

Ideal Baby Height And Weight Monitoring Design

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Abstract – Growth and development of infants are crucial aspects that need to be regularly monitored, with height and weight serving as key indicators of nutritional status. This study aims to design and develop a technology-based system to automatically monitor the height and weight of infants using ultrasonic sensors and load cells. The system is designed to provide accurate, practical, and continuous real-time measurements, integrating technologies such as ESP32, LCD, and Blynk application. Test results demonstrate that the system achieves high accuracy with an error percentage below 1%, along with optimal performance of the ultrasonic sensor (distance up to 80 cm) and load cell (weight up to 10 kg). Among the 6 samples tested, 2 infants were categorized as undernourished, 4 as normal. This system is expected to simplify the monitoring of infant nutritional status, support early detection of health issues, and contribute to improved growth quality.

Keywords: *Infant growth, infant development, nutritional status, ultrasonic sensor, load cell, ESP32, automatic monitoring, real-time, Blynk*



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I. INTRODUCTION

Infant growth and development is an important aspect that should be monitored continuously by parents and health professionals. Infant height and weight are key indicators for assessing the nutritional status and health status of infants. Failure to monitor these two indicators can lead to persistent health problems, such as malnutrition or obesity, both of which can have a negative impact on infant development [1].

In the context of the modern world, with the rapid development of technology, there is a need for a system that can monitor the height and body weight of infants in a more accurate, practical, and continuous way. Conventional monitoring systems that are still widely used require manual measurements that are

often not done in a routine manner, and are prone to human error. This highlights the need for a more innovative and efficient solution for monitoring infant growth.

The project “Design of Ideal Infant Height and Body Weight Monitoring” aims to develop a technology-based system that can automatically measure and monitor infant height and body weight in a real-time manner. With proper sensor integration and the ability to store and analyze data, this system is expected to help parents and health professionals in monitoring infant growth better. The data obtained from this system can be used to provide more accurate recommendations on the nutritional status of infants, as well as to provide early intervention if there are deviations from normal growth patterns.

With this system, it is hoped that a solution can be created that not only facilitates monitoring, but also makes a significant contribution to efforts to maintain the health of infants in their early years.

The research conducted by Muhamad Reza Ardaffa Putra, Bakti Yulianti, Sumpena entitled “Design of an Ideal Weight and Height Measurement Tool with the IoT-Based Bmi (Body Mass Index) Method”. The purpose of the design of this tool is to create a system for measuring body weight and height in an automatic way based on the Internet of things (IoT) which is connected via the internet for information on the results of measurements using Node.MCU ESP8266 as control, HC-SR04 Ultrasonic Sensor as a human height measurement, LoadCell Sensor as a human body weight measurement, Light Emitting Diode (LED) as a sign or indicator of Body Mass Index (BMI) calculation results, Liquid Crystal Display (LCD) for direct monitoring, and Google Sheet as a database of measurement results

Another research conducted by Lu'Lu'ul Maknunah1, Miftachul Ulum1, Hanifudin Sukri with the title “Design of Nutrition Detection Sensor Based on Child Atropometry Standards”. The working

principle of this tool utilizes an ultrasonic sensor to determine the baby's body length and a load sensor to determine the baby's body weight. The data received by the two sensors will be processed using the Stm32 microcontroller. By using the z-score formula, nutrition can be classified into several statuses based on child anthropomic standards. The processed data will be displayed on the LCD and then stored in the database. MySQL to facilitate reading the measurement results. So the author feels interested in conducting research with the title "Design of Ideal Baby Height and Weight Monitoring"

II. METHOD

In making a tool, the planning or design process of the tool is very important. With planning that has been prepared thoroughly beforehand, it is expected that the results can be in accordance with expectations and produce good tools that can work as expected. The planning process for making this tool includes all stages related to the circuit, namely Hardware and Software planning (programming language), for example the selection and preparation of each component, PCB manufacturing, installation on components and testing on the tool.

