Solar Based Digital Electronic Weighing Machine

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Abstract: *The supply of electricity is the biggest problem in our country so the aim of proposed system is to develop digital electronic weighing machine operating with the help of solar PV panel. This paper describes the design and implementation of an energy efficient solar power digital electronic weighing machine system ideal for laboratory, domestic, industry, and commercial use. This system utilizes a standalone microcontroller chip which highly reduced circuitry. This machine is totally based upon solar energy so it saves the electric energy. The system designed here measures weights ranging from 0-40 kg. The emergency light circuit works on the status of light dependent register (LDR).*

Keywords: Weighing Sensor, Solar panel, Microcontroller, LDR, Charge Controller

1. Introduction

The electronic digital weighing systems are used in business establishments and industries for weighing and segregating materials accurately for process sales. The electronic digital weighing system comprises the basic load cell which suitable signal output recorders, conditioners & indicators giving both the analog output system & digital output system for further processing. First the signals from load cell are amplified and fed to analog or digital converter and which provide the output in the digital format for display, printing and processing etc. The strain gauge base type of load cell is the most popular weight transducer which is used in the electronic digital weighing system. This work describes the design and implementation of high-resolution, low-cost and portable electronic digital weighing system is ideal for laboratory science, commercial and domestic use. This system utilizes a standalone microcontroller chip due to that circuitry highly reduced. The Developed electronic digital weighing balance senses, measures it and the mass which placed on a single point load cell is display on an LCD display.

The results from this study shows to several supporting locations may be added electronically, so this technique is suitable for determining the weight of very heavy objects, such as trucks and rail cars, and is used in a modern weight bridge. An LDR is a component that has a resistance that changes with the light intensity that falls upon it. They have a resistance that falls with an increase in the light intensity falling upon the device. The most obvious application for an LDR is to automatically turn on a light at certain level. The example of this could be a street light. LDRs can be used to control the shutter speed on a camera. The LDR would be used for the measure the light intensity and the set the camera shutter speed to the appropriate level. The resistance of an LDR may have typically the following resistances
Daylight = 5000Ω
Dark = 20000000 Ω

2. Literature Review

This system design gives a detailed weighing controller design method, which is according to the ingredients of the technical and logical requirements of production. Batching controller is designed with the strong anti-interference ability, high reliability, and cost-effective, compact size, full-featured and so on. It can be used as a stand-alone instrument system, and embedded instrumentation through the RS-232 communication protocol a standard interface with the top 485 industrial units in conjunction with networks [1].This system designs a 'smart basket' system which is an alternative solution to optimize management of electrical and water consumption in domestic laundry activities. This device acts as a microcontroller-based digital electronic weighing system and weighs unwashed clothes prior to the laundry stage. In the principle, the weights are measured through the use of force sensitive resistance sensor (FSR), where the final results are being displayed on liquid crystal display (LCD) [2].The goal of this system is to develop a low-cost and compact electronic circuit to control and drive the current of LEDs which arranged in a single type enclosure. The main advantage is to use the same type of equipment in the daily activities, where the ac line supply it and under the mains failure, supplied by the battery. [3].Vehicle dynamic weighing system is a weight measurement of the moving vehicle detection, dynamic measurement of moving vehicles in each axis of axle-load, and then to calculate the weight of a vehicle by the weighing system. Compared to the static parking weighing, it has high speed, high efficiency, do not interfere with regular traffic, etc., but its main disadvantage is low accuracy [4].This system introduces the interface circuit design between CS5532 and weighting sensor together with the application. The principle and the control method of the electromagnetic vibrator, and the circuit design of the zero crossing detection [5].The design takes full advantage of 24-bit Analog to Digital Converter (ADC) ADS1232 to sample the output of weighing transducer and weighted average method is used to process data [6].This system consist mathematical models of the load cell and forcing functions. These models are used to examine the suitability of this Kalman filter approach. Since this approach is based on the accurate model of the system in question, the exact model of the load cell based dynamic weighing system has been derived and presented [7]. In this system the automatic fruit-transportation gyro car works in the economic forest; the vehicle carried weighing system could improve its transportation efficiency. According to the requirement of the working condition of fruit transporting gyro car, the designed

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gyro car weighing system based on ARM controller [8]. The structure of a fuzzy model is identified by the concept of fuzzy space clustering. The input output space is clustered using a fuzzy means clustering scheme [9]. The load cell has been applied as a measurement sensor. The interface allows users to interact with the system. A software user interface along with the signal conditioning and data acquisition hardware has been fabricated [10].

