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THE ESTIMATION OF SKIN THICKNESSON ANTHROPOLOGISTS POINT BASED ON SKULL CT IMAGE USING LAGRANGE INTERPOLATION

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Abstrak

Abstrak Di era ini, ada lebih banyak kecelakaan atau pembunuhan yang menyebabkan begitu banyak korban sehingga kadang-kadang ada korban yang identitasnya sulit diketahui karena mereka telah kehilangan bentuk kulit wajah mereka. Penelitian ini membahas tentang rekonstruksi wajah manusia dengan menggunakan komputerisasi. dalam 2D, itu bertujuan mengidentifikasi dan mengembalikan wajah tengkorak, dalam upaya untuk mencapai kemiripan dengan seseorang ketika kehidupan didasarkan pada gambar CT 2D. Dalam penelitian ini, mengukur ketebalan titik-titik Antropolog antara tengkorak dan kulit luar wajah manusia adalah untuk mendapatkan ketebalan dengan cepat dan akurat. Metode yang digunakan adalah Interpolasi Lagrange di mana metode ini dapat digunakan untuk mendapatkan nilai baru dari data dalam rentang yang sudah ada. Beberapa bagian dari penelitian ini adalah persiapan data, pengujian data dengan lagrangeinterpolasi dan hasil tes. Akurasi rata-rata dari metode ini adalah 84,5%

Kata kunci: *Rekonstruksi wajah, titik antropologis, interpolasi lagrange, gambar CT 2D*

Abstract

Abstract In this era, there are more accidents or killings which cause so many victims that there are sometimes victims whose identity is difficult to know because they have lost the shape of their facial skin.This researchis dealing with reconstruction of a human face by using computerized in 2D, it aimed at identifying and restore the face of the skull, in an effort to achieve a resemblance to someone when lives are based on an image of a 2D CT. Some of the advantages that can be obtained from a computerized reconstruction compared to the reconstruction of the clay are in the speed of editing.When there is additional information, the picture and its data can be stored and repeated reconstruction can be done when it is necessary. In this research, measuring the thickness of Antropolog points between the skull and the outer skin of a human faceis to get the thicknessquickly and accurately. The method used is the Lagrange Interpolation where this method can be used to get a new value from data in the range that already exists. Some parts of this research is data preparation, testing data with lagrangeinterpolation and test results. Average accuracy of this method is 84,5%

Keywords : *Face reconstruction, anthropologist point, lagrange interpolation, CT 2D image*

1. INTRODUCTION

In medical science of law, forensic identification of the human face of the skull is an important process, especially when there is no other means are available, methods that have been used to produce a human face so that it can identify a person [1]. Manual techniques usually start from the in accordance with the depth of the skull or soft tissue at the replica of the skull, the skull is then covered with clay until completely hidden [2]. All the length of the post has been determined from the table

the average value of one's anatomy based groups, ethnicity, gender and age [3]. Besides, data such as Ante mortem is needed in the process of identification. Ante mortem data itself is the victim before he died. These data can be obtained through family or close relatives. Ante mortem data collection method is usually done by two methods; the simple method and scientific method. The simple method usually will be collected physical characteristics, jewelry and clothing worn before, and photo documentation. The scientific method is usually done by collecting data on fingerprints, medical records, and body fluids such as blood, semen, saliva, sweat, and dirt at the crime scene, ordontologi (teeth), anthropology, biology. Ante mortem fingerprints can be obtained via the personal data held such as ID cards, certificates, driver's license or the other. If the earlier methods cannot be done, then it will do a more scientific method, the DNA examination. Ante mortem DNA can be taken from the family or siblings nearby. Patients with medical conditions or medications that can affect the facial tissue removed from the study and the data used in the study [4] have provision normal weight and differentiated gender as for the provision of normal weight is determined by body mass index (weight in kilograms divided by the square height in meters). A person is considered normal weight, when the body mass index to fallbetween 18-25. Based on the research, [5]the measurement of the distance between the skin and the skull is possible.

In the present study as a picture or image data consists of 10 CT images in the sagittal position with the details of two used as a training image and 8 as image testing. Furthermore, at this stage of measurement in this study measured using two dots in the distance and result in pixels and then transferred to the unit mm (millimeters). One final stages of testing the data where the objective is to compare the new distance is obtained from the interpolation lagrange with the actual distance then analyzed lagrange interpolation accuracy in determining a new point based on existing data. In the present study the CT image data obtained restricted to age, gender and race can be different for each region in terms of shape and thick leather skull.

