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International Journal of Healthcare and Information Technology

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Article

Prototype Design of Arduino-based Automatic Portable Anthropometric and Health Nutrition Assessment Tool

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Abstract: The development of mobile-based applications has gained significant momentum, especially in developing countries like Indonesia. The Covid-19 pandemic has accelerated technological disruption, prompting a shift from manual to mobile-based systems. Advances in information technology have encouraged researchers to develop height measuring devices that are portable, efficient, fast and easy to use. It was new challenge in migrating from print and manual based systems to mobile based systems. The aim of this research is to design and develop a prototype for an arduino-based portable tool for anthropometric and nutritional assessment. The method used is the Prototype model method so it requires a systematic and sequential approach step by step. The tools used are ESP32 WROOM Microcontroller, ESP32 Expansion Breakout Board, HC-SR04 Ultrasonic Sensor, HX-711 Load cell Sensor, 20x4 I2C LCD. The developed anthropometric detection tool automatically determines nutritional status by measuring the weight and height of both children and adults. It is two separate tools that must be connected via WiFi Hotspot, the data from the two sensors will be processed via an Android application. In conclusion, this portable tool offers a user-friendly design compared to previously developed tools, enabling more effective and efficient nutritional status assessments.

Keywords: Automatic Portable Anthropometry; Arduino; Health Nutrition Assessment; Tool

Citation: E. T. Ardianto, H. Oktafa, H. Husin, F. L. Afriansyah, B. Y. Pratiwi, and A. D. Elisanti, "Prototype Design of Arduino-based Automatic Portable Anthropometric and Health Nutrition Assessment Tool", *ijhitech*, vol. 3, no. 1, pp. 38–44, Jun. 2025.

Received: 25-10-2024
Accepted: 20-06-2025
Published: 27-06-2025

1. Introduction

Mobile-based application development has become a global trend, particularly in developing countries like Indonesia Advances in information technology have encouraged researchers to develop height measuring devices that are portable, efficient, fast and easy to use (1). The challenges in migrating from print-based and manual systems to mobile-based systems have begun to be implemented in the health sector.

The need for digital health services has been addressed through various research studies. Includes applications for screening, service delivery, monitoring, evaluation and follow-up efforts to measure the effectiveness and efficiency of services. Several applications have been developed for growth monitoring and medical records, such as E-Posyandu and medical record systems at Community Health Centers (1), ((2), (3), (4), (5).

However, the weakness of this application is that it is still non-portable, for the reason of maintaining the accuracy of the tool. Apart from that, it is not yet integrated between one application and another application.

We have carried out an alternative solution by referring to several previous research, including the 2020-2022 research on anthropometric detection tools using an Arduino design (copyright ID EC00202053330) (6), Arduino-based Body Mass Index (BMI) measurement prototype (7), Arduino and Android-based anthropometric detection tools for Indonesian children (8), and the Digital Anthropometric Scale tool has been implemented in Menampu Village for Stunting cases (9).

However, the results of trials of anthropometric detection tools that we carried out in 2020 and 2022 show that the tools are not practical, are too big and require a large space, so it is necessary to develop existing tools. Previous research shows that the identification of nutritional status in children has been carried out through a long process using several tools and has high errors. Therefore, further studies are needed to design a prototype of a portable tool to determine nutritional status based on real time, has more complete functions, is more accurate because it can minimize human error. It is profitable, can be based on a house-to-house survey (10).

2. Materials and Methods

This research uses a prototype model approach. Prototype is a technique for collecting certain information regarding user information needs quickly. Focuses on presenting the aspects of the software that will be visible to users which includes stages 1. Communication, 2. Quick plan, modeling and quick design, 3. Construction of prototype, 4. Deployment, delivery and feedback applied to the design Child and Adult anthropometric detection systems. The tools used in this research include: ESP32 WROOM Microcontroller, Expansion Breakout Board ESP32 Microcontroller, HC-SR04 Ultrasonic Sensor, HX-711 Load cell Sensor, 20x4 I2C LCD circuit. The tools used are the latest versions that have more complete features than the tools used in previous studies. So that it provides more complete and accurate information on the results of anthropometric measurements.

During the implementation of the research, we carried out observations and met to define the desired device goals as a whole for approximately 6 months. Based on observations from the NCC research site, Health Department, we found that the anthropometric tools used are still not efficient and effective for determining nutritional status, so they require a large space and large tools.

