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Arduino Controlled Weight Monitoring With Dashboard Analysis

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Abstract: In this paper we are discussng how we can measure weight up to 180kg with help of load cells and monitor the weight on a webpage's dashboard. The objective of this paper is to be able to measure weight real-time and have charts, dashboards to be able to monitor weight of any object. Arduino will be entered into sleep mode and woke up periodically through an RTC DS3231 alarm interrupt. The readings are uploaded to local webserver through Ethernet Shield and then dynamic dashboards are made by using D3.js framework.
Keywords: Load Cells, DS3231 RTC Interrupt, Ethernet Shield Interfacing, Arduino Mega

I. INTRODUCTION

There a lot of procedures in the industry that need close monitoring during production activities. For example, while producing any chemical mixture we need to ensure the weight of different chemicals that are going to be used in the mixture to be in right proportion. Load cells are sensors that are used in the industry for variety of physical measurements. We can use IoT (Internet of Things) [5] to sense, measure and monitor any sensor. In proposed system we are using load cells to measure weight and monitor it on a dashboard.

II. LITERATURE SURVEY

The following hardware components were used

A. Arduino Mega

Arduino Mega micro-controller consists of ATmega1280 chip. It consists of 54 digital and 16 analog I/O pins, 4 UARTs, 16MHz crystal oscillator, ICSP header and USB connection. It is very helpful board for IoT based prototype applications.

B. Load Cell

The load cell is a strain gauge pressure sensor which senses the difference in pressure. They change resistance when we apply tension to it. The amount of tension or stress applied is directly proportional to the amount of change in the resistance. Here we are using strain gauge load cells to measure weight. Most load cells come with 4 wires:

1) E+ (Red) → Excitation +
2) E- (White) → Excitation -
3) S+ (Green) → Signal +
4) S- (Blue) → Signal -

C. HX711 (24 bit) Load Cell Amplifier

The HX711 Load Cell Amplifier enables to easily measure weight using load cell. It's possible to read the changes that occur in the resistance of the load cell by connecting the amplifier to Arduino. The HX711 works on I2C protocol. This is very helpful in creating commercial weighing scales.

D. Arduino Ethernet Shield

The Arduino Ethernet Shield [9] is used for Internet connectivity by stacking it up on Arduino Mega. The Shield comes with a Wiznet W5500 chip and has RJ-45 connection. It operates on 5V and gets connected to the Internet quickly with connection speeds of 10/100Mb.

E. DS3231 RTC

The DS3231 RTC [8] is very precise and cost effective real-time clock. It works on I²C protocol and has information about year, month, date, day, hours, minutes and seconds. It comes with a temperature-compensated crystal oscillator (TCXO) and crystal. There are two programmable alarms and square-wave output available.

