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ANDROID BASED BODY MASS INDEX DETECTION

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Abstract

Obesity and malnutrition are important health problems. To deal with the big risk of health problems, early detection can be carried out by using a standard Body Mass Index (BMI) formula. This detection application will take a photo of the object, which will later determine its Body Mass Index. The image obtained was RoIed using the Thersholding technique with a single threshold value of 160. It is hoped that it can help someone find out the value and category of their Body Mass Index by processing digital images via pixels. The research data obtained is able to inform body weight and pixel height from digital images so that the application can detect Body Mass Index efficiently and practically and can be used by the wider community with a Body Mass Index Detection accuracy of 70% at a distance of 230 cm between the camera and the object.

Keywords: ***Body Mass Index, Digital Image Processing, Thersholding, RoI.***

INTRODUCTION

Obesity and malnutrition are important health problems. According to WHO (2000), it is estimated that more than 700 million adults will be obese in 2015 and it is estimated that there will be an increase in the prevalence of obesity reaching 50% in 2025 for developed countries [1]. In Indonesia, the 2013 Riskesdas results show that the nutritional status of adults over 18 years is dominated by the problem of obesity. The prevalence of obesity in adults is 14.76% and overweight 11.48%, where the prevalence of overweight adults is 26.23% while the prevalence of underweight adults is 11.09%. To deal with the big risk of these health problems, early detection can be carried out by using a standard ideal body calculation formula called Body Mass Index (BMI) issued by the World Health Organization (WHO) or known as Body Mass Index (BMI) in Indonesia. This formula is used to calculate the body category for adults > 18 years which refers to calculating the ratio of body weight (in kilograms) to the square of body height (in square meters) and then produces a number output that has a category threshold according to the standards issued.

So far, to find out a person's BMI value and category, they are required to know their weight using a scale and their height using a meter first, then calculate it to get their BMI value and category. However, it is not certain that a person has a measuring and weighing device, and it is less efficient if applied en masse because it takes quite a long time to use it, such as carrying out height and weight tests during police tests. This application can also be applied in hospitals, community health centers and police offices to make work easier in the field of calculations and find out ideal values. For this reason, a BMI calculation system based on digital image processing has been developed as a tool to find out a person's BMI value and category quickly and easily.Therefore, based on this, an application was built that can detect Body Mass Index using an Android Smartphone device with the method used, namely the Thersholding threshold technique.

METHOD

This test was carried out by taking it at a distance of 230 cm to determine the optimal image taking distance for system accuracy. The size of the uploaded image is resized to 960 x 1280 pixels, then image segmentation is carried out which is processed using the threshold thresholding technique to obtain ROI. All images that have been processed one by one will be searched for the Body Surface Area, Body Weight, and then Body Mass Index values. In this research, the relationship between images to obtain BSA values is to use the object body surface area formula approach. BSA calculations use the human body approach to an elliptical tube as in Figure 1.

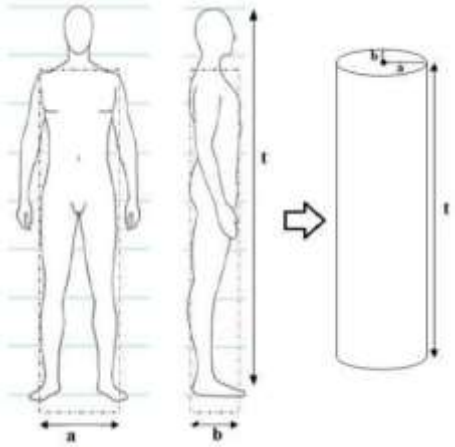


Figure 1. Body Approach to the Elliptical Tube.

