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Development of IoT System for Weight, Height, Temperature, and Heart Rate Monitoring with Health Recommendations

Pengembangan Sistem IoT untuk Pemantauan Berat, Tinggi, Suhu, dan Denyut Jantung dengan Rekomendasi Kesehatan

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Abstract – Health facilities such as community health centers, clinics, and hospitals play a crucial role in providing basic health check-up services, including measuring weight, height, body temperature, and heart rate. This examination is important as an initial step in early detection of disease and routine monitoring of patient health conditions. This study aims to develop an Internet of Things (IoT)-based health monitoring system that can automatically measure these body parameters, display data in real-time, print test results via a thermal printer, and provide simple health recommendations. This study uses the Research and Development (R&D) method with a modified Borg and Gall model approach. The system trial was conducted at the UI student dormitory in May 2025, involving 38 student respondents as samples. The results of the study showed that the developed system was able to perform measurements with high accuracy and fast response time. In addition, the features of printing results and providing health recommendations have been shown to increase service efficiency and user satisfaction. This system has the potential to support remote health services (telemedicine) and to increase public awareness of the importance of independent and regular health monitoring.

Keywords: health monitoring system, health recommendations, IoT, medical sensors, telemedicine

***Abstrak** – Fasilitas kesehatan seperti puskesmas, klinik, dan rumah sakit memiliki peran krusial dalam menyediakan layanan pemeriksaan kesehatan dasar, termasuk pengukuran berat badan, tinggi badan, suhu tubuh, dan denyut jantung. Pemeriksaan ini penting sebagai langkah awal dalam deteksi dini penyakit serta pemantauan rutin kondisi kesehatan pasien. Penelitian ini bertujuan untuk mengembangkan sistem pemantauan kesehatan berbasis Internet of Things (IoT) yang dapat secara otomatis mengukur parameter tubuh tersebut, menampilkan data secara real-time, mencetak hasil pemeriksaan melalui printer thermal, serta memberikan rekomendasi kesehatan sederhana. Penelitian ini menggunakan metode Research and Development (R&D) dengan pendekatan model Borg and Gall yang dimodifikasi. Uji coba sistem dilakukan di Asrama mahasiswa UI pada bulan Mei 2025, dengan melibatkan 38 responden mahasiswa sebagai sampel. Hasil penelitian menunjukkan bahwa sistem yang dikembangkan mampu melakukan pengukuran dengan akurasi yang tinggi dan waktu respon cepat. Selain itu, fitur pencetakan hasil dan pemberian rekomendasi kesehatan terbukti meningkatkan efisiensi pelayanan dan kepuasan pengguna. Sistem ini berpotensi mendukung layanan kesehatan jarak jauh (telemedicine) dan meningkatkan kesadaran masyarakat terhadap pentingnya pemantauan kesehatan secara mandiri dan berkala.*

***Kata Kunci:** IoT, rekomendasi kesehatan, sensor medis, sistem pemantauan kesehatan, telemedicine*

INTRODUCTION

Health facilities such as community health centers, clinics, and hospitals play an important role in providing basic health check-up services, including recording weight, height, body temperature, and heart rate. This examination is a crucial initial step in early detection of disease and regular monitoring of patient health conditions. Health is a fundamental aspect of human life that is greatly influenced by lifestyle, environment, and early detection of body condition. One way to maintain health is to routinely monitor physical body parameters such as weight, height, body

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temperature, and heart rate. This data is very important in determining a person's health status, detecting early symptoms of disease, and monitoring the effectiveness of treatment or fitness programs (Kurniyanti, Miftakhul, & Widya, 2024)

However, in practice, this measurement process is often done manually, which is time-consuming, and requires the presence of medical personnel or trained operators. This is a challenge especially in health facilities with limited resources or in remote areas. In addition, measurement results are often not well documented, complicating the process of analysis and ongoing follow-up (Rodgers et al., 2019).

With the development of Internet of Things (IoT) technology, automation in health monitoring has become more possible and efficient. IoT technology allows the integration of physical sensors with communication and computing systems to collect, to send, and to process data in real-time (Nugraha, Rosyadi, & Nugroho, 2016). In this context, the development of IoT-based health measuring devices that can automatically measure weight, height, temperature, and heart rate is very relevant and potential (Islam et al., 2015).

Various studies have shown that wearable devices or IoT-based monitoring systems can improve the efficiency of early detection of diseases, increase health awareness, and reduce the burden on the health care system (Albahri et al., 2019; Chen et al., 2016). As a development of previous studies, this system is also equipped with a feature for printing measurement results via a thermal printer and providing simple health recommendations. This feature aims to provide convenience for users and become physical evidence that can be stored or given to medical personnel (Rastogi, Gharde, & Kandasubramanian, 2020).

Thus, the development of this system not only facilitates the monitoring process but also applies the term *Telemedicine* which is a method of remote health services using information and communication technology (ICT) to diagnose, to treat, and to monitor patients in real-time without the need for direct face-to-face, moreover the development of this system also has the potential to increase user awareness and responsibility for their own health.

