
DESIGN AND IMPLEMENTATION OF AUTOMATIC RICE MEASURER BASED ON ARDUINO UNO R3 USING LOAD CELL WEIGHT SENSOR

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Abstract

Rice is one of the staple foods of the Indonesian people. The need for food plays an important role in maintaining the economic and social stability of the community. The problem that often occurs is that people measure rice using a glass to cook rice so that the amount of rice to be cooked is less accurate and takes a long time. This study aims to design and develop an automatic rice measuring system based on Arduino Uno which uses a load cell weight sensor to automatically measure the weight of rice according to the desired using an experimental method. The results of the study show that this automatic rice measuring system can measure and dispense rice accurately, according to the desired weight and when the rice has come out according to the desired weight, the tool will close automatically. This system can increase the efficiency of rice weighing, reduce waste, and provide visual feedback via I2C LCD. Based on the research conducted, the load cell weight sensor has high accuracy to respond to changes in load weight in real-time.

Keywords: Arduino Uno, Automatic, Load cell weight sensor, Rice, Rice measuring.

INTRODUCTION

Rice is a basic daily need for people. Almost the majority of the Indonesian population consumes rice as a staple food. The importance of this commodity is used as a reference in assessing the welfare of the community and is sometimes also used as a reference in assessing the socio-political conditions of the community. Rice is the main food commodity for the Indonesian people. Almost the entire population in this country consumes rice every day. This causes the rice commodity to have a very strategic value. In addition to the needs of many people, rice can also be used as a parameter for the country's economic and social stability. If there is a shortage or the community's rice needs are not met, it will have an impact on inflation and social unrest (Bulog, 2016). For example, the decrease in the amount of rice production in West Kalimantan is not in line with the population which increases every year. In 2020, there was an increase in the population from the previous year by 76,200 people. The negative correlation between the population and the amount of rice production in West Kalimantan causes uneven distribution of rice and threatens the availability of rice for the people in West Kalimantan, which can result in starvation (BPS Kalbar, 2020).

Indonesia is a large country with a large population so that food consumption, especially rice, is also high. In order to avoid an imbalance between the population explosion and the availability of rice, planning for rice consumption needs is needed (Rejekiningrum, 2013). The availability of food that is smaller than its integrity can create economic instability in a country. Various social and political upheavals can occur if food security is disrupted which can ultimately endanger national stability (Ismet, 2007).

The problem of domestic rice shortages is usually anticipated by the government by increasing reserves or importing rice. In historical records, Indonesia has always imported rice even though it has achieved rice self-sufficiency in 1984. Rice imports continued until reaching a peak of 4.7 million tons in 1999 and then decreased after 2008 when rice self-sufficiency was achieved again. Rice imports are carried out incidentally for various reasons such as price stabilization, increasing reserves, anticipating disasters, and so on. The government feels that the availability of rice is safe if the national rice surplus reaches 10 million tons per year which is planned to be achieved in 2014. Extensification and intensification programs continue to be rolled out including food diversification programs to reduce rice consumption while increasing consumption of foods other than rice (Suryana, 2011 in Setiawan, 2012).

According to research in 2012, the Ministry of Agriculture calculated that Indonesian people's rice consumption reached 102 kg per capita per year. This is considered to be quite high consumption. In fact, it is almost twice the world's rice consumption of only 60 kg per capita per year. Indonesian rice consumption is the highest consumption in Asia. Rice consumption in Korea reaches 40 kg per capita per year, Japan 50 kg per year, Malaysia 80 kg per year, Thailand 70 kg per year. The high national rice consumption rate is because rice is an inseparable part of the national food culture. The government is trying to reduce rice consumption with a food consumption diversification program. This is done because there are still many alternative foods that can be consumed. The decrease in rice consumption is at least 1.5% per capita per year (Neraca, 2013).

