Application of Load Cell Sensors in Gallon Size Detection for IoT-based Refill Depot Applications

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ABSTRACT
The purpose of this study is to apply load cell sensors on gallon size detectors for Internet of Things-based refill depots that can fill water into gallons and record the number of gallons that have been filled into the database which then the records can be accessed through the internet in realtime. The results of this study showed that load cell sensors can be used to measure gallon size in IoT-based refill depot systems

Keywords: *Load Cell Sensors, Io, detectors*

1. INTRODUCTION

Refillable drinking water depots as shown in Figure 1 generally serve 19-liter gallon filling. In the process of filling, usually, the filling of gallons is done manually by pressing the switch on the panel to open the solenoid faucet that can regulate the discharge of water flow with the gallon filling. And when the gallon is fully charged, the switch on the panel must be pressed again to close the solenoid faucet so that the volume of water in the gallon is appropriate and does not spill. Then gallons are given a lid and then marketed.

Figure 1. Depot of Filler Water

In every seller of refillable drinking water, there is usually always a sales record as shown in Figure 2, both in the depot filler section and on the gallon delivery courier. This is done to facilitate the process of making a report of daily sales results to calculate turnover, profit as well as salary distribution for employees.

Figure 2. Notes of Depot of Filler Water

In the making of the sales report, usually, the depot owner must participate in making and checking the report manually to ensure the calculation between the gallons sold and the money earned accordingly. One of them happened at riedzky Tirta Perkasa refill drinking water depot located at Jalan Setia Darma II No. 14 Tambun Selatan, Bekasi Regency. The thing that makes it more difficult is when the number of depots owned more than one and the location is far away, then inevitably the depot owner has to go to each depot to conduct surveillance and check the sales report manually

Therefore, it takes an automatic gallon charging system that can record and calculate each gallon filled or sold that can be accessed through the internet network in real-time web-based so that it can be accessed through a computer or smartphone to view data recapitulating the number of gallons from several depots simultaneously.

2. METHODS

The method used in this study is Engineering where the stages of this research start from design analysis to determine the specifications of designs that previously met the specified specifications, then conduct subsystem testing to choose the best alternative, then conduct experiments to prove that the selected design can meet predetermined requirements effectively and efficiently[2]. Based on the stages of the research can then be made flow into the flow chart as presented in Figure 3.

3. RESULTS AND DISCUSSION

This IoT-based automatic gallon filling system has a working principle when an empty gallon with a size of 12 liters or 19 liters is placed in the filing cabinet then after that, the filling cabinet door is closed, the system will calculate the empty weight of the gallon and then detect the type of gallon being placed. The known gallon type will be displayed on the LCD screen and filling will start automatically after a few seconds by activating the relay on the water pump and solenoid valve. If the filling is complete with the appropriate gallon weight, the relay will turn off and the buzzer will sound to remind you. Then, if Node MCU gets an internet connection, the charging data will be directly recorded in the database server. Then, the owner and depot employees can check the data on the number of gallons filled through the website. In addition, the website can be automatically reloaded for accurate and real-time data. The shape of the gallon filing cabinet can be seen in Figure 4. As for the load cell frame, it can be seen in Figure 4.

This feasibility test is carried out to determine whether this automatic gallon filling system can be declared feasible to fill according to the criteria and calculate the percentage of errors or errors that may occur in the filling process.

This test was carried out 5 times for each type of gallon by first measuring the weight of the empty gallon, then the weight of the gallon after it was filled. Then a calculation is carried out to determine the net weight of water which is calculated from the weight of the gallon after being filled minus the empty weight of the gallon before filling. The results of the net weight of the water can then be compared with the net weight on the packaging it should be, which is 12 Liters and 19 Liters to measure how much error occurs in the system. The results of these measurements can be seen in Table 1 and Table 2 for Gallon 12 L.

Figure 3. Front Side of Water Filler Automatic System.

Figure 4. The frame of Load Cel.

Table 1 The results of 12L Gallon measurements.

No*	Weight in device (g)	Weight in Digital Scale (Kg)	Tare (Kg)	Error %
1	427	12,5	12,1	0,008
2	428	12,6	12,2	0,016
3	417	12,4	12	0
4	428	12,5	12,1	0,008
5	408	12,6	12,2	0,016

*number of measurement

Error calculation for 12 Liter packaging can be formulated as follows.

$$Error = \left|\frac{Weight\ of\ water - 19\ Kg}{19\ Kg}\right| \times 100\% \quad (1)$$

From the data in Table 1, it can be seen that all tests on filling with 12-liter gallons the results on the net weight of the water show results that are by the weight that should be 12 Kg for 12-liter gallons because of 1 liter of water = 1 Kg. From the data, there is also a small error value with the largest error value, which is 0.016% of the weight it should have. After the measurements have been made on the device, to ensure that the resulting value is by the actual value, each gallon that has been tested is tested again with a GEA digital scale with a resolution of 0.1 Kg to compare its value. Comparison of the results of measuring 12-liter gallons with digital scales is presented in Table 2.

