Smart Quetelet Index Calculator with Diet Prescription

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Abstract- *The aim of this project is to design and develop an electronic device that measures Quetelet Index (BMI) automatically by using height and weight sensor, categories BMI and prescribes the diet plan for particular person without help of nutritionist. Calculating BMI is one of the best methods for assessment of population with overweight and obesity. BMI is based on two main factors - height and weight. The height and weight are calculated with the help of the ultrasonic transducers and load cell by using the micro-controller and the Artificial Neural Network (ANN) is used to get diet plan. The data from the load cell and ultrasonic sensor are processed to calculate the BMI. The calculated height, weight and BMI are displayed on to a LCD. To perform the above mentioned intelligent task, intelligent program written using embedded "Artificial Neural Network" is loaded into it.*

Keywords- BMI, height, weight, diet plan, artificial neural network.

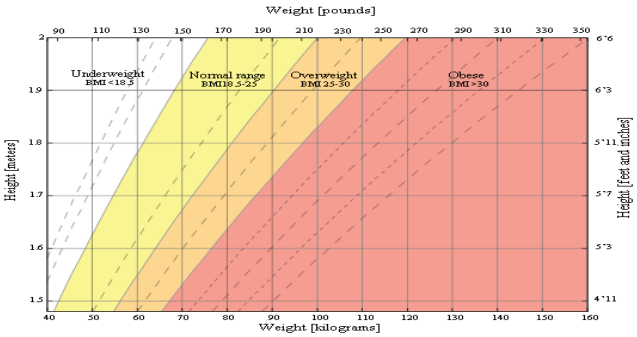
I. INTRODUCTION

Now-a-days health consciousness is being an important part of human. Because of this different centre for health and gym for fitness are becoming popular. There are different ways to calculate body compensation of the person. Body Mass Index, can approximately calculates the total fat of the person present in the body. BMI is based on the two variables such as height and weight of the person. Body Mass Index scores are a good indicator of whether you are at a healthy weight and how much body fat you have. Reaching and maintaining a healthy weight is important for overall health and can help you prevent and control many diseases and conditions. Having a high BMI can increase your risk factors for certain diseases such as cardiovascular disease (or heart disease), high blood pressure and diabetes type 2. That is why maintaining a healthy weight is so important.

BMIstands for "Body Mass Index," a ratio between weight and height. BMI is a standard "tool" for helping you judge your body weight and the amount of body fat you have. The most common way of calculating it is by dividing one's mass in kilograms by the square of the height in meters.The calculation of BMI can be done with the help of standard formula, BMI = [(Weight in Kilograms / (Height in Meters x Height in Meters)]. [1]

At international level the BMI is classified in four major classes i.e underweight (≤18.5), normal-weight (18.5<25),overweight (≥25)&Obese (≥30), each class includes several subclasses as shown in Table 1. [1]

This is a graph of BMI categories based on the World Health Organization data. The dashed lines represent subdivisions within a major categorization.[1]



Graph.1 BMI Categories

A person will be on a great risk if he has a high BMI. Through these measurements, physician can recommend different health risk related to weight. Forexample Skin fold measurements, fitness of a person, nutritionist can decide the diet of a person, and other screening of person's health. [2]
The new system is designed to get the accurate height and weight of the user and automatically calculate the BMI and judges whether the person is overweight or underweight. Also this system gives a proper diet plan according to calculated BMI to control their weight. So this new system plays smart role and this diet plan can be printed out as a prescription.

Classification	BMI(kg/m²)	
	Principal cut-off points	Additional cut-off points
Underweight	**<18.50**	**<18.50**
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	**18.50 - 24.99**	**18.50 - 22.99**
		23.00 - 24.99
Overweight	**≥25.00**	**≥25.00**
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	**≥30.00**	**≥30.00**
Obese class I	30.00 - 34.99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

Table- 1 The International Classification of BMI[1]

II LITERATYRE SURVEY

1. Goh Kim Nee & Muhammad Syazwan Bin Abu Bakar [4] developed an "Android-based Exercise Application". The parameters used in the calculation of the algorithm were BMI of the user, user's body condition and working hours. The developed prototype application is capable of mentioning three main outputs which are: a. types of exercise, b. suitable time to exercise and c. Duration of exercise. This Android based system is a useful application as it considers important inputs to filter suggestions.
2. Avinash S. Vaidya&Srinivasa K. Rao [5] developed "CGMS – An Automated Solution to Monitor Child's Growth" by low cost automated measurement unit which not only measures but also analyze the height/weight/BMI data obtained from it. After conducting the experiments, the results shows that error of +/- 5mm would not affect much when the BMI of child is considered as a growth factor.