Furthermore, Gita Wirjawan as Minister of Trade, once sparked controversy with his appeal in the mass media for Indonesian citizens to reduce rice consumption. As a replacement, the population was urged to change their carbohydrate diet, for example consuming cassava or sweet potatoes. The argument given was that data from the Central Statistics Agency (BPS) in 2011 stated that Indonesia's per capita rice consumption was 139 kg/year, higher than Malaysia's per capita rice consumption of only 63 kg/year. The appeal had a good intention, namely to change Indonesia into a rice exporter, from what had previously been the world's number one rice importer. By reducing rice consumption, then with the current production level, 2012 of 68.6 million tons of dry milled grain (GKG), or equivalent to 39.1 million tons of rice, Indonesia could export rice and achieve rice self-sufficiency.

There are several solutions to increase rice efficiency, including improving post-harvest processing technology to reduce yield losses, implementing more productive superior rice varieties, and using modern irrigation systems to increase yields. In addition, increasing distribution through digital logistics technology, as well as educational programs for the community on how to consume rice intelligently, can support waste reduction and ensure an even supply of rice. The way people determine the size of rice still uses estimates to meet daily food needs. This can result in inappropriate sizes (less/excessive (wasteful)), so that it can have an ineffective effect on managing rice as a daily food need. One method to support the community in measuring rice is to create a smart rice box that can measure rice based on automatic food portion settings. (Setiawan 2018)

With such problems, we conducted research by creating various innovations that can improve efficiency in everyday life, especially in the food sector. One of our innovations is to create a Smart rice box that can measure rice based on meal portions automatically using the Load Cell Sensor and Arduino Uno R3 microcontroller.

Arduino Uno, as the brain of the system, provides efficient and flexible programming and operation options. Using this tool, users only need to determine the desired amount of rice portions, and the system will automatically measure and dispense the required amount of rice. The application

of this technology not only improves efficiency in daily food preparation but also strengthens the concept of a smart home, which is in line with today's lifestyle advancements. In addition, the monitoring system on this tool allows users to see the availability of rice directly, thus contributing to preventing stock shortages (Setiawan, 2018).

This system is designed to offer an effective solution in measuring rice with a high level of accuracy, so that it can reduce manual errors in measurement and also minimize waste. In addition, this system aims to support modern household automation, where users only need to enter the desired portion size to get the appropriate rice measurement automatically. This research also develops a real-time rice stock monitoring feature, which allows users to monitor food availability easily and accurately. Through the implementation of this system, it is expected to provide a practical solution for household needs while contributing to the efficiency and food security of the community more broadly.

Research on the application of load cell sensors to Arduino Uno-based systems shows great potential in supporting automation in many sectors, especially in accurate weighing systems. By using this combination of technologies, it is expected to produce tools that not only increase efficiency, but can also support better food management at the household and community levels. This study also aims to analyze the development of a rice measurement system using a load cell controlled by an Arduino Uno microcontroller, as well as to identify the advantages and obstacles faced in its application.

LITERATURE REVIEW

Load Cell Sensor and Module HX711



Figure 2.2 Load Cell sensor

Load Cell is tool the usual electromechanics called Transducer, namely the style that works based on principle deformation a result material existence voltage the mechanics that work , then change style Mechanic become signal electricity . For determine voltage mechanical based on the results Robert Hooke's discovery that connection between voltage mechanical and deformation caused called strain . Strain This occurs in the layer skin from the material so that make it possible For measured using strain sensor or Strain Gauge. (Kitoma , 2020). as shown in figure 2.1. Here This is specification from Load Cell.

Table 2.1 Load cell sensor specifications

Rated Load	5kg
Working Voltage	3-12VDC
MaximumWorking Voltage	15VDC
Rated Output	1.0±0.15mV/V
Nonlinearty	0.03%F.S
Lag	0.03%F.s
Repeatability	0.03%F.S
Dimensions	Leangth(mm) : 80
Width (mm)	12.7
Height (mm)	12.7

For a series of load cells in the design used that is Already a package with HX711 module , HX711 is A component integrated from “AVIA SEMICONDUCTOR”, the HX711 precision 24-bit analog to digital converter (ADC) is designed for digital scale sensors in industrial control applications connected to bridge sensors . as shown in figure 2.2.

