Portable Real-Time BMI Nutritional Advice

A D Ab Karim¹, N A Md Lazam²*, N A Mohd Yahya³ and S Abdul Rahman⁴

¹, Student at Computer Engineering University Malaysia of Computer Science & Engineering, Cyberjaya Malaysia
²,3,4, Senior Lecturer at Computer Engineering University Malaysia of Computer Science & Engineering, Cyberjaya Malaysia

*Corresponding author: norazlinah@unimy.edu.my

Abstract. Overweight and obesity refer to body weight that is greater than what is considered normal or healthy for a certain height. Your body mass index (BMI) is one way to tell if you are at a healthy weight, overweight, or obese. The BMI is a measure based on your weight in relation to your height. Existing device only measure weight and height require the user to self-calculate their BMI based on the formula related to their weight and height. Furthermore, currently available systems cannot keep track user’s previous BMI record and do not provide a guidance or nutritional advice based on user’s current BMI. The solution to this is a proposed project which is an IOT based Portable Real-Time BMI nutritional advice that able to calculate user’s BMI and keep current and previous user’s record. The project aims to help people to monitor their BMI as a way of keeping a healthy weight. The objectives of this project are to develop a portable real-time measuring system to measure height and weight that can auto-calculate BMI and give nutritional advice using web-based application. The sensors used in this system are HX711 Load cell amplifier and Ultrasonic sensor. The system will perform weight and height measurement upon user’s command. Data from both sensors will be sent to NodeMCU Wi-Fi module for BMI calculation. Virtual server is used to store the data from the system app. Apart from BMI calculation, this system is able to display user’s previous BMI data as a performance tracker in monitoring their BMI. The application is also able to generate a nutritional advice based on user’s current BMI.

1. Introduction
Malaysia only views obesity as a risk factor for non-communicable disease (NCDs) rather than a disease even though Malaysia ranked the fattest country in South-East Asia and the sixth in the Pacific Region [1]. World Health Organization (WHO) reported the burden of disease failed to highlight the burden of the disease attributable to overweight and obesity [2,3]. BMI is the convenient rule of thumb used to categorize a person as underweight, normal weight, overweight or obese based on tissue mass and height [4].

The Dietetic and Food Service Department, Ministry of Health Malaysia, is available to provide dietary counselling to patients and provide a meal to all in-patient by outsourcing the services such as manage the dry night rations supply to the staff on duty and monitor meals provided for patients, paramedics, and on-call doctors. Their mission and vision are to promote a healthy lifestyle for Malaysian [5].

Currently, there are many existing systems that can measure weight and height. But a system that can auto calculate user’s BMI and store user’s record and progress are still missing. Portable real-time
BMI nutritional advice system is designed to help users monitor their BMI progress. The system will measure user’s height and weight and auto-calculate the BMI based on the data received from the sensors. The system allows users to either save their results or recalculate a new result. The system also will display user’s BMI progress for them to easily keep track of their performance. The system will provide nutritional advice and healthy tips based on user’s current BMI result.

2. Research and Method

2.1. System Overview

Arduino is an open-source physical computing platform which implements the Processing Language on a simple input/output (I/O) board. The Portable Real-Time BMI Nutritional Advice is an Arduino-based system. It is an integration of software and hardware system which connects sensors with a Wi-Fi module to a web-based application. This proposed system has two major modules which are hardware connectivity and web application.

Figure 1. Block diagram of The Portable Real-Time BMI Nutritional Advice System

Figure 1 shows the block diagram of The Portable Real-Time BMI Nutritional Advice System. The hardware connectivity consists of 2 types of sensors that connect to a NodeMCU Wi-Fi module. One of the sensors is a load cell. The load cell is connected to HX711 Amplifier to measure user’s weight. Weight measurement using this sensor implements the usage of Wheatstone bridge method [6].

A Wheatstone bridge is a configuration of four balances resistors with a known excitation voltage applied. R1 and R2 compose one voltage divider circuit while R3 and R4 compose the second voltage divider circuit. The output of a Wheatstone bridge is measured at V0. VEX represent the voltage source supply throughout the circuit. The resistor is laid out in a diamond pattern. The circuit has 2 compressions and tangent resistors pair. When load is added onto the circuit, the compression and tangent resistors value will be changed in the opposite direction. The output voltage will be measured between the 2 corners. The output voltage will remain zero when no load is applied in the circuit. With proper calibration, the weight of load can be measured using this circuit configuration. This is illustrated in figure 2.
Ultrasonic sensor is used to measure the height of user. The basic principle of ultrasonic distance measurement is based on echo. When sound waves are transmitted the waves are returned to the origin as echo after striking on the obstacle. Time travel of both sounds on outgoing and returning from/to origin after striking on the obstacle are calculated. As the speed of the sound is known, calculation on distance can be done by using the formula in equation 1.

