Portable Weight Measuring Instrument

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Abstract - ***There are various Digital Weight Measuring (DWM) instruments available in the market which are used to measure and display only weight of the grains and always stay stand still. The paper here encloses the modern weight measuring instrument named "Portable Weight Measuring Instrument". The approach towards Portable Weight Measuring Instrument displays the weight of grains as well as price of the selected grain, regardless of this it is made compact and light in weight (portable). These advantages of our system provide time saving and smart work. It is cheaper than other heavy electronic weighing machines. There is compact and lightweight Arduino family board "Arduino pro mini" is used which has capability to store data and to perform the logic operations. The data is of price of different types of grains that can be stored in EEPROM. The paper presents new technique for weight measurement by using Arduino pro mini.***

Keywords **– Arduino pro mini, DWM , EEPROM, Load cell, Amplifier (HX711).**

I. INTRODUCTION

With increasing research in electronic field and invention of very low cost solid state semiconductor devices and very high resolution ADC[1] converters, the conventional weight measurement devices are being replace by low cost and high precision weight measuring instruments. These instruments called the "Digital Weight Measuring" instruments. Till now DWM[2] instruments only display the weight of goods. This DWM instrument is classified to measure the weight of grains and made it portable so it is name as it have. This instrument is handy and modified to access different modes which stores the price of different grain products and display the weight and price with it. This system till now designed only for calculating the weight of grains up to 3Kg, but one can measure the weight as we want by setting weight counter to calculate the weight by using it number of times. In general today's most of the measuring devices are bulky and need to place them stand still but this modified system we can move wherever we want and easy to transport. The development of this type of instrument is quite easy due to availability low cost and compact size Arduino pro mini board making it perfect for this instrument, also very high precision amplifier and ADC makes it capable to measure the weight in milligrams also [3]. This instrument provide us the new way of weight measurement and easiness of conventional weight measuring systems.

II. DESIGN AND DEVELOPMENT TOOLS

The design and development of this device require the software simulation, sophisticated programming, hardware drives for its exact calibration and hardware prototyping.

- MATLAB is mathematical software tool for assessing the graph, critical solution on tedious problems.
- PROTEUS is circuit designing software for designing the circuit and observing its exact output.
- IDE is integrated development tool for programing the Arduino family controllers.

A. Load Cell

Load cell[4] is transducer which uses electrical and mechanical property of metal which changes its dimension when applied to strain, causes elastic deformation and change in resistance. The strain gauge type load cell is based on working of Wheatstone bridge network in which change in resistance causes the change in potential difference along its diagonally opposite terminals which is directly proportional to applied force[5-6]. It is made up of very fine wires making it grid structure which is glue to metallic elastic body of load cell. The strain or force applied on load cell tends to deform the load cell causing change in resistance of strain gauge will produce small increment and decrement of resistance of strain gauge according to compression and the expansion. This results will add extra resistance (ΔR) to its nominal resistance value (Rg). This resistance change is given by

Change in resistance = (Gf *applied strain * Rg)

Where

Gf : gauge factor.

Rg : nominal resistance

This resistance change is very small compare to nominal resistance and is magnified by resistive imbalance produced in Wheatstone bridge. When force on load cell is zero, the four resistive gauges are at same ohmic value[7-8].

(i.e. R1 = R2 = R3 = R4 = Rg ohm).

When load cell is loaded, the balance state get disturbed and the value of the resistances changes by factor (ΔR). The overall resistances value becomes (R1=Rg - ΔR, R2=Rg +Δ R, R3=Rg - ΔR, R4=Rg + ΔR) as compression force act on R1, R3 and expansion force act on R2, R4. The Wheatstone bridge is amplifier in four resistance system and find the exact resistance change using voltage change.