3. Chua, JeddEmille et al. [6] introduced an "Organized health-monitoring and data-gathering system" which monitors the patient and makes case-by-case diagnosis and treatment easy. The designed android program had successfully integrated a food database, a barcode reader, a blood pressure monitor, a weighing scale, BMI and a digital stethoscope for a working health-monitoring application. Android application monitors for daily calorie intake, exercise and physical activity, wireless transfer of health information from Bluetooth medical devices and acquisition and analysis of heart sounds via digital media.

4. Neil Erick Q. Madariaga and Noel B. Linsangan [7] developed an "Application of Artificial Neural Network and Background Subtraction for Determining Body Mass Index (BMI) in Android Devices Using Bluetooth" which compute the BMI using an Android tablet. The height of the person was estimated by applying background subtraction to the image captured and applying different processes such as getting the vanishing point and applying Artificial Neural Network & weight by using load cell. And sending the value to the computer by using Gizduino microcontroller and Bluetooth.

III. METHODOLOGY

The proposed system mainly consists of following systems which will be better than traditional system.

1. Very accurate measurement of height and weight to avoid BMI calculation errors.

This part includes load sensor and ultrasonic sensor. Load sensor gives the correct weight of the person standing on the platform and ultrasonic sensor measures the height of the same person, after getting these two values BMI can be calculated
All the measurements like height, weight and BMI can be displayed for better understanding.

2. Smart Diet Chart Predictor

Most of the times people gets their weight from machines but they don't know what to do with their diets because they are not aware of diet plans to control their weight, so proposed system plays smart role and gives a proper diet plan on computer without getting help of nutritionist & which can be printed out as a prescription.

Fig.2 shows the block diagram for the whole system. The diagram shows the two inputs necessary for the system that is weight sensor and the ultrasonic sensor.

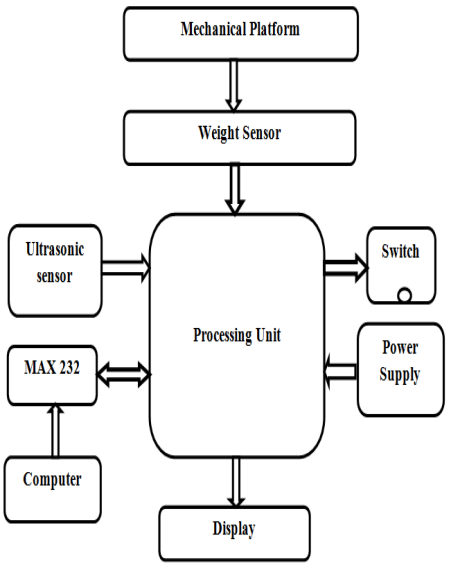


Fig.2 Block diagram of the proposed work

The whole system divided into two parts - BMI calculation and Diet prescription. The weight of the person is calculated through the load cell or a digital weighing machine. The height of the person is calculated by the ultrasound sensor. The ultrasounds sensor transmits and receives ultrasounds. First it emits ultrasounds, and when it strikes to any object or person in its proximity, it is reflected back after striking it, which is sensed by the sensor again. The height is actually calculated by multiplying the 'speed of the ultrasounds' and the 'time taken by the ultrasounds' to return back to the sensor. The data received from the Ultrasound Sensor and the Load Cell is then sent to the microcontroller, where calculations take place and then the result is sent to the display device**.**

The calculated BMI is displayed with different categories of BMI such as normal weight, underweight, over weight and obese, etc. After displaying, the signal is sent to the computer. The data base has the diet plan for each category of BMI. According to the calculated BMI, the diet plan is displayed on the display device as per data base without getting help of dietician and which can be printed out as a prescription.

IV. RESULTS

Microcontroller based BMI Calculator with Database and Monitor Display is successfully created and this is shown in fig.-3.The study was all about measuring Body Mass Index automatically with the help of a microcontroller. MCU Based BMI Calculator with Database and Monitor Display will measure the height, weight, and calculated BMI once the user stepped on the prototype. The data from the microcontroller will be saved in the database. The project used ultrasonic sensor to be able to determine the height, load cell to get the weight and a microcontroller to calculate the Body Mass Index of the user.

Fig.3- Microcontroller based BMI Calculator with Database and Monitor Display

Following are the some samples of the results shown by the system.