In this study consists of several parts, the first part is the introduction, and part 2 that is about where the research methods in research methodology consists of several sub-sections including data preparation 2.1, which there is a normalization of sub-section 2.2.1, grayscalling sub-section 2.1 .2, contrast stretching sub-section 2.1.3, Sobel edge detection sub-section 2.1.4 and subsequent placement of dots on the skin anthropologist in subsection 2.2,. In chapter 3 is the result of the test data by interpolation lagrange and after it's done to test against 8 image analyzer.

2. METHODOLOGY

This study consists of four stages: data preparation, placement anthropologists point, the test data with lagrange interpolation and the latter is the result of the test. Definition Interpolation is one method of matching the data points with a curve by making a skewer curve to any point on the data points in the table [6]. One of the goals of the interpolation of building curve through all the data points used. Interpolation can function when there is a curve that is formed is then used to determine the value of f (x) with x that is between the data points are awarded. And conversely, if the value is outside the data points are given then it is called extrapolation. Interpolation has a higher accuracy in determining value better than extrapolation. From the range of the curve then look for the value in the interval of data points (x0, xn) or (x0 <x k <xn) and this is called interpolation.

Schematic diagram of the study is shown in Figure 1.

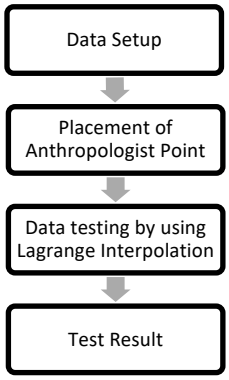

Figure1.Research Diagram

2.1. Data Setup

CT image of the head used in this study is an image that is taken in full starting up the neck to the top of the head usingCT scan. Data consisted of Indonesian people's faces photographed from CT-scan voluntary adult

male patients aged 28-35 years with normal body weight based on BMI (Base Mass Index) which is 17-23. One of the CT image shown in Figure 2

Figure2. Skull CT image

In this study, the Head CT image used as many as 10 pieces with 2 details the data used for the training data and the 8 data used for data testing. Length measurement of skin tissue between the bone of the skull to the outer skin of the face at some point anthropologist. Among the points anthropologists as shown in Figure 3, marked with No. 1-9 consisting of:

1. Supraglabella (S)
2. Glabella (G)
3. Nasion (N)
4. Nasale (Ne)
5. Subspinale (S)
6. Supradentale
7. Infra dentale (I)
8. Suprmanetale (Sm)
9. Pogonion (P)
10. Beneath chin (Bc)

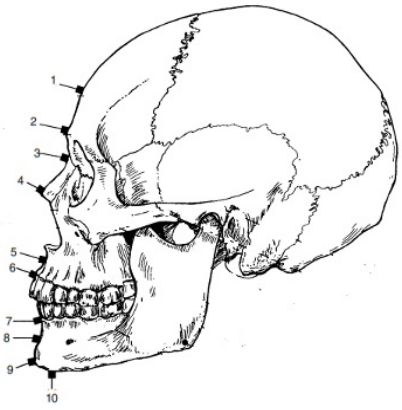

Figure 3. Anthropologist points on human skull [M. Vanezis,no. October, 2007.]

Before the placement stage of Anthropologist points on the image data setup process is carried out as follow:

2.1.1.Normalization

Normalization is a way to change the image size or image into the new predetermined size without losing important information from the image. In this study the process of equalizing the size of the image of the original size is 1116 x 644 to a size of 614 x 626.The purpose of equalizing the image is to avoid the difference in the ratio of the image in measurement process. By applyingnormalization process, the size of all images that will be proceed equally in size. Unification of the size of the data was done to facilitate the counting process.

2.1.2.Grayscalling

Grayscale is the transformation of RGB image into grayscale. The initial process is often done to the image processing is to convert color images into grayscale [9].Grayscale image consisting of black, gray, andgray white gray color is with various levels of black to nearly white. Grayscale image has a color depth of 8 bit or 256 color combinations of gray [10].

