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Digitalization of Weight and Height Measurement at Posyandu

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ABSTRACT

To monitor child growth, parents must routinely bring their children to integrated health posts, where height and weight measurements of toddlers are taken. This activity is crucial for monitoring development and detecting stunting. However, field challenges often arise, as integrated health post cadres struggle with calibrating and reading measurement results, particularly when dealing with uncooperative babies, which affects the accuracy of recording. This study aims to design and develop a tool to enhance the accuracy of height and weight measurements at integrated health posts. The tool employs a load cell sensor to measure weight, an ultrasonic sensor to measure height, and an ESP32 microcontroller to manage the circuit, with RFID for input processing. Measurement results are displayed on an LCD screen. The research methodology involves designing, creating, and implementing a moving average program for the measuring device. This research contributes to science and technology by applying Industry 4.0 technologies in public health. The study's findings will be published in a SINTA-accredited scientific journal and will serve as a digital measurement tool for integrated health posts.

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1. INTRODUCTION

Posyandu is a form of Community-Based Health Effort (UKBM) managed and organized by the community to implement health development, aiming to empower the community and facilitate access to basic health services, especially to accelerate the reduction of maternal and infant mortality rates [1][2]. Additionally, the government is actively working to combat child stunting [3][4]. Research by Daracantika indicates that one in three children in Indonesia is categorized as stunted [5]. According to Nutritionist Dr. Laila Hayati Sp. G (K), nutritional disorders in children can be prevented through regular monitoring of body mass and height, calculating the child's Body Mass Index (BMI) consistently, engaging in routine activities three to five times a week, and managing children's diets [6].

This underscores the need for effective monitoring of children's growth and development [7]. Currently, monitoring toddler nutrition at Posyandu involves measuring body mass and length using conventional scales and meters, which results in a time-consuming process [8][9]. This situation presents a challenge to develop a more optimal, accurate, safe, comfortable, and efficient measuring tool [10]. The goal is to create a single device that integrates both body mass and height measurement systems, using strain gauge sensors and ultrasonic transducers for evaluating toddler nutrition.

2. METHODS

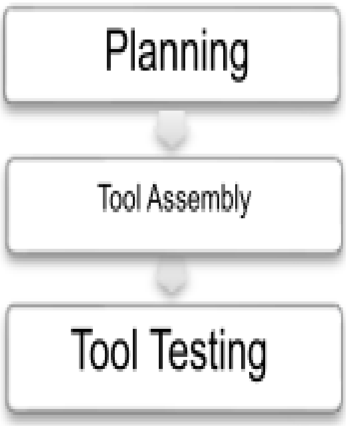

Figure 1. The research stages outlined in this section describe the methods used in the study.

From the problems described above, the approach taken to solve the problem was to design an automatic tool for measuring the weight and height of toddlers. The research stages to be carried out are outlined in **Figure 1**. The stages are as follows:

1) Planning

During the design stage, technical designs for measuring both the weight and height of toddlers will be developed [11][12]. This stage involves three main components: electronic hardware design, software design for the microcontroller, and the mechanical system for measuring the height and weight of toddlers [13].

2) Tool Assembly

At this stage, the tools will be assembled according to the designs that have been developed [14][15].

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3) Tool Testing

This is the final stage before field implementation [16]. The tool will first undergo calibration [17]. For the body mass sensor, a manual scale will be used as a calibration benchmark. For the body length sensor, the ruler will be tested for functionality and reliability until it is deemed suitable for application directly in the Posyandu (integrated health service post).

2.1. Block Diagram

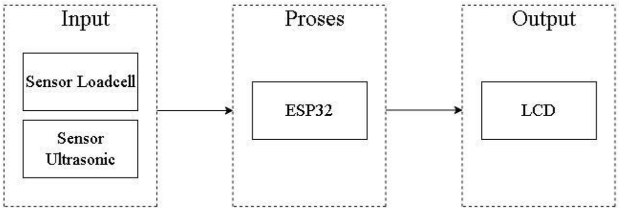

Figure 2. Diagram Block System

The components that constitute a digitalization system for measuring weight and height at the Posyandu can be grouped into three parts: input, process, and output. The block diagram of the prototype system for digitizing weight and height measurements is illustrated in **Figure 2**.

2.2. Design

1) Electronic Hardware Design

In the Electronic Hardware Design phase, the first step is to determine the specifications required by the system [18][19]. Next, the series of tools to be created are planned by selecting appropriate components and ensuring the correct voltage and current levels for the equipment [20]. An illustration of the electronic hardware design can be seen in **Figure 3**.