Research in the field of IoT-based health monitoring has experienced significant developments in recent years. Various studies have been conducted to integrate medical sensors with electronic and communication systems, thus creating practical, efficient, and real-time accessible health monitoring tools.

Kassab & Darabkh (2020) introduced the concept and basic architecture of the IoT that underlie various innovations, including in the health sector. This study shows how connected physical devices can exchange data to support intelligent decision making.

Islam et al., (2015) in their survey specifically discussed the application of IoT in the health system. This study emphasizes how medical devices can collect patient data such as body temperature, blood pressure, and heart rate, then send it to a central system for further analysis. However, this study has not discussed the aspects of personalizing measurement results and providing direct feedback to users.

Ud Din et al., (2019) developed an IoT-based health monitoring system that can detect vital body parameters such as temperature and blood pressure. This system also sends data to the cloud to be stored and monitored remotely. Even though it is quite sophisticated, this system does not yet provide an output feature in the form of direct printouts to patients.

Sari & Masfuri (2024) discuss various wearable systems and sensors for monitoring patient rehabilitation. This study emphasizes the importance of comfort of use and sensor accuracy, but has not yet reached the aspects of automation and integration into printing systems or recommendation provision.

According to research conducted by Santika & Subekti (2020) in a journal entitled Analysis of Body Weight and Height Against Nutritional Status, there is a significant correlation between body weight and height and a person's nutritional status. The study found that an imbalance between body weight and height can indicate health problems, such as malnutrition or obesity. For example, someone with a height below average but overweight is at risk of obesity, which can have an impact on chronic health problems such as hypertension and diabetes mellitus. Conversely, height that does not match the ideal body weight can also indicate malnutrition and nutrient deficiencies.

Due to its compact and modular design, this health monitoring device is easily transportable and can be quickly assembled or disassembled when needed. Its integration with wireless IoT connectivity allows healthcare professionals to remotely monitor patient data in real time, regardless of distance. This makes the device especially suitable for deployment in remote and underserved areas of Indonesia, where access to healthcare facilities and medical personnel is limited.

Moreover, in emergency scenarios or conflict zones such as Gaza, where healthcare infrastructure is often damaged or insufficient, the device provides a practical solution for frontline health assessments. Doctors can remotely view vital health indicators and offer medical recommendations, thereby bridging the gap in healthcare services and supporting urgent decision-making in crisis situations. The following Figure 1 shows the communication diagram of the device system.

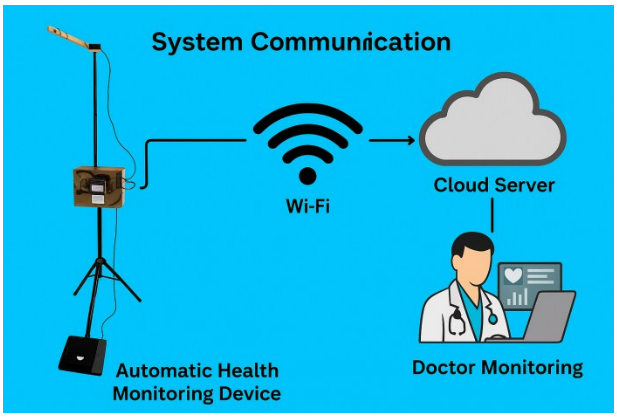

Figure 1 Communication diagram of the device system

The difference between the research that will be made with the research above is by using four sensors in one tool. Then the tool will be connected to IoT technology and a print terminal so that the data from this tool can be monitored from anywhere easily and quickly and the measurement results can be printed.

Local research in Indonesia is generally still limited to manual measuring tools for weight, body temperature, heart rate, and height without an automation system and connection to a network or printing system. Therefore, this study tries to contribute by integrating various sensors into one IoT system that not only performs measurements, but also produces physical output in the form of printouts and simple recommendations based on user data.

With this approach, the system developed is expected to be an integrated solution that is useful to be used in health facilities such as health centers, clinics, and independent health services.

This study identifies several problems, including how to design an IoT-based health monitoring system that is able to measure weight, height, body temperature, and heart rate automatically, how to integrate measurement results into a printed format that can be directly given to users as physical evidence of the examination, how to design a simple health recommendation system that can provide information or suggestions based on user measurement results, and to what extent is the level of accuracy and reliability of the system developed in measuring and printing data.

The general objective of this research is to design and develop an IoT based system that is capable of automatically monitoring physical body parameters such as weight, height, body temperature, and heart rate, and providing measurement results directly in the form of printouts and simple health recommendations to users. The specific objectives of this research are: (1) Designing hardware consisting of a weight sensor, height sensor, body temperature sensor, and heart rate sensor integrated into one system; (2) Providing output features in the form of printed measurement results that include weight, height, temperature and heart rate; (3) Implementing a simple health recommendation system based on measurable parameters, such as ideal weight suggestions or abnormal body temperature warnings; and (4) Testing the performance and accuracy of the system through trials on several user samples to ensure the reliability of the system in a real environment.

