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# Measuring of Cassava Starch Content by Using Strain Gauge

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**Abstract.** It has been realized an instrument for measuring cassava starch content digitally based on specific gravity method. The instrument is designed using strain gauge, which packing in load cell as a mass sensor, HX711 (Analog to Digital Converter), Arduino Uno as a data processor, LCD, and personal computer. The principles of this instrument are using specific gravity method, which is based on differences of cassava mass in the air and the water. Cassava starch content calculated by Arduino using Sungzikaw equation and displayed in LCD screen. The result showed that the instrument capable measure cassava starch content with the maximum capacity of 2,0 kg and average percentage error of less than 1,5 %.

## 1. Introduction

In Indonesia, cassava is one of the rice substitute food which has an important role in supporting national food security. But there are still many obstacles faced in changing the consumption style of the people that have been formed so far. Also, cassava can also be used as animal feed ingredients and industrial raw materials, especially in tapioca industry [1].

The tapioca flour industry is an industry that requires cassava as raw materials, has good development opportunities and prospects to meet market demand. This industry is widely available in Lampung Province so that it has a broad social and economic impact for the Lampung community. Lampung is the largest cassava producer province in Indonesia, as many as 7,387,084 tons per year [2]. Therefore the cultivation of cassava plants has a positive impact on the agroindustry and economy of the Lampung community.

The quality of cassava tube as raw material for tapioca industry can be measured by knowing the content of starch and hydrogen cyanide (HCN) [3]. However, only starch content was used to determine the quality of cassava tube in the field. This parameter is crucial because determines the price of cassava from farmers in tapioca factories. The higher the starch content, the higher the price of cassava. Generally fresh cassava starch content around 20 - 32% [4].

The specific gravity is the fastest and easiest method to be applied in the field for farmers to measure cassava starch content. By knowing the weight of cassava in the air and water, cassava starch content can be estimated accurately. This research aims to design a measuring instrument for cassava starch content using a strain gauge sensor as a weight gauge. This instrument uses HX711 as an analog



to digital converter, then digital data read and processed by Arduino and finally display it on the LCD screen.

**2. Materials and Methods**

According to Sungzikaw [5], cassava starch content (SC) was calculated by the empirical equation.

$$SC(\%) = \frac{SG - 1,00906}{0,004845} \tag{1}$$

where

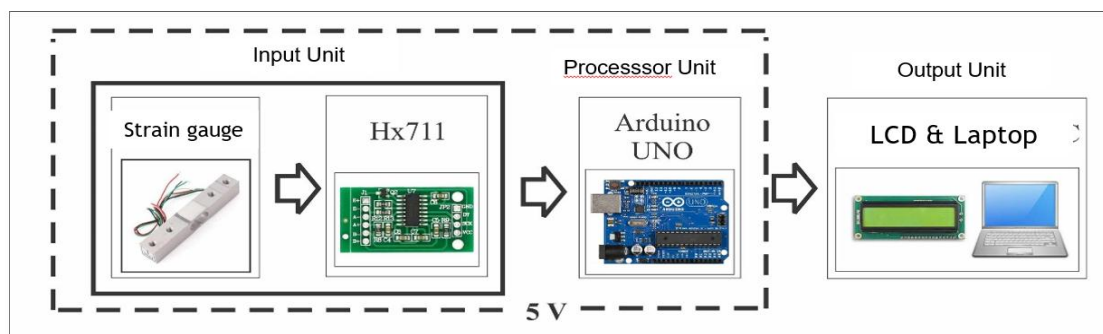
Specific Gravity  $SG = \frac{Ma}{Ma - Mw} \tag{2}$

Ma = weight of the cassava in the air (kg)

Mw = weight of the cassava in the water (Kg)

