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Penulis	: Sri Ratna Sulistiyanti, Muhammad Ifan Saputra, FX Arinto Setyawan, Umi Murdika, Yonathan Tri Handiko (**anggota**)
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Mengetahui/Menyetujui
Dekan Fakultas Teknik,

Dr. Eng. Ir. Helmy Fitriawan, S.T., M.Sc
NIP. 197509282001121002

Penulis,

Dr. Sri Ratna Sulistiyanti, M.T
NIP. 196510211995122001

Mengetahui/Menyetujui
Ketua Lembaga Penelitian dan Pengabdian pada Masyarakat
Universitas Lampung

Dr. Habibullah Jimad, M.Si
NIP. 197111211995121001

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Modeling of Digital Scale Based on IoT

Muhammad Ifan Saputra
Jurusan Teknik Elektro
Universitas Lampung
Bandar Lampung, Indonesia
m.ifan.saputra21@students.unila.ac.id

Sri Ratna Sulistiyanti
Jurusan Teknik Elektro
Universitas Lampung
Bandar Lampung, Indonesia
sr_sulistiyanti @eng.unila.ac.id

FX Arinto Setyawan
Jurusan Teknik Elektro
Universitas Lampung
Bandar Lampung, Indonesia
fx.arinto@eng.unila.ac.id

Umi Murdika
Jurusan Teknik Elektro
Universitas Lampung
Bandar Lampung, Indonesia
umi.murdika@eng.unila.ac.id

Yonathan Tri Handiko
Jurusan Teknik Elektro
Universitas Lampung
Bandar Lampung, Indonesia
yonathan.tri1048@students.unila.ac.id

***Abstract* — This system is designed to be able to measure the weight of an item and record IoT-based measurement results by displaying it through a database on a website automatically. Because the livestock sector in Indonesia is still largely unorganized and there is a need for clear supply chain management and support for supply chain performance, even though supply chain management has been made, stock taking still needs to be done. and can result in an imbalance with the number of items in the warehouse and also inefficiency for the company if it wants to see stock. Therefore, the author developed a digital weighing system using 4 IoT-based load cell sensors by recording measurement results through a database and displaying them in real-time on the LCD (Liquid Crystal Digital) and website. The development method used in this research is the prototype method, namely by realizing the system design that has been made. The conclusion of this study is the realization of a digital scale model using four IOT-based load cell sensors, with an instrument accuracy rate of 99.94373%, and the test object is large with a weight of 2-11 Kg.**

Keywords* — *Load Cell Sensor, Stock Taking, IOT, Website.

I. INTRODUCTION

Stock taking is an activity to control the administration and physical goods. By holding a stock take, it will be known whether the stock report is correct or not. At the time of stock-taking, it is often found that there are differences in goods such as more goods than the stock report or fewer goods than the stock report. In recording goods into Stock Taking there are also some input errors in weight and can result in inequality with the number of goods in the warehouse and also inefficiency for the company if you want to see stock, so it is necessary to add system functions at the access distance so that users can monitoring basic inventory from anywhere and can enter data directly [1]. System improvement can be done using IoT (Internet of Things) [2,3].

To implement this idea, it takes 4 load cell sensors that will read the weight of the object placed on the scale, the value read on each load cell sensor is amplified and converted from analog to digital with the Hx711 module to then be processed at the processing core, namely the NodeMCU. V3 ESP826 [4]. After successful processing, the weight measurement results will appear on the 16x2 LCD (Liquid Crystal Display). If the measurement result exceeds the set limit, the LCD (Liquid Crystal Display) will display an overload message (Overload) [6]. NodeMCU will wait for orders from the website if the website requires data to be displayed then NodeMCU will process sending data to the website through the database [7].

The idea was obtained from research that has been carried out previously, namely research by Achilon, et al entitled Analysis of Load Cell Sensor Results Measurements for Weighing Rice, Packages and Fruits Based on Arduino Uno which concluded that Load Cell Sensors are more efficient and accurate when used to measure fruit weight [8]. As well as research conducted by Abdul Muis Muslimin and Titin Lestari with the title Designing an Arduino Leonardo-based digital weighing device using a load cell sensor which concludes that the overall tool made can work and function as expected, so that it can be used as a digital weighing instrument capable of displaying the value of the load mass automatically on the LCD with the Atmega32u4 microcontroller as the main controller [9].

II. RESEARCH METHOD

In this study, a digital scale was designed using a Load Cell sensor and recording IOT-based weighing results. The main components of this tool consist of Load Cell Sensor, NodeMCU V3 ESP8266, 2x16 LCD, and also Load Cell Converter Hx711. The block diagram for this design tool is presented in Fig. 2. To more easily understand the design of this tool, a drawing of the tool design is presented in Fig. 3. This tool is designed to measure load using a Load Cell Sensor as a speed measuring component, while a 2x16 LCD is used as a result. measurement other than that the measurement results that have been displayed on the LCD 2x16 display will be displayed on the website, if the MCU Node gets an order to display the data on the website. This tool is also designed to provide a warning in the form of a short Overload message if there is a load display that exceeds a predetermined limit. Fig.1. is the result of designing a digital scale using a Load Cell sensor with loads placed at three different points. This is related to the data collection that will be carried out.