Sample1: Person A

Person A	
Weight =	59.2kg
Height =	174cm
BMI =	19.4

For person A the sensed height, weight and hence the calculated BMI is display on LCD Screen is shown in below figure-

Fig.-4

The diet plan for Person A is displaced on the monitor shown in Figure-

NORMAL					
TIME	FOOD	CARBOHYDRATES (gm's)	PROTEINES (gm's)	FAT (gm's)	CALORIES
Early morning	1 fruit	Fructose category 10 Glucose category 20	-	-	Fructose category= 40 Glucose category= 80
Break fast	1 plate pohe/upma/3idlies/2 dosa's + 1cup tea	20+15	5	8	172+60=232
Mid morning	1 glass butter milk	10	-	-	40
Lunch	2 chapati's +1 vati dal +1 vati bhaji +1 vati rice +1 plate salad	40+15+10+20+20	10+8+0+5+---	10+5+0 +0+0	290+137+40+ 100+0=567
Evening tea	1 cup tea	15	-	-	60
Late Evening	10 almonds	-	5	2	38
Dinner	2 chapati's +1 vati dal +1 vati bhaji +1 vati rice +1 plate salad	40+15+10+20+---	10+8+0+5+---	10+5+0 +0+0	290+137+40+ 100+0=567
Bed time	1 glass milk	10	7	-	68
			TOTAL CALORIES =		1612

Fig.-5 Diet plan for Normal weight

Sample1: Person B

Person B
Weight = 57.5kg
Height = 148cm
BMI = 26.0

For person B the sensed height, weight and hence the calculated BMI is display on LCD Screen is shown in below figure-

Fig.6-

The diet plan for Person B is displaced on the monitor shown in Figure-

OVERWEIGHT					
TIME	FOOD	CARBOHYDRATES (gm's)	PROTEINES (gm's)	FAT (gm's)	CALORIES
Early morning	1 fruit	Fructose category 10 Glucose category 20	-	-	Fructose category= 40 Glucose category= 80
Break fast	1 plate oats upma	10	5	-	40+20=60
Mid morning	1 glass butter milk	10	-	-	40
Lunch	2 fulka +1 vati dal +1 vati palebhaji +1 plate salad	40+15+10+0	10+8+0+0	0+5+0+ 0	100+137+40+ 5=282
Evening tea	1 cup green tea	-	-	-	10
Late Evening	1 rajgeera ladu	10	-	-	40
Dinner	1 bowl boiled moong	50	10	5	285
Bed time	1 cup milk + ½ tea spoon sugar	3.5 + 7.5	2.5 + 0	-	24 + 30=54
			TOTAL CALORIES =		811

Fig.7.- Diet plan for very overweight weight

Sample1: Person C

Person C
Weight = 59.2kg
Height = 135cm
BMI = 19.4

For person C the sensed height, weight and hence the calculated BMI is display on LCD Screen is shown in below figure-

Fig.8-The diet plan for Person C is displaced on the monitor shown in Figure-

OBESE CLASS I					
TIME	FOOD	CARBOHYDRATES (gm's)	PROTEINES (gm's)	FAT (gm's)	CALORIES
Early morning	1 fruit	Fructose category 10 Glucose category 20	-	-	Fructose category= 40 Glucose category= 80
Break fast	1 plate oats upma	10	5	-	40+20=60
Mid morning	1 glass butter milk	10	-	-	40
Lunch	2 fulka +1 vati dal +1 vati palebhaji +1 plate salad	40+15+10+0	10+8+0+0	0+5+0+ 0	100+137+40+ 5=282
Evening tea	1 cup green tea	-	-	-	10
Late Evening	1 rajgeera ladu	10	-	-	40
Dinner	1 bowl boiled moong	50	10	5	285
Bed time	1 cup milk	3.5	2.5	-	24
			TOTAL CALORIES =		781

Fig.9-Diet plan for Obese Class 1

V. CONCLUSION

As a result of this study, the Body Mass Index (BMI) of the person could be computed using load cell and ultrasonic sensor. Using a load cell weight of the person is calculated and using a ultrasonic sensor height is measured. The data received from the Ultrasound Sensor and the Load Cell is then sent to the microcontroller, where calculations take place and then the result is sent to the display deviceThe calculated data will be stored in the database and can be viewed for monitoring purposes**.**Then the signal is send to the computer where the database is already stored. Andaccording to the calculated BMI, the diet plan is displayed on the monitor. This is done by using Artificial Neural Network. This design is fully automatic, that means there is no need of nutritionist for getting the diet plan.The setup is a supportive tool for the nutritionist and personal working at remote places. This implementation of set up will benefit various places like hospitals, health centres, medicals, remote place health centre etc.

VI. ACKNOWLEDGMENT

We wish to thank Galaxy Hospitals Ltd., Warananagar, Maharashtra for giving us an opportunity to work in this field. The guidance, cooperation, practical approach and inspiration given by hospital provided me the much needed impetus to hard work.

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