3. Proposed System Design

The working principle of electronic is in carrying on the role of the size, quality, efficiency and force by weighing transducer and converts the signal and which is proportional to the amount in analog or digital forms in weighing instrument displayed. Fig.1. shows the block diagram of the proposed system. The hardware consists of a load cell, Instrumental Amplifier IC-INA128, PIC18F4550 I/P microcontroller, battery, LDR & LCD display. It essentially comprises of an 8-bit PIC18F4550 I/P microcontroller with a local memory for storing data from the INA-128. The high resolution without compromising range and which is achieved by designing a program system for interfacing an INA-128 to the 8-bit PIC18F4550 microcontroller. This is due to inbuilt serial programming interface (SPI) of the pic controller used. The output of the load cell is given to the Instrument Amplifier IC INA-128, which amplifies the signal and passes the output to the PIC18F4550 I/P microcontroller because the microcontroller cannot read the signal below 1 Volt and the load cell is giving the output in a few mill volts like 1.2mV, which is very small & weak signal so we need to amplify it. The Microcontroller is programmed in embedded C language using MPLAB IDE software and displays the output results accordingly in the LCD display. The DC supply is given to the LDR (Light Dependent Resistor) which operate on light intensity due to LED light works. The 12v/dc is give to LED and its output is given to LED light.
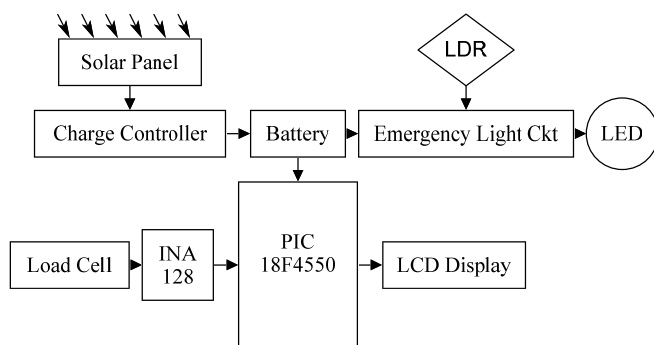

Figure 1: Block Diagram of Proposed System

4. Hardware Architecture Design

4.1 Solar Cell

The working principle of all today's solar cells is essentially the same. It is based on the photovoltaic effect and in general, the photovoltaic effect means potential difference which is generated at the junction of two different materials in response to visible or other radiation. The basic processes in behind the photovoltaic effects are:

a) The generation of the charge carriers which are due to the absorption of photons in the materials that form the junction

b) To subsequently separation of the charge carriers due to photo-generated in the junction

c) To collect the charge carriers due to photo-generated at the terminals of the junction

Photovoltaic energy conversion in solar cells consists of two essential steps. First, the absorption of light generates an electron hole pair. The hole and electrons are then separated by the structure of the device where the electrons to the negative terminal and holes to the positive terminal so due to that generating electrical power.

Table 1: Specification of solar cell

Power Ratting	Up to 15Watts
Power supply	12 Volt DC Plug
Current	1Amp@15V
Panel size in (mm)	505x345x22
Capacity	830mAmps
Weight	2kg
Mounting screws	4(Stainless steel)

4.2 Solar Charge Controller

A charge controller, battery regulator or charge regulator the rate at which electric current is limited to added or drawn from electric batteries. The charge controller prevents against overvoltage and prevents overcharging which can reduce battery performance and may pose a safety risk. To protect battery life, the deep discharging a battery or perform full controlled discharges, which depending on the battery technology.
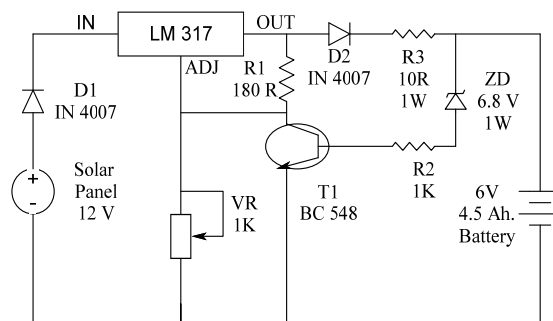

Figure 2: Basic Circuit Diagram of Solar Charge Controller

Solar charger has three basic functions which are given bellow.

a) To limit the voltage from the solar cell and as not to overcharge the battery so to regulate it with same charge.

b) When dc load are used that time the battery to get into deep discharge mode it has not to allow.

c) To allow using different DC loads and the supply of appropriate voltage.