In figure 1, the height, width of the front view, and width of the side view are denoted by t, a, and b. To find out the body surface area of the object, you need to know the circumference and area of the elliptical tube multiplied by several other parameters

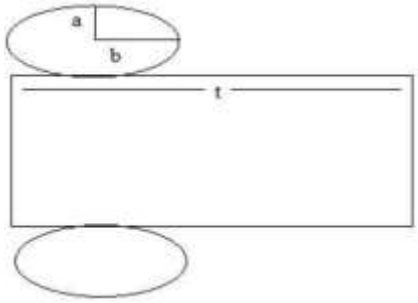


Figure 2 Elliptical Tube After Decomposition

Area of ellipse = 22/7 x (axb).....(1)

Perimeter of Ellipse = x (a + b) ..... (2)

The formula for describing the surface area of a geometric shape in Figure 2 is a combination of the area and perimeter of an ellipse as follows:

Surface area = $3.14 * (a * b) + 3.14 * (a * b) * t$

The surface area formula is multiplied by several other parameters to obtain the BSA formula with an elliptical tube surface area formula approach as follows:

BSA = $(3.14 * (a * b) + ((a + b) * (t * 2)))) * (\text{tpixels})2 * k * 0.0001$

$$tpiksel = \frac{tinggi\ badan\ (cm)}{tinggi\ badan\ (piksel)}$$

where a is the width of the front body (pixels); b is the side front width (pixels); t is body height (pixels); k is the multiplying factor while tpixel is the conversion of pixels to cm. The multiplier factor used in the system is found by entering the multiplier factor randomly so that the resulting weight is close to the original weight of the object. Until the multiplier factor that is closest to the original weight is obtained. In the next process, body weight is calculated using the Mosteller formula approach and the BMI formula discovered by Adolphe Quetelet.

$$Berat\ Badan = \frac{(BSA^{2})*3600 \ldots}{(t*2)*tpiksel}$$

This formula is the formula used to calculate body weight which is used as system output.

A. Program Algorithm Block Diagram

Program algorithms in system design are created using Block Diagrams. This diagram is used to determine each system stage in the application when it is executed from start to finish. The block diagram can be seen in Figure.

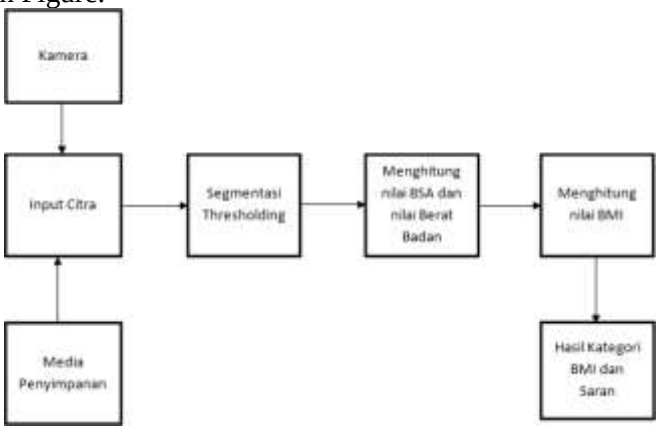
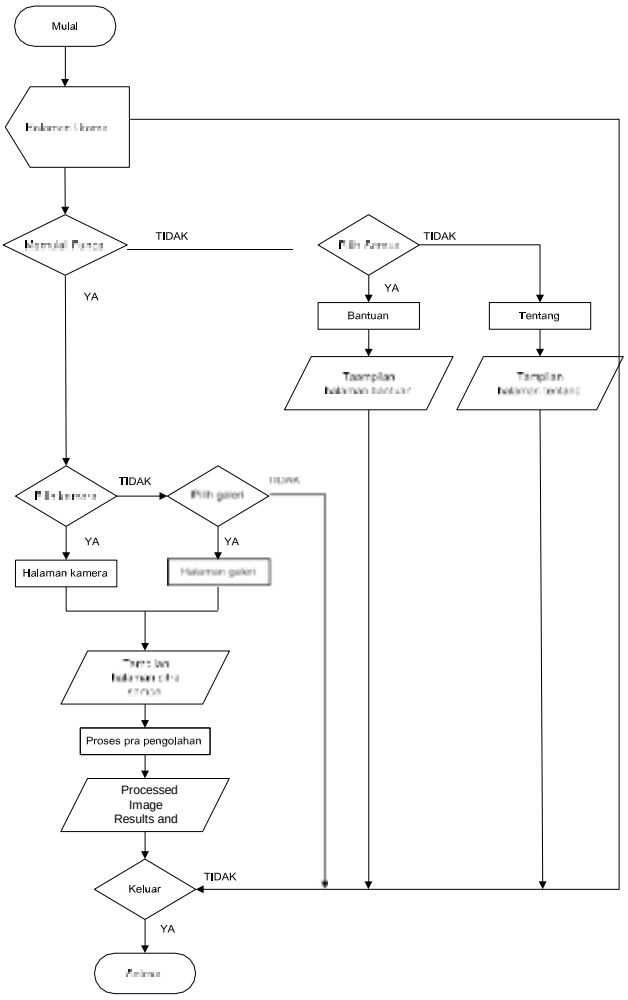


