PIC Based Liquefied Petroleum Gas Usage Indicator with Extreme Low Power Consumption

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Abstract-*Cylinder of Liquefied Petroleum Gas (LPG) is used commercially as well as non-commercially for cooking purposes, and the only time when we know that it is empty is after it has stopped responding. This paper proposes a novel method to tackle this situation, the weight of the cylinder is monitored using a load cell. The use of pressure sensor is avoided since it can cause gas leakage if not mounted properly and also the RFID sensor used for sending data is risky, since gas can interact with radio frequency and explode. The Microcontroller with Extreme Low Power (XLP) consumption technology processes the data from the sensor and if found below a particular threshold value it is indicated by the display device. Use of Arduino is avoided since the application needs to be power and cost efficient.*

Keywords:Display device, Load Cell, PIC, XLP Technology.

I. INTRODUCTION

Liquefied Petroleum Gas, or commonly used term LPG, is used worldwide on daily basis. In India, especially it has a high frequency of usage in rural areas. Though piped gas lines are being used in metropolitan cities, rural areas use gas cylinder for their daily chores. It is used widely for cooking food and also for heating. Many of the times, almost every time situation arises that the cylinder runs out of gas, without our knowledge. Hence it is important to detect the gas usage, which can be done by monitoring decrease in weight of the gas cylinder. The most important point to be taken into account is that, this could have been carried by taking pressure into account, but as it is dangerous to handle gas pressure, it is necessary to take safety precautions. As a result, we have used the concept of measuring the gas by its weight. Our project mainly deals with monitoring the gas usage and to give idea to the user about the content of gas remaining in the cylinder. Accordingly, the user can book the cylinder without any problems. Also, daily usage of the cylinder can be noted down which will give us an idea about the gas required for our daily needs.

II. LITERATURE SURVEY

According to the Ministry of Petroleum and Natural Gas, there are a total of 17.78 crore domestic LPG connections in the country [1]. This is about 715 connections for every 1000 households. South India has the highest number of connections with 5.62 crore followed by North India (5.51 crore), West India (3.97 crore) & East India (2.68 crore). [2]Provisional Ministry of Petroleum and Natural Gas (MoPNG) data indicates that in FY 2014-15:

- Total subsidized consumption increased by 18%, or 166 million cylinders (the largest increase recorded)
- Total unsubsidized consumption decreased by 19%, or 43 million cylinders (the largest decrease recorded)
- Subsidized consumption increased to 86% of total LPG consumption (from 81% in FY 2013-14)
- Subsidized consumption increased to 97% of domestic consumption (from 92% in FY 2013-14)

Now instead of installing sensor on each and every cylinder

it would more convenient have a trolley with the proposed installed on it with user, this idea far more feasible and logical.

III. RELATED WORK

Ajay Kumar, Mukesh Kumar, Balwinder Singh [3], showed about the design of the trolley to measure the weight of cylinder. Here LCD was used which had a greater power consumption. Kumar Keshamoni and SabbaniHemanth[4], implemented the concept which had high power consumption as compared to PIC Microcontrollers. I. Juvanna , N. Meenakshi [5] developed a systemwhich measured the pressure and gave the information about the change in pressure of the container, the pressure range of gas inside the cylinder and thus alarming the user. Continuous measurement was done by using a wireless pressure sensor inside the cylinder. Sushil Kumar Paridda, Ankit Pratik, Sharad Kumar Pani, Rati RanjanSabat [6]developedthe pressure detection schematic system which gave the information about the change in pressure that occurs in the container and indicating it to the user. Continuous measurement of the pressure in the cylinder was done by using a wireless pressure sensor inside the cylinder. The updated level is displayed by the LED-output and the blinking is enabled as the threshold reaches.

IV. SYSTEM BLOCK DIAGRAM AND THE COMPONENTS

As shown in the figure 1, the weight of the cylinder is measured by load cell. Here, the instrumentation amplifier acts as a signal conditioning circuitry. The output of this amplifier is processed by PIC Microcontroller. The output is indicated accordingly through the LED Bar graph.