Table 2: Specification of charge controller

Voltage	12/24v Nominal
Max array Voltage	50 volts
Max Output	10Amps
S.P.C(at charging)	0.02Amps
S.P.C(at ideal)	0.01Amps
Set point Tolerance	+/- 5%
Efficiency	96%

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4.3 Load cell

The device which is used to convert the applied force into an electrical signal that called as load cell which is a transducer. This is indirect conversion and it happens in two stages. A load cell is a device that is used to measure weight or force. When a force is applied to it in a specific manner, a load cell produces an output signal that is proportional to the applied force. Through a mechanical arrangement and where the strain gauge deforms by sensing the force. The strain-gauge measures deformation (strain) as an electrical signal, because of the strain gauge changes the resistance of the wire which is effective. In a Wheatstone bridge configuration there are mainly four types of strain gauges of load cell. The load cells are available in one quarter bridge or two half bridge. Load cells can be used individually or in combinations in weighing devices, as dictated by the geometry of the object to be weighed. Fig 3 show the basic circuit diagram of load cell.
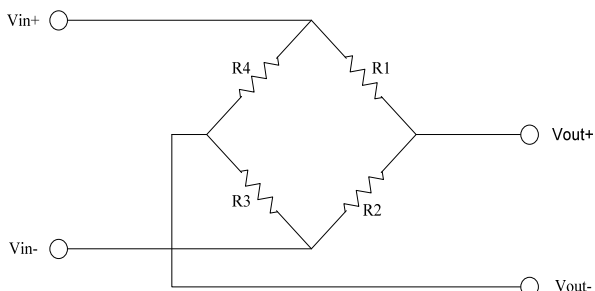

Figure 3: Basic Circuit diagram of a load cell

The output of electric signal is normally in the order of a few (mV) millivolts and an instrumentation amplifier is required for amplification before it can be used in the system. To calculate the applied force which given to the transducer can be scale of transducer output. Load cells is available in various types that exist include pneumatic load cells, hydraulic load cells and strain gauge load cells. The force of electrical signal conversion happens in two stages.
a) The Force applied deforms the element which in turn deforms the strain gauges.
b) The Strain gauges convert the deformation to electrical signals.
Table III shows the specification of load cell.

Table 3: Specification of load cell

Rated output	1.989 mv/v
Input impedance	402±10Ω
Output impedance	350±5Ω
Zero balance	±1.5%F.S
Recommended voltage	9~12 VDC
Allowed voltage	5~12VDC
Safe overload	120%F.S
Ultimate overload	150%f.s

4.4 PIC18F4550-I/P

PIC18F4550 is in PIC18 family controller where it is a 8 bit microcontroller. PIC18F family is based on the 16-bit instruction set architecture. The PIC18F4550 consists of 2 KB SRAM with 32 KB flash memory and 256 Bytes EEPROM memory. PIC18f4550 controller has 40 pin which consisting of 5 I/O ports which is PORTA, PORTB, PORTC, PORTD and PORTE. PORTB and PORTD have 8 pins to transmit or to receive 8-bit I/O data and the remaining ports have different numbers of pins which are used for I/O data communications. The different internal and external clock sources are available so PIC18F4550 are easily can work. PIC18F4550 work on a varied range of frequency from 31000 Hz to 48 MHz This PIC18F4550 has four in-built timers. The various inbuilt peripherals like ADC are available in PIC18F4550, comparators etc in this controller. The enhanced communication protocols like SPI, I2C, EUSAR, USB etc are equipped by the PIC18F4550 controller. Fig 4 show the pin diagram of PIC18F4550 controller.
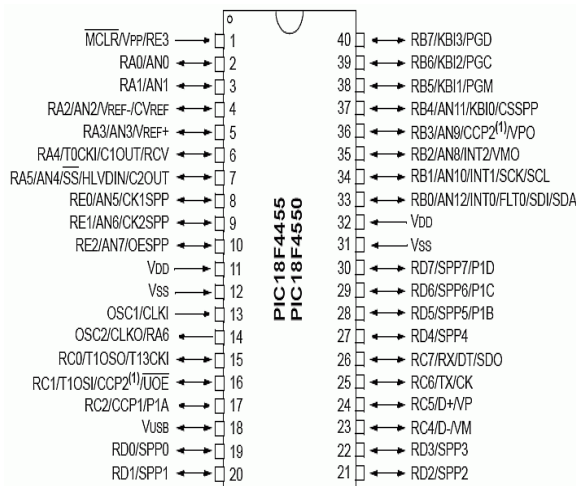