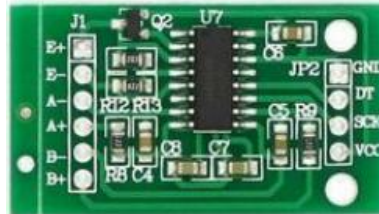


Figure 2. 3 HX711 Module

HX711 is module amplifier designed signal special For used with load cell. This module functioning For convert signal The analog data produced by the load cell becomes digital data that can be used read by a microcontroller , such as Arduino. The HX711 is equipped with with two input channels that allow user For connecting two load cells together simultaneously . In addition , the module This offer gain and speed settings reading that can customizable , making it ideal for application measurement weight required accuracy tall .

The formula used For count heavy using load cell sensor can stated as:

$$W = m \times g$$

Where:

W = Weight (N)

m = Mass of object (kg)

g = Acceleration gravity (about 9.81 m/s on the Earth's surface)

This formula show that heavy a object is product of mass objects and acceleration gravity at work to him

Arduino Uno R3

Arduino Uno, as seen in Figure 2.5, is one of the type board microcontroller based on the Atmega328 chip. This board equipped with 14 digital input/output pins, of which 6 can be used as a PWM output, as well as 6 analog input pins . In addition, the Arduino Uno also has 16 MHz oscillator , USB port, power jack, ICSP header, and reset button .



Figure 2. 4 Arduino Uno R3

Arduino is used in tool measuring instrument rice automatic as controller main that processes data from the load cell sensor for measure heavy measured rice . The load cell changes style or heavy become signal electricity which then strengthened and changed into digital data by the HX711 module , which is then processed by Arduino. Based on this data , Arduino controls actuator such

as stepper motors or servos for add or reduce amount rice until reach desired weight . In addition , Arduino allows system equipped with interface users, such as LCD or LED, for display information heavy rice and system status . With ability flexible programming , Arduino ensures system functioning in a way automatic , efficient and accurate , facilitating the measuring process rice with A little or without intervention man.

Mikro servo 9g

Servo motor is device electromechanical designed For control position, velocity and acceleration burden with great precision . This motor works based on closed loop principle , meaning He own system bait keep coming back continuously compare position current with desired position . As seen in figure 2.4



Figure 2. 5 Mikro Servo 9g

In this smart rice box tool , a servo is used For open or close channel expenditure rice moment desired weight Already fulfilled .

LCD I2C.

LCD (Liquid Crystal Display) is frequently used components used in system measurement For display information in real- time . As seen in figure 2.5



Figure 2. 6 LCD I2C

The I2C LCD on the smart rice box works For display information like heavy rice , storage status , or warning . I2C enables efficient communication with only two data cables , minimizing pin usage on Arduino Uno R3. In the project Here , Arduino processes data from the load cell sensor to count heavy rice and display the results on the LCD, so that make it easier user in monitor heavy rice that comes out . The role of the I2C LCD is as visual interface that presents data in real-time.

Project Board And Jumper Cable

Project Board (Breadboard) functioning as board place assemble component electronic in a way temporary without need soldering . In the Smart Rice Box project , a breadboard is used For to compose and connect components such as Arduino Uno, load cell sensors, and I2C LCDs flexible. This allows testing and modification series with easy before make circuit permanent , and simplify the debugging and setup process repeat components

Jumper cables are used For Connecting pins on components on the project board or on the Arduino. In the Smart Rice Box project , jumper cables connect the Arduino to the load cell sensor, I2C LCD, and components. others , so that ensure proper data and signal flow between device .

Jumper cables allow series can arranged with easy and fast, facilitating communication between component For ensure function system walk with Good.

RESEARCH METHOD

(Setiawan, 2018)The design of the smart rice box starts from the Prototype design. Figure 3.1 is a component design, namely the interface between the Arduino and the load cell sensor with the HX711 module. The output component is an integrated I2C 16x2 LCD as a display, then a servo motor as a driver to open and close the rice storage container. The power supply for each component comes from the Vout 5Vdc Arduino which is connected in parallel. Likewise, the power supply for the servo motor.