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III. BLOCK DIAGRAM

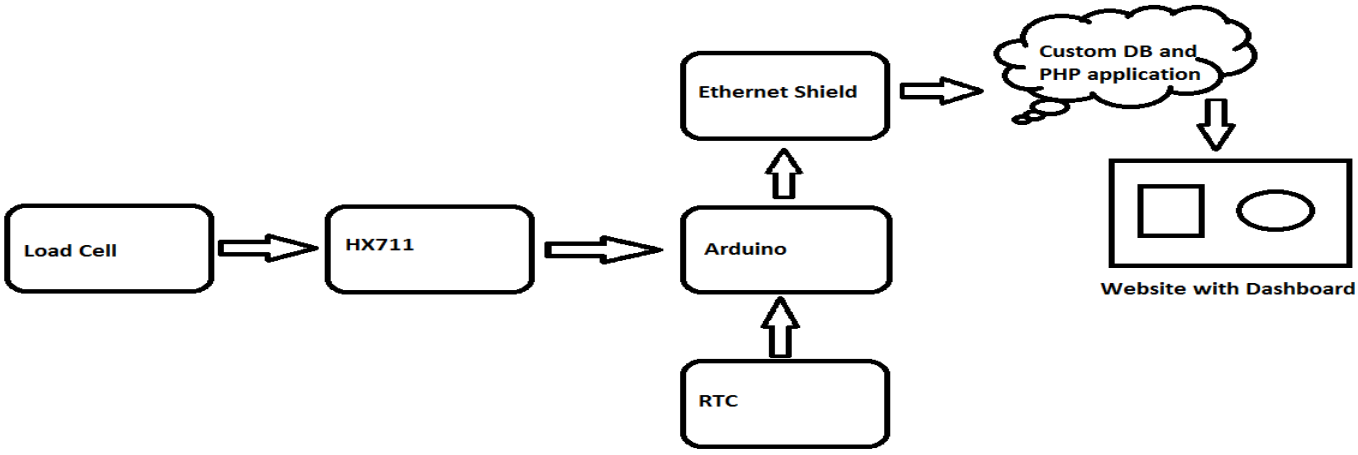


Fig.1 Block Diagram of the system

A. *Load cell and HX711*

The load cell is a strain gauge pressure sensor which senses the difference in pressure. They change resistance when we apply tension to it. The amount of tension or stress applied is directly proportional to the amount of change in the resistance. These load cells are connected in a Wheatstone bridge [1] to convert that change in resistance into equivalent change in voltage. Since voltage is in few micro volts hence a 24bit ADC HX711 [11] is used which senses the minute change in the load sensor reading. The ADC converts analog voltage signal from the load cell into digital. We need amplify the readings and then read them into the micro-controller. As the load cell characteristics are non-linear [4] with respect to weight change, we need to calibrate the readings in controller.

B. *Ethernet Shield and Dashboard*

The readings taken into Arduino are sent to the local web server running a custom database using Ethernet shield. We can use XAMPP to run a MySQL database and feed readings into it. Then by writing a PHP, HTML [2] code and using D3.js framework [3] we can display the readings dynamically onto a webpage. At places where there is no Internet connectivity, we can use GSM Shield instead of Ethernet Shield.

C. *Real Time Clock - RTC DS3231*

To save power we can enter Arduino into sleep mode and wake it up on RTC alarm interrupt which can customized. The RTC can interrupt the Arduino periodically and wake it up to take the readings and then again enter into sleep mode. There are two customizable Alarm interrupts available in DS3231 RTC [6]. The alarm interval can be adjusted based on the system requirement.

IV. CONNECTION DETAILS

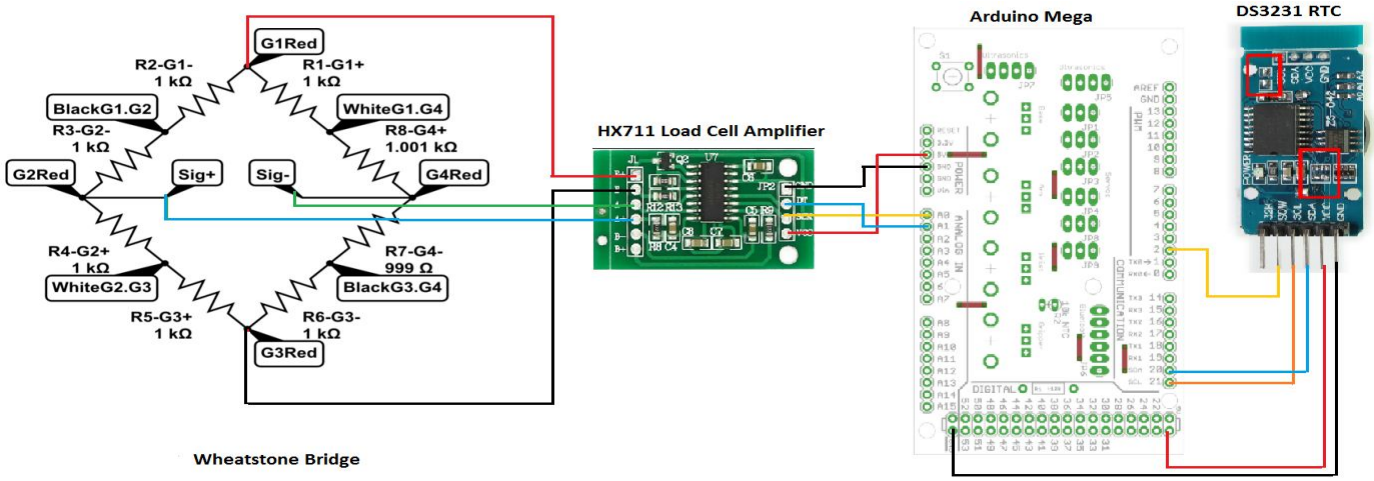


Fig. 2 Connection details of all the components.

