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Design of Arduino-Based Height and Weight Measurement System to Support Halal Healthcare Services

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ABSTRACT
Height and weight are important indicators in monitoring nutritional status and health, particularly in growing children. This study aims to design an Arduino-based height and weight measurement system utilizing the HC-SR04 ultrasonic sensor for height measurement and manual weighing. The collected data are used to calculate the Body Mass Index (BMI) and analyzed through questionnaires involving several respondents. The system is developed to support healthcare services aligned with halal principles, where nutrition and growth monitoring can be performed accurately, efficiently, and based on Islamic values. The results show that the height measurement device functions effectively and provides consistent outcomes. This system has potential applications in Islamic educational institutions, pesantren, and sharia-based healthcare services as part of efforts to preserve health by Islamic teachings.

Keywords:
Height, Weight, Arduino, HC-SR04 ultrasonic sensor

Introduction

Physical appearance, such as ideal weight and height, is one of the desires of every person, whether teenagers, young people, or adults, because it is more attractive(Ats & Johan, 2008). Beyond aesthetics, many individuals often express concerns about their health, linking it to being underweight or overweight. Excess body weight increases the risk of diabetes, hypertension, and high cholesterol (Perdana, 2013). Likewise, insufficient height may also be associated with higher risks of cardiovascular diseases. Genetic factors and poor nutritional intake are key determinants influencing height and weight. Young people pursue various strategies to achieve ideal body weight and height, including regular exercise, dietary regulation, and growth-enhancing supplements (Afdali dkk 2018). However, some individuals neglect these aspects.

Technological advancements are progressing rapidly compared to the past. One consequence of this progress is the reduced burden on human effort. For instance, numerous height-measuring devices have been developed as technology evolves. In healthcare settings, height measurement is commonly performed using manual tools, which are often time-consuming. In this technological era, digital systems should ideally replace manual devices. In this study, the authors propose the design of an automated height measuring device (Hutasoit dkk, 2019).Within Muslim communities, maintaining good health is considered an amanah (trust) and is aligned with sharia principles that emphasize the importance of a halal and healthy lifestyle. Therefore, developing a height and weight measurement system based on Arduino and equipped with an ultrasonic sensor aims to support halal healthcare services, with the expectation of improving the efficiency and accuracy of nutritional and growth monitoring in line with Islamic values.

Height and weight are two crucial factors used as indicators to assess abnormal conditions and are considered risk factors for various diseases (Kanwar et al, 2018). Height indicates physical growth (Humaera et al., 2018) and provides a reference for evaluating body proportions. Several factors influence height, which can be classified as internal, such as genetics and hormonal conditions, and external, such as environment, nutrition, socioeconomic status, and other factors (Ratulangi & Tanudjaja, 2010). Height measurement is typically performed by standing upright without footwear using devices such as stadiometers (Hutasoit et al., 2019). On the other hand, body weight, measured in kilograms (kg), is a key parameter for assessing health status (World Health Organization Expert Committee, 1995). Weight data can calculate additional metrics, such as Body Surface Area (BSA) and Body Mass Index (BMI). Ideal body weight is often evaluated using BMI, with threshold values set according to WHO and FAO guidelines. Maintaining an ideal weight has significant health benefits, and weight loss can be achieved through exercise and diet. Men prefer exercise as a weight control strategy, while women more commonly adopt dietary measures (Afdali et al., 2018).

Adolescents are particularly vulnerable to overnutrition, which is characterized by excessive body weight relative to age or height due to abnormal fat accumulation. Adolescent obesity is multifactorial, influenced by increased fast food consumption, physical inactivity, genetic predisposition, media exposure, psychological factors, socioeconomic status, dieting practices, age, and gender (Astutik & Winarningrum, 2017).