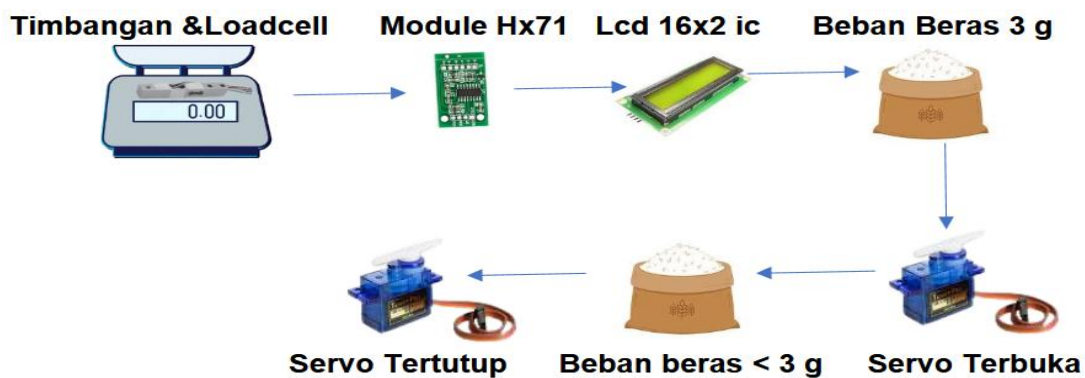


Figure 3. 1 Prototype diagram

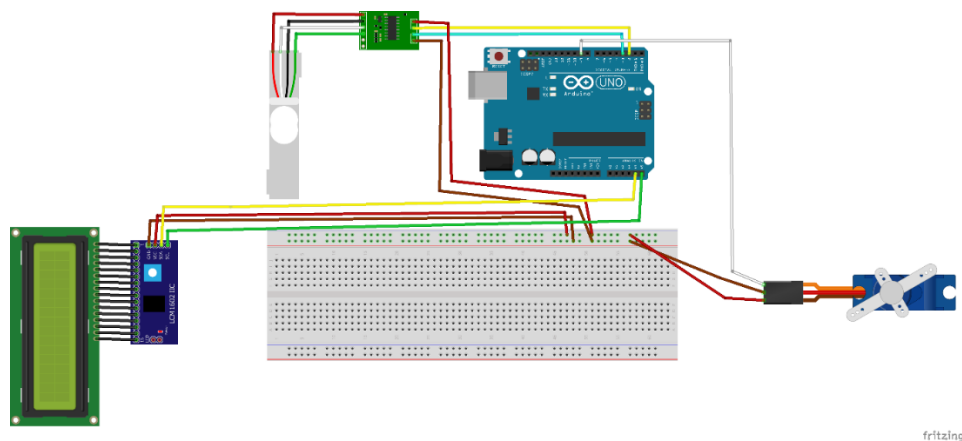


Figure 3. 2 Schematic of the smart rice box prototype

The prototype design is continued by making a smart rice box design as in figure 3.3. The smart rice box is made of transparent plastic box material with a size of 20 x 20 cm or 1000 ml.



Figure 3. 2 Prototype smart rice box

This automatic rice measuring weight sensor circuit uses several main components, namely load cell, HX711 module, Arduino Uno R3, micro servo, and I2C LCD. The load cell functions to measure the weight of the rice placed on it, producing a signal that is then amplified and converted into digital data by the HX711. This data is sent to the Arduino, which acts as the brain of the system to process information and control the servo motor. The servo is used to open or close the rice outlet channel when the desired weight is reached. Meanwhile, the I2C LCD displays information about the weight being weighed and the system status in real time. All components are connected using jumper cables on the project board for easy arrangement. With this system, users can easily measure and dispense rice automatically, increasing efficiency in food processing.

The next method of software design is presented in the following Flowchart 3.3.

