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Load Cell based Fuel Level Measurement using Arduino Uno Microcontroller

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ABSTRACT

The increasing corruption in fuel filling process, as well as the increasing vehicle theft, has become a big deal to the society. Thus, this paper has proposed a product that serves beneficiary to both these issues. The corruption in fuel filling process is rectified through fuel level measurement using a load cell. Though there are numerous methods to measure the fuel level including those like mechanical float, optical sensors, ultrasonic etc., the accuracy in measurement is met by the use of load cell involving Arduino Uno microcontroller. Here the precision in measurement is made even in a milliliter of added fuel. The measured output is sent via the global system for mobile communication (GSM) technology to the user mobile so that verifiable record can be created. Thus, a permanent record of filled fuel can be maintained. This would help the owners of transportation network companies to maintain an individual record of their vehicles that are run by their paid drivers. Apart from the level measurement, vehicle theft is overcome by the Global positioning system (GPS) technology. The GPS system fitted to the vehicle would share the accurate location of the vehicle to the registered user. In case of theft, the location of the filling station along with the measured fuel is sent to the registered network through the GSM technology. Thus the paper produces a complete design of the fuel cell that is implemented in a GPS and GSM enabled vehicle.

Keywords: *Load cell, GSM, GPS, and PIC.*

1. INTRODUCTION

Fuel level measurement has become a necessity in our daily life. There are numerous methods for measuring fuel, ranging from the methods including mechanical float and optical sensors to ultrasound method [1] - [5]. However, most of these methods are no suitable for the accurate level of fuel measurement. Hence, load cell [6] – [8] based fuel measurement is implemented. For safety and record purposes, the measured fuel level and the location of the vehicle while filling the fuel is sent to the registered network using Global System for Mobile Communications (GSM) module and Global Positioning System (GPS) module respectively. The interfacing of the load cell and other modules with the vehicle is done by using Arduino Uno microcontroller [9] – [11].

1.1 LOAD CELL

A load cell is a transducer that is used to convert a force into electrical signal. It is shown in Fig 1. These sensors sense the force (or weight) of the items and the electronic circuitry processes the sensor output and displays it on the indicator. Load cells are highly accurate transducers which provide the user with the information not generally obtainable by other technology due to commercial factors. [6] - [8] Load cell primarily consists of a spring material and strain gauge. Spring material causes a strain due to the applied force and strain gauge changes its resistance in accordance with the change in strain.

Fig 1: Load Cell

1.1.1 Spring Material

The sensing or spring element is the main structural component of the load cell [7]. The element is designed in such a way that it develops a strain, directly proportional to the load applied. When an external force is applied, a molecular force works between the molecules constituting the object, generating an internal force that tries to prevent the deformation by the applied force. When the external force is balanced with the internal force generated inside the object, the deformation of the object ceases. At this moment, the internal force per unit area that is generated on the cross-section of the object is called the "stress" and the change in dimensions per unit original dimensions is called "strain". The spring material develops the strain in proportion to the applied force.

1.1.2 Strain Gauge

Strain gauge utilizes the principle of change in resistance of many metals when they are elongated or contracted. It is shown in Fig 2. Since resistance depends upon the resistivity, length and cross-sectional area of the material [12]. The same metallic wire will have different electrical resistance depending on whether it is elongated or contracted. The longer the metallic string becomes, the larger the resistance. The strain gauge utilizes this principle and is defined as a device whose electrical resistance varies in proportion to the amount of strain in the device.

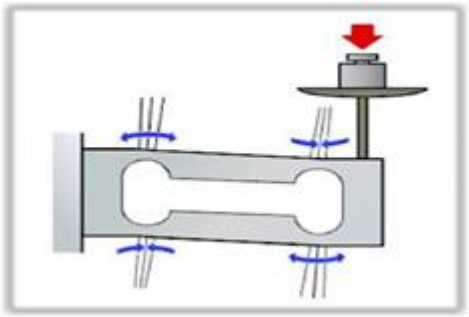

Fig 2: Strain Gauge

1.1.3 Wheatstone Bridge

The Wheatstone bridge can be used to measure very low values of resistances down in the milli-Ohms range. It is shown in Fig 3. It is an electrical circuit used in load cell to measure an overall change in resistance [13]. It increases the sensitivity and reduces the effect of temperature.