Figure 3 Block Diagram of the Human Body Mass Index Detection Process System

B. Software Flow Diagram

Software flow diagrams show the process for running an application as a whole. The stages are carried out from the opening process to the detection process. The flow diagram of the human body mass index detection application can be seen in Figure 4.

Figure 4 Flow diagram of the Body Mass Index Detection Application



Man

C. Interface Design

Interface or display design is needed to provide an overview and explanation of each application process from start to finish. This design contains the contents of each page displayed, such as the use of buttons, text and images. The function of this design is to provide an overview of the application's structured interface so that it is easier to understand when operating.

1) Main menu page interface

The main page shows the appearance of the application when it is first opened as shown in Figure 5.

Figure 5. Main Page Interface

2) Image Upload Page Interface

This page shows the process of uploading coffee bean image data that will be used for detection as shown in Figure 6

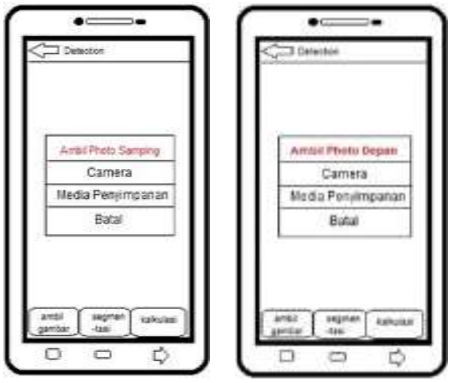


Figure 6 Image Upload Page front and side views

3) Interface Page selection

This page shows the display of the process of changing human body image data that will be used as shown in Figure 7.

Figure 7 Selection page

4) Process Analysis Page Interface

This page is a page that contains analysis of processed human body images in the form of images and the results of the image's body mass index as shown in Figure 8.

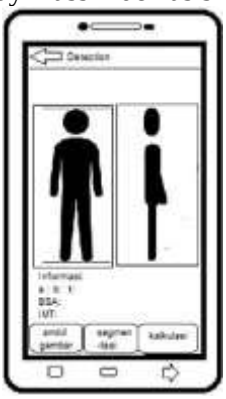


Figure 8 Process Analysis Page

RESULTS AND DISCUSSION

Contents Results and Discussion

A. Application Implementation

In the implementation, we will discuss the procedures and functions contained in the coffee bean quality detection application. This application testing aims to determine the extent of success of the application in detecting human body mass index taken via camera and gallery.

1) Main page display

The main page implementation contains the initial display of the human body mass index detection application showing the main menu page. This page contains several buttons shown in figure 9.

Figure 9 Main page display

On this page there is a display logo at the top. Apart from that, there are 4 (four) buttons which function the same as a pointer to direct the user to the next page according to the name of the button. start detection button, help button, about button and exit button.

2) Help View

The help display will appear when on the main page the user selects the help button at the top right. Contains instructions for using each stage of the processing process from start to finish as shown in figure `10.

Figure 10 Help Display

3) About View

The About view will appear when on the main page the user selects the about button at the bottom left. Contains information about the application shown in figure 11 below.