RESEARCH METHOD

This study adopts a system engineering and software development approach tailored to the technical nature of IoT-based health monitoring research. The approach emphasizes iterative design, implementation, testing, and evaluation of the system.

The system development begins with a comprehensive design of the system architecture, as illustrated in Figure 2. This block diagram and workflow illustrations that depict the interactions among sensors, microcontroller, Wi-Fi data communication, cloud data storage and processing, and the monitoring interface via a web-based application (Blynk). These diagrams serve as technical guidelines for prototype construction and system testing.

Data security is a top priority in system development. Health data transmitted from the IoT device to the cloud is encrypted using TLS protocols to ensure confidentiality and data integrity during transmission. Additionally, access to the monitoring application is protected through token-based authentication, restricting data access to authorized users and healthcare professionals only.

Beyond technical testing, the study also conducts usability evaluations involving end-users, specifically volunteers in a semi-clinical setting. This evaluation assesses the ease of device operation, system response time, and clarity of the displayed measurement results and health recommendations. User feedback is collected via structured questionnaires and interviews to inform further system improvements.

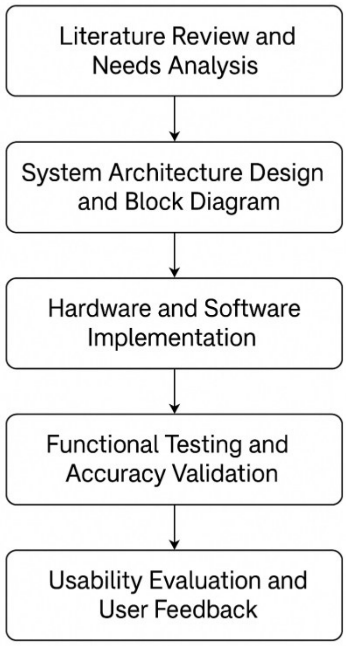

Figure 2 Research Methodology

Figure 2 illustrates the research methodology workflow employed in this study. The process begins with a comprehensive literature review and needs analysis to identify the requirements and gaps in existing IoT-based health monitoring systems. Next, the system architecture is designed, including detailed block diagrams that map out the relationships between sensors, microcontroller, communication modules, cloud storage, and user interfaces.

The research was conducted at the UI student dormitory in May 2025. This location was selected due to its accessibility, availability of basic health screening equipment, and the presence of qualified healthcare professionals who could assist in validating the measurements obtained from the IoT-based health monitoring system. The setting provided a controlled yet practical environment for testing the prototype with real users, enabling the researcher to gather relevant data on system performance, usability, and accuracy in a semi-clinical context.

The product developed in this study is an IoT-based automatic health monitoring system that is able to measure four physical parameters of the body, namely weight, height, body temperature, and heart rate. This system is designed to produce data in real-time, integrated with a digital platform, and provide physical printouts and automatic health recommendations.

The main components of the system in this study are divided into two:

- Hardware: Load Cell with HX711 for weight measurement, Ultrasonic Sensor HC-SR04 for height measurement, Temperature Sensor MLX90614 for body temperature measurement, Pulse Sensor for heart rate measurement, Ardino Uno Microcontroller as the main processing unit, ESP32 Microcontroller as the data sender via WiFi connectivity, LCD Display 20x4 to display measurement results directly, and Thermal Printer to print measurement results and health recommendations.
- Software: Programming language: Arduino IDE (C++) for sensor control, Interface system (Blynk): Firebase-based Web Dashboard to store and display real-time data, and Simple algorithm features for data analysis and providing health recommendations based on measured parameters.

The system is designed modularly to be flexible for further development, including the addition of advanced sensors, integration into electronic medical records, or connection to mobile applications as shown in Figure 3.

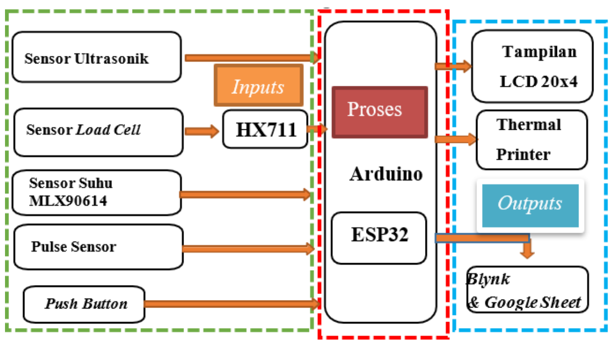

Figure 3 Block Diagram System

As can be seen from the block diagram system, the function of this device utilizes the inputs shown in Figure 3 within the green box, such as the load cell sensor for measuring body weight, the Ultrasonic sensor for measuring height, the MLX90614 temperature sensor for measuring body temperature, and the pulse sensor for measuring heart rate. These inputs are then processed by the Arduino and ESP32, as shown in Figure 3 within the red box, to produce outputs that will be printed and displayed on the 20x4 LCD and the Blynk platform, as shown in Figure 3 within the blue box.