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- Wheatstone bridge configuration of load cell

Wheatstone bridge[4] amplify the voltage across the resistor in considerable amount, that means small voltage drop across the resistance is amplified across the two terminals of bridge. The voltage V_{in} is given to the two diagonally opposite terminals and and output voltage V_{out} is obtained through diagonally opposite terminals of applied voltage. The voltage V_{out} through resistor branches is zero when load on load cell is zero, hence initially bridge is balance. After loading condition V_{out} at two branches is given as

$$Vout = \left(\frac{R2}{R1+R2} - \frac{R4}{R3+R4}\right) Vin$$

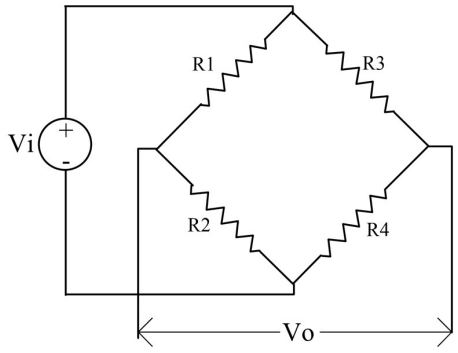

Fig.1 Ckt diagram of wheatstone bridge

The actual configuration of load cell consist of 4 to 6 wires. The 4 wire load cell has temperature compensating system in it. Load cell is manufacture by considering the wire length is caliberated and compansated. The 6 wire load cell has not the temperature compansting network in it, instead it has given 2 extra wires. These sense line act as feedback to the voltage source connected to the sense terminal of load cell. The advantage of this system that we can extend the length of wire to any extend. The load cell perform within the specifiation limit if these sense lines are not used[9-11].

- The Complete Circuit diagram of precise load cell

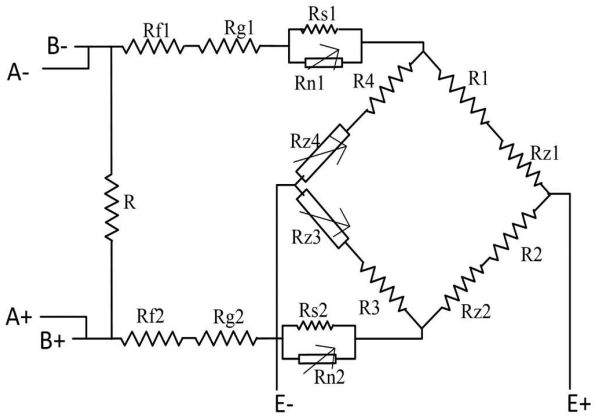

Fig.2 Ckt diagram of Load cell

The output signal of load cell is given by

$$Vo = \left(\frac{Ld + La}{Emax}\right) Ve$$

Where

V_0 = Output voltage (mV)

Ld = Dead load on load cell

La= Applied load

E_{max}= Load cell capacity

V_e = Exitation voltage

B. Load cell amplifier

The voltage output obtained through the load cell is very low i.e. in few millivolts. Small change in voltage is sometimes is nondetectable causing faulty reading or decrease the resolution of the system. The microcontroller used has inbuilt ADC converter so that the analog readings obtain through load cell is directly converted into digital value. The microcontroller available has 10 bit ADC and obtain the output voltage in 1024 steps. (2^{10}=1024) i.e. the resolution of load becomes when it is excited by 5v is given by

$$Resolution = \frac{5v\ (Ve)}{1024\ (step\ size)}$$

= 4.8 millivolt(mV)

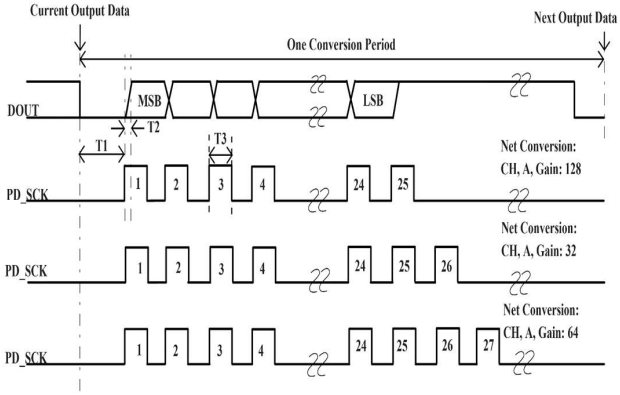

Fig.3 Data output, Input and gain selection timing and control

This resolution is very small when it is deformed by small weight and it is not detectable so higher bit ADC is required for this purpose.

Pin PD_SCK and DOUT are used for data retrieval, input selection, gain selection and power down controls, when output data is not ready for retrieval, digital output pin DOUT is high. Serial clock input PD_SCK should be low. When DOUT goes to low, it indicates data is ready for retrieval. By applying 25~27 positive clock pulses at the PD_SCK pin, data is shifted out from the DOUT output pin. Each PD_SCK pulse shifts out one bit, starting with the MSB bit first, until all 24 bits are shifted out. The 25th pulse at PD_SCK input will pull DOUT pin back to high[12].

