Body Mass Index Measurement System using Image Processing

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Abstract: In general, to know the ideal body weight, one must first weigh the weight and measure its height manually. After that do the calculations with certain mathematical formulas so that a conclusion about the condition is ideal body weight. However, it is less efficient especially if applied in bulk. Therefore, the author will create a system with the Image Processing application in real-time using the webcam by specifying the height and width of the body at a specific distance and scale that applies the calculation of the value of the pixel values where the pixel value is as a reference as a variable function to obtain the person's height and weight estimate. Then after gaining height and weight than the calculation of Body Mass Index with Broca formula to be useful as an identification system in effectively measuring human body mass index. This system can be used as a system that can require humans to more efficient time and reduce human error. The output generated from this system is the high value, weight, and BMI values of the person's body whether the condition is ideal or not.

1 INTRODUCTION

This In the current era of developments, various human-created technologies are required to be more effective, fast, and easy in assisting human work in the areas of health, information, communication, and other areas. The more technology used is the more practical human work. The Discovery and development of new technologies are expected to bring a positive impact on human life in all things more efficiently (Triyandi, 2014).

The identification system of a person does not escape the technological developments that occurred in the present era. Such an identification system can be a measurement of the human body by utilizing high parameters and weight gain (Wicaksana 2016). By utilizing these parameters, one can identify and know the condition of the body is ideal or not. In general, to know the ideal body weight, one must first perform the measurements manually. After that do the calculations with certain mathematical formulas so that a conclusion about the condition is ideal body weight. However, there are still many people who rarely control their weight regularly, while it is very important to know whether the condition of the body is good or not in the weight and height, especially if applied in bulk because it will require a lot of weighing and measuring tools as well as long enough time for its use (Efendi, 2017).

It is therefore created a system in real-time using the webcam by specifying the height and width of the body at a specified distance and scale that applies the calculation of the pixel value in which the pixel value is referenced as a variable function to obtain the person's height and weight estimate.

Then after gaining height and weight, the calculation of Body Mass Index with Broca formula to be useful as an identification system in measuring the human body mass index.

2 BASIC UNDERSTANDING

2.1 Image Processing

Image processing or image processing is a method to better improve the image quality by utilizing several methods of image processing itself, such as the setting on the color or image size. Image processing is widely utilized to detect an object, where input from the image processing can be a photo or motion picture in real-time, while the output can be a parameter related to imagery such as the pixel value in the image detected according to its needs (Putri, 2016).

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Research is conducted by implementing the image processing system in the calculation process, where when a person's body is faced with the camera, the camera will detect the image (tracking) and then determine the point of the coordinate until finally obtained the high value and width of the pixel used as a reference in the calculation.

2.1.1 RGB Image

The RGB image or color image is a digital image composed of 3 main colors, namely red, green, and blue. Meanwhile, in an image, other colors are the result of the combination of the three main colors (Makalalang, 2012). RGB color concepts can be shown in Figure 1 RGB Color Concepts.

2.1.2 Blob Counter

Blob Counter is a method of image processing used to calculate, filter, and extract objects contained in an image by mapping the object to obtain the dimensions or size of the desired object. The principle is to nod all the pixels that have a value less than the same as the background pixel value as the background of the object. Thus the pixel that has the value above the background pixel value will be considered as the object. The mapping is then done to distinguish between the background and object (Uma, 2010).

2.1.3 Broca Formula

The BROCA formula is a formula used to determine the ideal body weight by simply utilizing the height measurement parameters (Hutabarat, 2016). In this study, using a formula of Broca that is utilized to get the value of a person's ideal weight and also is one as a point of reference to get the value of weight prediction from the detected body. Here is the Broca formula

$$\text{Ideal BW(Kg)} = (\text{Body Height(cm)} - 100) - \left((\text{Body Height(cm)} - 100) \times 10\%\right) \quad (1)$$

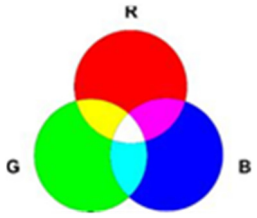

Figure 1: RGB color concepts (Makalalang, 2012).

2.1.4 Body Mass Index

Body Mass Index is an indicator to determine the bodyweight of a person whether it has a body that is too thin, ideal, or too fat and is a good measurement way to assess the risk of illness that can occur due to an unideal weight, by utilizing the height parameters in meters and weight in units Kg (Saffana, 2018; Andre, 2016; Heriansyah, 2017). The formula of the body mass index calculation can be seen in Equation (2).

$$\text{BMI} = \frac{\text{Body Weight (Kg)}}{\text{Body Height (m)} \times \text{Body Height (m)}} \quad (2)$$

From the result of the calculation, it is obtained by classifying the percentage of whether a person's weight is too thin, ideal, or too fat. The classifications can be seen in Table 1. BMI Value Classification.