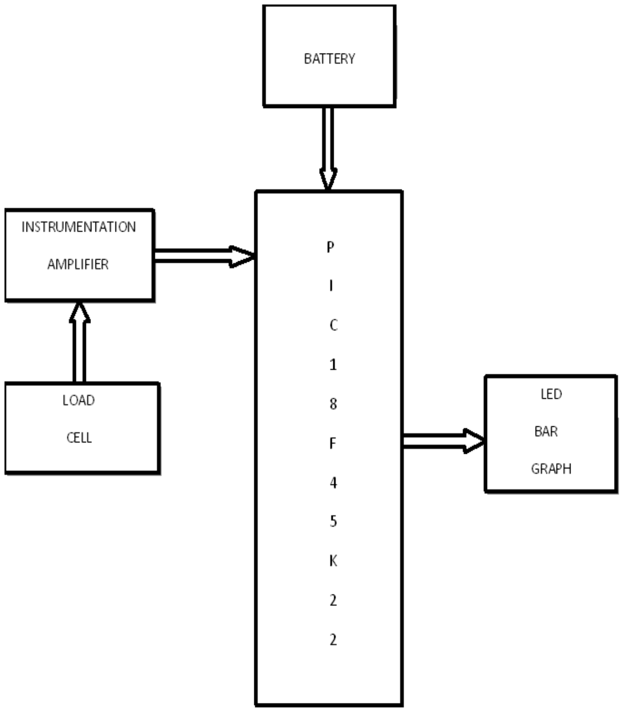

Figure 1: Block Diagram of proposed system

A. Peripheral Interface Controller (PIC)

- The Microcontroller used in the system is PIC18F 45K22 [7] which is of 8 bit.
- The main reason for selecting this microcontroller is its Extreme Low Power consumption.
- The typical current drawn by the PIC in the sleep mode is 20nA, hence used for power critical application. This will keep the user away from frequently charging the battery which will further contribute in low cost and maintenance.
- It has on chip 10-bit Analog to Digital Converter (ADC) which can take input from 30 channels. Another very striking feature of this PIC is that it can do the conversion even in sleep mode.
- It is cheaper as compared to other modules.

B. Load cell

A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. It consists of strain gauges arranged in the bridge fashion as shown in Figure 2. Thisbridge is excited with stabilized voltage (usually 10V). The difference voltage proportional to the load then appears on the signal outputs. The load cell output is rated in millivolts per volt (mV/V) of the difference voltage at full rated mechanical load. We have used a load cell which measures weight upto 40kg.

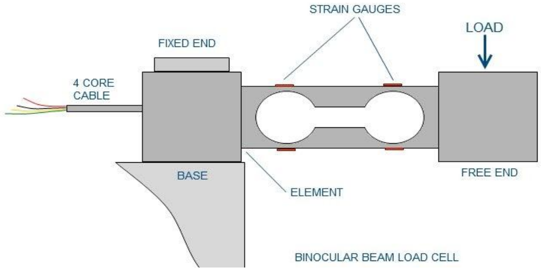

Figure 2: Internal Structure of Load Cell

C. Instrumentation Amplifier (OP07)

As the output of load cell is in millivolts, this voltage needs to be amplified in order to make it compatible with the PIC. This amplification is done by Instrumentation Amplifier. Also, this amplifier takes in very low inputs to amplify it to required voltages. The instrumentation amplifier is constructed with the help of OP07 [8], which is precision operation Amplifier. Some of the main features of this IC are,

1. It operates on a single polarity supply.
2. It has a very low offset.
3. It has a high precision gain.

- **Calculations for selecting the value of gain**

The formula of gain for Non-Inverting configuration is given by-

$$A = \frac{V_{out}}{V_{in}} = 1 + \frac{R2}{R1}$$

The Circuit Diagram for OP07 as shown in Figure 3

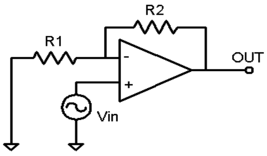

Figure 3

whereR1 is the resistor connected between the negative terminal and ground and R2 is the resistor connected along the feedback path.