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A. Wheatstone bridge and HX711

1) Excitation + → E+
2) Excitation - → E-
3) Signal + → A+
4) Signal - → A-

B. HX711 and Arduino Mega

1) SCK → A0
2) SDA → A1
3) VCC → 5V
4) GND → GND

C. Aduino Mega and DS3231 RTC

1) Pin 2 → INT/SQW
2) SDA → SDA
3) SCK → SCL
4) 5V → VCC
5) GND → GND

V. OBSERVATION AND RESULTS

A. Comparison between Bathroom Weighing Scale and Custom made Weighing Scale

TABLE I WEIGHT MEASUREMENT RESULTS

No	Weight in Kg			Error
	Max Weight	Regular Scale	Custom made Scale	
1	180	20.10	20.09	0.01
2	180	38.07	38.04	0.03
3	180	87.57	87.55	0.02
4	180	73.87	73.85	0.02
5	180	107.35	107.34	0.01

B. Implementation of DS3231 Alarm Interrupt

The RTC is initialized and then whenever time match occurs, an alarm is triggered and the interrupt wakes up Arduino from sleep. The raw reading is taken. This reading is then scaled and converted to weight in Kg. Once the reading is taken, the Arduino is entered into sleep again and woke up when the next time match occurs. Each reading is sent to a web server running a custom database through Ethernet Shield.



Fig. 3 Interfacing of DS3231 RTC, Arduino Mega and Ethernet Shield

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C. Displaying Data on Webpage

The weight readings are inserted into custom MySQL database [10]. Then by querying the database through a PHP application we can get the data into an array. This json data is passed to the javascript function and the readings can be to be displayed using a simple graph.

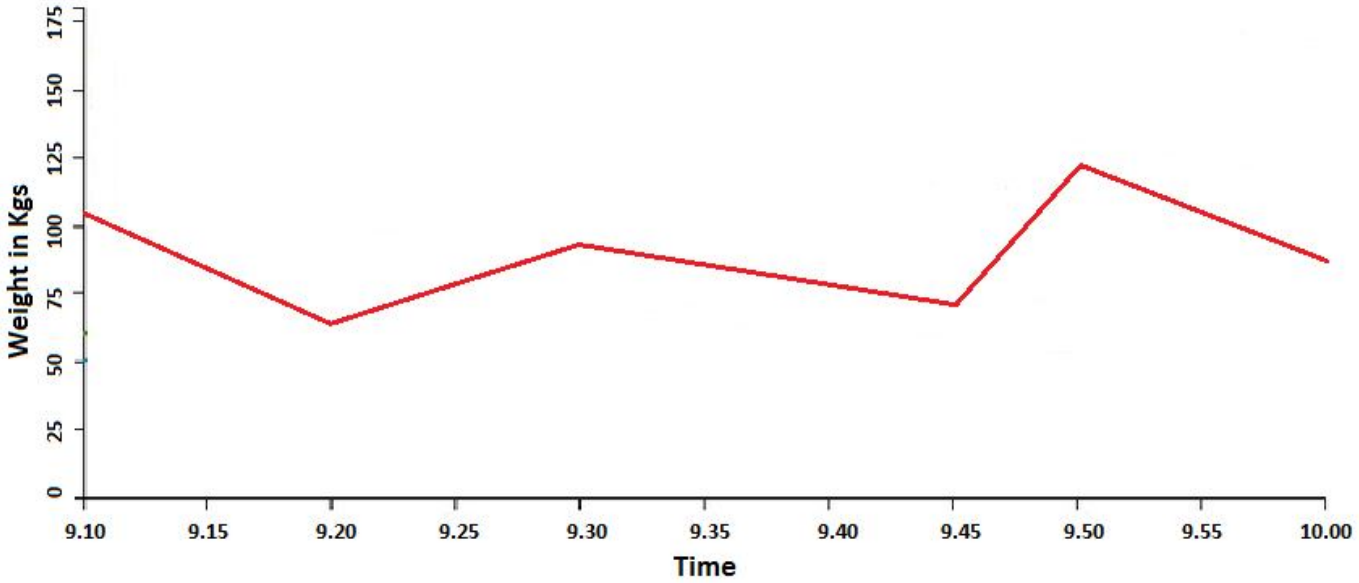


Fig.4 displaying weight readings using a graph.