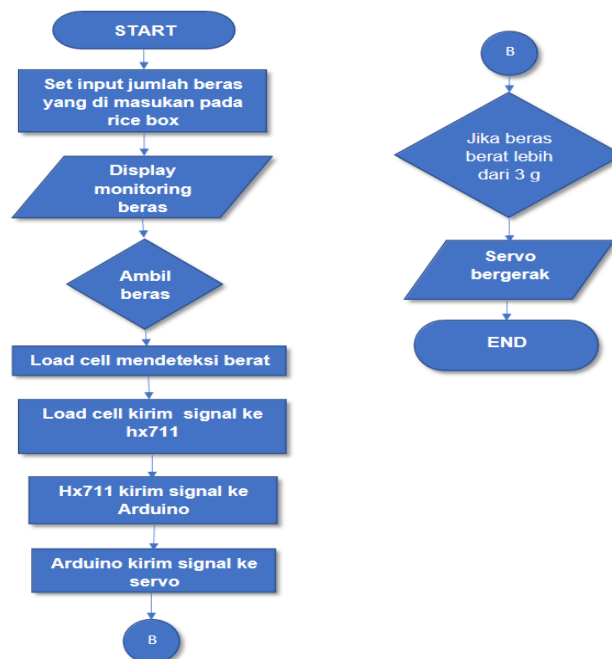


Figure 3. 3 Flowchart software smart rice box

Software design, contains programming for load cell, I2C LCD, rice quantity input process in the tank, menu for rice intake input process, rice measurement algorithm, servo motor mechanical

system and program for monitoring system. The program is divided into several sketches or sheets, with one sketch functioning as the main program. In each sketch, call each other function sketch that is made according to needs through the “void” function created in each sketch. This technique is used because it is simple and practical, creating functions that can be called several times as needed.

Rice Measurement Algorithm Calculation

The formula used to calculate weight using a load cell sensor can be expressed as:

$$W = m \times g$$

Where :

W = Weight (N)

m = Mass of object (kg)

g = Acceleration gravity (about 9.81 m/s on the Earth's surface)

So if we use rice output of 1 gram, 3 grams, and 5 grams, the results obtained are:

- Output 1 gram

$$m = 1 \text{ gram} = 0,001 \text{ kg}$$

$$g = 9,81 \text{ m/s}^2 \text{ (Acceleration of gravity)}$$

then substitute it into the formula :

$$W = m \times g$$

$$W = 0,001 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$W = 0.00981 \text{ N}$$

So, the gravitational force of an object that has a mass of 1 gram is approximately 0.00981 N

- Output 3 gram

$$m = 3 \text{ gram} = 0,003 \text{ kg}$$

$$g = 9,81 \text{ m/s}^2 \text{ (Acceleration of gravity)}$$

then substitute it into the formula :

$$W = m \times g$$

$$W = 0,003 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$W = 0.02943 \text{ N}$$

So, the gravitational force of an object that has a mass of 3 gram is approximately 0.02943 N

- Output 5 gram

$$m = 5 \text{ gram} = 0,005 \text{ kg}$$

$$g = 9,81 \text{ m/s}^2 \text{ (Acceleration of gravity)}$$

then substitute it into the formula :

$$W = m \times g$$

$$W = 0,005 \text{ kg} \times 9,81 \text{ m/s}^2$$

$$W = 0.04905 \text{ N}$$

So, the gravitational force of an object that has a mass of 5 gram is approximately 0.04905 N

RESULTS AND DISCUSSION

After preparing the tools and materials, the next step is to design the final result of the Automatic Rice Measuring Weight Sensor project. This design includes all the components needed to ensure the system functions properly. The following are the finished results of this project:

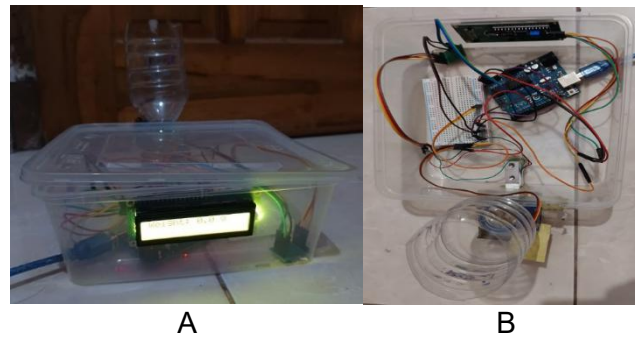


Figure 4.1 Prototype Results (A); Circuit Schematic (B)

The automatic rice measuring weight sensor system based on load cell, HX711, Arduino Uno R3, micro servo, and I2C LCD is an innovative solution for weighing and dispensing rice precisely. At the core of this system, the load cell functions as the main sensor capable of detecting the weight of the rice load placed on it. This load cell converts the pressure from the load into an electrical signal, which is then amplified and converted into digital data by the HX711 module. The HX711 module is specifically designed for weight measurement applications, so it can provide high accuracy. This digital data is then sent to the Arduino Uno R3, which functions as the brain of the system, for further processing.