C. Arduino pro mini

The Arduino Pro Mini is microcontroller based on the ATmega328 compatible with C programming language, no complex hardware required for interfacing, easy analysis for programming and computation. Arduino pro has 6 PMW output pins and 6 analog inputs pins leading to total 14 digital input/output pins with Vcc and Ground, an on-board resonator, a reset button, and holes for mounting pin headers. The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The layout is compatible with the Arduino Mini. The Arduino pro mini works at 5V or 3.3 V and 16 MHz crystal frequency [13].

III. SIMULATION AND HARDWARE RESULTS

The simulation results plotted in MATLAB are exactly same as the results obtain in hardware implementation.

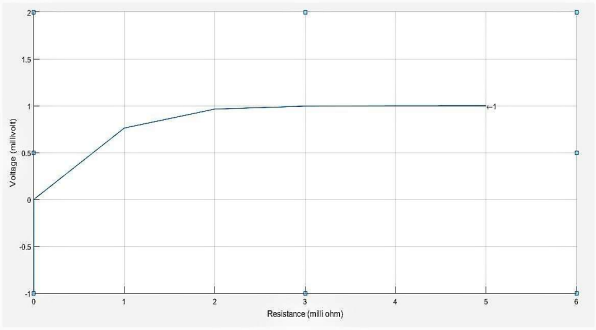

Fig.4 Graph of resistance vs Volatge.

In this graph voltage vs resistance is plotted. The resistance of load cell is increase up to specific limit i.e. up to its elasticity hence maximum voltage obtain in load cell is also fix. The resistance and voltages are in Millis so the maximum resistance of load cell resistors after applying strain on maximum 3 kg capacity load cell is obtain 5 milliohm and voltage obtain across the load cell is 1mV. The graph is quit increasing up to the these value ,after that load cell goes out of service[14-16].

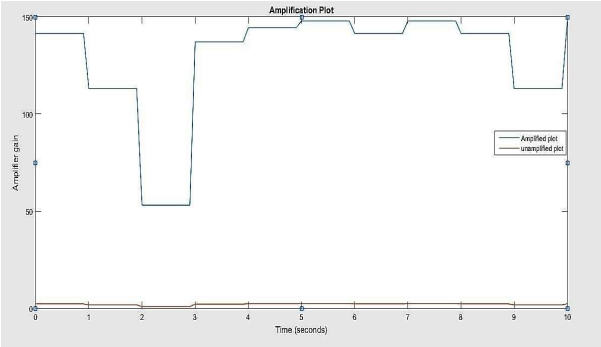

Fig.5 Graph of amplifies vs unumplified output

The graph with amplified and unamplified output of load cell is presented here. The amplified output is obtain using load cell amplifier (HX711 IC) which has inbuilt ADC. The gain of amplified system is very high and precise, even very small change in voltage is also interpreted, leading towards very precise weight measurement system.

The change in load cell resistance vs total output obtain in this case is in analog form.

IV. CONTROL FLOW CHART

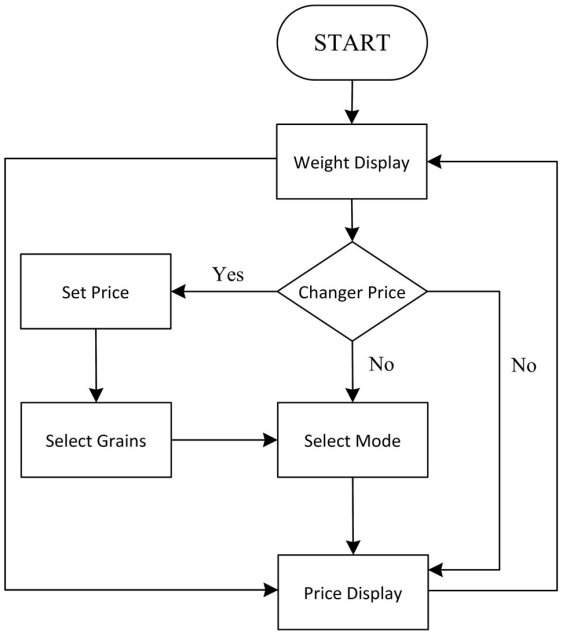

Fig.6 Flow chart of visual interface of system.

