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# GSM Based Student's BMI Monitoring System Device

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**ABSTRACT**

The aim of the project was to design a GSM based student's Body Mass Index (BMI) monitoring system device. It was proposed to overcome the problem of obesity. The function of this device is to calculate the body mass index using two basic parameter that are weight and height. For weighting mechanism this device using the load cell while as for height it using ultrasonic sensor. Only student with Radio Frequency Identification (RFID) card can used this machine since it provided with RFID sensor. BMI calculation will be displayed on LCD and parent will be notified via message by using GSM module.



## Introduction

Obesity among children is becoming a serious health problem. Obesity means having too much body fat which is caused by an imbalance in energy input versus output. The Body Mass Index (BMI) is a method to measure of body fatness for most children. BMI is a number calculated from a child's weight and height. Additionally, the BMI scores give an indirect measure of body fat. Depending on the BMI value calculated the persons can be classify as underweight, healthy weight, overweight or obese.

Based on the Ministry of Health (MOH) Malaysia report, 60% Malaysian are overweight or obesity, half of it which is 30% is super obese or extremely fat. From this report, the conclusion is only 40% Malaysian is normal weight. What is more worried, obesity problem has entered child group. The study estimated more than a quarter of children (27%) with excess body fat might not be classified as obese when using BMI measurements alone. This means the missed children don't get the same support to achieve a healthy weight as those correctly identified as overweight or obese have a greater chance of developing certain cancers including breast cancer for women over age 50 as well as high blood pressure, high blood cholesterol or other lipid disorders, diabetes, heart disease, and stroke. Risks of being underweight may be malnourished. In addition they have an increased risk of developing health problems including compromised immune function with increased susceptibility to infections, anemia, osteoporosis, menstrual irregularities and impaired fertility.

Many researchers had focused on the development of BMI calculating devices using different type of sensor including ultrasound sensor and load cell, infrared sensor. Some researchers upgrade the system by adding wireless features by using GSM and ZIGBEE. Most of the researcher focused on the calculated of the BMI index by taking data of weight and height to be applied on the BMI index formula.

Dealing with ultrasound and load cell, Burhan uddin Ismail, Syed Fahad Akbar Ali and Ali Asghar Ayaz (2012) focused on the getting weight by convert mechanical force from load cell to electrical signal and process through microcontroller. While for the height, the ultrasound sensor with built-in transmit and receive circuitry transits the ultrasound signal by transmitter, it reflect back to the receiver after striking the object or person and height is then calculated by multiplying the speed of the ultrasound signal and the time taken by the it to return back to the sensor. All this data is manipulated through microcontroller and then the result is displayed on the LCD display. The result only can be displayed at the LCD only cannot be transfer to others devices for monitoring.

Mohd Hairudin, Jaffri (2007) proposed the Infrared Distance/Height Measurement system, where the system using infrared sensor to measure distance or height. In the beginning of this. From the data research about the signal being transmitted by the IR is needed to match with it receiver. Most of the distance or height measurement equipment in the market today is using the ultrasonic application. Basically, both ultrasonic and infrared would be suitable to detect the objects at those ranges. Ultrasonic travels at the speed of sound relatively slow. So the time between emitting and receiving can be measured. It is easy to calculate the distance knowing the speed of sound and the time.

Puneet Singh Purnima (2014) not only focused on the calculating of BMI base on the data get from the ultrasonic and load cell, the improvement done by added the wireless features such as ZIGBEE and GSM. By using this method, the data not only can be view in the device but also can be share in PC and Mobile Phone. Taking advantages of that features, the data can be easily share to responsible person of patient for continuous monitoring of health parameters. In case of any emergency condition, an alarm is also sent to the responsible person's mobile in the form SMS alert, through GSM modem describing that immediate action is required.

This project focused on the getting data of height and weight by using ultrasonic sensor and load cell and process through the microcontroller to calculate BMI of the

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students. The and can be sent to the student's parents by using SMS alert as the alarm. The result will send to their parent through the message if the student is overweight or underweight. This device will help as a reminder for the guardian or parents to control their children health when they get the BMI information. This device was proposed to place at the school where every student must have their own access card. The radio-frequency identification (RFID) device must be scanned to retrieve the identifying information of the student by using the access card. The access card has an input and microcontroller as a main processing. After the student tag the access card at the GSM base student BMI monitoring system device, the BMI result will appear on the Liquid Cristal Display (LCD)

**The Proposed Algorithm**

There are several procedures have been done in order to implement BMI monitoring system. The procedure consists of two parts, which is software and hardware. The software is programming using microcontroller as a main character that will communicate with ultrasonic and load cell sensor circuit as the input. The output is the display of BMI data on the LCD. The microcontroller used as a processing the circuit. The GSM system will send data to parents of students who rate BMI has problem. Fig. 1 shows the block diagram of GSM base student BMI monitoring system..