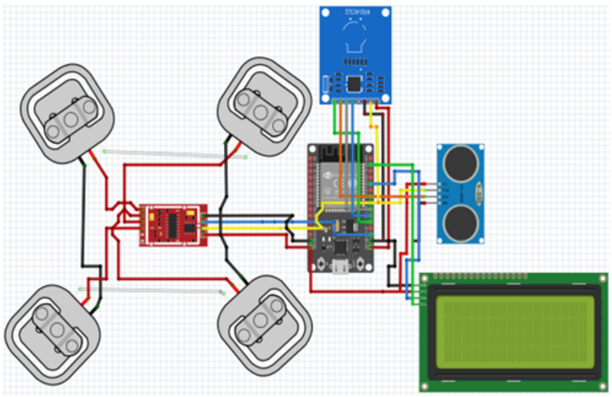

Figure 3. Wiring Circuit

2) Microcontroller Program Design

The software design involves programming the ESP32 microcontroller using C++. The text editor used for designing this microcontroller program is the Arduino IDE sketch, which is the default Arduino programming application and includes a feature to directly upload the program code to the ESP32. For details on the microcontroller program design process, refer to **Figure 4**.

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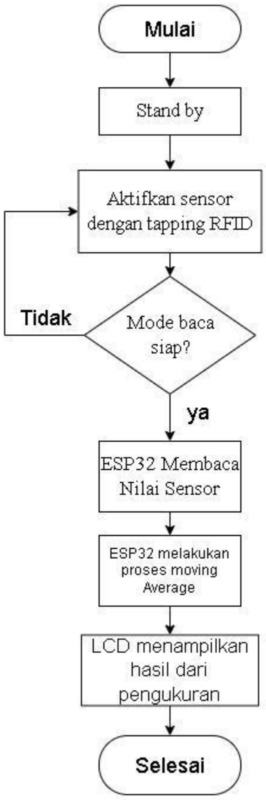

Figure 4. Flowchart System

3) Mechanical design of measuring instruments

At this stage, the design of a tool for measuring the weight and height of toddlers is explained. This explanation facilitates understanding of the tool that will be developed in this research [13]. Below are the results of the tool design drawings:

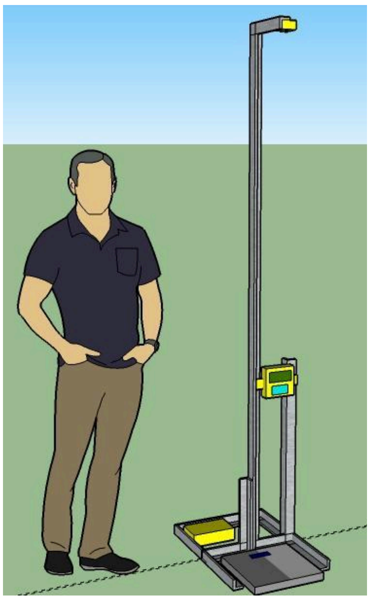

Figure 5. Tool's Design

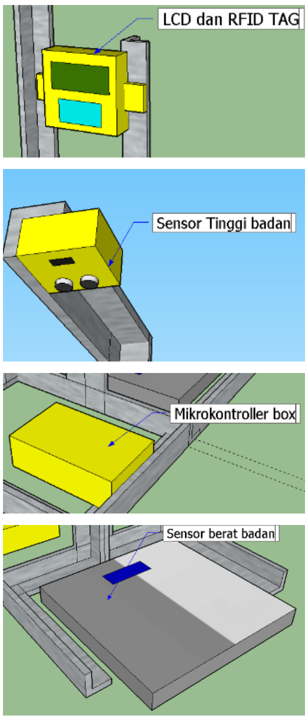

Figure 6. Design and Microcontroller

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In **Figure 5** and **Figure 6** above, the overall design of the toddler weight and height measuring device is shown. It can be seen in **Figure 2**. In the first row, there is a design image of a height sensor that contains an HC SR-04 ultrasonic sensor. In the second row, there is an RFID tag and display screen which contains an RFID mfrc-522 sensor and a 20x4 LCD along with its i2c. In the third row, there is a microcontroller box that contains an ESP32 microcontroller and an HX711 module, and in the fourth row, there is a weight sensor that contains a sensor.