The Digital weight measuring instrument has ability to calculate weight with great accuracy and high precision, it also denotes the price of the grains. This could be achieved by control program which lead user to more sophisticated output.

A. Visual interface of system :

- The weight and price of grains is continuously display on the LCD, total price display depending on previously entered price. The controller displaying weight & price continuously until user selects mode.
- Modes are nothing but the type of grain which is to be weighted. The keypad buttons are allotted to choose the type of grain under measurement.
- In the market, the prices of grains changes day by day, so it is most important to change the price. The price of grain can be change by pressing pound sign '#' and then pressing the number to which that grain is assigned (whose price user want to change) is pressed. Then enter the current market price.

B. Connection Diagram

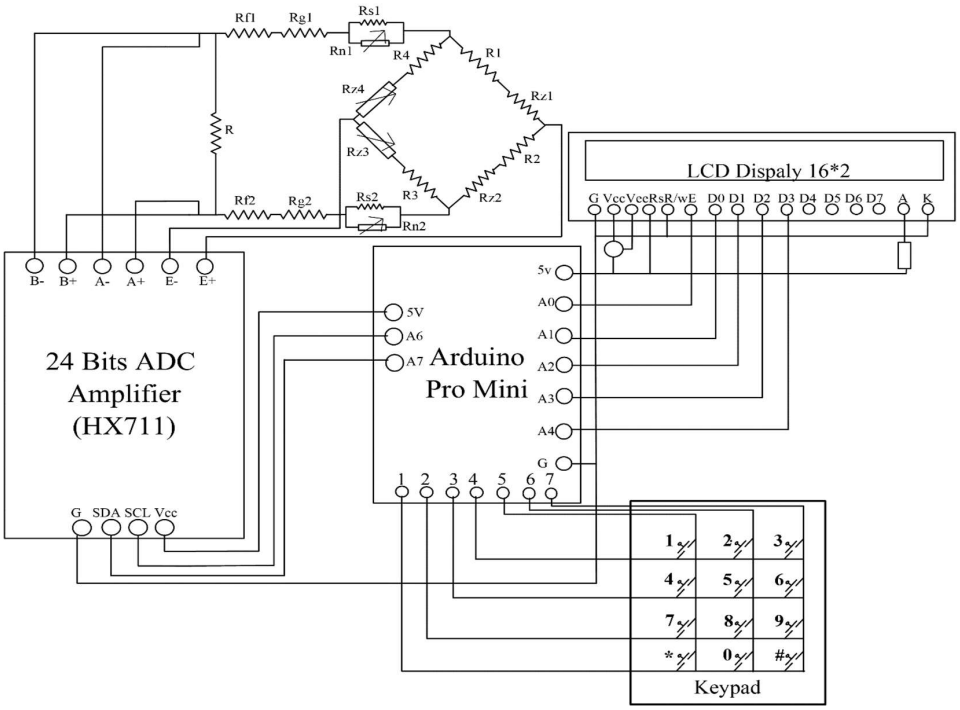

Fig.7 Connection diagram of this system

- Furthermore, cross check whether price of the grain is changed or not by just selecting corresponding mode. Later automatically price for grain whose weight contained by system is displayed on the screen.
- The predefined modes of grains in the system are as follows.

Modes	Grains
0	Sugar
1	Wheat
2	Rice
3	Jowar
4	Bajra (Pearl Millet)
5	Peanuts
6	Soya beans
7	Toor Dal (pigeon pea)
8	oats
9	Dates

C. Hardware Implementation:

All above the componets are fitted into the jar shape container making it compact and portable. This jar is used for the weight measurement of grains. The grains are fill in the jar and price is set according to grains type mention in the pricemodes , the total weight and price of grain is getting displayed on the screen . As how weight is measure in the new system.

Fig 8. Hardware of system

V. Conclusion

The paper presents new approach for weight measurement which is compact in size, easy to handle, low cost and user-friendly. The performance of Arduino pro mini is found suitable for weight measurement over a traditional system. This proposed topology eliminates drawbacks of traditional weight measurement system and improves overall system performance.

Future work will be carried out by giving a training to weight measurement device using neural network to improve the overall efficiency and quality.

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