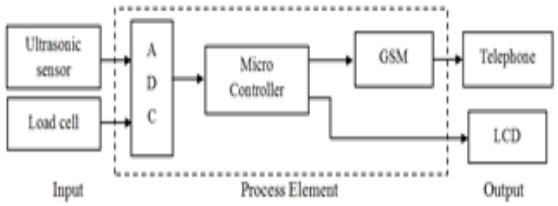


**Figure 1. Block diagram of BMI system.**

Fig. 2 shows the flowchart of GSM base student BMI monitoring system. This project starts with RFID sensor. When the RFID sensor receives the signal from RFID card, the system will operated. However, if RFID sensor not receives signal from RFID card the system not operated and no calculation of BMI will done. It will return to start.

After receive the signal, RFID will active the microcontroller to active all sensor and start the program. Microcontroller will active the ultrasonic sensor and load cell. Ultrasonic sensor is used to measure height while load cell sensor is used to measure weight of the student. After that, ultrasonic sensor and load cell will send measurement of height and weight to microcontroller respectively to calculate BMI of the student. Microcontroller will calculate the BMI and send the output into LCD and LCD will display weight, height and BMI result.

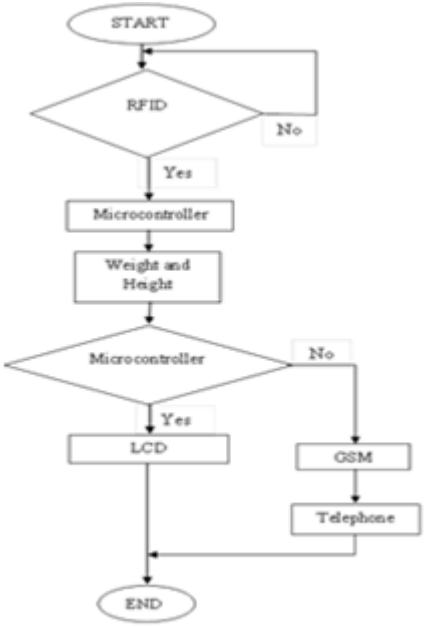


**Figure 2. Flowchart of BMI system.**

If the BMI result not in standard which is not healthy weight, the microcontroller will send the signal into GSM and GSM will send the data to the parents' telephone by using SMS.

**Results and Discussion**

**A. System Process**

This project start operates when a student tag the RFID tag to the machine. Then, RFID activate the microcontroller to measure weight by using load cell in unit kilogram (kg) and to measure height by using ultrasonic sensor in unit centimeter (cm). Then the data of weight and height are transmitted to microcontroller for calculate the BMI result. Then the BMI result will send the output to LCD and LCD will display weight, height and BMI result. Lastly, the microcontroller will send the signal to GSM, if the BMI result is not healthy weight the data will send to parents while if the BMI result is healthy weight the data will not send.

**B. Weight analysis**

Table 1 shows the data of student weight collected from student year four, SK Air Jernih. Based on this table, the maximum weight for student year 4 in SK Air Jernih is 48 kg

**Table 1. Weight of student year 4 SK Air Jernih.**

| No | Name | Actual Weight (kg) | BMI System Weight (kg) | Percentage Error (%) | Accuracy |
|---|---|---|---|---|---|
| 1 | Muhammad Taufik bin Ali | 45 | 47 | 4.44 | 0.96 |
| 2 | Muhammad Zafran bin muhammad Ali | 27 | 28 | 3.70 | 0.96 |
| 3 | Mohd Haziq bin Mohd Husin | 30 | 30 | 0.00 | 1.00 |
| 4 | Muslim bin Ramli | 46 | 46 | 0.00 | 1.00 |
| 5 | Mohd Farid bin Abdullah | 42 | 43 | 2.38 | 0.98 |
| 6 | Abu Zarim bin Zamri | 39 | 40 | 2.56 | 0.97 |
| 7 | Saiful Zafik bin Zainudin | 44 | 45 | 2.27 | 0.98 |
| 8 | Mustakim bin Yahya | 48 | 49 | 2.08 | 0.98 |
| 9 | Muhamad Faiz bin Ramli | 31 | 30 | 3.23 | 0.97 |
| 10 | Muhamd Hadi bin Muhammad Hamzah | 29 | 29 | 0.00 | 1.00 |
| 11 | Siti Aisyah binti Ramzi | 37 | 38 | 2.70 | 0.97 |
| 12 | Nur amira binti Abdul Rahman | 30 | 31 | 3.33 | 0.97 |
| 13 | Nor Huda binti Muda | 34 | 34 | 0.00 | 1.00 |
| 14 | Syamzira binti Hasan | 26 | 27 | 3.85 | 0.96 |
| 15 | Intan mastura binti sulaiman | 47 | 47 | 0.00 | 1.00 |