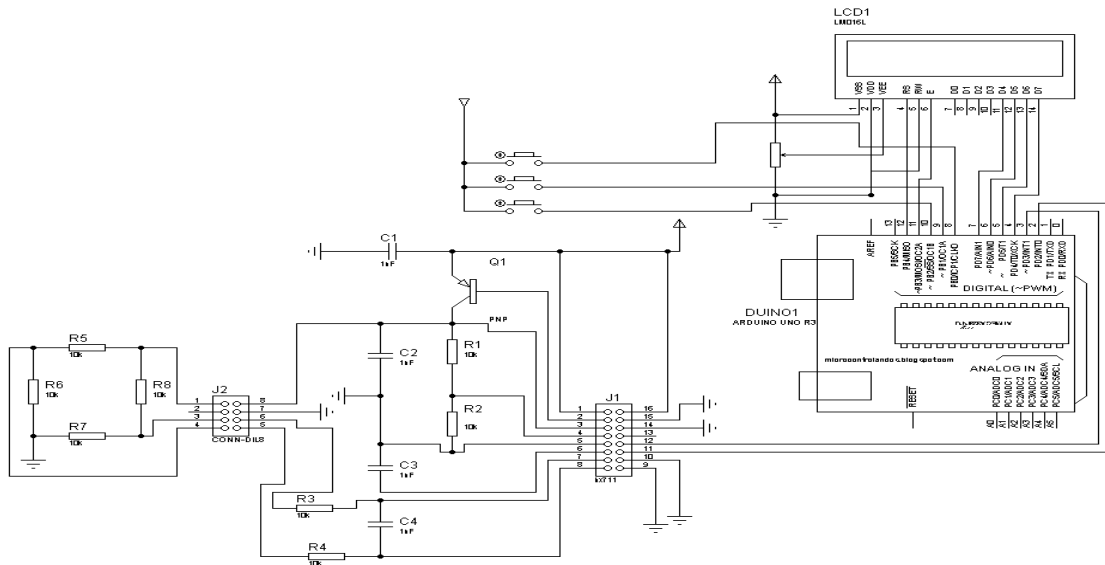
This research aims to make the measuring instrument of cassava starch content based Sungzikaw equation. This equation has been compared with the ISI [6] and Kanthavong [7] empirical equations by Cuvaca [3] to estimate the cassava starch content. The result is that the Sungzikaw equation gives an estimation result that is almost the same as the other equations.

The block diagram of the design of the starch content measuring instrument as in figure 1, consists of input, processors and outputs units.



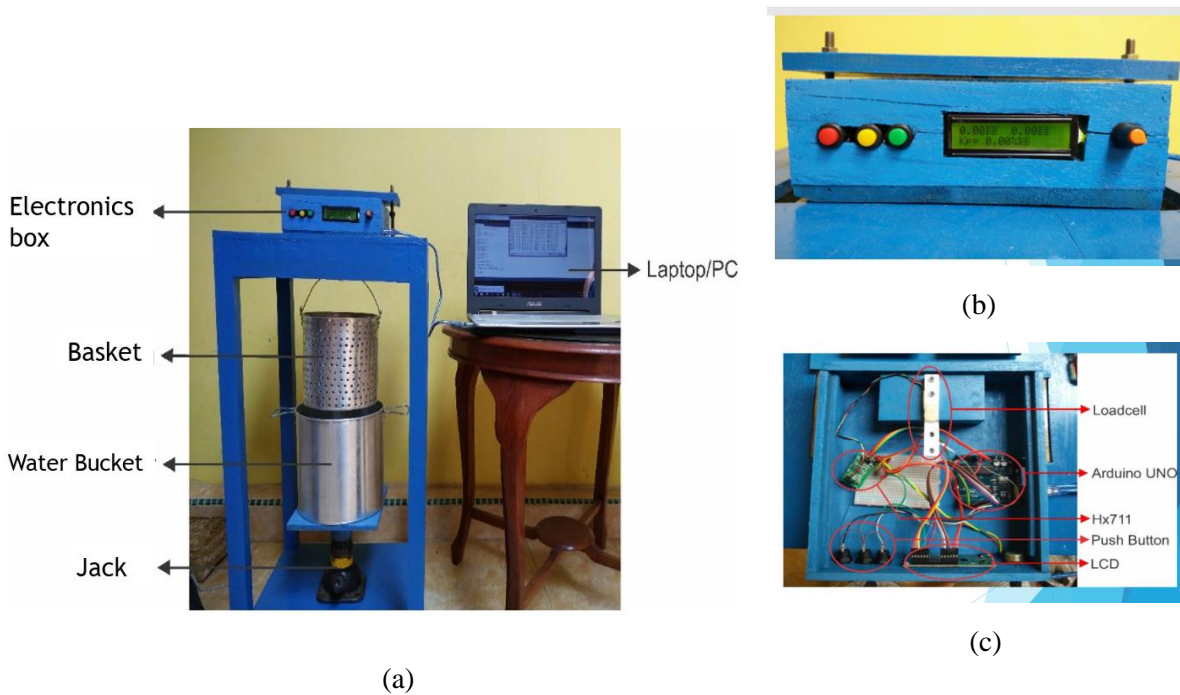
**Figure 1.** Block Diagram of cassava starch content measuring instrument

The strain gauge sensor is embedded in the load cell which packed in aluminum metal beams. This sensor is assembled in the Wheatstone bridge. Load cells receive cassava weight, releasing the analog electrical signals were proportional to the mass. Through the A input, HX711 converts the analog weight signal into a 24-bit digital signal which is transmitted in series to Arduino on pin 2 and pin 3. The Arduino reads Ma and Mw data, calculates the specific gravity value (equation 2) then calculates the starch content (equation 1) and display it on the LCD screen. The complete electronic circuit of the starch content measuring instrument such as figure 2.