Figure 11 About View

4) Start View

The detection start display shows the page for the image that will be uploaded to the application taken from the camera and gallery, which can be seen in Figure 12 below.

Figure 12 Start View

B. Implementation of Image Processing to Detect seed quality

Image Processing implementation will be applied in the detection start display. The image capture process is carried out using a camera and gallery, then the image is processed using a thresholding segmentation process. This segmentation process is carried out to obtain selected image results based on the area of interest (Region of Interest). After that, the pixels are processed by normalizing the height, front width and side width of the RoI pixel. and calculate BMI using the elliptical cylinder formula to obtain body surface area (BSA) and pixel height values after normalization.

1) Detection Start Display

The display for taking images will appear after pressing the start detection button on the main page display. This display in the human body mass index detection application shows the page for the image that will be uploaded to the application which is taken from the camera and gallery shown in figure 13.

Figure 13 Detection Start Display

After the image has been uploaded, the next process is by pressing the segmentation button which functions to remove background background and select parts of the human object and change the image to an ROI image selected from Thresholding.

2) Image Process Page View

After the image is selected, the next process is to press the segmentation button again to start the process for detecting human body mass index as shown in Figure 14.

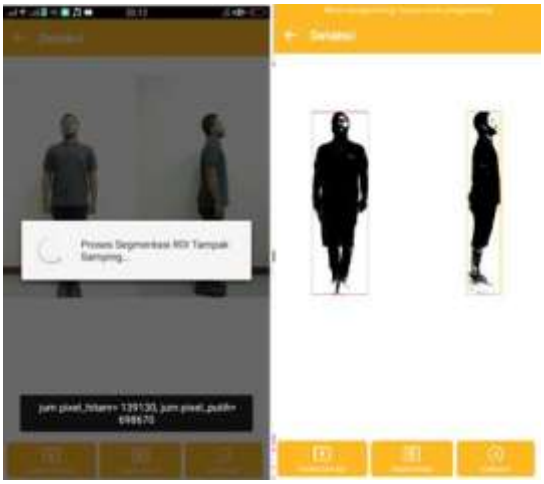


Figure 14 Image Process Page View

On this page there are 2 (two) images in the form of imageViews whose size corresponds to the previously uploaded image which contains the original image and the one which has been processed into a grayscale image which contains elements in the intensity matrix representing various intensity values or degrees. grayscale, where the value 0 represents black and 1 represents full intensity or white, then the grayscale image is converted to edge detection sobel (edge detection) to mark parts that are image details and to correct details of blurry images, which occur due to errors or the effects of the image acquisition process.

3) Image analysis display

After the image is processed, press the calculation button to start the analysis process. This display displays the final results of image processing on body mass index detection which is shown in Figure 15.

Figure 15 Image Analysis Display

This image analysis page displays the image that has been analyzed by marking the part that is a detailed image of the human body and displays details of the width of the image, front view, side view and height of the image. Then the results are weight and pixel height on the human body. Based on this value, a person's Body Mass Index value can be determined, as well as suggestions for the person to lose or increase their weight.

C. System Testing Using Thersholding Method

In this research, the system testing stage was carried out by training on several selected image data samples. This stage of testing is to find the thersholding threshold value, namely image segmentation that separates objects from the background in an image based on differences in brightness or light darkness. The test results to find thersholding threshold value can be seen in table 1.

TABLE I TESTING THERSHOLDING VALUE

Nilai Ambang Batas	Hasil Citra Terseleksi	Nilai Piksel		Hasil Citra Terseleksi	Nilai Piksel	
		Hitam	Putih		Hitam	Putih
>60		97501	740299		45759	792041
>80		128298	709502		55989	781811
>120		151782	686018		81572	756228
>160		162700	675100		91762	746038
>200		206716	631084		122094	715706
>220		300730	537070		156847	680953

Based on table 1, the single threshold operation is a division limit of only one, meaning the pixel values are grouped into two groups. Image regions that tend to be dark will be made darker (perfect black with an intensity value of 0), while image regions that tend to be bright will be made darker. bright (perfect white with an intensity value of 1). From the results of the tests that have been carried out, the threshold value taken is >160. If the value is greater than 160 then change it to white, if it is smaller than 160 then change it to black.