The design of the tool that will be used in the prototype. The design of the ideal baby height and weight monitoring will be illustrated with a schematic series of the tool as shown in the image below:

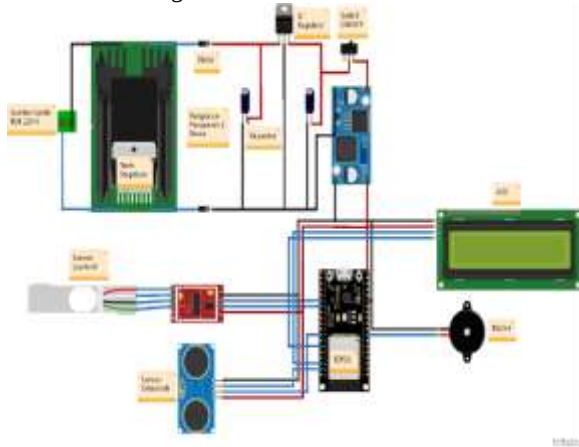


Figure 1. Circuit Schematic

Figure 1 is a circuit schematic of the components used in this study. The following are the specifications and how the components used work:

- 1) PLN is the main power source used with a voltage of 220V.
- 2) The 5V DC power supply is the power supply used in this study with an output voltage of 5V DC and a maximum current of 1A. The power supply

contains components such as transformers, diodes, capacitors and regulator ICs.

- 3) Ultrasonic Sensor as a detector of human height.
- 4) LoadCell Sensor as a detector of human weight.
- 5) Buzzer as a marker or indicator of the results of the Body Mass Index (BMI) calculation.
- 6) Liquid Crystal Display (LCD) to display the baby's weight and height.
- 7) ESP32 as the brain of the components used.

At this stage, the flowchart is made by designing a simple algorithm in the form of a flow diagram to facilitate the manufacture of the tool. In order for the manufacture of the tool to be carried out smoothly, the algorithm on the tool is described with a flow diagram first as in Figure 2.

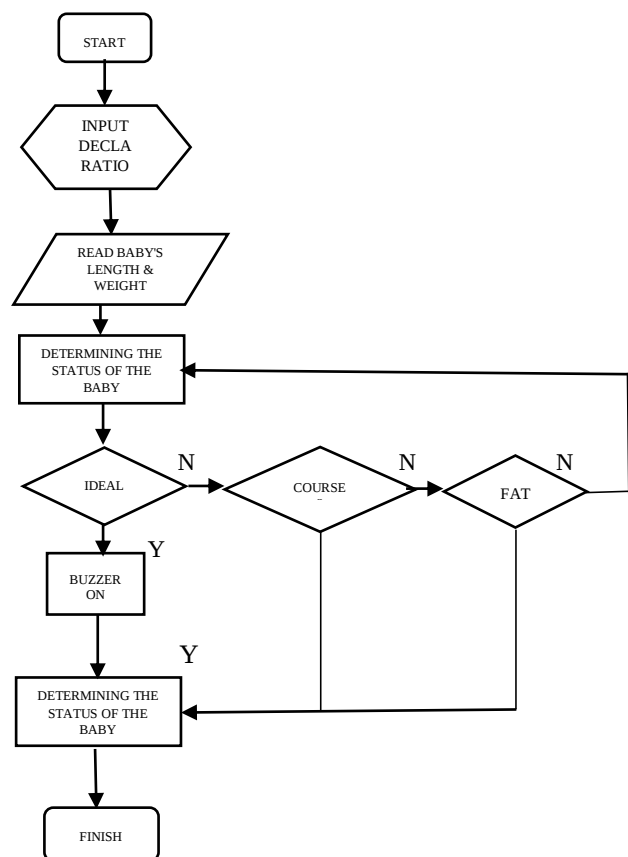


Figure 2. Flowchart

III. RESULT AND DISCUSSION

This measurement has the purpose of knowing the level of success of the tool that has been made, where the test will be carried out with several measurement points. The measuring point can be seen in the figure below:

Description:

TP 1: Measurement point at the PLN source which is the input voltage to the transformer.

TP 2 : Transformer measurement point, calculating the voltage outputted by the centretap type transformer.

TP 3 : Measurement point of the voltage after the diode in the power supply.

TP 4 : Voltage measurement point se.te.lah of the capacitor in the power supply.