**Figure 2.** Complete electronic circuitry for cassava starch measuring instrument

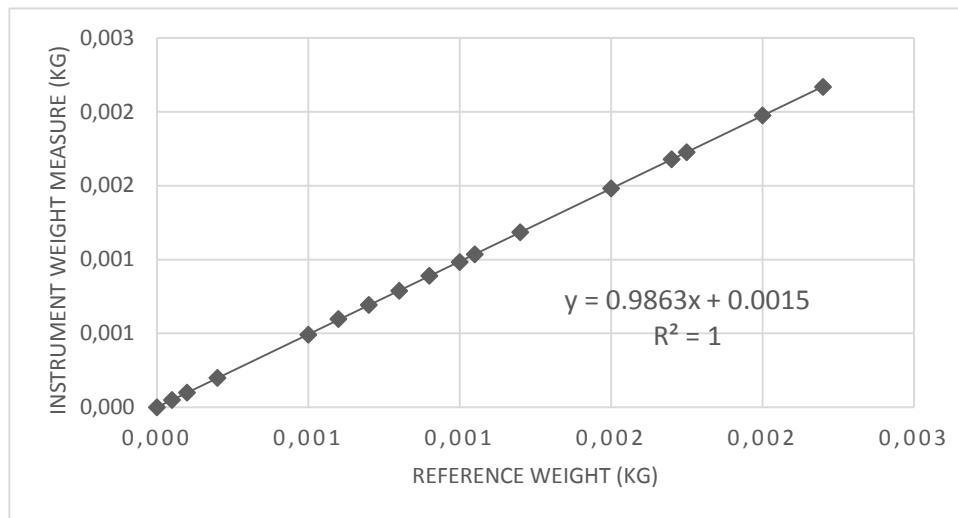
The physical design of cassava starch content measuring instrument such as figure 3.



**Figure 3.** (a) Complete instrument for measuring starch content; (b) LCD screen panel; (c) Top view of the electronics box.

**3. Results and Discussion**

Before used to measure cassava starch content, a designed instrument is calibrated in mass measurements so that the measurement results are accurate. The calibration results of load mass (weight) measurements using a strain gauge sensor like the graph in figure 4.



**Figure 4.** Calibration graph of mass load measurements.

As shown in figure 4, the results of the mass measurement calibration are excellent. This is indicated by the calibration equation where the gradient of the calibration equation is close to 1, which is 0.9863. Furthermore, the starch content measuring instrument was tested on three types of cassava with a sample mass of 1.0 kg and 2.0 kg.

In this test, the measurement results of cassava starch content from the instrument were compared with the measurement results manually as a reference as shown in table 1 and table 2.

**Table 1.** Test results of measurement of cassava starch content of the sample 1.0 kg

Cassava Sample	SC Instrument (%)	SC Reference (%)	Error (%)	Accuracy (%)
A	16.392	16.612	1.326	98.674
B	16.148	16.356	1.272	98.728
C	14.880	15.088	1.375	98.625
		Average	1.324	98.676

**Table 2.** Test results of measurement of cassava starch content of the sample 2.0 kg

Cassava Sample	SC Instrument (%)	SC Reference (%)	Error (%)	Accuracy (%)
A	17.031	17.2762	1.419	98.581
B	6.504	6.6035	1.507	98.493
C	20.161	20.453	1.428	98.572
		Average	1.451	98.549

According to the data in tables 1 and table 2, it was shown that the measurement error of the instrument was minimal, averaging less than 1.5% or with accuracy more than 98.5%. These results confirm that the cassava starch content measuring instrument using a strain gauge sensor resulting high accuracy measurement or small errors.

#### 4. Conclusion

It has been shown that the strain gauge sensor (load cell) is capable of providing high performance as a transducer for measuring the weight of the load that required in the cassava starch content measuring instrument with specific gravity method. This performance is shown in the calibration of mass measurements. In this method, the strain gauge plays an essential role in measuring or detecting the weight of cassava in the air and water. Together with the ADC HX711 which is compatible with a load cell and with Arduino as a digital device processor, it can be produced instruments to measure cassava starch content with errors of less than 1.5% or accuracy more than 98.5%.

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