# Arduino and Android-Based Anthropometric Detection Tools for Indonesian Children

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**ABSTRACT**
Current anthropometric measurements at Community Health Centers (CHC) by cadres and health workers in Indonesia are not completely accurate. This inaccuracy is influenced by errors when measuring, determining the age, the accuracy of cadres, and non-standard anthropometric measuring instruments. For this reason, it is necessary to design a more practical anthropometric detection tool of children's nutritional status for health practitioners and cadres, reducing the risk of mal diagnostic due to human error. It is very important to help the CHC for examination anthropometric measuring. The development life cycle system (DLCS) method, which includes planning, analysis, design, implementation, testing, and management applied to system design. This instrument was expected to be a standard solution for measuring the nutrition status of Indonesian children that was still conducted manually and separately. The design began with the identification of the child's weight and height, calibration and analysis of the function of the sensor, then the design process of the measuring instrument. At the trial stage, the data were displayed on the LCD. This series of activities used the Arduino nano R3, then data were sent to Bluetooth, and forwarded to the Android system. This study produced a detection system for children's nutritional status using body length/ age, weight/height, and bodyweight/age parameters. This android system produced nutritional status categories, namely normal, stunted, wasted, and underweight.

***Keywords:*** *Anthropometry, Arduino, Android, Children's, Stunted, Underweight, Wasted.*

## 1. INTRODUCTION

The double burden of malnutrition is characterized by the coexistence of undernutrition along with overweight and obesity. Since 2014 in the world, 42 million children under the age of five were overweight or obese but 156 million were affected by stunting (low height-for-age). While 50 million children were affected by wasting (low weight-for-height). Indonesia itself has a triple burden of nutritional problems, namely stunting, wasting, and obesity as well as deficiencies of micronutrients such as anemia. Basic health research 2018 showed that 25.7% of adolescents aged 13-15 years, 26.9% of adolescents aged 16-18 years with short and very short nutritional status, the prevalence of stunting in children under five in Indonesia in 2018 reached 30.8% [1]. The prevalence of stunting in children under five in Indonesia is the second-largest in Southeast Asia after Laos, which reached 43.8% [2].

The second nutritional problem is wasting. The prevalence of wasting in Indonesia reaches 10.2%, it becomes a serious problem if the prevalence of stunting reaches 10.0% -14.0%, and is considered critical if ≥ 15.0%, will become a public health problem. seriously in Indonesia. While the third nutritional problem is obesity, the prevalence of obesity in 2016 in adults aged 18 years and overreached 33.5% (BMI> 25), while in children aged 5-12 years it reached 20.7%. Obesity is an excessive accumulation of fat due to an imbalance of energy intake (energy intake) with the energy used (energy expenditure) for a long time [3]. The impact of the triple burden in Indonesia has fatal consequences for the productivity of children in adulthood. Stunted children have the potential for imperfect growth and development, low motor skills, a higher risk of suffering from non-communicable diseases [4], and perinatal mortality. The first step that must be taken by health workers is the ability to diagnose early stunting in children. However, several facts show that the results of monitoring nutritional status at CHC in Indonesia tend to be inaccurate and the inaccuracy is caused by errors in anthropometric measurements by cadres, errors in determining the age of toddlers, low level of ability and accuracy of cadres, and 90% of cadres make errors in weighing techniques and measurement errors. systematic height and weight due to non-standard equipment and its various types [5]. Errors in determining the age of children under five cause overcalculation (the age of the child is older than the actual situation), the incidence of overcalculation reached 51.9%. The impact of overcalculating is that the number of children under five who are categorized as having undernutrition becomes more. And the most dangerous thing is if there is an undercalculate (the age of the child becomes younger) so that the number of children who have nutritional problems will be less than the reality. If the incidence of stunting is unknown, children will fall into a worse condition because they do not get adequate treatment. Some of the stunting detection tools that have been made include the Wall Growth Chart, which was tested for sensitivity [6].