3. Results

3.1. Anthropometric Detection Tool Design

The design of the tool can be explained in the image as follows:

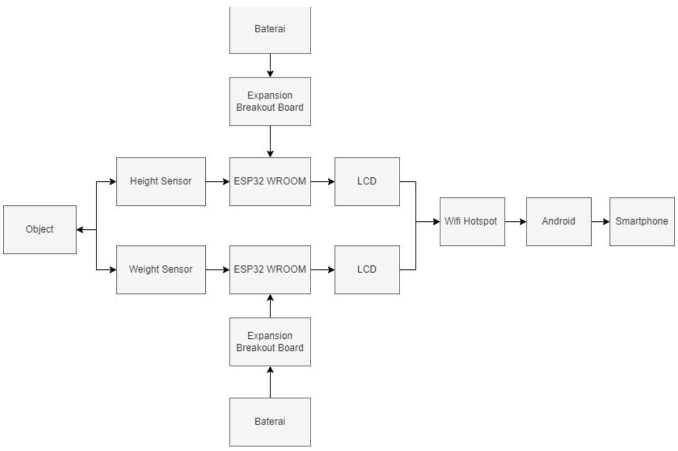

Figure 1. Block Diagram of Arduino-based Automatic Portable Anthropometric and Nutritional Assessment Tool.

Figure 1 shows a system with two separate devices, each containing an ESP32 WROOM 32 Microcontroller, ExpansionBreakout Board, LCD, and sensors. These devices perform different functions, measuring body height and weight respectively. So if it is used to measure nutritional status, it must be connected via WiFi Hotspot and the data results from the 2 sensors will be processed via an Android application.

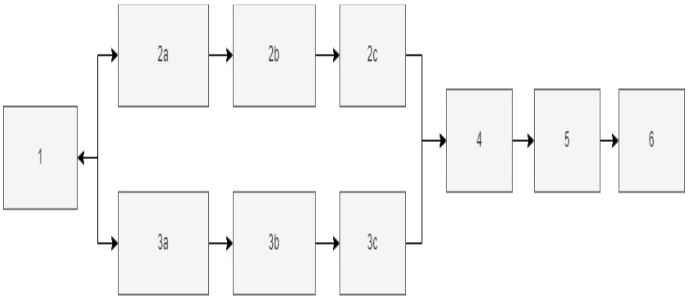

Figure 2. Block Diagram of Arduino-based Automatic Portable Anthropometric and Nutritional Assessment Tool.

Figure 2. presents the overall circuit schematic, consisting of ESP32 WROOM Microcontroller circuit, HC-SR04 Ultrasonic Sensor, HX-711 Load Cell Sensor, and 20x4 I2C LCD circuit. The process flow activities include: (1) Objects as data input; (2a) HC-SR04 Ultrasonic sensor to detect object height; (2b) data processing is carried out by the ESP 32 WROOM microcontroller in the form of an Ultrasonic sensor; (2c) the data results that have been processed from the microcontroller will be displayed via the LCD screen; (3a) HX-711 Load Cell sensor to detect the weight of objects; (3b) data processing is carried out by the ESP 32 WROOM microcontroller in the form of those originating from the Load Cell sensor; (3c) the data results that have been processed from the microcontroller will be displayed via the LCD screen; (4) a tool for measuring height and weight via integrated Wi-Fi Hotspot connectivity so that the data will be sent to the Android application; (5) data sent from the two devices will be processed via an Android application: (6) The Android Smartphone displays the data in the form of numbers.

The tool flowchart can be explained in the image as follows:

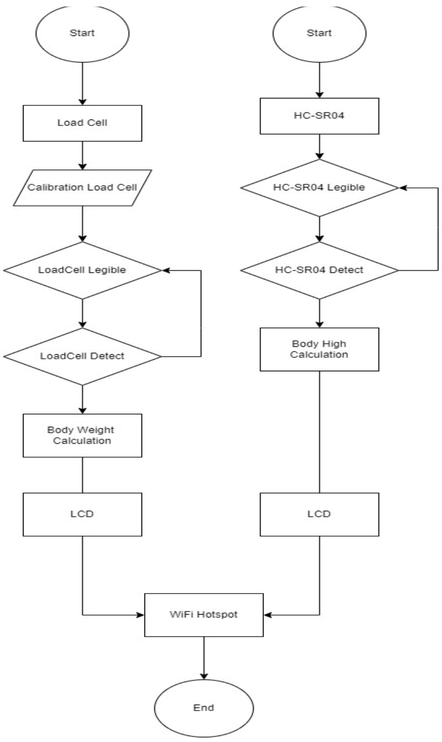

Figure 3. Flow chart of prototype Automatic Portable Anthropometric and Nutritional Assessment Tool.

Figure 3. explained, this prototype uses two separate tools with two ESP32 WROOM 32 microcontrollers and two sensors, namely the HC-SR04 Ultrasonic sensor and the HX-711 Load Cell sensor. which and are used together. The tool will start working via the start and loading buttons according to its function, namely measuring the subject's height and weight. The sensor will take measurements and will be displayed via the 20x4 I2C LCD on both devices. Next, the two tools will send the measurement data and process it in an Android application via a WiFi Hotspot connection in one room.