Obesity is a chronic condition characterized by abnormal or excessive fat accumulation, representing a significant public health issue. Its health implications have received increasing attention in recent years, necessitating further studies on its harmful effects (Nieto-Garcia et.al, 1990). Obesity affects all age groups, but is particularly detrimental for individuals over 40 years old. It is diagnosed using a BMI of over 30 kg/m^2(Gupta, Parikh, & Swarnalatha, 2020). Literature suggests that overweight men are often perceived more favorably or with greater body satisfaction compared to women (Pradana, 2013). Obesity in children and adolescents has tripled since the 1980s. Obese youth are more likely to experience chronic health conditions and elevated risks of cardiovascular diseases later in life. Furthermore, age can limit healthy behaviors, and misperceptions about weight may contribute to unhealthy practices(Amaliah et al, 2012).

Aging also influences body composition, including reduced lean mass and fluid levels (Kuczmarski et al, 2001). Lifestyle factors, such as lack of physical activity and skipping breakfast, significantly correlate with BMI and may contribute to overweight and related health issues(Kaprio et al, 2003). BMI derives from a person's height and weight (Hill & Roberts, 1998). However, height and weight measurements alone do not provide a comprehensive picture of an individual's physical development (Tanner et al, 1966). making them insufficient as sole indicators for health monitoring (Hume, 1966).

Various measuring devices have been developed to assist humans in determining important parameters. Among these, height-measuring tools are commonly used to assess object height. However, many existing devices remain analog (Marthunus, 2015). Advanced height measuring devices use distance sensors, which convert physical quantities into electrical signals for detection. The HC-SR04 sensor is a distance sensor capable of measuring without physical contact by emitting electromagnetic waves (Hutasoit et al., 2019). Arduino, an open-source electronic platform, serves as the central processing unit in this study. Equipped with a microcontroller chip and utilizing a simple programming language, Arduino enables straightforward system design and implementation (Cahyono & Supriyatno, 2018).

Methods

Tools and Materials

- Phillips and flathead screwdrivers
- Wire cutter
- Measuring tape
- Soldering iron
- Laptop
- Scissors
- Arduino Uno + USB downloader cable
- Ultrasonic Sensor HC-SR04
- LCD i2C 16×2
- 9-volt battery
- Solder tin
- Two boxes (large and small)
- Adhesive (hot glue)
- Male and female jacks (12 pieces)
- PCB board
- Resistors
- On-off switch

Block Diagram

The block diagram illustrates the overall working principle of the system. As shown in Figure 1, the system comprises three essential components: the Sensor unit (HC-SR04) as the input unit responsible for detecting and converting height parameters into electrical signals; the Arduino Uno as the central processing unit that receives, processes, and converts signals from the sensor into measurable height data; and the Liquid Crystal Display (LCD) as the output unit, which visually displays the measurement results to the user.

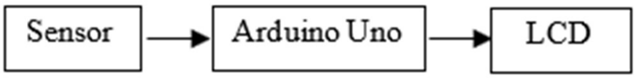

Figure 1. Block diagram of the height measuring system

Flowchart

The flowchart in Figure 2 systematically visualizes the operational procedures of the height measurement device. The process begins with sensor initialization, ensuring the sensor is ready for data collection. The next crucial step is calibration, where the system performs adjustments to guarantee measurement accuracy; this step repeats if calibration does not meet predetermined criteria. Once calibration succeeds, the process continues with repeated readings from the ultrasonic sensor until stable and valid data is obtained. The measurement process concludes after successful data acquisition.