Fig. 1. Digital Scales Prototype

The tool design block diagram is as follows :

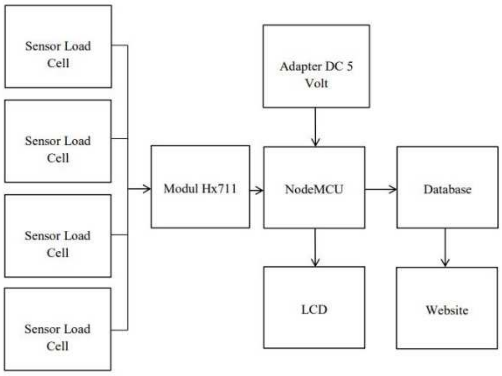

Fig. 2. Tool Design Block Diagram

When the 4 load cell sensors read the weight of the object placed on the scale, the value read on each load cell sensor is amplified and converted from analog to digital with the Hx711 module to then be processed at the processing core, namely the NodeMCU V3 ESP826. After successful processing, the weight measurement results will appear on the 16x2 LCD (Liquid Crystal Display). If the measurement result exceeds the set limit, the LCD (Liquid Crystal Display) will display an overload message (Overload). NodeMCU will wait for orders from the website if the website requires data to be displayed then NodeMCU will process sending data to the website through the database

The functions of the tools or components used in this study are as follows:

1. Asus X441U laptop which is used to program NodeMCU V3 ESP8266 via Arduino IDE software.
2. Load Cell Sensor which is used to determine the weight of an object
3. NodeMCU V3 ESP826 which functions as the main controller for tool processing and the link between the scale model and the website via a Wifi connection.
4. LCD (Liquid Crystal Digital) which is used to display measurement data that has been processed by NodeMCU V3 ESP8266.
5. Hx711 Load Cell Converter which functions as an amplifier to condition the analog signal from the load cell sensor and converts it into a digital signal.
6. Arduino IDE is used as a software to manage commands that must be carried out by the Arduino Mega2560..

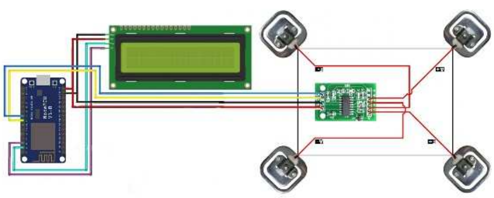

Fig. 3. Research Tool Design

A. *Test Result Data at Center of Weight A*

TABLE I. TEST RESULT DATA AT CENTER OF WEIGHT A

No	Load Weight (Kg)	Digital Weighing Data (Kg)	Designed Device Data (Kg)	Deviation	Error (%)	Accuracy (%)
1	2	1,9	1,88	0,02	0,01	99,99
2	3	2,9	2,84	0,06	0,02	99,98
3	4	3,9	3,88	0,02	0,005	99,995
4	5	4,9	4,92	0,02	0,004	99,996
5	6	5,9	5,78	0,12	0,02	99,98
6	7	6,9	6,58	0,32	0,048	99,952
7	8	8,0	7,64	0,36	0,047	99,953
8	9	8,9	8,76	0,14	0,015	99,985
9	10	9,7	9,50	0,2	0,021	99,979
10	11	10,8	10,79	0,01	0,0009	99,9991
Average				0,127	0,01909	99,98091

Based on Table 1, namely the result data on testing tools with rice objects at point A, it can be concluded that the tool that has been designed has an average deviation of 0.127, an average error of 0.0190%, and has a measurement accuracy value of 99.9809% at the center point. weight A

B. *Result Data on Container Area 30x30cm*

TABLE II. RESULT DATA ON CONTAINER AREA 30X30CM

No	Center of Weight	Average Deviation	Average Error (%)	Average Accuracy (%)
1	A	0,152	0,0302465	99,969755
2	B	0,075	0,0145111	99,985489
3	C	0,083	0,0176071	99,982393
Average		0,1033	0,02078	99,9792

Based on Table 2, tool testing was also carried out at 3 centers of weight with an area of 30x30 cm weighing container using a weight variation of 2-11 Kg. The designed digital scale has a deviation value of 0.1033 error of 0.0207% with an accuracy of 99.9792%.

C. *Result Data on Container Area 50x50cm*

TABLE III. RESULT DATA ON CONTAINER AREA 50X50CM

No	Center of Weight	Average Deviation	Average Error (%)	Average Accuracy (%)
1	A	0,104	0,0202	99,9816
2	B	0,1	0,0242	99,9712
3	C	0,104	0,0202	99,9816
Average		0,1026	0,0215	99,9781

Based on Table 3, tool testing was also carried out at 3 centers of weight with an area of 50x50 cm weighing container using a weight variation of 2-11 Kg. The digital scale designed has a deviation value of 0.1026, an error of 0.0215% with an accuracy of 99.9781%.