D. Perform calculations of body surface area, body weight and body mass index

In this research, the system testing stage was carried out by training on several selected image data samples. The samples are processed first to maximize the accuracy of determining the Body Mass Index category. then look for the values a, b by calculating the max width minus the min width of the selected object, and the t value by calculating the max height minus the min height of the selected object. All images that have been processed one by one will be searched for the Body Surface Area, Body Weight, and then Body Mass Index values. The following is an example of a manual calculation in an application program: The first thing you have to do is find the values of a (front width), b (side width), and t (height) by calculating the max width minus the min width of the selected object, and the t value by calculating the max height minus the min height of the object. selected. And known value

a= 300,0 b=182,0 t=972,0.

Kedua menghitung nilai t_{piksel}dengan cara :

$$t_{piksel}= \frac{tinggi\ badan\ (cm)}{tinggi\ badan\ (piksel)}$$

tcm =((t*175)/972)
= (972*175) / 972
=170.100/ 972
=175

$$t_{piksel}= \frac{175}{972}$$
=0,180

Ketiga hitung Body Surface Area:

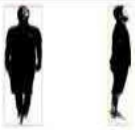
BSA = (3,14/2*(a*b)+((a+b)*(t*2))))*(tpiksel)2*k*0,0001
BSA=(3,14/2*(300*182)+((300+182)*(972*2))))*(0,180)2*0,539 0,0001
=(3,14/2*(54600)+((482)*(1944))))*(0,0324)*0,539*0,0001
=(3,14/2*(54600)+(937008))*(0,0324)*0,539*0,0001
=(3,14/2*991608)*(0,0324)*0,539*0,0001
=(1556824)*(0,0324)*0,539*0,0001
=2,72

Fourth, calculate the Body Weight value

Body Weight=((〖BSA〗^2)*3600)/(((t*2)*tpixels)
=((〖2.72〗^2)*3600)/((972*2)*0.180)
=(7.3984*3600)/(1944*0.180)
=26,634.24/349.92
=76.1

And the last thing is to calculate the Body Mass Index value using the formula:
BMI= body weight / (height)2
= 76.1/(175*175)
= 76.1/30.62
=24.85

TABLE II APPLICATION TESTING

No	Citra asli	Citra *ROI*	Analisis citra			Kategori
			Nilai BB	Nilai TB	Nilai IMT	
1			76,01	175,00	24,85	Kelebihan Berat Badan
2			42,51	153,41	18,06	Berat Badan Kurang
3			55,72	156,02	22,84	Berat Badan Normal
4			105,82	162,55	40,05	Obes II
5			66,04	174,28	21,74	Berat Badan Normal
6			44,91	150,69	19,77	Berat Badan Normal
7			49,25	152,67	21,13	Berat Badan Normal
8			84,64	170,68	29,06	Obes I
9			62,34	153,4	26,49	Obes I
10			53,09	153,94	22,4	Berat Badan Normal

This test was carried out by taking at a distance of 230 cm and 250 cm to determine the optimal distance for image taking for system accuracy.

TABLE III
SAMPLE OF DISTANCE INFLUENCE SYSTEM TESTING RESULTS

Data	Berat Badan (kg)		Tinggi Badan (kg)		akurasi Berat Badan(%)	akurasi Tinggi Badan(%)	Jarak (cm)
	Real	Hitungan	*Real*	Hitungan			
Citra 1	76	76,01	175	175,00	100,01	100,00	230
	76	72,87	175	175.00	95,88	100,00	250
Citra 2	43	42,51	153	153,41	98,86	100,00	230
	43	53,59	153	145,29	80,23	94,96	250
Citra 3	54	55,72	157	156,02	96,91	99,37	230
	54	66,55	157	157,9	81,14	99,94	250
Citra 4	106	105,82	165	162,55	99,83	98,51	230
	106	93,73	165	161,86	88,42	98.09	250
Citra 5	67	66,04	175	174,28	98,56	99,58	230
	67	64,53	175	174,28	96,31	99,58	250
Citra 6	45	44,91	155	150,69	99,08	97,21	230
	45	43,02	155	149,99	95,06	96,76	250
Citra 7	51	49,25	155	152,67	96,56	98,49	230
	51	51,58	155	154,12	98,87	99,43	250
Citra 8	80	84,64	170	170,68	94,51	99,60	230
	80	80,02	170	161,68	99,97	95,10	250