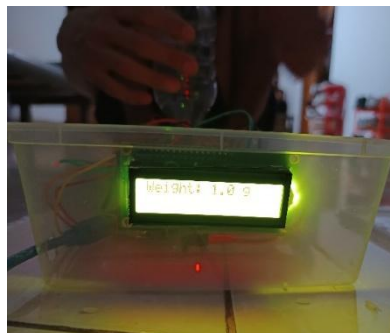


Figure 4. 2 If given a load of 1 gram



Figure 4. 3 If given a load of 3 gram



Figure 4. 4 If given a load of 5 gram

As shown in Figure 4.2 - 4.4, After Arduino receives data from HX711, the system will continue to monitor the weight of the rice. In this study, we dispense rice with 3 weight variations, namely 1 gram, 3 grams, and 5 grams. When the detected rice weight reaches the specified output, Arduino will activate the micro servo. This servo has an important task in the system, namely opening and closing the rice outlet channel. Once the rice weight reaches the specified limit, Arduino sends a signal to move the servo to the closed position, which automatically stops the flow of rice. In this way, the system prevents overweighing and ensures that the amount of rice dispensed is as desired by the user.

The I2C LCD serves as a user interface, displaying important information about the weighing process. This screen provides clear visual feedback, such as the weight of the rice being weighed and the status of the system whether it is ready or not. For example, when the weight reaches 3 grams, the LCD can display a message such as "Weight: 3g". With this feedback, users can easily monitor and control the weighing process, which improves efficiency and convenience of use. Overall, this system not only improves accuracy in weight measurement, but also makes it easier for users to weigh rice, making it an ideal solution for household and small industry needs.

Based on the research that has been conducted, the following is a table of research results on the suitability of input with output :

Table 4.1 Comparison of input and output values

NO	INPUT	OUTPUT	EROR (%)
1	1 gram	1 gram	0%
2	2 gram	2 gram	0%
3	3 gram	3 gram	0%

Based on table 4.1, testing of the device that releases rice with three different weight variations, namely 1 gram, 3 grams, and 5 grams is accurate. Because the device shows good performance, where the output produced is in accordance with the input given, without any errors or mismatches in the rice release process. This shows that the device has high accuracy and precision in responding to the desired weight variations. Thus, it can be concluded that this device can be relied on for measurement tasks with consistent accuracy and no errors in operation, making it effective for applications that require precise weight distribution.

However, there are some drawbacks that need to be considered. The circuit consisting of various components can be complex, and requires technical knowledge for installation and maintenance. The load cell capacity is also limited, so if used to weigh loads exceeding the maximum

capacity of 5g, the sensor can be damaged. The dependence on electrical power is a challenge, as the system will not function when there is a power outage or power outage. In addition, periodic system calibration is required to maintain accuracy, which can be a time-consuming process. Finally, the load cell sensor is susceptible to environmental disturbances such as vibration or temperature, which can affect the measurement results. Overall, although this system has many advantages, it is important for users to also consider the disadvantages and challenges that may be faced in its implementation.

CONCLUSION

Based on the research that has been conducted, it can be concluded that it covers the challenges faced in the food sector, especially the uneven distribution of rice production that often occurs in various regions. This unevenness causes inefficient rice distribution and imbalance in food availability in several regions, which ultimately affects national food security. One of the solutions proposed by the government to overcome this problem is to increase the efficiency of rice distribution and stock management, as well as ensure a more precise rice weighing and dispensing process. In this context, the use of sensor technology, such as the load cell that has been tested in this study, offers great potential to support this solution. This system can also demonstrate its level of reliability by automatically stopping the flow of rice when the weight reaches a certain limit, namely 1 gram, 3 grams, and 5 grams with the right settings. However, system testing shows that things in the environment, such as vibrations, can affect system performance, and these things must be considered to ensure the system operates optimally. By utilizing this technology, it is hoped that the rice distribution process can be more efficient and avoid waste or inaccuracy, so that it can contribute to better and more equitable food management throughout Indonesia.

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