3. RESULTS AND DISCUSSION

3.1. Tool Assembly

1) Electronic Hardware Assembly

In the process of assembling electronic hardware, the first thing to do is to make a casing to protect the components, making this casing using a 3d printer. The casing has protected the components, the next step is to do the wiring of each electronic hardware where each module and sensor are connected to the ESP32. Refer to **Figure 7** and **Figure 8**.

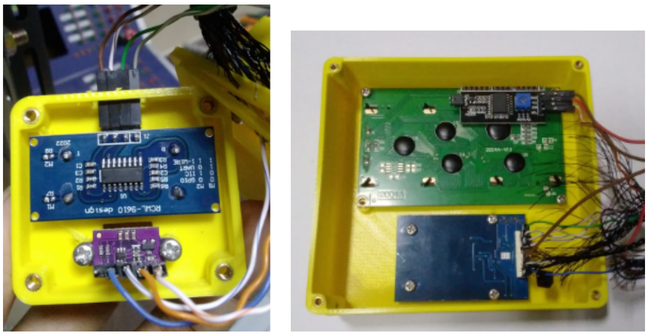

Figure 7. Assembly of ultrasonic sensors, LCD, and RFID

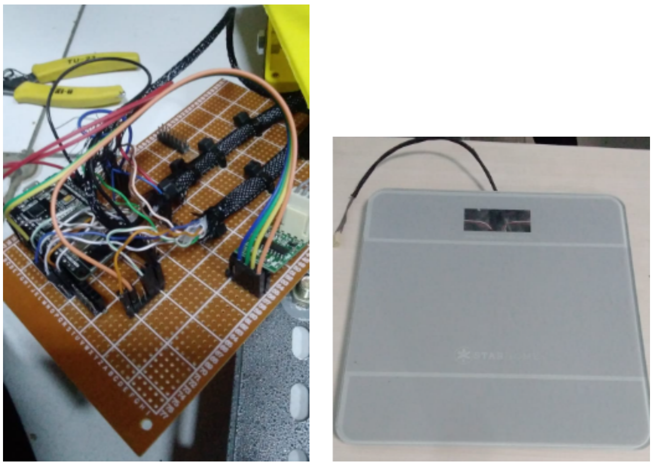

Figure 8. Assembly of Load cell sensors, hx711, and ESP32

2) Microcontroller Program Assembly

In the assembly stage of the microcontroller program, the first step is to install the Arduino IDE application. Next, install all the necessary initialization requirements for each module or sensor that will be used. The final step is to create a program using C++ that is tailored to meet the desired objectives.

3) Mechanical Assembly of the Measuring Tool

In the process of assembling the mechanics of the measuring instrument, the first step is to design the frame and dimensions according to the requirements. Next, gather the tools and materials needed to construct the frame. The frame, which supports each sensor and

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the LCD, is made using perforated angle iron. An image of the toddler's weight and height measuring instrument can be seen in **Figure 9**.

Figure 9. Measuring instrument for toddlers' weight and height

3.2. Testing

Sensor testing is conducted to determine the accuracy of the sensor measurements. Of the two types of sensors to be tested—height sensors and weight sensors—only the testing and validation for the height sensor have been completed. The results of the height sensor test are shown in **Table 1**. Meanwhile, the results of the weight sensor test will be displayed in **Table 2**. The following are the results of the distance sensor test, which will be used as a height-measuring tool.

1) Testing of the height sensor

Table 1. Results of the HC-SR04 Ultrasonic Sensor Testing.

Measurement Distance (cm)					
Ruler Distance	**Measure Element 1**	**Measure Element 2**	**Measure Element 3**	**Average Measurement**	**Average Error (%)**
30	29,6	30,2	30,4	30,068	1,11%
40	39,7	39,5	40,1	x 39,7	0,75%
50	50,7	50,2	50,5	50,46	0,993%
60	60,4	59,7	60,0	60,03	0,39%
70	69,1	70,1	69,6	69,60	0,647%
80	81,3	81	80,5	80,93	1,167%
90	90,7	90,9	90,4	90,60	

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100	100,9	101,5	100,8	101,08	0,74%
110	111	111,6	110,7	111,10	1,067%
120	121.8	119,8	120,7	120,50	0,67%
					0,75%

Table 1 shows the results of the height sensor measurement test. The data were collected at 10-cm intervals within a height range of 30 centimeters to 1.2 meters. At each measurement point, three readings were taken, and the average value was calculated. The results indicate that the average error in the height sensor test is 1.1%, which is below the target error specification of 5%. The graph for measurement test can be seen in **Figure 10.**