TABLE IV
EFFECT OF DISTANCE ON SYSTEM ACCURACY

Jarak (cm)	Rata-rata Akurasi (%)
230	70 %
250	20 %

Based on table 4, it shows that testing at a distance of 230 cm has better accuracy results than at a distance of 250 cm. The test results at a distance of 230 cm have an accuracy value of 70% and at a distance of 250 cm the accuracy is 20%. This is because the image was acquired at a distance of 230 cm. The entire body posture of the object from head to toe is seen more clearly in the image, making cropping easier. At a distance of 250 cm, the image is too far away. Another influencing factor is accuracy in image cropping so that it influences the system output. Testing this parameter has proven that the ideal data to use as a reference for taking pictures is a distance of 230 cm.

E. System accuracy testing

The system that has been built has an accuracy for detecting human body mass index of around 70%. The standard of test results is that if the difference in value is >3 then it is declared failed because the difference value is much different from the real value. To calculate the percentage success rate in the following way:

%Success = (Number of successful samples) * 100/ (number of all samples)
%Success = 7*100 /10
= 70 %
%Failed= (Number of failed samples) * 100/ (number of all samples)
%Failed= 3*100 /10
= 30 %

The failure of the system itself is caused by accuracy when taking pictures, light and camera focus are the main influences on success in detection.

TABLE V
COMPARISON OF ACTUAL DATA WITH SYSTEM OUTPUT DATA

Data	Berat Badan (kg)		Tinggi Badan (kg)		Selisih Berat (kg)	Selisih Tinggi (cm)	akurasi Berat Badan(%)	akurasi Tinggi Badan(%)	Keuksesan	
	Real	Hitungan	*Real*	Hitungan					Ya	Tidak
Citra 1	76	76,01	175	175,00	1,00	0,00	100,01	100,00	✓	
Citra 2	43	42,51	153	153,41	0,49	0,41	98,86	100,00	✓	
Citra 3	54	55,72	157	156,02	1,72	0.98	96,91	99,37	✓	
Citra 4	106	105,82	165	162,55	0,18	2,25	99,83	98,51	✓	
Citra 5	67	66,04	175	174,28	0,96	0,72	98,56	99,58	✓	
Citra 6	45	44,91	155	150,69	0,09	4,31	99,08	97,21		✓
Citra 7	51	49,25	155	152,67	1,75	2,33	96,56	98,49	✓	
Citra 8	80	84,64	170	170,68	4,64	0,68	94,51	99,60		✓
Citra 9	65	62,34	157	153,04	2,66	3,96	95,90	97,47		✓
Citra 10	51	53,09	155	153,94	2.09	1.06	96.06	99,31	✓	

CLOSING

Conclusion

After conducting research and discussion regarding the Android-based Body Mass Index detection application, the following conclusions were drawn:

1) In the detection process using the Body Mass Index category application which is classified into 5 categories, to determine body surface area based on pixel width and height using the threshold thresholding technique with a threshold value of >160.
2) The effective distance for testing is 230 cm. This is because the image was acquired at a distance of 230 cm. The object's entire body posture from head to toe is visible more clearly in the image, making cropping easier.
3) Failure in detection is caused by factors in light data collection which is the main factor in determining success in detection, then when taking image samples the focus on the smartphone camera becomes the most important reference for detecting Body Mass Index and the correct camera distance so that failure does not occur in the system. This Body Mass Index detection application has an accuracy of 70%.

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