3 PROPOSED METHOD

In Figure 2, the first step is to do an acquisition of an image to the object (human body) in a full body in a standing position. This process is conducted with a distance of 300 cm against the object as well as a camera height 80 cm from the floor. In the detection process, the camera will look for the object in real - time, where the rectangle will enlarge or shrink according to the detected object, and the result of the pixel coordinate value will also change according to the rectangle size, after the stable rectangle, then capture the image to make it easier for someone to know the body mass index.

When the object has been captured by the camera, the program will then perform its approximate height and width calculation using pixel value calculations. Where to use the calculation formula as follows:

$$\text{Body Height Prediction(cm)} = \text{Pixel Height-Average(Error Pixel Height)} \quad (3)$$

$$\text{Body Width Prediction(cm)} = \text{Pixel Width-Average(Error Pixel Width)} \quad (4)$$

Table 1: BMI value classification.

Nutritional Status	BMI
Weight deficiency	< 18,5
Ideal	18,5 – 24,9
Excess weight	25–30
Fat	30–40
Fat unhealthy	> 40

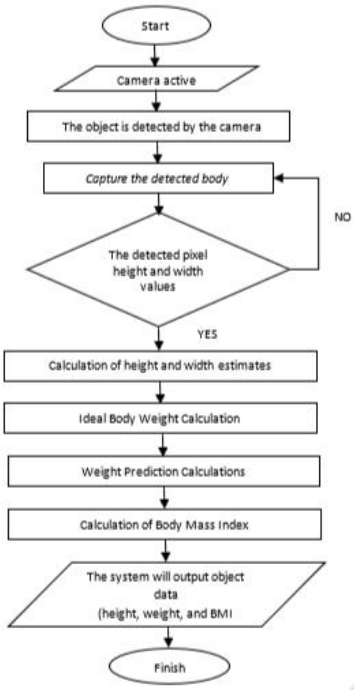

Figure 2: Flowchart system.

After the approximate value of height and width of the body in cm, the next step is to do the calculation of Ideal body weight with Broca formula as in Equation 1. The next step is to determine the approximate weight value of the body by utilizing the height and width parameters, as well as the ideal weight value. The calculation formula is as presented in Equation (5). After obtaining the high prediction and weight parameters, the Body Mass Index (BMI) calculation with the calculation of the formula corresponds to equation (2).

$$\text{Body Weight Prediction(Kg)} = ((\text{Average}(\Delta_{\text{BH-BWi}})\text{-(BH-BWi)}) + \text{BW Ideal(Kg)} \quad (5)$$

B.H (cm): Height prediction value in cm units.
Average (Error Pixel Height): The average value of pixel high error obtained from sample data.
Average (Error Pixel Width): The average value of of pixel width error obtained from sample data.
Average ($\Delta_{\text{B.H-B.}Wi}$): The average value of difference from the height prediction and boody width obtained from sample data.
(B.H – B.Wi): Delta value in height prediction and width prediction of body detected.

4 RESULT AND DISCUSSION

4.1 Data Retrieval

At the beginning of the study, cropping on the image filtering results by removing the background from the image so that only the remaining objects will be detected and then calculated. Filtering is done by setting the RGB parameter, in this research the RGB value is set to the value R = 222, G = 89, B = 83, then the RGB filtering result image in the filter returned to binary to get the intact object image so that it is easy to detect by the BLOB counter. The result of the BLOB counter can be shown in Figure 3.

4.2 Determination Equation of Calculation

The determination of the equation of calculation in this research is conducted by taking some sample objects (human body) which are used as the calculation of height and width estimate of the body. Sample data is taken in the form of height, shoulder width, and actual weight and calculation of the ideal weight gained from the actual height and weight. The comparison is conducted by retrieving the sample data of the height and width pixel on the tracking result object on the camera. The result of the calculation will be recorded for further analysis.

The obtained data is calculated to determine the ideal weight value of a person by processing the existing parameters. The average value of the error at the height of the pixel and the average value of the error at the pixel width can be used as a reference to get the height and width predicted value of the human body detected by the camera. In the study, 30 human objects were used as samples to determine the average error value, and the value obtained for is 64.5 for the average height error and 2.25 for the average error width of the body. Determination of calculations to get high prediction values and width of the body can be seen in equations 3 and 4. The following Table 2 is the result of the high and wide prediction calculation of the body. The prediction of person's weight prediction could be calculated using Equation (5). The calculation results are presented in Table 3 and Table 4.

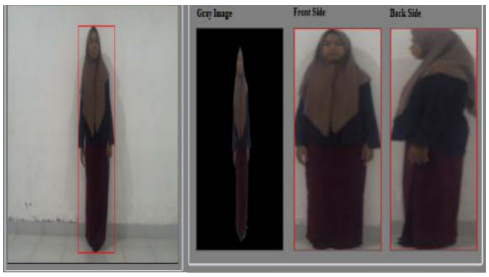

Figure 3: Blob counter detection results.

Table 2: Results of height and width prediction calculation.