The output of load cell at maximum weight (40kg) is 16mV with the rise of 2mV/V, and hence it would require a large gain to amplify its output. Here we have selected the gain of 331 by selecting the value of resistors as R2= 330kohms and R1=1kohms which would be compatible with the ADC of the microcontroller that is 5V, we would require a gain of 312.5kohms. The nearest value available was 330kohms.

D. Voltage Regulator

A voltage regulator is designed to automatically maintain a constant voltage level. Depending on the design, it may be used to regulate one or more AC or DC voltages 78xx (sometimes L78xx, LM78xx,MC78xx...) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. There are common configurations for 78xx such as 7805 (5V) [9] which is used in this experiment.

E. LED Bar Graph

LED bar graph is a video signaling device. These 10 segment bar graph LEDs are used to indicate levels separately. These are nothing but 10 individual LEDs housed together, each with an individual anode and cathode connection. They are available in various colors such as blue, red, yellow, and green. [10] The maximum current required, when all the LEDs glow is approximately about 10 mA.

F. Negative Voltage Convertor

The Instrumentation Amplifier (OP07) requires both negative and positive voltage, which is nothing but dual power supply. Hence, an IC7660 is required which converts positive voltage to negative voltage of same value. It has a power efficiency of 98%, with the range of inputs from 1.0 V to 10V. [11]