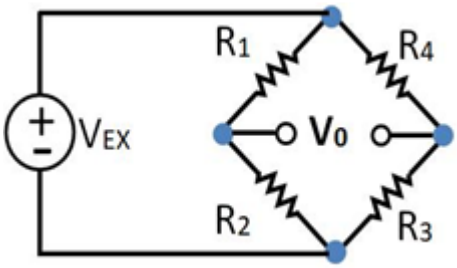

Fig 3: Wheatstone bridge

The output voltage equation of Wheatstone bridge can be given by

$$Vo = \left[\frac{R3}{R3+R4} - \frac{R2}{R1+R2}\right] * \text{Vex}$$

1.2 PIC MICROCONTROLLER

Arduino Uno combines a micro-controller along with all of the extras to make it easy for you to build and debug your projects. The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Fig 4: Arduino Uno Microcontroller

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader

2. METHODOLOGY

In this system we have interfaced the load cell to the Arduino Uno controller through a HX711 Amplifier for regulating the voltage level, so we have a high accuracy of measuring the weight. And we interfaced the GSM and GPS module to the controller so that it could send the measured weight of fuel to the owner along with the location. [6] When a vehicle enters into the petrol station, reset button is pressed so that initial amount of fuel is measured through load cell and it gives the value to the controller, the controller itself saves the initial amount. When the fuel tank is closed load cell measures the total amount of fuel and the added level of fuel is calculated by subtracting the initial level from total level, and it is displayed in the dashboard and also it sends the added level of fuel to the owner using GSM via SMS. [10] The SMS also contains the location of the vehicle where the fuel is added through GPS module. [11] Thus the driver dishonesty and location of vehicle can be found and it is used in finding of theft vehicles. The flowchart of the system is shown in Fig 5. The diagram in Fig 6, is the proposed block diagram of our system. It shows the interfacing of the load cell, GPS and GSM modules with the Arduino Uno controller. The input to the system is obtained from the load cell which is interfaced to the system via HX711 amplifier weighing scale motherboard. While the output is obtained in the display unit attached to the output port of the controller. The GSM and GPS modules are interfaced through the I/O ports of the controller.

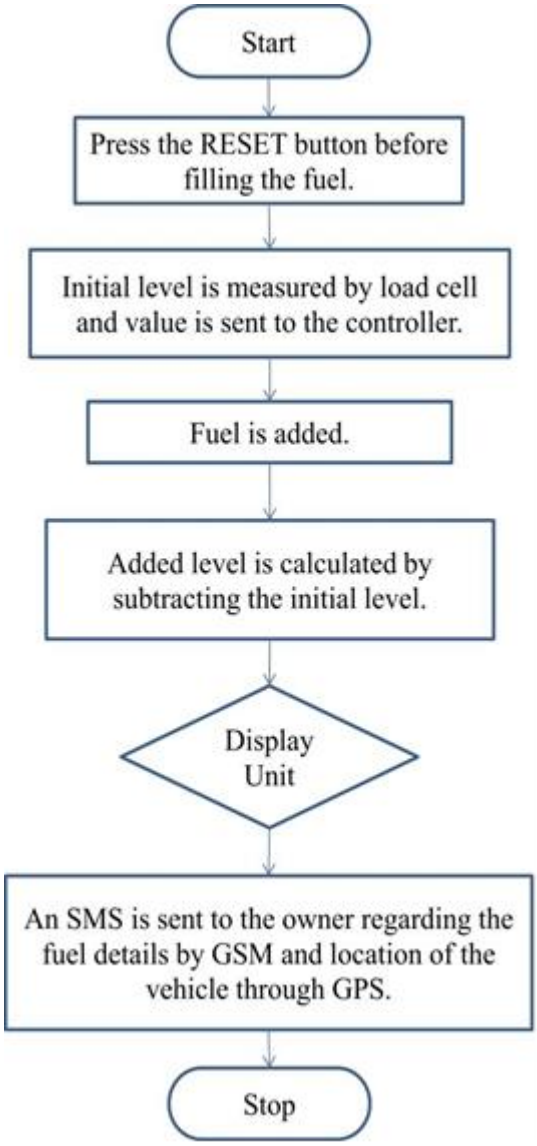

Fig 5: Flow Chart

The flowchart of the system is shown in Fig 5. The diagram in Fig 6, is the proposed block diagram of our system. It shows the interfacing of the load cell, GPS and GSM modules with the Arduino Uno controller. The input to the system is obtained from the load cell which is interfaced to the system via HX711 amplifier weighing scale motherboard. While the output is obtained in the display unit attached to the output port of the controller. The GSM and GPS modules are interfaced through the I/O ports of the controller.