Data collection in this study was carried out through several methods that were adjusted to each stage in the system development process: (1) Literature Study: Reviewing scientific references on IoT technology in the health sector, biometric monitoring system design, and R&D-based system development approaches; (2) Interviews with Experts: Interviews were conducted with medical personnel at the Makara UI Clinic to understand the needs of a health monitoring system that is in accordance with clinical practice; (3) Direct Observation: Observation of routine health check-up activities at the clinic, to get a real picture of the workflow, tools used, and user expectations.

Data analysis in this study was conducted through a combination of qualitative and quantitative approaches, according to the characteristics of the data obtained: (1) Qualitative Analysis: Used to analyze the results of interviews with experts and input from users. Observation results and narrative descriptions from the trial were used to assess aspects of usability and user experience; (2) Quantitative Analysis: System measurement data was compared with standard medical measuring instruments to test the validity and accuracy of the sensor. Mean Absolute Error (MAE) and standard deviation calculations were used to assess system performance; (3) Descriptive Statistical Evaluation: To measure the level of user satisfaction, system effectiveness, and perceptions of printed output and recommendations. The Likert scale was used in the questionnaire and analyzed using percentages and mean scores.

Validation is carried out to ensure that the developed system meets technical standards and user needs, and is suitable for use in a clinical context:

1. Expert Judgment, conducted by two categories of experts:
   - Technology/Informatics experts: assess the technical aspects of the system, interface, and data accuracy.
   - Medical experts: assess the accuracy of health information and the relevance of recommendations provided by the system.
2. User Validation (User Testing):
   - Field trials are conducted by general users at the UI student dormitory.
   - Their responses to the interface, ease of use, speed of printing results, and confidence in recommendations are analyzed to determine the effectiveness of the system.
3. System Function Validation:
   - Through a comparison of system data with manual medical measuring instruments, to ensure consistency of measurement results.
   - Testing the stability of the system over a long operational period (durability testing).

RESULTS AND DISCUSSION

While previous studies have explored various IoT-based health monitoring systems, there remains a lack of standardized benchmarks and direct comparative analyses among similar systems. This research addresses this gap by implementing a prototype that not only integrates multiple physiological parameters but also evaluates its accuracy and usability relative to conventional manual measurements. Future work includes benchmarking the system's performance against existing commercial and research devices to establish standardized metrics for efficacy and user experience.

Testing was carried out on the ESP32 Microcontroller to ensure that this unit is able to read input from various sensors accurately, process data correctly and has the ability as a data delivery system obtained from the device to the Blynk website quickly and accurately. Testing on the ESP32 was carried out by uploading the program provided in the Arduino IDE Software to the ESP32 component using a Universal Serial Bus (USB) cable. The followings are the steps for testing the ESP32:

a) Connecting the ESP32 to a laptop using a USB cable
b) Opening the program provided on the Arduino IDE.
c) Uploading the program from the Arduino IDE to the ESP32 and ensuring that no errors occur until the upload is complete.
d) Seeing the action of the LED on the ESP32

After seeing the action of the LED on the ESP32 blinking every one second, according to the uploaded program. It is certain that the ESP32 is in good condition and ready to be used as an IoT system controller on the system. Testing was carried out on the

Arduino Uno Microcontroller to ensure that the microcontroller is in good condition and has the ability as the brain of the tool's logic system. Testing was carried out in the following aspects:

Compatibility Test with Sensors: Arduino Uno was tested to read data from several sensors directly, namely: Load Cell + HX711 (body weight), Ultrasonic HC-SR04 (body height), MLX90614 (body temperature) and Pulse Sensor (heart rate).

The following Figure 4 shows the location of the Arduino Uno microcontroller on the tool. The results show that Arduino Uno is able to read HX711, HC-SR04, pulse sensor and MLX90614 sensors smoothly using standard libraries.

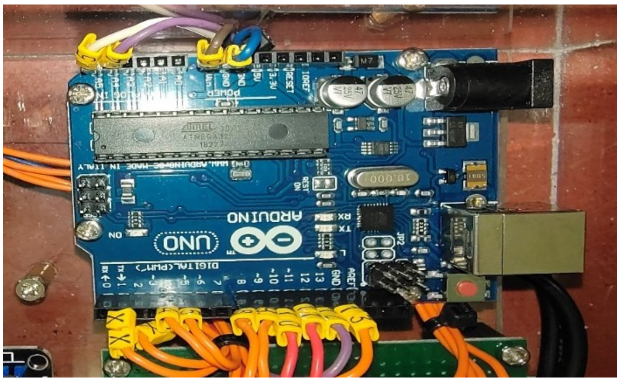

Figure 4 Physical Form of Arduino Uno Microcontroller in the Tool

In this Load Cell Sensor Testing, researchers have conducted 38 weighing trials. Researchers compared the load cell sensor with manual scales commonly used in health centers. This trial is very important so that researchers know how much error is produced by the load cell sensor that will be used as a digital weight scale.

