PRECISE MASS MEASUREMENT USING DATA ACQUISITION SYSTEM

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Abstract- ***Precise mass measurement is not only used essentially in industrial processes but also used in various medical processes. This review basically covers the use of Data acquisition system comprising of daq card NI USB 6009 for measuring mass of solid or liquid with high precision with the help of load cell CZL 601. A simple circuit has been designed where the signal acquired by the load cell by application of mass has been amplified and filtered and is then captured by the DAQ card. User friendly and interactive Graphical User Interface has been designed in LabVIEW software at front end and a powerful and effective data acquisition software has been written at backend using LabVIEW software. The mass of solid/liquid will appear on the screen and can be stored for further processing.***

Keywords: DAQ Card, Load cell,LabVIEW, GUI

I. INTRODUCTION

Nowadays, many types of mass measuring instrument are commonly used in real life engineering applications to acquire real time data. Load Cells are one of these examples which are used to measure the load instructures. A strain gage load cell is an electrically resistive wire element that changes resistance when the length of the wire element changes. The gage is bonded to a steel cylinder that will shorten when compressed or lengthen when stretched. Because thegage is bonded to the cylinder, the length of the wire will lengthen or contract with the cylinder. The electrical resistance is proportional to the length of the wire element of the gage. By measuring theresistance of the strain gage, it is possible to determine the load on the load cell [1]. Mass measurement technique is very much susceptible to errors. Errors are caused by biases in standards used, by operators and environmental factors like temperature etc.Output signal from these instruments is in the form of voltage or current signals which is calibrated against some known values of input. These output signals (Volt /Amp) are weak signals and mostly of the order of 10^{-3} or even less.Direct measurement of signals obtained from the measuring instrument makes it difficult to draw meaningful conclusions and addition of noise makes the task more cumbersome. In order to ease the task, these signals are amplified and filtered before measurement. For any available equipment with some specified least count, amplification of signal increases the sensitivity of the system. Filters are used to remove the unwanted portion of signal (noise), generated by surrounding or the circuit itself [2].

This review describes the use of a simple and inexpensive circuit to measure mass of solid and liquid precisely using DAQ card USB 6009, load cell CZL 601 and software used at backend for displaying mass measured by load cell is made using LabVIEWand a user friendly interactive GUI at frontend was also made using LabVIEW software.

II. EXPERIMENTAL SETUP

The following shows the setup for a designed virtual instrument for precisely measuring the mass of solids/liquids.

A. Description

Precise mass measurement is mainly divided into these sections:

- Sensing elements
- Data Acquisition elements
- Control elements

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Sensing elements

Sensing elements are the elements that receive a signal or stimulus (as heat or pressure or force or motion etc.) and responds to it in a distinctive manner. Sensors used for force(weight) measurement are:

- Load cell
- Strain gauge

Load cell used is calibrated using regression analysis and thus equation obtained is

$$y = m * x + c$$

where,

y = mass in gram

x = voltage measured by DAQ card [3]

The regression analysis has been used to calibrate the load cell and has been shown in the figure below:

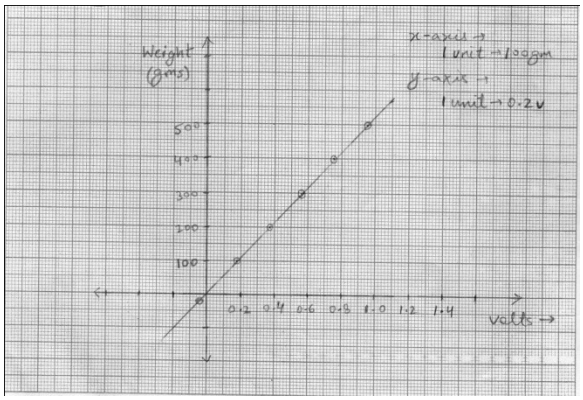

Fig.2.1 Calibration of Load cell

Data Acquisition elements

Data acquisition card developed by National Instruments uses the principle of Data Acquisition which is a process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems typically convert analog waveforms into digital values for processing. The components of data acquisition systems include:

- Sensors that convert physical parameters to electrical signals.
- Signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values.
- Analog-to-digital converters, which convert conditioned sensor signals to digital values.

Control elements

- Data acquisition applications are controlled by software programs developed using various general purpose programming languages such as BASIC, C, Fortran, Java, Lisp ,LabVIEW.

B. Hardware Description

Precise mass measurement can be divided into following sections:

- Power supply section-Triple output power supply delivering 0-30V/0-3A on 2 outputs and 0-5V/0-3A on 1 output.
- Sensor section-Load cell is a transducer that converts the force (weight) into an electrical signal.
- Amplification section- Output obtained is in the order of 10^{-3}V/A or less, non inverting amplifier is used to amplify the weak signals obtained.
- Control section- The output obtained from load cell and amplifier is fed to DAQ card which converts the electrical signal to weight using suitable calibration measures.
- Display section-The final output is displayed on computer screen using LabVIEW software.