for actual weight and 49kg for BMI system weight. This weight is measure from the student's name Mustakim bin Yahya. Percentage error weight for Mustakim bin Yahya based on actual weight and BMI system weight is 2.08% and the accuracy of this product is 0.98.

For the minimum weight student year four in SK Air Jernih is 26 kg for actual weight and 27 kg for BMI system weight. This weight is measure from student's name Syamzira Binti Hasan. The percentage error weight for Syamzira Binti Hasan is 3.85% and the accuracy of this product is 0.96. The average accuracy for 15 students is 0.98.

Figure 3 shows graph of student year 4 for the actual weight and BMI system weight in the unit of kilogram (kg). The red line is represent data for BMI system weight in kg unit and blue is represent data for actual weight in kg unit. Based on the graph, the maximum weight for actual weight and BMI system weight is close to 50 kg and the minimum of student weight according to actual weight and BMI system weight is less than 30kg and close to 25kg. The graph shows the data collected from BMI system weight compared to actual weight of student is slightly different.

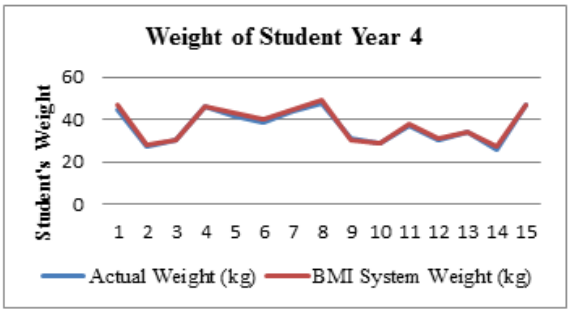


**Figure 3. Weight of student year 4.**

**C. Height analysis**

Table 2 shows the data of student height collected from student year 4, SK Air Jernih. Based on this table, the maximum height for student year 4 SK Air Jernih is 145cm for actual height and 144 cm for BMI system height. This height is measure from the student's name Intan Mastura binti Sulaiman. Percentage error height for Intan Mastura binti Sulaiman is 0.68% and the accuracy of this product is 0.99.

For the minimum height student year 4 SK Air Jernih is 128cm for actual height and 129cm for BMI system height. This height is measure from student's name Mohd Hadi Bin Muhammad Hamzah. The percentage error height of Mohd Hadi Bin Muhammad Hamzah is 0.78% and the accuracy of this product is 0.99. The average accuracy for 15 students is 0.99.

Figure 4 shows the graph of student year 4 according to actual height and BMI system height in the unit of centimeter (cm). The red line is represent data for BMI system height in cm unit and blue is represent data for actual height in cm unit. Based on the graph, the maximum height for actual height and BMI system height is 145 cm and the minimum of student height according to actual height and BMI system height is less than 130cm. Only two student have height lest than 130cm. The graph shows the data collected from BMI system height compared to actual height of student is slightly different.

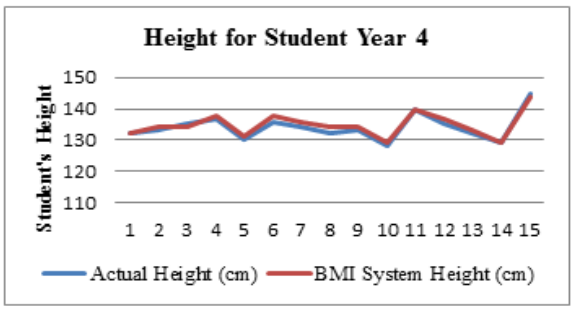


**Figure 4. Height of student year 4.**

**D. BMI analysis**

Table 3 shows the Body Mass Index (BMI) data collected from student year 4, SK Air Jernih. The calculated BMI is calculated from the actual value of height and weight of student year 4 by using a formula, while the measured value is collected from the BMI system.

Based on the table, the maximum BMI of student year 4 in SK Air Jernih is 25.8 for calculated BMI and 27 for measured BMI. This BMI is collected from the student's name Muhammad Taufik Bin Ali. According to the BMI category, Muhammad Taufik Bin Ali is overweight. The percentage error BMI of Muhammad Taufik Bin Ali 3 is 4.6% and the accuracy of this product is 0.95.