3.2. System Development

After going through the system design stage, proceed to the system development stage. This system development uses several tools with several functions, including:

1. The ESP32 WROOM 32 microcontroller, developed by a company called Espressif Systems, has several advantages. One of them is the Wi-Fi and Bluetooth modules that are integrated in it. The presence of this feature makes it easier for students to create IoT systems that require a wireless connection. In addition, ESP32 also has low cost and low power (11). Better Speed and Performance: ESP32 has a faster Dual-Core 32-bit processor compared to ESP8266. This means the ESP32 can handle more complex tasks more efficiently (12).

2. ESP32 Microcontroller Expansion Breakout Board. Expansion boards have an important role in increasing system capacity. There are various types of modules that can be used to expand the capabilities of a system. The local module is attached directly to the main board, while the remote module can be installed separately and far from the main board (13). The advantages of using an expansion board can add more features and peripherals to a project without sacrificing performance (12), Another advantage is flexibility in design, namely being able to connect the ESP32 with various additional devices such as OLED screens, temperature sensors, relays, or motors, thereby providing flexibility in designing a system that suits your needs. Expansion boards can expand the number of GPIO pins and have more available, making it possible to connect more external devices, sensors, or actuators to the microcontroller. The board works perfectly with the Arduino IDE and can operate in three modes: AP, STA, AP + STA coexistence. Additionally, the board comes with an expansion power board, 9V battery power cable, and jumper cable.

3. The HC-SR04 sensor is an ultrasonic sensor that is widely used to measure the distance to an object. uses sonar principles to determine the distance to an object (14). The working principle is to send ultrasonic waves and measure the time it takes for the waves to reflect back to the sensor. The measuring range of this sensor is from 2 cm to 400 cm (approx. 0.8 inches to 157 inches) with an accuracy of approximately 0.3 cm. This sensor consists of two modules: an ultrasonic transmitter (trig pin) and an ultrasonic receiver (echo pin). VCC: Supplies voltage to the sensor (5V). Trig: Input pin to trigger sending ultrasonic waves. Echo: Output pin that produces a signal based on wave reflection time and GND: Ground connection (ground) (15)

4. Load Cell Sensor is a component used to measure the weight or load on an object. A load cell is a device that converts the force or load applied to an object into an electrical signal that can be measured (16). The working principle is based on changes in resistance to the strain gauge installed in it. A strain gauge is a sensor that measures deformation or strain in an object. When a load is applied to the load cell, the strain gauge experiences a change in resistance, and this can be converted into a weight value. (17).

5. HX711 Amplifier is an amplifier module specifically designed to read data from load cells. This module has analog to digital conversion capability with 24 bit accuracy. The

HX711 functions to amplify very low output signals from the load cell so that they can be read by the microcontroller (18). The HX711 is equipped with two channels so it can be used to connect two load cells at once. VCC: Connect to positive voltage (usually 5V). GND: Connect to ground (ground). DT (Data): Connect to the data pin on the microcontroller. SCK (Clock): Connect to the clock pin on the microcontroller. Once connected, the HX71 can read weight data from the load cell (18).

6. 20x4 LCD with I2C interface is a component that is often used in electronics projects. This screen allows you to display text, numbers, symbols, and even images onto a screen with a size of 20 columns and 4 rows (19). LCD 20x4 (Liquid Crystal Display) is a character display that has 20 columns and 4 rows. I2C (Inter-Integrated Circuit) is a communication protocol that allows devices to communicate over just two cables (SDA and SCL). By using I2C, we can connect a 20x4 LCD to a microcontroller (such as Arduino or ESP32) with fewer cables. A 20x4 I2C LCD has 4 pins: GND: Connected to ground (0V). VCC: Supply voltage (usually 5V). SDA: I2C data signal. SCL: I2C clock signal (20).

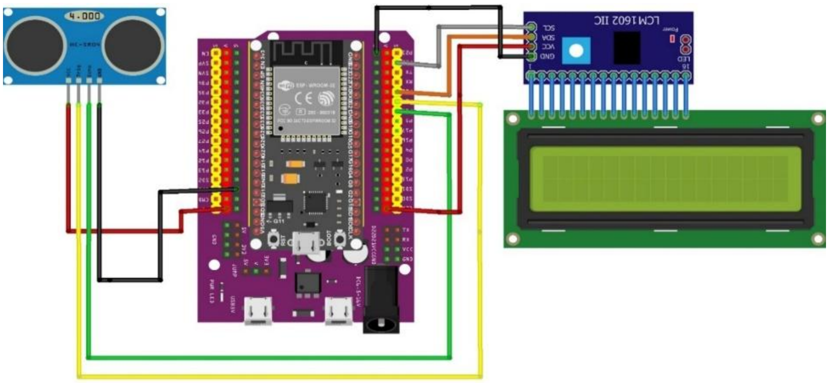

Figure 4. Flow chart of prototype Automatic Portable Anthropometric and Nutritional Assessment Tool.