TP 5 : Measurement point at the output voltage of IC 7805.

TP 6 : Measurement point at the voltage source of ESP32

TP 7 : Measurement point at the output voltage of the Loadcell Sensor.

TP 8 : Measurement point of the output voltage on the Ultrasonic Sensor.

TP 9 : Measurement point of the output voltage on the 20x4 LCD.

TP 10 : Measurement point of the output voltage on the buzzer.

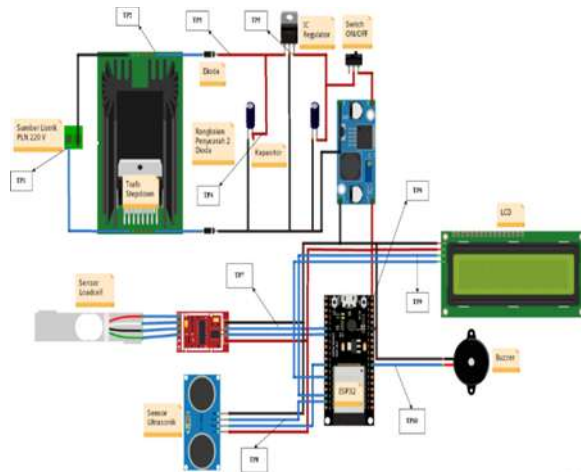


Figure 3. Measurement Point

Measurements are repeated 5 times in order to get accurate and optimal results After the measurements are taken, the average results are obtained from the following formula:

$$\bar{x} = (x_1 + x_2 + x_3 + \dots + x_n) / n \quad (1)$$

Description:

$(\sum X_i) / n$ = Total number of samples

X_i = Measurement

n = Number of measurements

$\bar{x}$ = Average price

To find out how much the percentage of differences and errors that occur in the measurement results using the formula. Therefore, to find out how much the percentage of error can be found using equation 2.

$$\% \text{ Error} = |(\text{Measurement} - \text{Calculation}) / \text{Measurement}| \times 100\% \quad (2)$$

Description:

%Error = Total Percentage error.

Measurement = Voltage Data Measurement Results.

Calculation = Calculated Voltage Data

After getting the value of the measurement results, the next process is to perform calculations on the parts that can be calculated and then compared with the measurement results to find out the percentage error. Transformer voltage is calculated based on existing specifications with data that has been measured using equation, a value can be obtained as below:

Table 1. measurement results

No	Measurement	Measurement Point	Unit	Measurement result (volt DC)					Average (Volt DC)	Description
				1	2	3	4	5		
1	Power Supply	Input Power Supply (TP1)	V _{ac}	220,01	220,04	220,01	219,07	220,02	219,99	Input to trafo
		Trafo (TP2)	V _{ac}	5,04	5,03	5,04	5,05	5,04	5,04	Input to diode
		Dioda (TP3)	V _{ac}	5,12	5,11	5,12	5,11	5,11	5,11	Input to Kapasitor
			I _{ac} mA	400	380	380	400	400	392	Output Kapasitor
		Capacitors (TP4)	V _{ac}	5,5	5,5	5,5	5,4	5,4	5,46	Input to IC 7812
		IC 7805 (TP5)	V _{ac}	5,2	5,2	5,21	5,21	5,2	5,204	Input Stepdown
2	ESP32	TP6	V _{dc}	5,01	5,02	5,04	5,03	5,05	5,03	Voltage Input ESP32
3	Sensor Loadcell	TP7	V _{dc}	5,08	5,09	5,07	5,03	5,01	5,056	Voltage Input ESP32
4	Sensor Ultrasonik	TP8	V _{dc}	4,98	4,99	4,97	4,93	4,91	4,956	Output to ESP32 on
				0,5	0,5	0,5	0,5	0,5	0,5	Output to ESP32 inactive
				0,4	0,4	0,4	0,4	0,4	0,4	Output to ESP32 inactive
5	LCD 16x2	TP9	V _{dc}	4,98	4,99	4,97	4,93	4,91	4,956	Output to ESP32 on
6	Buzzer	TP10	V _{dc}	4,98	4,99	4,97	4,93	4,91	4,956	Output to ESP32 on
										Output to ESP32 on

$$a = \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{220}{5} = 44 \text{ V}$$