Based on the data contained in the load cell sensor trial, the results showed that weight measurement had an error percentage of 0.00% - 2.81%. While the difference between the measurement results using a weight measuring device and microcontroller with a mechanical scale reached 0.0 kg - 1.8 kg. The following Figure 5 shows the process of taking data.

From the table of results of the digital load cell sensor and analog scales in the clinic, the Linear Regression value Y = 0.6902 + 0.9919X was obtained, which will then be entered into the Arduino program to correct the offset value on the Load Cell Sensor.

This equation was obtained by calibrating the digital output of the load cell (X) with actual manual weight measurements (Y).

- X represents the raw sensor reading (in kg) from the load cell.
- Y represents the actual body weight measured using a manual scale (in kg).
- The intercept (0.6902) compensates for a fixed offset between the sensor and the true value.
- The slope (0.9919) indicates how closely the sensor's measurements follow the true values. Since it is close to 1, it implies high linear accuracy after correction.

Figure 5 Process of Generating Data

Based on the data contained in the Ultrasonic sensor trial, the results showed that height measurements had an error percentage of 0.00% - 1.29%. While the difference between the measurement results using an Ultrasonic sensor and a manual ruler reached 0.0 cm - 2.0 cm.

From this test, the results were obtained where the data results from the HC-SR04 Ultrasonic sensor were close to accurate results, as evidenced by conducting 38 trials, 15 trials of height measurements using an Ultrasonic sensor according to the meter as a comparison and 23 trials did not match the meter or error. However, even though the measurement was in error or did not match the meter, the error results were not that far from the actual results or from the meter.

From the data of manual and digital Ultrasonic sensor results, the Linear Regression value Y = 2.0291 + 0.9877X was obtained, which will then be entered into the Arduino program to correct the offset value on the Ultrasonic sensor. This calibration aligns the height values from the Ultrasonic sensor (X) with manual height measurements (Y).

- X represents the measured distance by the Ultrasonic sensor (in cm).
- Y is the actual body height measured manually (in cm).

- The intercept (2.0291) shows the base offset due to signal delay or fixed measurement bias.
- The slope (0.9877) being close to 1 means that the sensor readings are linearly proportional to real height values.

Based on the data contained in the MLX90614 temperature sensor trial, it was found that body temperature measurements had an error percentage of 0.00% - 3.54%. While the difference between the measurement results using a body temperature measuring device with the MLX90614 temperature sensor reached 0.00oC - 1.30oC. From the data of the MLX90614 temperature sensor results from a distance of 1 cm, which is the closest to the thermometer reading, the Linear Regression value Y = 16.8446 + 0.5410X is obtained, which will then be entered into the Arduino program to correct the offset value on the MLX90614 Sensor.

The MLX90614 is an infrared temperature sensor whose reading (X) is corrected using this regression to match clinical thermometer measurements (Y). X represents the sensor's digital temperature reading (in °C). Y is the actual body temperature as measured by a contact-based clinical thermometer (in °C). The intercept (16.8446) is relatively high, indicating that without correction the sensor reads much lower than the actual temperature. The slope (0.5410) suggests that the sensor's response is not 1:1 and needs significant gain adjustment.

Based on the data contained in the pulse sensor trial, the results showed that the pulse sensor measurement had an error percentage level of 1.16% - 25%. While the difference between the measurement results using a clinical pulse device with a pulse sensor reached 1 - 20 pulses / min. From the pulse sensor data, the Linear Regression value Y= 36.6460 + 0.5293X was obtained, which will then be entered into the Arduino program to fix the offset value on the pulse sensor. This equation calibrates the raw pulse reading (X) from the optical sensor to match actual pulse measured using a clinical device (Y).

- X is the digital pulse sensor reading (in beats per minute).
- Y is the reference heart rate from a clinical pulse oximeter (in bpm).
- The intercept (36.6460) is large, which means the raw sensor values start lower than the actual pulse.
- The slope (0.5293) shows that the sensor sensitivity is only half of the true value, thus requiring gain amplification.

From the table obtained from the load cell sensor data, researchers can get the error percentage so they can create graphs and linear regression equations as shown in Figure 6, then this equation will be entered into the program.