In Figure 4. it is shown that the design of a height measuring device uses an HC-SR04 ultrasonic sensor connected to the ESP32 Microcontroller Expansion Breakout Board which has been combined with 38 pins on the ESP32 WROOM 32. The pins on the sensor are connected to the Expansion Breakout Board via several pins as follows: ECHO pin to Pin 18, Trigger pin to Pin 19, VCC pin to (+) 5V pin and Ground pin to (-) Ground pin. Meanwhile, the 20x4 LCD pin with an I2C interface will be connected to several pins as follows: VCC pin to (+) 5V pin, Ground pin to (-) Ground pin, SCL pin to pin 22, SDA pin to Pin 21.

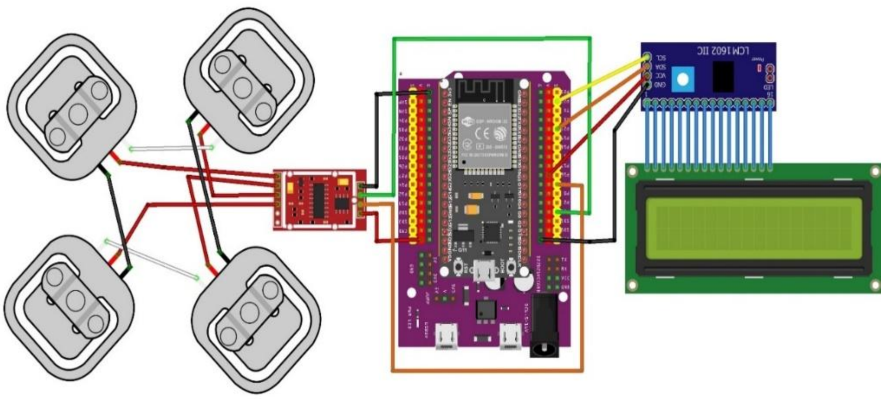

Figure 5. Prototype of Weight Measuring Tool Using Load Cell Sensor

Figure 5. illustrates the weight measuring device design, which uses a loadcell sensor connected to the HX711 amplifier and connected to the ESP32 microcontroller xxpansion breakout board which has been combined with 38 pins on the ESP32 WROOM 32. The pins on the sensor are connected to the expansion breakout board via several pins as following: Data pin to Pin 15, SCK pin to Pin 4, VCC pin to (+) 5V pin and Ground pin to (-) Ground pin. Meanwhile, the 20x4 LCD pin with an I2C interface will be connected to several pins as follows: VCC pin to (+) 5V pin, Ground pin to (-) Ground pin, SCL pin to pin 22, SDA pin to Pin 21.

The results of the research show that the Arduino-based Automatic Portable Anthropometric and Health Nutrition Assessment Tool is used to determine nutritional status automatically to calculate the weight and height of children and adults. This tool is two separate tools, each of which has an ESP32 WROOM 32 microcontroller and sensor so that if it is used for anthropometric measurements to measure nutritional status it must be connected via WiFi Hotspot. The data generated by the 2 sensors will be processed via an Android application.

This prototype is prepared for use in the field such as health centers, integrated health posts, villages. As the results of our previous research, the prototype in this study has a system that produces nutritional status categories including normal, stunting, wasted and underweight (8). This prototype can be used to measure anthropometry and nutrition health of children over 2 years old and adults except pregnant women. In terms of use, this tool is more practical because it uses sensors that are programmed to facilitate cadres and health workers. Apart from that, a similar prototype also has a good level of user satisfaction reaching 87% to 90%, has easy features and can be used by cadres, posyandu officers and community health centers (21)

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4. Conclusions

The prototype design of this tool has been able to meet the planned research design, where the tool already has functions and can be integrated into one android-based application. In addition to being more efficient in terms of the number of tools and sensors used, this tool is able to simplify the process of identifying and recording nutritional status, saving time, requiring less technical expertise, saving examination space and easy to carry. Further development of the tool is needed to integrate more complex health parameters, such as heart rate, cholesterol, and uric acid levels, enhancing its diagnostic capabilities.

5. Patents

Acknowledgments: We gratefully acknowledge the funding from the Ministry of National Education, Culture, Research and Technology of The Republic of Indonesia through the PNBP Competitive Research Grant Politeknik Negeri Jember.

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