In addition, in 2019 there has been the dissemination of innovation in height growth detection using growth mats, but to get accurate measurement results requires special training. So it is necessary to have a detection system that is easier, and more practical to be applied by health practitioners in the field. This Android application can shorten the 4 stages of stunting diagnostics (measurement, reporting, data entry, and diagnosis). The purpose of this study was to design an android-based child anthropometric detection system. Detection of nutritional status has been carried out by measuring body length and height directly using an infantometer (for ages <24 months), and microtoise (for ages> 24 months). Furthermore, the cadres could record the measurement results into the toddler cohort book and fill in the growth chart on the Card Towards Healthy (KMS), so the nutritional status of toddlers could be identified accurately and documented well. Some of the studies that have been carried out still carried out the system manually, focusing more on increasing knowledge but not providing appropriate technology to the community. The results of previous research have found innovations for early detection of stunting using growth mats found by the Bantul Regency Government, Central Java [7]. However, this tool still has shortcomings, namely less practicality, and takes a long time and skilled personnel, and is only for children aged <2 years. This research was designed to produce a digital anthropometric detection system product using a toddler height sensor which is applied to the android system. Health workers and cadres could find it very easy to use this system independently and it could shorten the 4 stages of stunting diagnostics (measurement, reporting, data entry, and evaluation) and could help the recording system.

## 2. METHOD

This study used a System Development Life Cycle (SDLC) design. SDLC in software systems engineering is a process of creating and modifying systems as well as models and methodologies which include the stages of planning, analysis, design, implementation, testing, and management which are applied to the design of an anthropometric detection system in children under five. This research was conducted from March to October 2020 at the Information Technology Laboratory Politeknik Negeri Jember. The tools used in this research included Arduino nano microcontroller, Bluetooth, smartphone, load cell, ultrasonic sensor, 20x4 LCD circuit. One way to detect nutritional problems is by physical detection through anthropometric measurements. The previous study on height measurement applications was entitled automatic body selection gate on Arduino-based playing, which uses utilizing the HC-SR04 ultrasonic sensor as a height measurement and is processed using Arduino [8]. Before taking the planning stage, we had taken preliminary studies for about 6 months. We had an experience with Integrated Post Service (IPS) at a different location in Jember district and we found that BMI measurement in children is not commonly screening to nutrition status. The measurement tools have become a limitation apart of anthropometric measurement tools. It is also because the measurement of BMI in children takes a long time and goes through several manual processes. Then we took some literature studies from previous research and we decided to compile anthropometric desition tools using BMI limits for Indonesian children age 0 – 60, using 4 main criteria, namely very thin (<-3 SD), thin (-3 SD to <-2 SD), normal (-2 SD to 2 SD), fat (> 2 SD) base on the Indonesian Ministry of Health, 2011 [9]. This design process was carried out six times, involving lecturers and students from the health department, two robotics laboratory technicians, and a lecturer majoring in information systems. Based on determining the age of the toddler, physical detection could be done by using data collection techniques for height and weight which could be displayed in a numeric form on LCD and smartphone. Arduino nano microcontroller that has I/O pins read the height, age, and weight values sent by the circuit and accompanied by serial communication between Bluetooth so that it could display data in the form of numbers into a smartphone. Another research presented an application using Arduino and Bluetooth electronic scale to connect to smartphones to obtain weight information of daily water intake. Bluetooth technology is low-power and it can ensure the reliability of data transmission using an Arduino board as a major application development tool [10]. The proponents designed a circuit that combined the functions of the ultrasonic proximity sensor and weight sensor in one system and developed software embedded in two microcontrollers that control and manipulate the whole system of the design project. The design utilized the hardware tools include ultrasonic proximity sensor, weight sensor, Gizduino ATMEGA328, and sensor Amplifier [11]. Digitally height and weight of the human body measuring instrument-based sound module Arduino is a modern measuring instrument that serves to measure the height and weight of the human body and provides information on BMI (body mass index) and weight of the human body. This tool was designed using ultrasonic sensors SRF-04 as a measurement of height and Load Cell as a measurement of weight and had an LCD and output of the sound module. This tool has a maximum height limit measure measuring 200 cm and a maximum weight limit of 200 Kg. From the testing, this tool had a fault or error in the measurement of the weight of 0,43% and measurement error or error in height measurement of 0, 72% [12]. In the first stage, a standard tool analysis of the two objects to be measured (weight and height) was carried out and identifies the need for a circuit on the measuring instrument. Development was carried out based on the results of the design based on the results of the analysis. Testing was a stage used to assess the functioning of the tools being developed. The data were in the form of height and weight of infants and toddlers.