Table 2. Comparison of 12 L Gallon Measurements with Digital Scales

Measurement	Weight in device (Kg)	Weight in Digital Scale (Kg)	Error
1	12,5	12,5	0%
2	12,6	12,6	0%
3	12,4	12,4	0%
4	12,5	12,5	0%
5	12,6	12,6	0%

Error calculation on digital scales (TD) for 12 Liter packaging can be formulated as follows

$$\% = \left|\frac{Weigh\ in\ device - Weight\ in\ Digital\ Scale}{Weight\ in\ Digital\ Scale}\right| \times 100\% \quad (2)$$

Based on the results of weight testing using digital scales as presented in Table 2 and after being compared between the weight measured by the tool and the weight measured by the digital scale, there is no difference from the test for 12-liter gallons. All values in the test show the results of calculating an error of 0% or there is no difference. For 19L gallons, the test results can be seen in Table 3 and Table 4.

Table 3. 19 L Gallon Filling Measurement Results

No *	Blank gallon (g)	Fulfilled gallon (kg)	weight of water (kg)	error
1	771	19,7	19	0%
2	807	19,8	19	0%
3	778	19,8	19,1	0,005%
4	768	20	19,3	0,015%
5	756	19,8	19,1	0,1%

*number of measurement

For 19L packaging, the error calculation for the packaging can be formulated as follows.

$$\%Error = \left|\frac{Weight\ of\ water - 19\ Kg}{19\ Kg}\right| \times 100\% \quad (3)$$

From Table 3, it can be seen that from 5 experiments, all of them showed the net weight of water after being filled, which was 19 Kg according to the weight of a 19-liter gallon because of 1 liter of water = 1 Kg. From the data, there is also an error with the largest error value of 0.1%. After the measurements have been made on the device, to ensure that the resulting value is by the actual value, each gallon that has been tested is tested again with a GEA digital scale with a resolution of 0.1 Kg to compare its value. Comparative data on the measurement results of 19-liter gallons with digital scales are presented in Table 4.

Table 4. Comparison of 19 L Gallon Measurement with Digital Scale.

Measurement	Weight in the device (Kg)	Weight in Digital Scale (Kg)	Error
1	19,7	19,7	0%
2	19,8	19,7	0,005%
3	19,8	19,7	0,005%
4	20	19,9	0,005%
5	19,8	19,8	0%

Error calculation on digital scales (TD) for 19 L packaging can be formulated as follows.

$$\% = \left|\frac{Weigh\ in\ device - Weight\ in\ Digital\ Scale}{Weight\ in\ Digital\ Scale}\right| \times 100\% \quad (4)$$

Based on the data presented in Table 4, it can be seen that the measurement value on the tool with the measurement value on the digital scale is very close. This is evidenced by the error calculations carried out in 5 experiments on the 19-liter gallon, there is an error value with the largest number, namely 0.005%.

Based on all the test results that have been carried out on the tool, it appears that all the test results are by the predetermined test criteria. The tool has succeeded in reading the types of gallons between 12-liter gallons and 19-liter gallons correctly and filling the gallons automatically according to the proper weight with the largest error of 0.016 for the 12-liter gallon type and the largest error of 0.1% for the 19-gallon type liter. For the 12-liter gallon type, after comparing its value with digital scale measurements, the results from 5 experiments showed no error at all. As for the 19-liter gallon type, after comparing the results of measurements made by tools with measurements made with GEA digital scales with a resolution of 0.1 Kg there is an error with the largest error value of 0.005%.

In addition, after the filling is complete, the tool can send data to the webserver to record the data that has been completed into the database. From the data in the database, it can then be accessed via the website to view the gallon filling log.

4. CONCLUSION

Based on the research that has been done, it can be concluded that this IoT-based automatic gallon filling system can fill gallons automatically according to the size of the gallon with the difference in weight should be 0.16% for 12-liter gallons and 0.1% for 19-liter gallons. . In addition, the proven record of filling each gallon can be seen on the web page referring to the depot code, cupboard code, date and time when filling was completed.

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