Transformer voltage based on measurements as in table 1 obtained the results as below:

$$a = \frac{V_{measurements}}{V_2}$$

$$V_2 = \frac{V_{measurements}}{a} = \frac{219,99}{44}$$

$$V_2 = 4,99 \text{ V}$$

In the TP3 calculation is the output voltage of the diode before passing through the capacitor which is the output of the transformer, and the output voltage of the diode silicon is 0.7 V in the circuit, it can be calculated using the following equation

$$[V_{DC} = 0,636 \cdot (V_m - V_t)]$$

where:

$$V_m = V_{rms} \sqrt{2}$$

$$V_m = 4,99 \cdot \sqrt{2}$$

$$V_m = 7,056 \text{ V}$$

Then we get VDC:

$$V_{DC} = 0,636 \cdot (V_m - V_D \cdot V_D)$$

$$V_{DC} = 0,636 \cdot (7,056 - 0,7 \times 0,7)$$

$$V_{DC} = 4,17 \text{ V}$$

In the TP4 calculation stage, the output voltage of the rectifier diode passing through the capacitor (1000µF) is carried out using the following equation

$$V_{DC2} = V_m - \frac{2,17 \cdot I_{DC}}{C}$$

$$V_{DC2} = 7,056 - \frac{(2,17) \cdot (0,000392)}{0,001}$$

$$V_{DC2} = 7,056 - 0,85$$

$$V_{DC2} = 6,206 \text{ V}$$

From the results of the measurements that have been carried out such as the data above, there is an average value at each measurement point. This value has a function to get the percentage value. error in measurement. To perform the calculation, the following equation is used:

$$\% \text{ error} = \left| \frac{\text{measurements} - \text{calculation}}{\text{measurements}} \right| \times 100\% \dots \dots \dots (4)$$

$$\% \text{ error} = \left| \frac{\text{Datasheet} - \text{Measurements}}{\text{Datasheet}} \right| \times 100\% \dots \dots \dots (5)$$

the percentage error value for each component can be found as below.

% error TP4 :

$$\% \text{ error} = \frac{\text{measurements} - \text{calculation}}{\text{measurements}} \times 100\%$$

$$\% \text{ error} = \left| \frac{5,46 - 5,116}{5,46} \right| \times 100\%$$

Using the same formula as the calculation of the percentage error in TP4, the percentage error in each measurement point can be found. The following table shows the results of the calculation of the percentage error of each measurement point:

Table. 2 Percentage Error

No	Measureme nt Position	Measure ment Point (Volt)	Data sheet (Volt)	measre ments (Volt)	calcula tion(Volt)	error (%)	Description
1	PowerSupply	TP1	220	219,99	-	0,0004	Good
		TP2	-	5,04	4,99	0,009	Good
		TP3	-	5,11	4,17	0,18	Good
		TP4	-	5,46	5,116	0,06	Good
		TP5	-	5,204	-	-	-
2	ESP32	TP6	5-12	24,03	-	-	In range
3	Sensor Loadcell	TP7	4,5-5,5	5,056	-	-	In range
4	Sensor Ultrasonik	TP8	3-5,5	4,956	-	-	In range
5	LCD 16x2	TP9	3-5,5	4,956	-	-	In range
6	Buzzer	TP10	3,3-5,5	4,956	-	-	In range

Ultrasonic sensor testing was carried out to read the process of the baby's length to be measured. Testing 13 times from the value of 0 cm to more than 80 cm.

Table 3. Ultrasonic Sensor Testing

No	Measured Distance(cm)	Detected
1	0-5	Yes
2	5-10	Yes
3	10-15	Yes
4	15-20	Yes
5	20-25	Yes
6	25-30	Yes

7	30-35	Yes
8	35-40	Yes
9	40-45	Yes
10	45-60	Yes
11	60-70	Yes
12	70-80	Yes
13	> 80	No

Loadcell sensor testing was carried out 11 times. This test aims to test the performance of the loadcell sensor whether it works properly or not according to the maximum weight of the baby to be weighed, which is 10 kg.

