MICROCONTROLLER (PIC16F877A)

The 16F877A is one of the most popular PIC microcontrollers and it's easy to see why - it comes in a 40 pin DIP pinout and it has many internal peripherals. The only disadvantage that you could level at it is that it does not have an internal clock source like most of the other more modern PIC's. The 16F877A is a capable microcontroller that can do many tasks because it has a large enough programming memory (large in terms of sensor and control projects) 8k words and 368 Bytes of RAM.

The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to decide what external devices to attach without worrying too much if there are enough pins to do the job. One of the main advantages is that each pin is only shared between two or three functions so it's easier to decide what the pin function (other devices have up to 5 functions for a pin).

A slight disadvantage of the device is that it has no internal oscillator so you will need an external crystal or other clock source. However the internal oscillator is only 1% accurate and adding a crystal (max 20MHz crystal - for 5MHz internal instruction cycle) and two 15pFcapacitors is not a great chore - the accuracy will be 100ppm depending on the crystal used.

Ultrasonic Sensor

Ultrasonic sensors can be used to solve even the most complex tasks involving object detection or level measurement with millimeter precision, because their measuring method works reliably under almost all conditions. No other measuring method can be successfully put to use on such a wide scale and in so many different applications.

The devices are extremely robust, making them suitable for even the toughest conditions. The sensor surface cleans itself through vibration, and that is not the only reason why the sensor is insensitive to dirt. The physical principle—the propagation of sound—works, with a few exceptions, in practically any environment.

Ultrasonic Sensing

The principle of ultrasonic devices is based on the amount of time it takes to send and receive reflected ultrasonic sound wave from the media Ultrasonic waves are similar to audible sound waves in that they are mechanical waves. The speed of ultrasonic waves can be more easily influenced than the speed of light. The temperature and type of gaseous media have a tremendous effect on sound waves. The temperature of the gaseous media influences the speed of the wave. The higher the temperature, the faster the sound waves travel.

While the temperature at the level device can be compensated by a temperature sensor in the ultrasonic device, the level measurement will only be accurate if the entire space between the sensor and liquid are the same temperature. The type of gaseous media also influences the speed of the sound waves. For example, sound travels almost three times faster in helium than it does air. Most ultrasonic devices can be programmed for the type of gaseous media the sound waves will travel through.

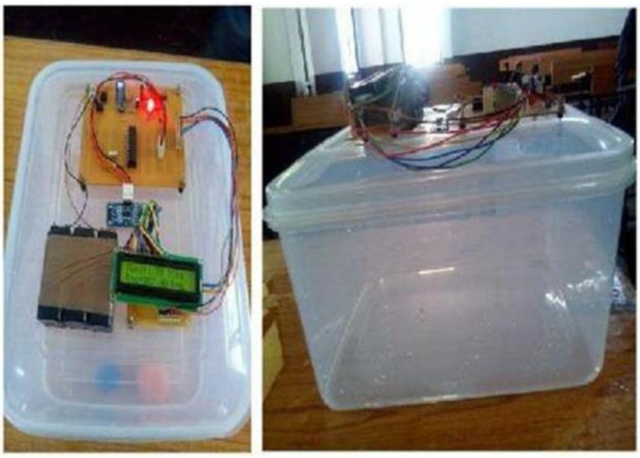

Fig 7: Experimental Testing

VII.CONCLUSION:

The Digital fuel indicator design like that described above will most likely be more accurate, more reliable, and cheaper than other analog meters, and will allow for added features that benefit both the customer. In the near future, the different vehicle company manufacturers will implement this kind of fuel system which also provides security for the vehicle owners.

Not only will the measurement be more accurate, but, the consumers also will not be cheated for their hard earned money.

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