For the minimum BMI student year 4 SK Air Jernih is 15.3 for calculated BMI and 16 for measured BMI. This BMI is collected from student's name Muhammad Zafran Bin Muhammad Ali. According to the BMI category, Muhammad Zafran Bin Muhammad Ali is underweight. The percentage error BMI of Muhammad Zafran Bin Muhammad Ali is 4.5% and the accuracy of this product is 0.96. The average accuracy for 15 students is 0.98.

Graph for Body Mass Index (BMI) of student year 4 is shown in the Figure 5. The graph shows the comparison of data for calculated BMI and measured BMI is slightly different. The red line is representing data for measured BMI which is collected from the BMI system while the blue line is

**Table 2. Height of student year 4 SK Air Jernih.**

| No | Name | Actual Height (cm) | BMI System Height (cm) | Percentage Error (%) | Accuracy |
|---|---|---|---|---|---|
| 1 | Muhammad Taufik bin Ali | 132 | 132 | 0 | 1.00 |
| 2 | Muhammad Zafran bin muhammad Ali | 133 | 134 | 0.75 | 0.99 |
| 3 | Mohd Haziq bin Mohd Husin | 135 | 134 | 0.74 | 0.99 |
| 4 | Muslim bin Ramli | 137 | 138 | 0.72 | 0.99 |
| 5 | Mohd Farid bin Abdullah | 130 | 131 | 0.76 | 0.99 |
| 6 | Abu Zarim bin Zamri | 136 | 138 | 0.97 | 0.99 |
| 7 | Saiful Zafik bin Zainudin | 134 | 136 | 0.97 | 0.99 |
| 8 | Mustakim bin Yahya | 132 | 134 | 0.97 | 0.99 |
| 9 | Muhamad Faiz bin Ramli | 133 | 134 | 0.75 | 0.99 |
| 10 | Mohd Hadi bin Muhammad Hamzah | 128 | 129 | 0.78 | 0.99 |
| 11 | Siti Aisyah binti Ramzi | 140 | 140 | 0 | 1.00 |
| 12 | Nur amira binti Abdul Rahman | 135 | 137 | 0.97 | 0.99 |
| 13 | Nor Huda binti Muda | 132 | 133 | 0.75 | 0.99 |
| 14 | Syamzira bin Hasan | 129 | 129 | 0 | 1.00 |
| 15 | Intan Mastura binti Sulaiman | 145 | 144 | 0.68 | 0.99 |

**Table 3. BMI of student year 4.**

| No | Name | Calculated BMI | Measured BMI | Percentage Error (%) | Accuracy |
|---|---|---|---|---|---|
| 1 | Muhammad Taufik bin Ali | 25.8 | 27 | 4.6 | 0.95 |
| 2 | Muhammad Zafran bin muhammad Ali | 15.3 | 16 | 4.5 | 0.96 |
| 3 | Mohd Haziq bin Mohd Husin | 16.5 | 17 | 3 | 0.97 |
| 4 | Muslim bin Ramli | 25 | 24 | 4 | 0.96 |
| 5 | Mohd Farid bin Abdullah | 24.9 | 25 | 0.4 | 1.00 |
| 6 | Abu Zarim bin Zamri | 21.1 | 21 | 0.4 | 1.00 |
| 7 | Saiful Zafik bin Zainudin | 24.5 | 24 | 2 | 0.98 |
| 8 | Mustakim bin Yahya | 27.5 | 27 | 1.8 | 0.98 |
| 9 | Muhamad Faiz bin Ramli | 17.5 | 17 | 2.8 | 0.97 |
| 10 | Muhamd Hadi bin Muhammad Hamzah | 17.7 | 17 | 3.9 | 0.96 |
| 11 | Siti Aisyah binti Ramzi | 18.9 | 19 | 0.5 | 1.00 |
| 12 | Nur amira binti Abdul Rahman | 16.5 | 17 | 3 | 0.97 |
| 13 | Nor Huda binti Muda | 19.5 | 19 | 2.5 | 0.98 |
| 14 | Syamzira bin Hasan | 15.6 | 16 | 2.5 | 0.98 |
| 15 | Intan mastura binti sulaiman | 22.4 | 22 | 1.7 | 0.98 |

representing data for calculated BMI. Based on the graph, the maximum BMI for calculated BMI and measured BMI is more than 25. According to the BMI category, if the BMI more than 25, it classified as overweight. From the graph, the minimum of student BMI based on calculated BMI and measured BMI is near to 15 and less than 18. If BMI less than 18, it classified as underweight.