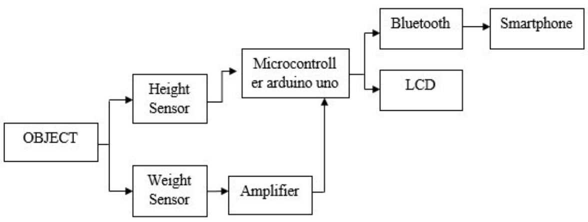


**Figure 1**. The Flow of Anthropometric Detection Equipment System for nutritional status

The system currently designed used the Arduino nano r3 microcontroller. This microcontroller used Arduino software and was very easy to program and install directly into the circuit (Figure 1). The tool to be studied also used Android to monitor the height, weight, and age of infants and toddlers at IPS and Public Health Center (PHC), so IPS cadres and PHC officers were not measured manually anymore but the results were automatically displayed on the LCD and android smartphone. So the system analysis to be studied was basically to make it easier for parents, IPS cadres, and PHC officers to do a job.

### *2.1. Anthropometric Detection Tool Design*

The research process flow included (1) Baby objects as data input; (2) a. height sensor, b. weight sensor and c. amplifier to read data in the form of baby objects; (3) Arduino nano as a data processor for the three sensors that will be sent to an Android smartphone; (4) Bluetooth as serial communication; (5) LCD 20x4 To display this gauge; (6) The android smartphone displays data in the form of numbers sent from Bluetooth on the android display with the help of the MIT app inventor software. The design results can be shown in the overall circuit scheme presented in Figure 2, showing the overall circuit scheme consisting of a load cell circuit, an ultrasonic sensor circuit, a ds18b20 sensor circuit, a 20x4 LCD circuit, a Bluetooth circuit, and an Arduino nano.

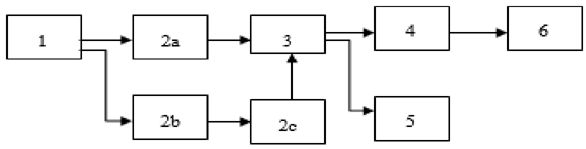


**Figure 2**. Design of an Anthropometric Detection Tool

Arduino microcontroller was tested using a simple program and circuit. The program and circuit were made to ensure that all pins on the microcontroller still functioned well. The simplest test program could use a program to turn on the LED. The connection between the LEDs on pin 13 of the Arduino microcontroller, when testing the Arduino microcontroller, was only programmed to turn on the LED. This aimed to find out whether the microcontroller still worked properly or was damaged. Furthermore, testing the Arduino microcontroller was done with a 5 volt led.

## 3. RESULTS AND DISCUSSION

This anthropometric detection application system for nutritional status for toddlers used a microcontroller with an Android-based Arduino device. The previous research report, [13] design and development of automatic height measuring devices used ultrasonic sensor HC-SR04 based on Arduino R3. The general description of the application includes the process of data input (measurement), data processing using Arduino was sent to a smartphone using Bluetooth. To facilitate data retrieval was done by looking at the results of numerical data at the time of measurement using electronic devices so that the data taken could be displayed in a numeric form on the LCD and android smartphone. Arduino nano microcontroller that has I/O pins is to read the height, age, and weight values sent by the circuit and accompanied by serial communication between Bluetooth so that it can display data in the form of numbers into a smartphone.