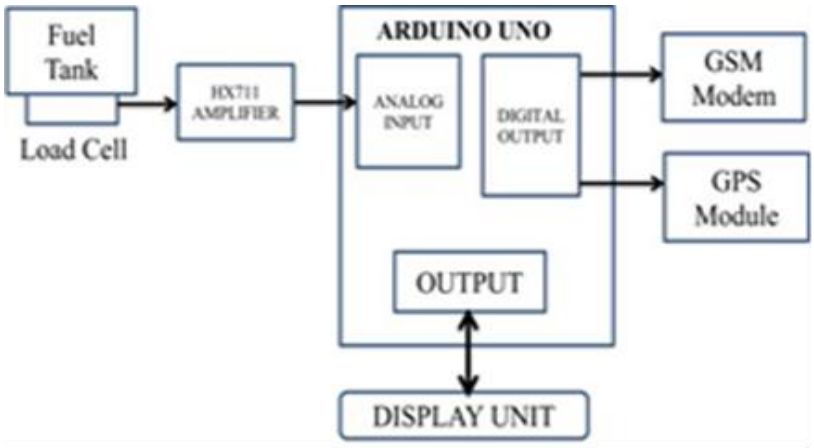

Fig 6: Block Diagram

3. RESULTS AND DISCUSSIONS

Thus, a measuring system for the measurement of fuel in two-wheelers is composed. The system consists of a highly precise load cell interfaced with an Arduino Uno, which gives the accurate value of the fuel measured in the display provided on the dashboard. The measured value is also sent as a message to the registered phone number via the GSM module which is interfaced with the system. For anti-theft purposes, the location of the vehicle is also sent to the registered network using GPS module. The implementation is shown in Fig7.

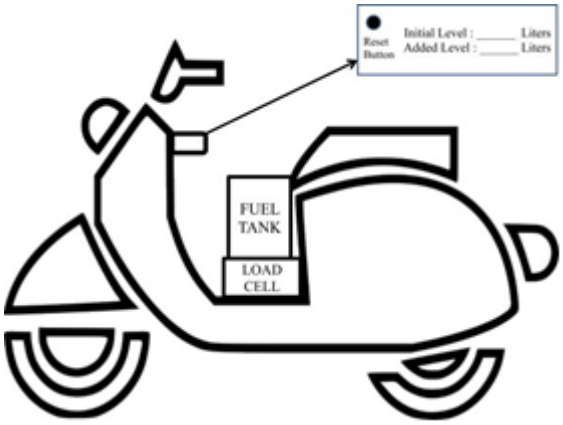

Fig 7: Implementation

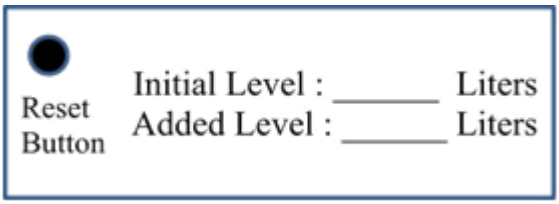

Fig 8: LCD Display

The LCD display for the system is shown in Fig 8. The display present on the dashboard of the vehicle consists of a reset button which is pressed before filling the fuel. When the button is pressed the initial level of fuel is measured and displayed in liters on the display. After pressing the button the fuel is filled and the button is pressed again. Now the added level of fuel is displayed on the display.

4. CONCLUSION

Thus, the proposed systems measures the fuel level added in the petrol bunk and sends the measured value to the display unit on the dashboard and also send an SMS alert to the owner about how much level of fuel is added along with the location. From this design, corruption in the petrol bunk is avoided and owner is alerted with SMS. We implemented this design in real time and it was a success.

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