IV. FLOWCHART

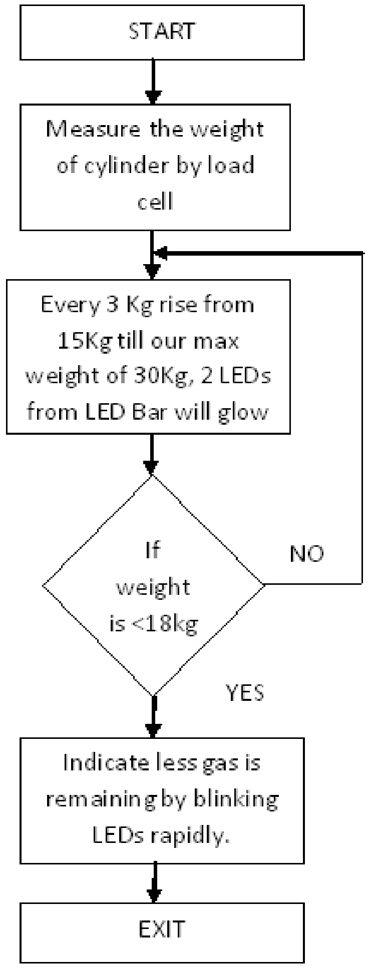

Figure4: Flowchart of proposed system

V. IMPLEMENTATION

Figure 5: Experimental Set Up Diagram

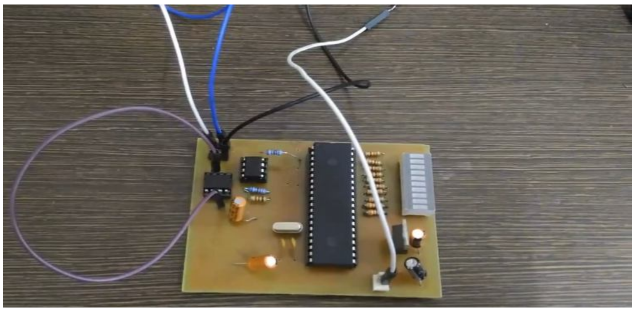

Figure 6: PCB of the required circuit

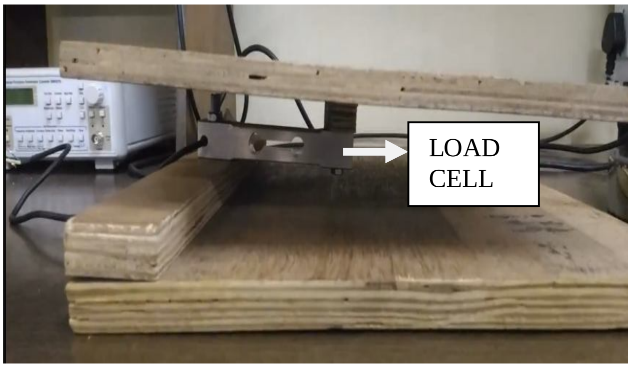

Figure 7: Mounting of load cell

The main idea of our project is to measure the amount of gas used or left in the cylinder by calculating the weight of cylinder which is measured by the load cell. The flowchart is illustrated in figure 4 and experimental setup diagram in figure 5. The PCB of proposed system is shown in figure 6.Here, the load cell, as seen in figure 7, is a transducer which converts mechanical energy (bend or stress due to applied force) to electrical energy. The output of the transducer as observed is linear with 2mV rise for every 5Kg. Hence, proportional output would be given by the load cell for a weight of 40Kg.As the output of Load cell is very low, in fact in mV it needs to be amplified so that it would be compatible with PIC Microcontroller. For this we have Instrumentation Amplifier, OP07, which would provide sufficient amplification based on the gain selected. Also, as this configuration would require both positive and negative supplies, we would require a voltage convertor IC, ICL7660, which would convert negative voltage tocorresponding positive voltage. This output is then given to microcontroller which analyses the change and produces proportional output.The microcontroller has an inbuilt ADC which has been given predefined values during coding. As soon as the output of OP07 is given to the microcontroller the ADC itself selects the range and according to the coding technique used appropriate number of LEDs will glow in the LED Bar Graph used.The system is designed in such a way that for every 3 Kg rise, from 15Kg (tare weight or dead weight) till our max weight of 30Kg (figure 8), 2 LEDs from LED Bar Graph will glow. Hence all the 10 LEDs will be utilized from the Bar Graph. For the weight below 15Kg, it would indicate that very less gas is left in the cylinder [figure 9-(i) and (ii)] and a new cylinder needs to be booked.Hence, the gas left will be indicated accordingly by the LEDs on the LED Bar Graph. The whole system is then enclosed in a plastic closure as shown in figure 10 to improve its aesthetic looks. The dimensions of the PCB are 8.5cm X 8.5cm.