Figure 4: Pin Diagram of PIC18F4550 Controller

4.5 Light Dependent Resistor (LDR)

A Light dependant resistor also know as a LDR, photo resistor, photoconductor or photocell, is a resistor whose resistance increases or decreases depending on the amount of light intensity. LDRs (Light Dependant Resistors) are a very useful tool in a light/dark circuits. A LDRs can have a variety of resistance and functions. For example it can be used to turn on a light when the LDR is in darkness or to turn o a light when the LDR is in light. Fig 5 show the structure and symbol of LDR.
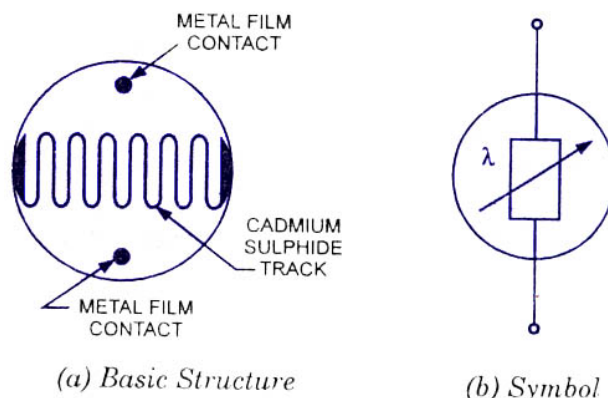

Figure 5: Basic Structure and Symbol of LDR

It can also work the other way around so when the LDR is in light it turns on the circuit and when it's in darkness the resistance increase and disrupts the circuit. How LDR is made from a chemical compound called cadmium sulfide (CdS). LDR's are made of semiconductors as light sensitive materials, on an isolating base. This compound changes

resistance depending on how bright the light is that shines on its collecting surface. The bright light causes low resistance values between the two leads while dim light causes higher resistance values. Fig 6 shows the basic circuit diagram of LDR.
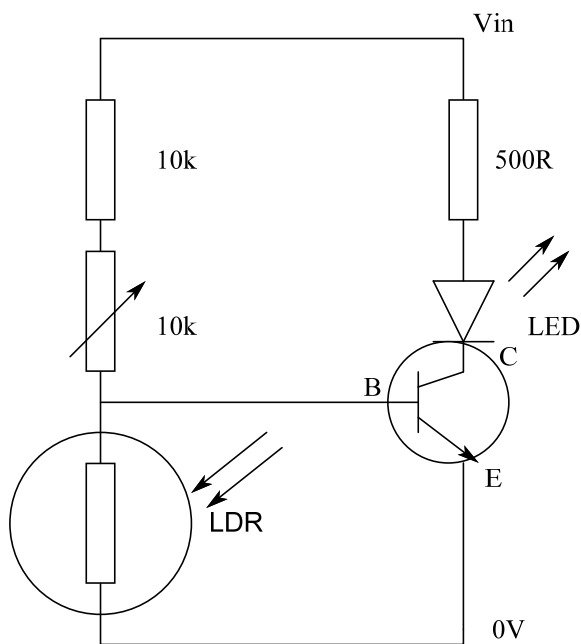