### *3.1. System planning*

This study produced an anthropometric detection system for nutritional status for children using BMI/U parameters [14]. Children were the object of data input, while the data input included body weight and height, age and, gender, then the data were read by the toddler's height and weight sensors. The results of the detection system prototype design for children were described in the form of a flowchart in Figure 3. The flow of the system design starts from the load cell sensor calibration process and the HC-SR 04, followed by reading the load cell sensor and the HC-SR 04 sensor. If the sensor was read then it proceeded to the detection of the weight sensor and the HC-SR 04 sensor. However, if the sensor was not readable then the process of reading the load cell sensor and the HC-SR 04 sensor was repeated. The next stage was the calculation of nutritional status which was processed through the Arduino system. The results of the calculation were displayed on the LCD screen and sent using Bluetooth which was forwarded to Android to produce nutritional status decisions.

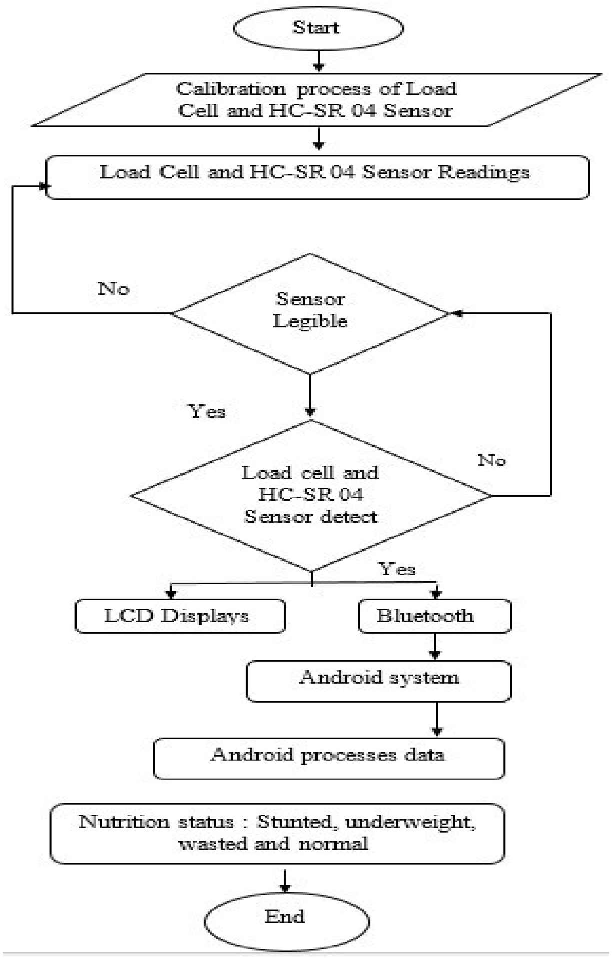


**Figure 3**. Flowchart of the anthropometric detection system for Indonesian children's nutritional status.

Based on the flowchart in Figure 3, it is developed into a block diagram showing the overall circuit scheme consisting of a load cell circuit, an ultrasonic sensor circuit, a 20x4 LCD circuit, a Bluetooth circuit, and an Arduino nano, as in Figure 4.

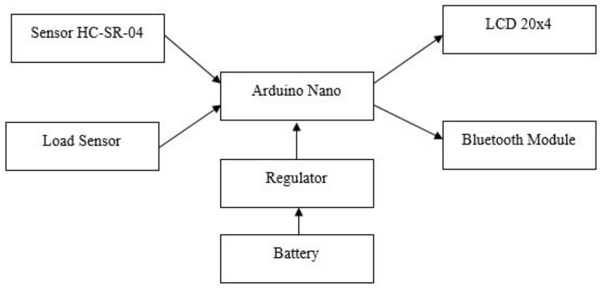


**Figure 4**. Block diagram of the anthropometric detection system for nutritional status for Indonesian children.

### *3.2. System Development*

After going through the system design stage, it was continued at the system development stage. The system development used several tools with several functions including:

a. The HC-SR 04 sensor is an electronic module that detects an object using sound. The ultrasonic sensor consists of a transmitter (transmitter) and a receiver (receiver). The transmitter functions to transmit a sound wave towards the front. If there is an object in front of the transmitter, the signal will bounce back to the receiver. The function of the ultrasonic sensor is to detect objects or objects in front of the sensor or device for measuring distances.