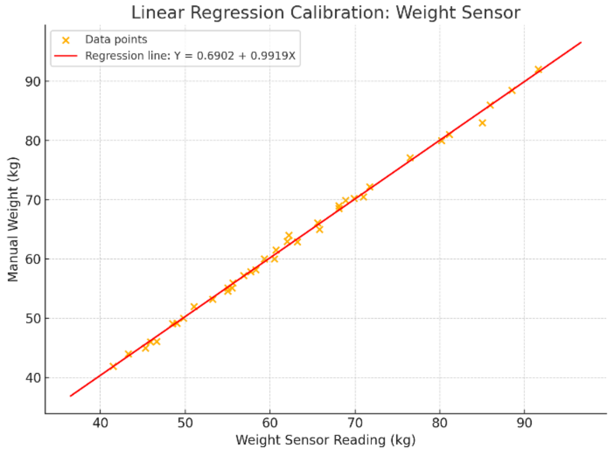

Figure 6 Load Cell Sensor Calibration Equation Graphs

This graph shows the relationship between the load cell sensor readings and actual manual weight measurements. The regression line is almost a perfect linear fit, meaning the sensor's output closely matches the real weight with just a small offset and nearly 1:1 scaling. This calibration ensures accurate weight readings by correcting for slight sensor biases. In Table 1, the results of the load cell sensor calibration will be shown:

Table 1 Measurement Result Data After Calibration

No	Age (Year)	MM /Kg	MLCS/ Kg after calibration	D	*Error* %
1	35	81.00	80.90	0.10	0.12
2	28	58.20	58.15	0.05	0.08
3	26	88.50	85.50	0.00	0.00
4	27	83.00	83.00	0.00	0.00
5	30	65.00	65.00	0.00	0.00

Table Notes:
MM = Measurement Manually; MLCS = Measurement with Load Cell Sensor; D = Difference.

Based on the data contained in the load cell sensor calibration trial, the results showed that the weight measurement had a percentage error rate that was very close to the measurement data. For example, the data in Table 1 shows the percentage error after the calibration process, such as sample no. 5, which before calibration the percentage error rate reached 1.23% and after calibration it reached 0%. This shows that the load cell can provide accurate and consistent measurement results.

From the table obtained from the results of Ultrasonic sensor data, researchers can get the percentage of error so that they can create a linear regression equation as shown in Figure 7, then this equation will be entered into the program to provide accurate and consistent results.

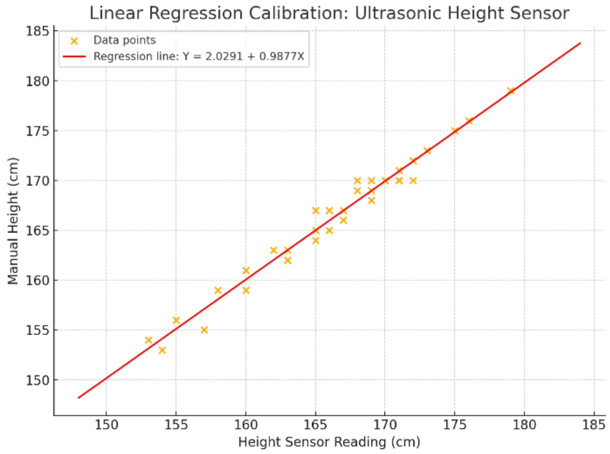

Figure 7 Ultrasonic Sensor Calibration Equation Graphs

The graph illustrates how the Ultrasonic sensor readings correspond to actual body height measurements. The regression line indicates a strong linear relationship with a small positive offset. This calibration helps adjust the sensor output to reflect true height, compensating for any fixed measurement bias. In Table 2, the results of the Ultrasonic sensor calibration will be shown:

Table 2 Measurement Result Data After Ultrasonic Calibration

No	Age (Year)	MM/ Cm	MU/ CM SaC	D	*Error* %
1	26	170	170	0	0.00

Table Notes:
MM = Measurement Manually; MU/ CM SaC = Measurement with Ultrasonic/ CM Sensor after calibration; D = Difference.

Based on the data contained in the Ultrasonic sensor calibration trial, it was found that the height measurement had a very small percentage error rate. For example, the data in Table 2 shows the percentage error after the calibration process, before calibration the percentage error rate reached 0.59% and after calibration it reached 0.0%. This shows that the Ultrasonic can provide accurate and consistent measurement results.

Based on the data contained in the MLX90614 temperature sensor calibration trial, it was found that body temperature measurement has a range effect on the distance between the object and the sensor position. For example, the data in Table 3 below clearly shows the effect of distance that affects data accuracy. This shows that the MLX90614 temperature sensor can provide accurate and consistent measurement results from a distance of 1 cm between the measured object and the sensor position.

Table 3 MLX90614 Temperature Sensor Measurement Calibration Result Data

No	Age (Year)	TCT (°C)	MR MLX90614 TfD:		
			1CM	2CM	5CM
1	35	36.50	35.90	35.16	33.41
2	28	36.30	36.10	34.53	30.25
3	26	36.20	36.80	35.43	31.79
4	27	36.60	36.70	34.81	29.29
5	30	36.50	36.40	36.18	32.66

Table Notes:
TCT = Temperature with Clinical Thermometer (°C); MR MLX90614 TfD = Measurement Results MLX90614 Temperature (°C) From Distance.

From the table obtained from the results of MLX90614 Temperature sensor data, researchers can get the percentage of error so that they can create a linear regression equation as shown in Figure 8, then this equation will be entered into the program to provide accurate and consistent results.