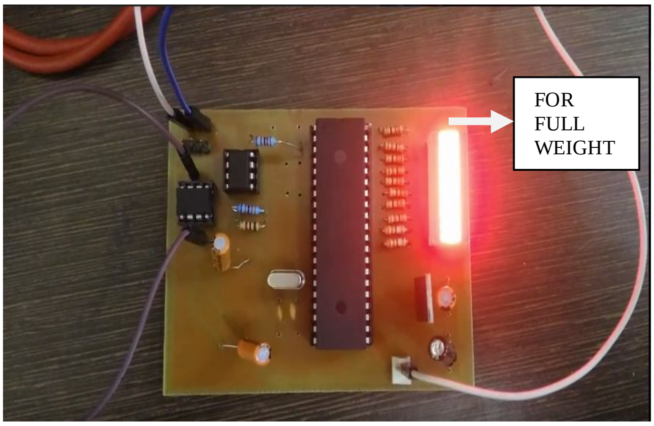

Figure 8: For >27.5Kg and <30Kg weight with its output

Figure 9-(i): 15Kg weight or the gross weight

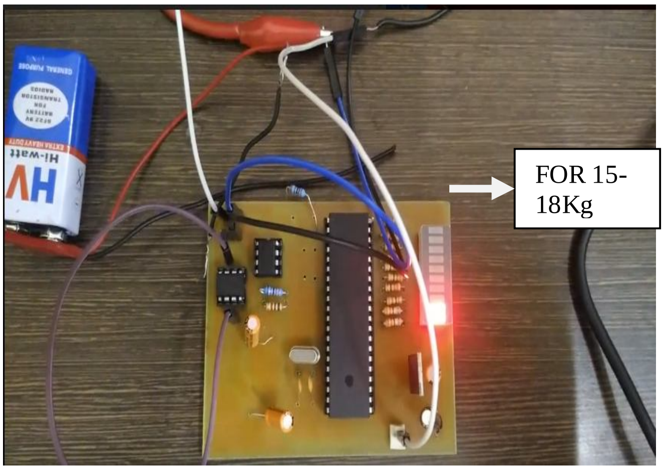

Figure 9-(ii):15-18 Kg weight with its output

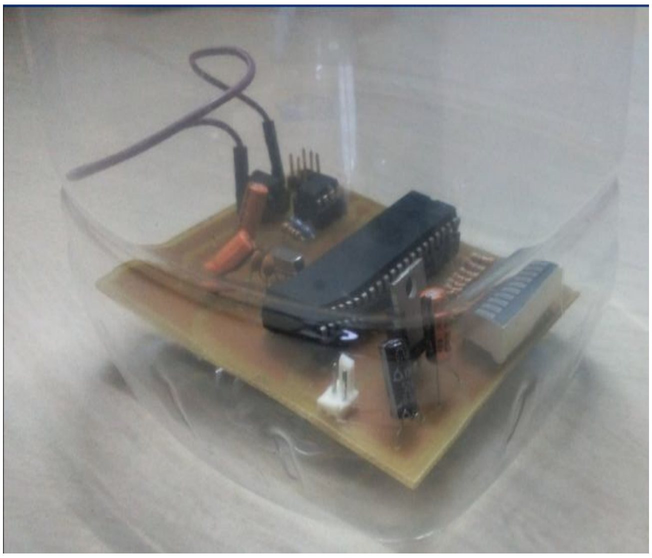

Figure 10: PCB enclosed by protective covering

VI. RESULT

The outputs for different combinations of weight were calculated. For Load Cell, we used the standard weights of 2.5Kg, 5Kg, 10Kg, etc available in the gymnasium and placed on the wooden support. We also noted different readings by using combinations of these weights to adjudge the linearity of load cell and found the results as shown below (Table 1 and Figure 11). Hence, from the graph the linearity of the load cell could be seen.

Table 1: Calibration Table

Weight	**Output Voltage**	**Output Voltage after amplification**	**Number of LEDs glowing from LED BAR GRAPH**
5 Kg	2 mV	0.47 V	0
10 Kg	4 mV	0.93V	0
12.5 Kg	5.4 mV	1.09 V	0
15 Kg	6 mV	1.34 V	2
17.5 Kg	7.4 mV	1.56 V	2
20 Kg	8 mV	1.82 V	4
22.5 Kg	9.4 mV	1.98 V	6
25 Kg	10 mV	2.18 V	8
27.5 Kg	11 mV	2.52 V	10
30 Kg	12 mV	2.67 V	10

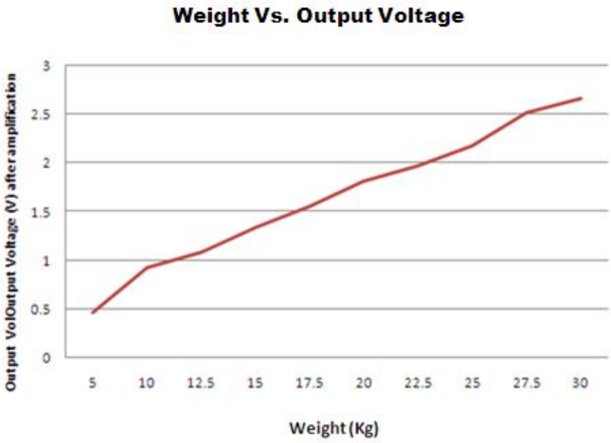

Figure 11: Output Graph

VIII. CONCLUSION

Hence, we designed a system which would provide sensor interface to monitor the gas usage, to measure the weight of gas and to indicate it accordingly by the display. Also, the system is designed to minimize the power consumption which was achieved by using microcontroller and LED Bar Graph. The device used is also compact in shape and size, and the cost of the design is also affordable.

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