b. Load Sensor or Load cells, also known as load sensors, are weight sensors which when given a load (weight) on the iron core. Load cells consist of four wires. Two cables function as existence while the remaining two cables are output signals. Loadcells (transducers), including electro-mechanical devices, work because of the mechanical stress activity, which then converts the mechanical force into electrical energy.

c. Arduino nano is an open-source electronic kit specifically designed to make it easier to create objects or develop electronic devices that can interact with various sensors and controllers. Arduino nano can make users do prototyping, program the microcontroller, make sophisticated microcontroller-based tools easily.

d. The regulator or voltage regulator is useful for controlling or lowering the voltage applied to the Arduino board and stabilizing the DC voltage used by the processor and other elements.

e. The battery is a power source that is used to support the microcontroller, apart from the battery, this resource can use USB power (if connected to a computer with a USB cable), but you can also use an adapter (battery).

f. 20x4 LCD functions serve as an output/data viewer that we displayed.

g. The Bluetooth module is a wireless communication module via Bluetooth which operates at a frequency of 2.4 GHz with a choice of two connectivity modes.

**Figure 5**. Tool design on the Arduino module and regulator

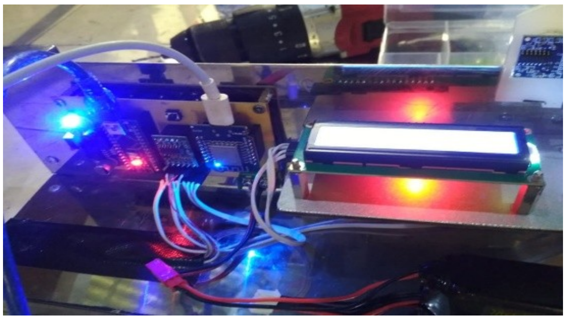

**Figure 6**. System testing of children's scales


**Figure 7**. LCD Display

Furthermore, the data that had been displayed on the LCD were sent using Bluetooth. From Bluetooth, data can be retrieved by android through the software MIT app inventor and can be recorded by cadres. The distinguishes in this study were the parameters for determining nutrition status that were based on Children's anthropometric standards guidelines released by the Ministry of Health of the Republic of Indonesia. Children's anthropometric standards for Indonesians. This design had a lower error in the measurement from the previous research and the fault of the weight reached 0,25%, and an error in the height sensor of 0,5%.