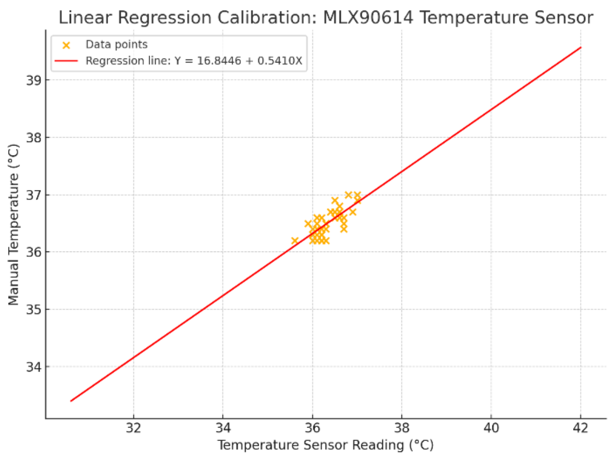

Figure 8 MLX90614 Temperature sensor graphs

This graph compares temperature readings from the MLX90614 sensor with clinical thermometer measurements. The regression shows a significant offset and a slope less than one, indicating the sensor underestimates actual temperatures without calibration. The calibration corrects these deviations for reliable temperature readings.

The measurement results show that the readings from the pulse sensor can vary depending on the position of the sensor placement, the quality of the received optical signal, light interference, and hand movement interference. Therefore, a linear regression analysis is carried out and this equation will be entered into the Arduino program to improve the results of the sensor readings to provide accurate and consistent results as shown in Figure 9.

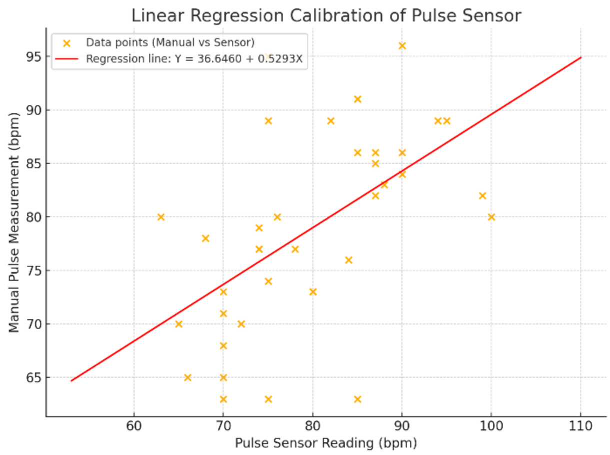

Figure 9 Pulse Sensor Calibration Equation graphs

The pulse sensor graph plots sensor readings against clinical heart rate measurements. The calibration line has a noticeable offset and a slope around 0.5, showing the needs, both offset and scaling adjustments to align with clinical standards. This improves the accuracy of heart rate monitoring.

Based on the data contained in the pulse sensor calibration trial, the results showed that the heart rate measurement had a very large percentage error. Based on the results of the system response test displayed in Table 5, it can be seen that the time to turn on the monitoring device from the off state or position takes 7.36 seconds from the average test. Then for the system response experiment with the device off until connected to the Blynk Application, it takes 8.11 seconds as shown in table 4.

Table 4 System Response Test on Monitoring Tools

Test	Living Tools(s)	Connect to Blynk(s)
1	6.62	7.21
2	6.73	7.03
3	6.53	7.67
4	7.35	7.63
5	8.57	9.03
Average	7.36	8.11

The display on the LCD will change every 0.25 seconds. To lock the data display on the LCD, the user must press the left push button. After that, the user must press the right push button to send the locked data to Blynk and Google Sheet in real time and print the measurement results, as in Figure 10.

Figure 10 Print Results by Tool Users

Data collection was carried out at the University of Indonesia Dormitory located in Srengseng Sawah, Jagakarsa District, South Jakarta City, West Java, which took place on May 17, 2025. Researchers used manual scales to measure weight, meters to measure height and digital thermometers to measure body temperature and blood pressure devices to measure the heart rate of the sample. Then the results of the manual tool data have been compared with the tool that the researcher made which consists of several components, including a load cell sensor to measure weight, an Ultrasonic sensor to measure height, an MLX9064 temperature sensor to measure body temperature and a pulse sensor to measure heart rate. These sensors are connected to the Arduino microcontroller and the ESP32 microcontroller. The ESP32 microcontroller is then connected to the Internet and can communicate with the server via a WiFi network.

Health recommendations were generated based on four key physiological parameters: weight, height, body temperature, and heart rate. The process begins with the measurement of all four inputs as shown in Figure 11. From the weight and height values, the system calculates the Body Mass Index (BMI), a widely used metric to assess nutritional status.