No	Name	H.B Act (cm)	Pre. H.B (cm)	Error (cm)	B.Wi Act (cm)	Pre. B.Wi (cm)	Error (cm)
1	Alin	165,0	165,6	0,6	40,0	36,8	3,3
2	Arya	173,0	176,6	3,6	41,0	38,8	2,3
3	Bunga	156,0	161,6	5,6	37,0	36,8	0,3
4	Cindy	162,0	158,6	3,4	40,0	35,8	4,3
5	Dita	160,0	155,6	4,4	34,0	33,8	0,3
6	Erin	156,0	149,6	6,4	38,0	36,8	1,3
7	Ilmi	160,0	157,6	2,4	43,0	40,8	2,3
8	Ipen	166,0	167,6	1,6	46,0	44,8	1,3
9	Limcol	168,0	169,6	1,6	42,0	40,8	1,3
10	Maul	174,0	180,6	6,6	43,0	38,8	4,3

Table 3: Calculation results on sample data.

No	Nama	B.B ideal Asli (kg)	B.B Asli (kg)	T.B Asli (cm)	Prediksi T.B (cm)	Error (cm)	L.B Asli (cm)	Prediksi L.B (cm)	Error (cm)
1	Alin	58,5	52,2	165,0	165,6	0,6	40,0	36,8	3,3
2	Arya	65,7	54,9	173,0	176,6	3,6	41,0	38,8	2,3
3	Bunga	50,4	48,7	156,0	161,6	5,6	37,0	36,8	0,3
4	Cindy	55,8	56,5	162,0	158,6	3,4	40,0	35,8	4,3
5	Dita	54,0	45,8	160,0	155,6	4,4	34,0	33,8	0,3
6	Erin	50,4	54,7	156,0	149,6	6,4	38,0	36,8	1,3
7	Ilmi	54,0	69,0	160,0	157,6	2,4	43,0	40,8	2,3
8	Ipen	59,4	71,8	166,0	167,6	1,6	46,0	44,8	1,3
9	Limcoln	61,2	67,3	168,0	169,6	1,6	42,0	40,8	1,3
10	Maulana	66,6	58,0	174,0	180,6	6,6	43,0	38,8	4,3

Table 4: Calculation results on sample data

Prediksi T.B - 122,5 - (Prediksi T.B-Prediksi L.B)		Prediksi B.B ideal (kg)	Prediksi B.B (kg)	Error BB (kg)
128,8	-6,3	59,0	52,7	0,5
137,8	-15,3	68,9	53,6	1,3
124,8	-2,3	55,4	53,1	4,4
122,8	-0,3	52,7	52,4	4,1
121,8	0,7	50,0	50,7	4,9
112,8	9,7	44,6	54,3	0,4
116,8	5,7	51,8	57,5	11,5
122,8	-0,3	60,8	60,5	11,3
128,8	-6,3	62,6	56,3	11,0
141,8	-19,3	72,5	53,2	4,8

5 CONCLUSIONS

Based on the results and analysis that has been done in the study can be concluded that the system can work with an average percentage of the body's high error rate of 4.1% and weight by 8.6 and the distance, color, and clothing used by the measured object greatly affect the outcome of the image.

REFERENCES

Andre, J. A., 2016. *System security webcam dengan menggunakan Microsoft visual basic*. STMIK Amik, Riau, Pekan Baru.

Efendi, T., Uljanah, I. I., Tsauri, T. A., 2017. Rancang Bangun Sistem Pengolahan Citra Digital untuk Menentukan Berat Badan Ideal. *Jurnal Informatika Sunan Kalijaga*.

Heriansyah, T., 2017. Hubungan Indeks Massa Tubuh dengan Jumlah Circulating Endothelial cell. *Jurnal Pendidikan dan Pengajaran*.

Hutabarat, J. C. J., 2016. Perancangan Aplikasi Menentukan Berat Badan Ideal Dengan Menggunakan Algoritma K-MEANS CLUSTERING. *Riset Komputer (JURIKOM)*.

Makalalang, R. A., 2012. *Perancangan Sistem Pemantau dan Penentuan Tempat Parkir Berdasarkan Digital Image Processing*. Buku Jurnal Teknik Elektro, Universitas Sam Ratulangi Sulawesi Utara.

Putri, A. R., 2016. Pengolahan Citra dengan Menggunakan Webcam pada Kendaraan Bergerak di Jalan Raya. *Jurnal Ilmiah Pendidikan Informatika*.

Saffana, N., 2018. *Menghitung Berat Badan Ideal dengan Rumus Broca*. Indonesia.

Triyandi, D., Adler, J., 2014. *Sistem Otomasi Gerbang dengan Pengolahan Citra Membaca Nomor Plat Kendaraan*. Universitas Komputer Indonesia, Bandung, Jawa Barat.

Uma, F., 2010. *Penjejak Objek Pada Kursi Roda Cerdas Autonomous*. Makalah Seminar Tugas Akhir, Jurusan Teknik Elektro, Universitas Dipenogoro.

Wicaksana, R. B., Hidayat, B., Aulia, S., 2016. Classification Height and Weight of Human Footprint Using Gabor Wavelet and KNN Method Based on Android. *e-Proceeding of Engineering*, vol. 3, IEEE.