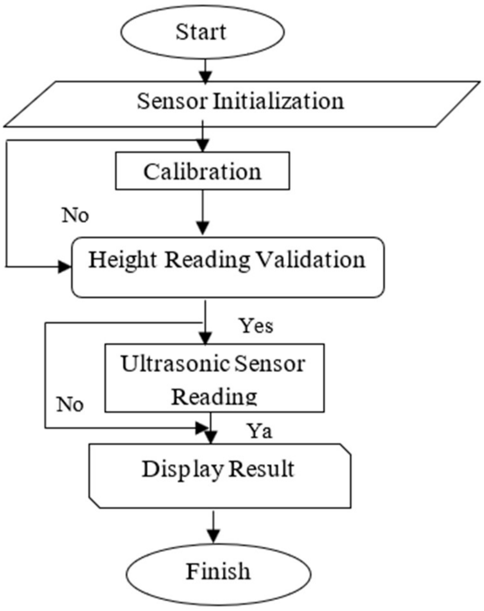

Figure 2. Flowchart of the height measuring system

Results and Discussions

Height Measurement Testing

The Arduino-based height measurement system calculates the distance between the HC-SR04 ultrasonic sensor and the object in front of it. The sensor emits ultrasonic waves and measures the time of the reflected signal to determine the distance, which is then converted into height data by the Arduino Uno microcontroller. The measurement results are displayed on an LCD screen. Testing on 20 respondents (Table 1) showed an average error rate of 0.75%, indicating an average accuracy of 99.25%, which falls into the high category. The measurement success rate reached 99.25% on average, demonstrating the system's feasibility as an alternative digital height measuring device. These results are superior to those reported by Afdali et al. (2018) who recorded an average error of 1.2% on a similar Arduino-based device. Furthermore, this system supports findings by Hutasoit et al. (2019), who successfully automated height measurement in community health centers, albeit with slightly higher error rates. The non-contact feature of this height measuring device also aligns with the principles of halal healthcare services. This functionality allows measurements without physical contact between healthcare workers and patients, adhering to Islamic teachings on modesty in gender interactions (hifdz al-'ird or safeguarding honor). The system's speed and accuracy also benefit from delivering more efficient and hygienic healthcare services in sharia-based facilities such as Islamic hospitals, pesantren, and Muslim women's community health posts.

Table 1. Observation data of the height measuring device

Respondent	Height (cm)		Error Percentage (%)
	Meteran	Modul	
1	140	141	0,71
2	147	147	0
3	150	150	0
4	136	136	0
5	133	133	0
6	130	131	0,77
7	144	145	0,69
8	135	135	0
9	111	111	0
10	114	114	0
11	117	117	0
12	131	131	0
13	133	133	0
14	125	120	0
15	131	130	0,76
16	128	128	0
17	113	113	0
18	119	118	0,84
19	145	145	0
20	130	130	0

Body Mass Index (BMI) Calculation

BMI results for the 20 respondents are shown in Table 2. The nutritional status distribution reveals that most male respondents are underweight, while female respondents exhibit more varied nutritional statuses, including cases of obesity. This finding is consistent with Nieto-Garcia et al. (1990), who reported a higher prevalence of obesity among women due to hormonal factors and lifestyle patterns. Similarly,Kanwar et al. (2018) noted an increasing prevalence of obesity among urban adolescent females. Although BMI is a practical method for assessing nutritional status, several studies highlight its limitations. Kuczmarski et al. (2001) emphasized that BMI does not account for body fat distribution or muscle mass. Therefore, additional parameters such as waist circumference or body fat percentage are recommended to strengthen nutritional assessments.

In the context of halal healthcare, the BMI information provided by this device can assist Islamic health institutions in effectively monitoring community nutrition. Regular nutritional monitoring supports the Islamic principle of hifdz al-nafs (preservation of life and health). Gupta et al. (2020) also advocate for IoT-based technologies to enhance healthcare services that are safe, efficient, and aligned with halal principles. Moreover, the device eliminates the need for patients to excessively expose their bodies, as they only need to stand under the sensor without direct contact. This feature adds value for implementation in pesantren, sharia hospitals, or Muslim women-focused health services.

Table 2. Observation data of BMI

Responden	Berat Badan (Kg)	Kalkulator IMT
1	48	24,5
2	50	23,1
3	92	40,9
4	32	17,3
5	23	13,0
6	28	16,6
7	43	20,7
8	42	23,0
9	15	12,2
10	18	13,9
11	18	13,1
12	26	15,2
13	31	17,5
14	35	22,4
15	25	14,6
16	28	17,1
17	19	14,9
18	22	15,5
19	40	19,0
20	33	19,5

Conclusion

The Arduino-based height and weight measurement system utilizing the HC-SR04 ultrasonic sensor demonstrated high accuracy, with an average error of 0.75%, and effectively calculated Body Mass Index (BMI). Its non-contact measurement feature supports halal healthcare services by upholding the principles of modesty (hifdz al-'ird) and health preservation (hifdz al-nafs), making the system highly applicable in sharia-based healthcare facilities such as Islamic hospitals, pesantren, and Muslim community health centers.

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