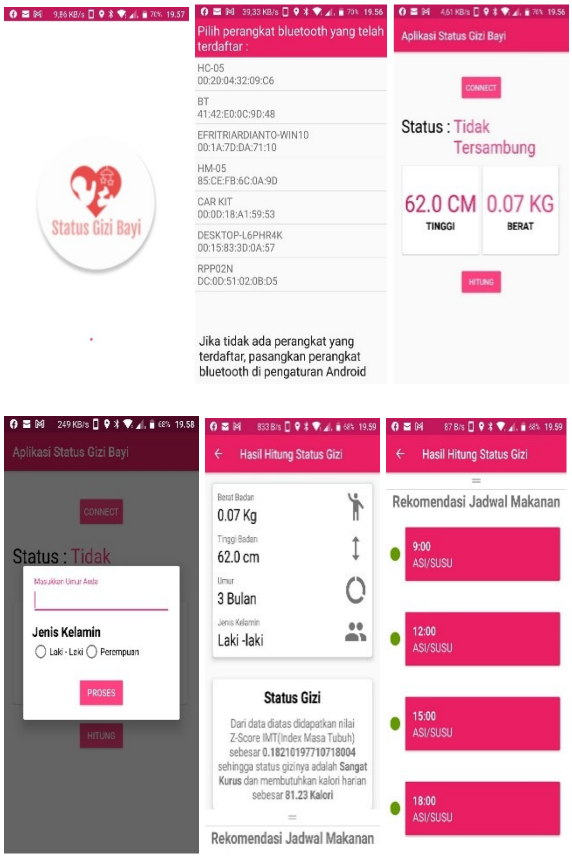


**Figure 8**. Design on the Android

## 4. CONCLUSION

This anthropometric detection system for nutritional status in children used parameters to calculate the weight, height of a toddler. The system identified an error on the weight sensor of 0.25% and the distance sensor of 0.5%. It is necessary to correct and calibrate the tool before measuring the height and weight of children. This android-based system can make cadres and health workers identify and record measurement results easily, but it still needs to be developed into a more specific identification system, for example displaying stunting conditions for infants and toddlers in real-time, and needs recommendations for infant food intake according to the results of biochemical examinations of the baby's body through the development of an expert system

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## REFERENCES

[1] Ministry of Health of the Republic of Indonesia, “Basic Health Research (Research and

Development Agency for Health Ministry of Health Republic of Indonesia),” Jakarta, 2018.

[2] United nations childrens fund (unicef), “The second highest prevalence of stunting for Indonesian under five in ASEAN,” 2017.

[3] World Health Organization, “The world health report 2000 - Health systems: improving performance,” 2000.

[4] Y. A. Widanti, “Prevalence, risk factors, and impact of stunting on school-age children,” *J. Technol. Food Ind.*, vol. 1, no. 1, 2017.

[5] S. F. Suyatno and M. I. Kartasurya, “The accuracy of monitoring nutritional status at Post Integrated Service is cause for concern,” 2017.

[6] H. T. Sinaga and M. Manalu, “Using Modified Growth Chart in Posyandu Effectively Improved Child Weight Gain in Deli Serdang District, Indonesia,” *Pakistan J. Nutr.*, vol. 14, no. 9, pp. 547–552, 2015.

[7] P. D. T. dan T. R. I. Kementerian Desa, “Growth Mat: An Innovation To Prevent Stunting From The Village For Indonesia. Directorate General of Village Community Development and Empowerment.” https://ditjenppmd.kemendesa.go.id/index.php/view/detil/143/tikar-pertumbuhan-inovasi-cegah-stunting-dari-desa-untuk-indonesia (accessed Nov. 24, 2020).

[8] B. Ramadhan, “Automatic Height Selection Gate on Arduino- based Playgrounds,” 2016.

[9] Indonesian ministry of Health, “Antropometric Standards For Assesing Childrens Nutritional Status,” 2011.

[10] B. Dai, R.-C. Chen, and W.-B. Yang, “Using Arduino to Develop a Bluetooth Electronic Scale for Water Intake,” in *2016 International Symposium on Computer, Consumer and Control (IS3C)*, Jul. 2016, pp. 751–754, doi: 10.1109/IS3C.2016.192.

[11] B. M. S. Baladad, J. V. Magsombol, J. N. B. Roxas, E. L. De Castro, and J. A. Dolot, “Development of automated body mass index calculation device,” *Int. J. Appl. Eng. Res*, vol. 4, no. 7, pp. 5195–5201, 2016.

[12] M. Kusriyanto and A. Saputra, “Rancang bangun timbangan digital terintegrasi informasi bmi dengan keluaran suara berbasis arduino mega 2560,” *Teknoin*, vol. 22, no. 4, pp. 269–275, Nov. 2016, doi: 10.20885/teknoin.vol22.iss4.art4.

[13] T. M. Sembiring, “Design And Development Of Automatic Height Measuring Devices Using Ultrasonic Sensor Hc - Sr04 Based On Arduino R3,” *2019*.

[14] World Health Organization, “The World Health Report 2005 - make every mother and child count,” 2005.