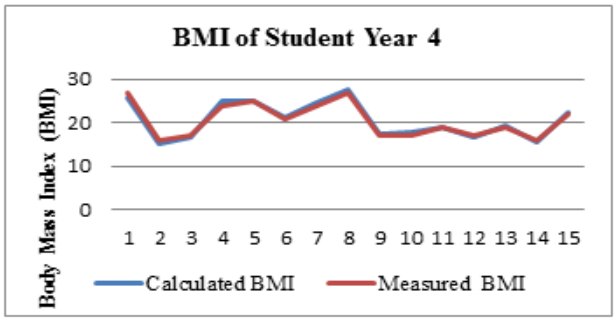


**Figure 5. Body Mass Index (BMI) of student year 4.**

The BMI system will send the message if the student's BMI have problem which is the BMI is not in category healthy weight. The healthy weight BMI is start from 18 to 24. If BMI is more than 24, it is in overweight classification and if BMI is less than 18 it underweight classification. BMI has six classifications there are underweight, healthy weight, overweight, obese class 1, obese class 2 and obese class as shown in Table 4.

**Table 4. Body Mass Index (BMI) classification.**

| Body Mass Index (BMI) | Classification |
|---|---|
| <18.5 | Underweight |
| 18.5-24.9 | Healthy Weight |
| 25.0-29.9 | Overweight |
| 30.0-34.9 | Obese class 1 |
| 35.0-39.9 | Obese class 2 |
| >40.0 | Obese class |

Table 5 shows the action of the BMI system after the BMI was measured. The BMI system will take the action send or not send the message according to the result of student BMI. BMI system send message to the parent of 9 unhealthy students while others parent of healthy students not received the message. It means that, 60% students in year 4 are unhealthy.

From the 9 unhealthy students, 6 students are underweight and 3 students are overweight. The percentage of students that have healthy weight is 40% which are 6 students from 15 students. There are none student in the obese classification. The percentage of unhealthy student is more than the percentage of healthy student. Parents for unhealthy students must control their children's nutrition because in the future, their children will lead to a higher unhealthy rate among college students.

**Conclusion**

A GSM base student BMI monitoring system is a fully functional sorter machine that implemented by using load

**Table 5. Body Mass Index (BMI) system action.**

| No | Name | Measured BMI | System Action | BMI Category |
|---|---|---|---|---|
| 1 | Muhammad Taufik bin Ali | 27 | Send Message | Overweight |
| 2 | Muhammad Zafran bin muhammad Ali | 16 | Send Message | Underweight |
| 3 | Mohd Haziq bin Mohd Husin | 17 | Send Message | Underweight |
| 4 | Muslim bin Ramli | 24 | No Send Message | Healthy Weight |
| 5 | Mohd Farid bin Abdullah | 25 | Send Message | Overweight |
| 6 | Abu Zarim bin Zamri | 21 | No Send Message | Healthy Weight |
| 7 | Saiful Zafik bin Zainudin | 24 | No Send Message | Healthy Weight |
| 8 | Mustakim bin Yahya | 27 | Send Message | Overweight |
| 9 | Muhamad Faiz bin Ramli | 17 | Send Message | Underweight |
| 10 | Muhamd Hadi bin Muhammad Hamzah | 17 | Send Message | Underweight |
| 11 | Siti Aisyah binti Ramzi | 19 | No Send Message | Healthy Weight |
| 12 | Nur amira binti Abdul Rahman | 17 | Send Message | Underweight |
| 13 | Nor Huda binti Muda | 19 | No Send Message | Healthy Weight |
| 14 | Syamzira bin Hasan | 16 | Send Message | Underweight |
| 15 | Intan mastura binti sulaiman | 22 | No Send Message | Healthy Weight |

cell sensor in order to increase the overall throughput which results with a forecasted performance. The performance of the proposed machine was analyzed and proved to reliable. This project can work successfully. The GSM will send the message if student's BMI has problem and RFID will detect the ID card. The machine can successfully performed if the load cell and ultrasonic detect perfectly.

The GSM base student BMI monitoring system provides benefits to the parents to monitor their children health. It is because nowadays, parents have less time to plan and prepare healthy meals. As a result, children are eating more processed and fast foods that are usually less healthy than home-cooked meals. Children also see up to 10,000 food commercials every year. Most of these are for fast food, candy, soft drinks, and sugared cereals. This project can give awareness to parents for monitor their children health by receiving SMS.

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