D. Repeatability Test Result Data

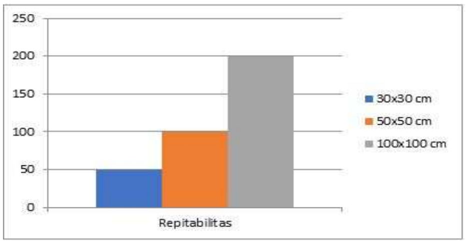

Fig. 4. Result of Repeatability Data

Based on Figure 4, the Repeatability data on the wide variation of the digital scale container, shows that the best repeatability is shown in the test with the smallest container area, namely the repeatability of 50 grams in a container area of 30x30 cm, 100 grams in a container area of 50x50 cm and 200 grams in a container area of 100x100 cm. . This repeatability value is obtained based on sensor calibration, the repeatability can vary according to the size of the container used. The use of a 30x30 cm container area is good for users who want high accuracy in measurements with a load object that has a size according to the container area, while in measurements with a load object that has a larger size, the use of the container area will be better with a larger area of 100x100 cm.

E. Test Result Data Sending Data to Website Pages

The dashboard that serves as a place to display the data from the load cell sensor readings is made using the Thinger.io platform. This dashboard displays sensor reading data online and can be accessed via the internet, sending data on these results in real-time, which means to get output that matches sensor readings, digital scale models and devices used to access the website must be connected to the internet network.

Fig. 5. Display Weight Data on Website Pages

ts	Berat
2022-05-24T08:23:52.982Z	-0.2648695707321167
2022-05-24T08:30:39.834Z	-0.2888000011444092
2022-05-24T08:33:55.114Z	0.22702325880527496
2022-05-24T08:38:06.714Z	-0.2578538954257965
2022-05-24T08:41:05.859Z	-0.24063636362552643
2022-05-24T08:55:31.029Z	-0.34931817650794983
2022-05-24T09:10:31.886Z	9.513.772.964.477.530
2022-05-24T14:55:02.121Z	4.101.010.101.010.100
2022-05-24T14:59:43.031Z	6.101.010.101.010.100
2022-05-24T15:04:50.823Z	6.911.111.111.111.110
2022-05-24T15:10:16.355Z	8.000.636.363.625.520
2022-05-24T15:13:10.233Z	8.288.800.001.144.440
2022-05-24T15:19:32.476Z	8.000.636.363.625.520

Fig. 6. Display of Weight Data in Database

Based on Figure 6 above, the data recording is displayed on Thinger.io or the database of the results of measuring the weight of the load measured at a certain time. The first column contains ts data (timestamp) which shows the date and time of measurement, in the second column, the weight data is in Kg units.

III. RESULT AND DISSCUSION

In designing a digital scale prototype using a Load Cell Sensor, data retrieval is carried out using loads that vary from 2kg to 11kg. Data collection in this study was carried out at the Integrated Laboratory of Electrical Engineering, the University of Lampung which took place from January 2021 to March 2022. Then the results of the data collection will be compared with the results of the data that has been weighed with digital scales that have been manufactured, this is done to ensure that the prototype of a digital scale using a Load Cell Sensor can run well.

In collecting data, the load to be measured is placed at three different points, namely placing it at point A, placing it at point B, and placing it at point C.

(a) (b) (c)

Fig. 7. Data Collection Process By Laying Loads at Three Different Point

After the load is measured at the three desired points, the NodeMCU requires the next command to send data to the website. If there is an order to send data to the website, then NodeMCU will send it to Thinger.Io.

Fig. 8. Display of Measurement Result Data on Thinger.Io Dashboard

Based on Figure 8 the measurement data on the Thinger.io dashboard, Shows the display of weight data shown by a circle chart, this weight data will be displayed in real-time by the website, it is also seen that the connection between the website and the microcontroller can be monitored on the Thinger.io dashboard, starting from the data sent, received data and the IP address that connects the microcontroller to the website

After the analysis is done, some factors affect the level of error value from the measurement data on the design tool. has been designed.

CONCLUSION

After making the design and analysis, it can be concluded that the digital scale model has been realized using four IOT-based Load Cell sensors. The function of the tool that has been designed is to measure the load, where the load data will be displayed on a 2 x 16 Liquid Crystal Display (LCD) and the Website, and when there is a load that exceeds the speed it should be, there will be a warning in the form of a short message (Overload).) displayed on the Liquid Crystal Display (LCD) measuring 2 x 16 with an accuracy rate of 99.94373%. This design tool is expected to be used in the future in a minimum of two pieces to realize its use in recording goods into Stock Taking

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