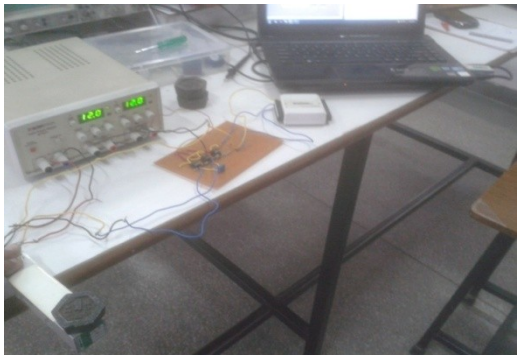

Fig.2.2 Hardware Setup

C. Software Description

Powerful and effective data acquisition software at the back end has been written in LabVIEW that reads the equivalent voltage of the mass of solid/liquid. User friendly and interactive GUI screen has been designed in LabVIEW at front end to accomplish the data acquisition, parameter setting, file manipulation, control, synchronization of other functions involved in measurements. The mass of solid/liquid under measurement will be displayed on the screen and data can be stored for further processing [3].

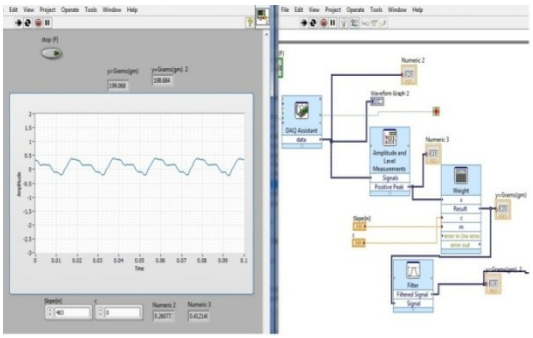

Fig.2.3 Software Setup (Labview)

III. BLOCK DIAGRAM

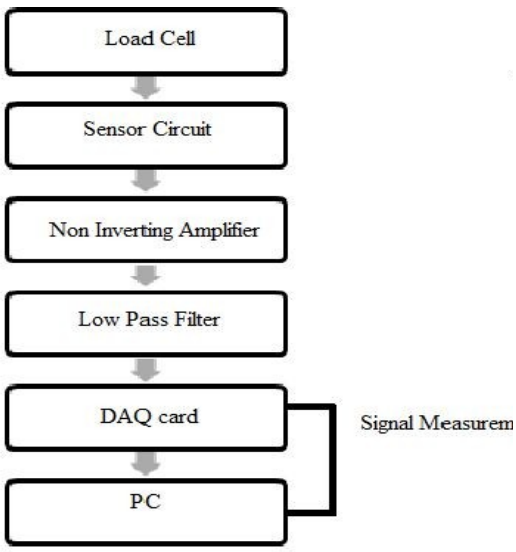

Fig.3.1 Block Diagram

Firstly, force in terms of weight is applied to the transducer Load cell. It consists of a sensor circuit in which four strain gauges are connected in balanced full wheatstone bridge form. Due to the force applied on load cell, there is change in resistance of strain gauges and thus wheatstone bridge gets disbalanced hence produces an output in voltage. This voltage output is in millivolts, so this needs to be amplified using a non-inverting instrumentation amplifier circuit. The output of amplifer is filtered using a low pass RC filter to attenuate the high frequency unwanted noise affecting the output.Now, this signal is captured by the DAQ card and a user friendly and interactive GUI screen has been designed in LabVIEW software at front end and powerful and effective data acquisition software has been written at backend using LabVIEW software in a computer. Finally, the mass of solid/liquid will appear on the screen and can be stored for further processing.

IV. RESULT ANALYSIS

Mass measurement is carried out by finding the voltage generated by the load cell. The mass of liquid or solid can be calibrated so as to display mass on the designed GUI in Labview on computer screen and can also be stored in the database log file for further processing. The setup can be used to find mass of solid/liquid. The result shows that this setup can be used economically for precise measurement of mass.

Mass of sample using electronic balance (gm)	Mass of sample using setup (gm)	Voltage (amplified) (mv)	Temperature (centigrade)
10.900	10.914	37	25
15.500	15.552	40	25
21.700	21.736	44	25
26.300	26.734	47	25

Fig.4.1 Result Analysis

V. CONCLUSION

A framework has been presented which incorporates the use of load cell and data acquisition card for precisely measuring weight. The accuracy has been indicated by the difference shown between the measured data using DAQ card and data obtained by conventional weight measurement techniques. Besides, a comparison between the two systems has been carried out and it concludes that DAQ system gives highly accurate, reliable and precise output required with real time data.

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