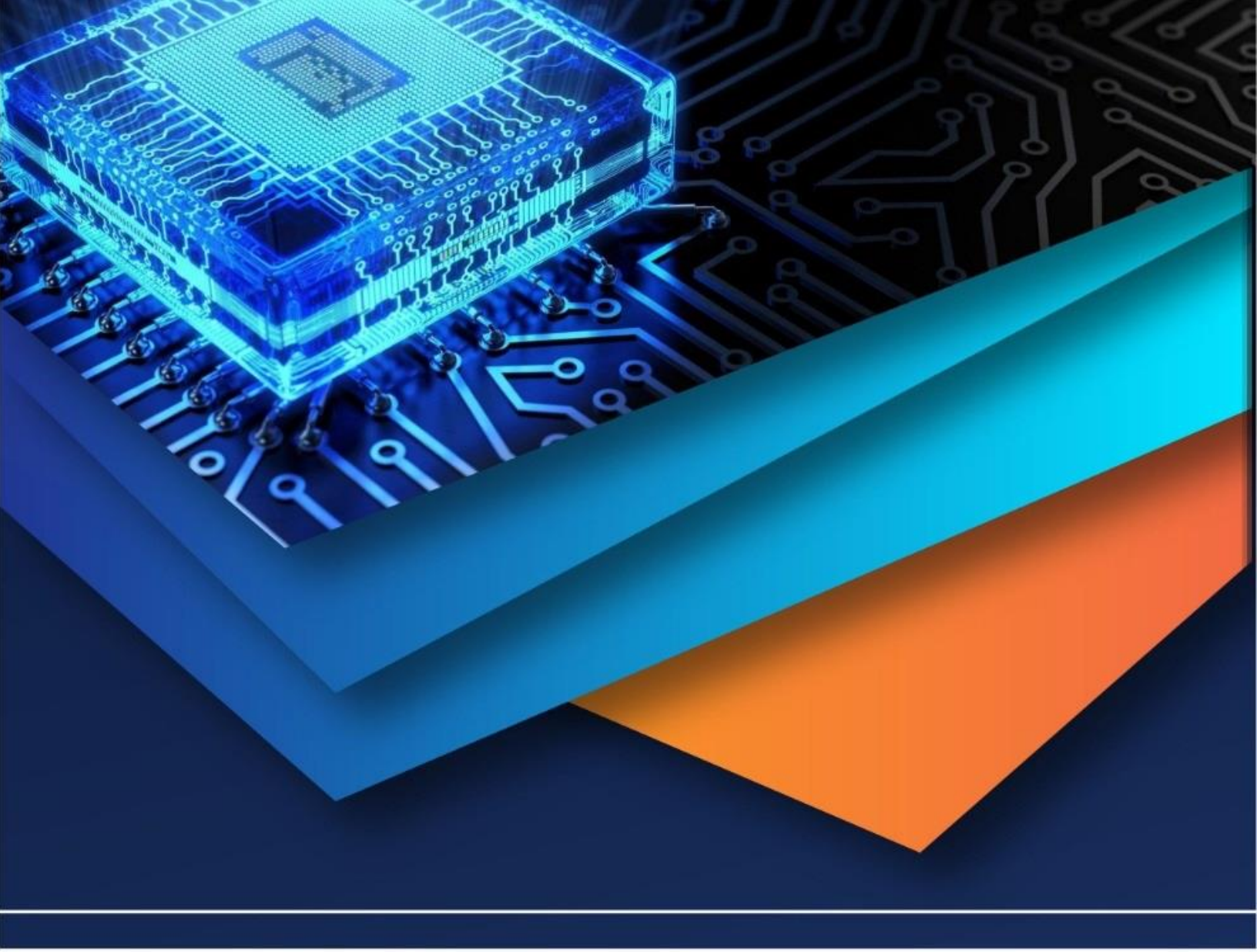
VI. CONCLUSION

Weighing scale is a measuring device used to measure weight of any object. In the proposed system, we were able to measure weight up to 180 Kg. The accuracy of the weight measurement was ±0.03Kg. We are keeping the Arduino in sleep mode for a minute and waking it up every minute whenever 00 seconds match. These readings are then successfully displayed on the webpage. The ability to measure, monitor and analyse weight of raw materials used in production activities is very crucial. We can monitor the trend of usage of individual materials. This trend can be helpful in determining if we are efficiently using the resources, finding which resources are causing the production cost to increase, which resource will have larger impact on the production cost and what alternatives would be helpful in reducing the cost of product. Similarly, various other sensors can be used to monitor or sense different objects and these readings can be uploaded on the Internet. With the help of analytical tools, this data can be used to perform analysis on existing system. By analyzing these systems we can enhance them, improve their performance and find cost effective solutions.

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