- If the BMI is below 18.5, the system interprets this as underweight and proceeds to check the body temperature and weight range. If the body temperature is normal and the body weight is below 25 kg (or another set threshold), the system recommends maintaining adequate nutrition.
- If the BMI is within the normal range (18.5–24.9), and the body temperature is below 37.3°C (indicative of no fever or inflammation), the recommendation provided is to “keep up a healthy lifestyle”.
- On the other branch, the system checks heart rate. If the resting heart rate is below 60 bpm (a condition known as bradycardia, which may require further investigation if not caused by athletic conditioning), the device recommends the user to seek medical advice.

After evaluating all parameters against their respective reference ranges, the system prints a personalized health suggestion via the thermal printer. This feature helps users receive instant, tangible feedback based on their current physiological state, making the device useful for basic health screening in both clinical and remote settings.

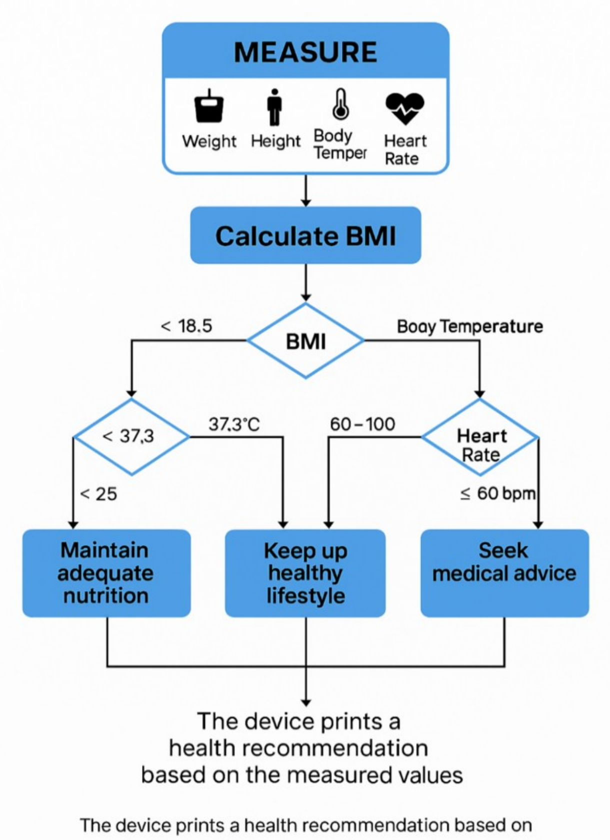

Figure 11 Health Recommendation Flowchart

The design of the tool made is simple and easy to disassemble and carry anywhere. the distance from the Ultrasonic sensor to the scale board of the tool measures 196 cm. The sample of this study were residents of the University of Indonesia student dormitory aged 18-35 years. The advantage after this tool is made is that it can help people monitor their health effectively and efficiently. However, there are several weaknesses that need to be considered in the use of this tool, such as the tendency of sensors that are not completely accurate in some cases and the limited range of the WiFi network that can interfere with data transmission. It is better if this tool is used widely, further testing of the accuracy and safety of the tool is carried out as in Figure 12.

Figure 12 The Design of the Machine

CONCLUSIONS

Based on the testing and system analysis that has been carried out, it can be concluded as follows:

1. An IoT-based automatic human weight, height, body temperature, and heart rate measuring device has been realized with printed results. Users can monitor and access measurement data remotely via the Blynk website that has been connected to the device, and data can be stored in Google Sheets.
2. Based on the data contained in the load cell sensor trial, body weight measurement has an error percentage of 0.00%-2.81%. While the difference between the measurement results using a body weight measuring device and a

microcontroller with a mechanical scale reaches 0.0 kg-1.8 kg.

3. Based on the data contained in the Ultrasonic sensor trial, it was found that height measurement has an error percentage of 0.0%-1.29%. While the difference between the measurement results using an Ultrasonic sensor and a manual meter reaches 0.0cm - 2.0cm.
4. Based on the data contained in the MLX90614 temperature sensor test, it was found that body temperature measurements had an error percentage of 0.0% - 3.54%. While the difference between the measurement results using a body temperature measuring device with the MLX90614 temperature sensor reached 0.00oC - 1.30oC.
5. Based on the data contained in the pulse sensor test, heart rate measurements had an error percentage of 1.16% - 100%. While the difference between the measurement results using a blood pressure measuring device with a pulse sensor reached 1 - 89 pulses / min.
6. Based on the results of the system response test, it can be seen that the time to turn on the monitoring device from an off state takes 7.36 seconds from the average test. Then for the system response experiment with the device off until connected to the Blynk Website, it took 8.11 seconds.

This tool still has shortcomings so that development is needed. Here are suggestions for research development:

1. It would be better if further researchers added batteries or cheap electrical energy sources such as solar panels so that if the lights go out the system can still be used and so that the tool can be carried anywhere.
2. It is necessary to strengthen the final design of the tool so that it is more stable and more accurate in terms of measurement problems.
3. Using certain inputs such as keypads or QR code scanners so that data from measurements can be integrated with the health center or clinic registration system.

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