Figure 6: Basic Circuit Diagram of LDR

4.6 Instrumentation Amplifiers (INA-128)

The INA128 and INA129 are low-power with general purpose instrumentation amplifiers offering with excellent accuracy. Their versatile 3-op amp is design and small size makes them ideal for the purpose for a wide range of applications. The current-feedback of input circuitry provides wide bandwidth even at high gain G= 100 at 200 kHz. An external resistor with single form set the any gain from 1 to 10,000. The INA128 provides the industry standard gain equation and INA129's gain equation is compatible with the IC-AD620.The INA128/INA129 is trimmed for very low offset voltage (50mV) in laser stage with drift (0.5mV/°C) and high common mode rejection ratio (CMRR) (120dB at G ³ 100). INA128 operates with power supplies as low as ±2.25V, and quiescent current is only 700mA—ideal for battery operated systems. Internal input signal protection can withstand up to ±40V without damage. The INA129 & INA128 is available in 8-pin plastic DIP and SO-8 surface-mount packages, specified for the –40°C to +85°C temperature range. The instrumentation amplifier IC-INA128 is also available in dual configuration. Fig. 7 shows the internal structure of INA128.
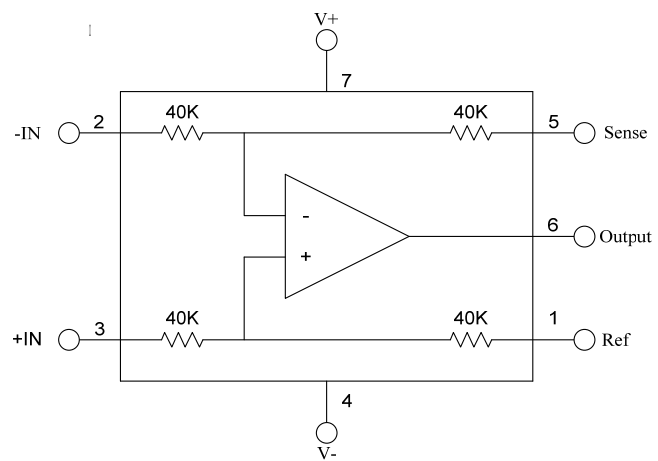

Figure 7: Internal Structure of INA128

4.7 Liquid Crystal Display (LCD)

Alphanumeric displays are used in a wide range of applications, including palmtop computers, point of sale terminal, word processors, medical instruments, cellular phones, photocopiers, etc. The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different types of characters and symbols. The full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used).

A 16x2 LCD display means it can display 16 characters per line and there are 2 such lines. In this each character is displayed in 5x7 pixel matrixes in 16x2 LCD type. Command and Data registers are two resistors which are available in 16x2 LCD. The command instructions give to the LCD by the command resistors. A command instruction is given to LCD for the predefined task like clearing its screen, initializing it, setting the cursor position and controlling display etc. The data to be displayed on the LCD is stored in data resistors. The ASCII value of the character of data registers to be displayed on the LCD.

5. Result and Discussion

The characteristics of this type of load cell are determined by studying the output signal of load cell with the various weights applied to the load cell. Power supply 12 volt Dc is applied for the excitation of the load cell and with the help of multi meter the output is measured in mill volts. A plot between Load and output signal revealed that the output varies linearly with the load applied to the load cell. The snapshot shows an interfacing between the PIC controller and load cell module with LCD display. Fig8 shows the interfacing of load cell with PIC18f4550 microcontroller chip and emergency light circuit.

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Figure 8: Snapshot of interfacing between Load cell and PIC

Table 4: Calibration Results

Sr. No.	Applied weight(Kg)	Excitation Voltage(V)	Output Voltage Without gain (mV)	Output voltage with gain(V)
1	40	5	9.5	4.75
2	30	5	7.125	3.56
3	20	5	4.75	2.37
4	10	5	2.375	1.18
5	05	5	1.1875	0.59
6	01	5	0.237	0.118

Table 4 shows that the calibration result of the load cell in that we are applied the different weights the load cell and the respective output voltage is measure the same excitation voltage is applied to all weights that is 5 V. the two different output voltages is calculated one with gain and without gain.

6. Conclusion

In this paper, a low cost, solar based automatic digital weighing machine system is designed. This electronic machine indicated that the equipment could be used as laboratory area, consumer field, industrial field and the performance analysis indicated that there was no significant difference in mean value of measurements from set weights (10, 20, 30 and 40 Kilograms) and the measured weights at the 95% probability level.

The study shows that minimum average percentage error (< 0.2%) was observed for 10, 20 and 30 Kilograms weight measurements. This measurement revealed that weighing of product by solar base electronic digital weighter is very precise. Solar electronic digital Automatic weighing system can be used for weighing purpose and also dosing of any products up to 40 Kg.

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