$$\text{Distance (cm)} = \frac{\text{Time} \times 0.0034 \text{ cm/s}}{2}$$

(1)

By taking multiple readings to different distances, ultrasonic sensor can produce a fairly accurate object location [7,10]. The data receives will be send to the NodeMCU Wi-Fi Module and send to the web application. BMI calculation for this system use a new formula designed by Nick Trefethen [8] as shown in formula (4).

Web application executes three main functions to calculate BMI, to show performance, and to generate nutritional advice. The calculate BMI function is the integrated function connected to the hardware to obtain user’s height and weight and auto-calculate user’s BMI. The show performance function display user’s record in a graphical presentation based on how many measurements they have taken. The last function is generating nutritional advice which offers health tips from authorized dietician based on user’s current BMI [9]. Final module diagram is shown in figure 3.
Figure 3. Final module integration for BMI nutritional advice.

The final prototype of this development is shown in figure 4. Four load cells will be embedded inside the scale frame on each edge. A foldable pole will be stored inside the pole case when it is uninstalled. The foldable bracket is installed on the tips of the poles and is positioned at 90° which an ultrasonic sensor is placed to measure user’s height.

Figure 4. Side and front view of BMI nutritional advice
The system will perform weight and height measurement upon user’s command. Then, data from both sensors will be send to NodeMCU Wi-Fi module for BMI calculation. Data received from Ultrasonic sensor is represented as Height using the following formula:

\[ \text{Height (m)} = 2.15 - \frac{\text{ultrasonic sensor value}}{100} \]  

(2)

Data received from load cell with HX 711 amplifier is represented as weight using the following formula:

\[ \text{Weight (kg)} = \frac{\text{HX711 amplifier value}}{100} \]  

(3)

Finally, both sensors value recorded resulting in obtaining the BMI value using the following formula.

\[ BMI = \frac{1.3 \times \text{weight}}{\text{height}^{2.5}} \]  

(4)

### 2.2. System Flow Diagram

![System flowchart](image)

**Figure 5.** System flowchart
Figure 5 shows the flowchart diagram of the system. Once user browses the system’s designated URL, Login page will be displayed. Once user has clicked either one account, they will be directed to the application Home page. On this page, three main buttons will be displayed which is “Calculate BMI”, “Performance” and “Nutritional Advice”. User can choose which function they want to perform. For every page that user is directed to, the system will provide a return home page button shown as “Home”.

3. Result and Discussion

Figure 6 shows the Homepage of the system. Main Page offers three functions namely Calculate BMI, Performance and Nutritional Advice. The result of user’s BMI is shown once the user’s height and weight are measured. It summarizes height, weight, BMI and status in one page. The system is able to store the data in MYSQL database if the users wish to save the data. This is shown in figure 7.

User can view their progress, by clicking “Performance” button and it will direct them to a page where the graph is generated based on the user’s record. The graph will show user’s BMI and date of when the measurement is taken as shown in figure 8.
A nutritional advice page will be displayed when the user clicks the “Nutritional Advice” button. There are four (4) different health tips based on BMI categorization which are Nutritional Advice for Underweight, Normal, Overweight and Obese. The tips displayed will shows user’s current BMI and a list of health tips for user to follow to maintain or improve their healthy weight.

**Figure 8.** Data represent in graph

**Figure 9.** The generated nutritional advice for Underweight
Figure 10. The generated nutritional advice for Normal Weight

Figure 11. The generated nutritional advice for Overweight

Figure 12. The generated nutritional advice for Obese.
4. Conclusion
The Portable Real-Time BMI Nutritional Advice might be a redundant of the same technologies that have existed. Nevertheless, this system aims to help people to be aware about their BMI (ideal weight) in order to remain healthy. The system is able to integrate two calibrated instrument that measure weight and tall into a comprehensive system that can auto calculate BMI and stores the data into a local database. The data can be retrieved so that users are able to track their progress. The system makes use of Arduino sensor and the add on feature able to display the data in a graphical form. Nevertheless, there are always rooms for improvement. For future work, the system should ideally be equipped with robust operating capabilities such as battery usage instead of power supply and developed in mobile based application for user to easily access. The Arduino has been used widely in IOT application [11-15].

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