Table 4. Loadcell Sensor Testing

No	Weight Produced(Kg)	Detect
1	<1	Yes
2	1-2	Yes
3	2-3	Yes
4	3-4	Yes
5	4-5	Yes
6	5-6	Yes
7	6-7	Yes
8	7-8	Yes
9	8-9	Yes
10	9-10	Yes
11	> 10	No

This test was conducted to measure the weight and length of infants using a combination of two types of sensors, namely an ultrasonic sensor to measure body length and a loadcell sensor to measure body weight. This test aims to evaluate the measurement accuracy and categorize the nutritional status of infants based on the body weight and length obtained. The data tested involved infants with a maximum age of 7 months. Table 5 below is the result of testing involving 6 infants, which shows the variation of nutritional status based on growth standards. The following table illustrates the test results that include body weight, body length, as well as the nutritional status category of the measured infants

Table 5. Baby Weight and Length Testing Results

No	Gender	Age (Mon th)	Measurement Using Tools		Manual Measurement		Error (%)		Nutritio n Status
			Length(cm)	Weight (Kg)	Length (cm)	Weight (Kg)	Length (%)	Weight (%)	
1	Female	3	4,86	57	4,8	56	1,25	1,79	Ideal
2	Male	1	3,28	52	3,4	52	3,53	0	Undern ourishe d
3	Female	0	2,5	44	2,5	44	0	0	Undern ourishe d
4	Male	1	3,9	55	4,1	54	4,88	1,85	Ideal
5	Female	0	2,4	47	2,6	47	7,69	0	Ideal
6	Female	3	4,82	56	3,8	56	26,84	0	Ideal

From the results of the measurements and calculations that have been carried out, it can be analyzed as follows:

1. In the measurements that have been made in table 1 and table 2 the percentage error is below 1%. The percentage errors of all components are all below 1%, which means the tool is working properly and in accordance with what is expected.

2. The test results of the ultrasonic sensor and loadcell show good performance with 100% success rate within the expected range. The ultrasonic sensor successfully detected distances up to 80 cm, but was not detected for distances beyond that, according to its specifications. Similarly, the loadcell sensor was able to read weight up to 10 kg, but did not detect weight above that limit, which was also in accordance with the expected conditions. This test demonstrates that both sensors function optimally within the predefined limits for reading the baby's length and weight.

3. This test was conducted to measure the weight and length of infants using ultrasonic and loadcell sensors to evaluate measurement accuracy and categorize nutritional status based on growth standards. Of the six infant samples tested (maximum age 7 months), two infants were categorized as malnourished with below-standard weight despite near-normal body length, while the other four infants had ideal nutritional status. These results show that monitoring infant growth is essential to ensure adequate nutrition and prevent nutritional problems. The display of the measurement results on the LCD and the Blynk App showed data agreement, confirming that this system can be used for more effective infant growth monitoring.

IV. CONCLUSION

Based on the results and discussion of the research "Ideal Baby Height and Weight Monitoring Design" can be concluded as follows: Percentage Error: The device shows a percentage error of 0.31%, with all components under 1% error, indicating that the device is working well and as expected. Ultrasonic sensor and loadcell be working optimally with 100% success. The ultrasonic sensors detect distances up to 80 cm, and the loadcell reads beats up to 10 kg, according to specifications. This test measured the infant's weight and length using an ultrasonic sensor and loadcell to assess accuracy and nutritional status. Of the six samples (≤ 7 months old), two infants were undernourished, while the other four were ideal. This result emphasizes the importance of growth monitoring to prevent nutritional problems, with the data display on LCD and Blynk showing the suitability of the measurement. In further development, it is recommended to do a scale calibration to maintain the accuracy of the tool. Based on the above conclusions, there are several suggestions that can be made so that the tool is maximized, namely the use of the ultrasonic sensor HC SR04 replaced by SRF04 which has a better level of accuracy, so that the measurement results will be better. In addition, at the time of testing the Load Cell sensor experienced an error, this was due to the tires not being on the Load Cell. In order for the reading of the body weight to be more precise, it is necessary to add a Load Cell sensor.

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