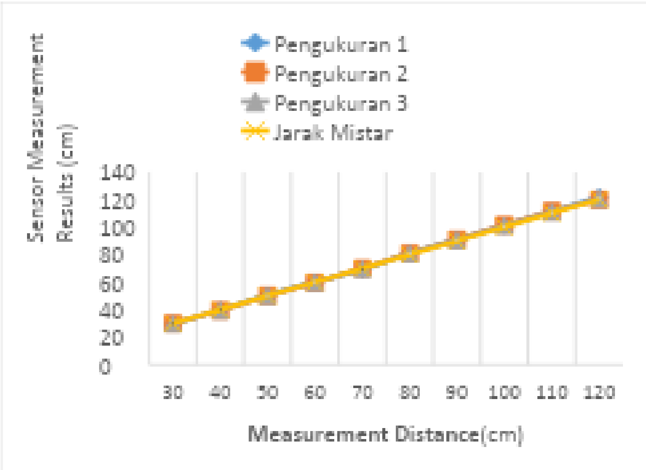

Figure 10. Distance Sensor Testing Graph

2) Weight Sensor Testing

Table 2. Results of the Load Cell Sensor Testing

Measurement Period (KG)					
Body Weight	**Measure Element 1**	**Measure Element 2**	**Measure Element 3**	**Average Measurement**	**Average Error (%)**
5	5,14	5,1	5	5,08	1,60%
10	10,25	9,99	10,09	10,11	1,17%
15	15,18	15,2	14,97	15,12	0,91%
20	20,17	19,97	20	20,05	0,33%
25	25,19	25,3	24,95	25,15	0,72%
30	30,5	31	30,9	30,80	2,67%
35	36,1	34,2	35	35,10	1,81%
40	40,19	40,1	40,28	40,19	0,48%
45	40,5	45,61	45,7	45,60	1,34%
50	50,18	49,98	50,25	50,14	0,30%

Table 2 shows the results of the Load Cell Sensor Measurement Test. The data were collected at 1 kg intervals within the 3 kg to 12 kg range. At each measurement point, three readings were taken, and the average value was calculated. From these measurements, it can be concluded that the average error of the load cell sensor test is 2.67%, which is below the target error specification of 5%.

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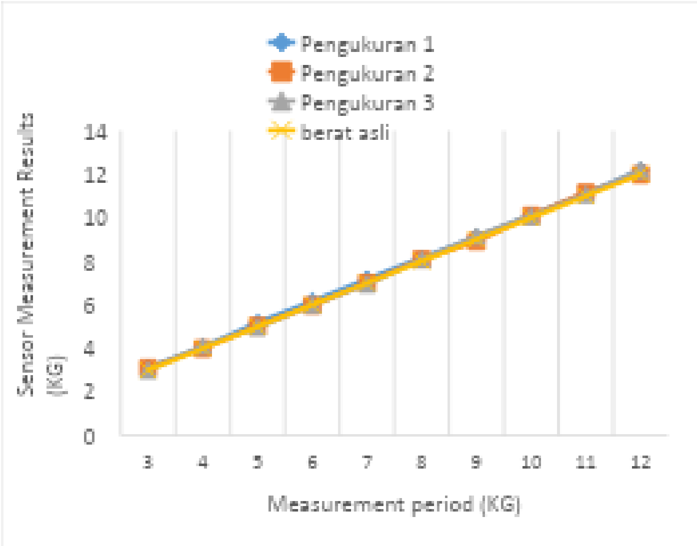

Figure 11. Comparison of the Load Cell with a Standard Scale

In **Figure 11**, you can see that the measurements from the ruler serve as a reference for the load cell sensor. The results from the three measurements consistently match and increase, which is due to the increasing mass. It can be concluded that the error in the sensor measurements is not always linear and tends to be greater as the distance between the object and the sensor increases.

4. CONCLUSION

Based on the research conducted, it was concluded that height and weight measurements can be performed using an automated measuring tool. The height sensor has a measurement range of 30 cm to 1.2 meters, while the weight sensor has a range of 3 kg to 12 kg. The average error for the height sensor test results is 0.75%, and for the weight sensor testing, it is 1.13%.

For the distance used as a height sensor and the mass used as a weight sensor, the average error is below 2%. These results indicate that the sensor is suitable for use as a height-measuring tool. However, the frame design still requires improvements, particularly regarding the durability of the frame, which needs to be stronger. Weight sensor testing will be conducted in the next stage. The application development is expected to be completed by early December.

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