2.1.3. ContrastStretching

Contrast Stretching is one of the image enhancement processes that aims to clarify and sharpen certain characteristics or features of the image so that the image is more easily perceived and analyzed more thoroughly. Contrast stretching is a technique that improves contrast by increasing the dynamic range of the intensity values in the image.

The contrast in the image stated the distribution of light and dark colors. An image has low contrast when dynamic range is also narrow, otherwise, if the image has a high contrast when dynamic range is wide. Dynamic range is measured by the difference between the highest intensity and the lowest intensity values that make up the pixels in the image [10].

2.1.4. Sobel edge detection

According to Hambali, [11] he said that Edge detection is the process to determine the location of the points that are edges of objects. This operator uses two 3x3 pixel kernel for calculating the gradient so that the estimation of gradient are right in the middle of the window [12]

2.2. Anthropologists point placement on the skin

In this research, anthropologist point placement on the skin is limited to only 10 points. Since the object of this study point measurement only existing features on the face. Image anthropologists point on the skin as shown in Figure 4.

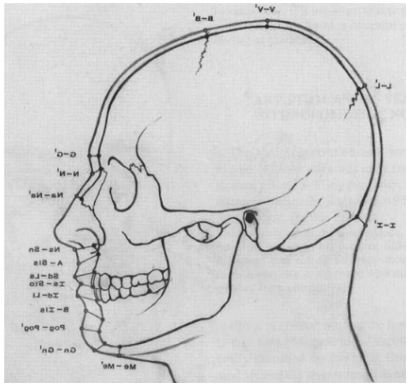

Figure 4. Anthropologist points on the skin [M. Vanezis,no. October, 2007.]

The thickness of the skin was measured using pixel positions using the equation:

$$f(x) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (1)$$

2.3. Lagrange Interpolation

Lagrange interpolation is used to find polynomial function P (x) certain degree that passes through a number of data points [7]. The general form of the Lagrange interpolation of order n is:

$$fn(x) = \sum_{i=0}^{n} \mathrm{Li}\,(x) f(xi) \quad (2)$$

Where:

$$L_i(x) = \prod_{\substack{j=0 \\ j \neq i}}^{n} \frac{x - x_j}{x_i - x_j} \quad (3)$$

And

$$f(x) = L_1(y_1) + L_2(y_2) \ldots . + L \quad (4)$$

Lagrange Equation orde 1 as follow :

$$f_1(x) = \frac{x - x_1}{x_0 - x_1} f(x_0) + \frac{x - x_0}{x_1 - x_0} f(x_1) \quad (5)$$

Lagrange Equation orde 1 as follow:

$$f1(x) = \frac{(x - x_1)(x - x_2)}{(x_0 - x_1)(x_0 - x_2)} f(x_0)$$

$$+ \frac{(x - x_0)(x - x_2)}{(x_1 - x_0)(x_1 - x_2)} f(x_1) + \frac{(x - x_0)(x - x_1)}{(x_2 - x_0)(x_2 - x_1)} f(x_2)$$

. . . (6)

3. RESULT

In this study, the steps taken are normalized with dimensions comparable image to 614 x 626 to be more accurate in measuring anthropologist point. After normalization then the image is converted to grayscale image as shown in Figure 5 where the initial RGB image format is converted to grayscale.

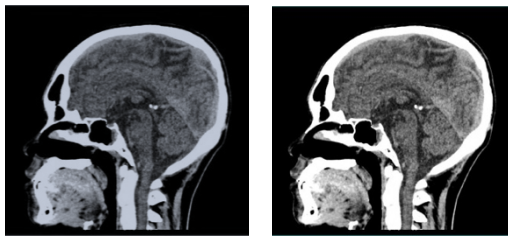

Figure 5. (a) Image before grayscalling, (b) ImageafterGrayscalling

After grayscalling image, the next step is contrast stretching the image in order to become sharper and clearer.

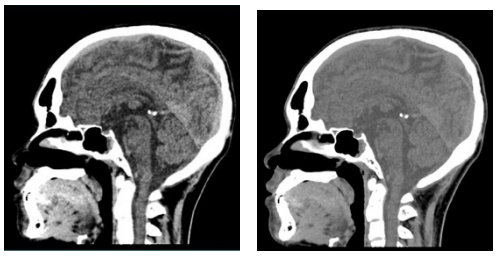

Figure6. (a) Image before contrast stretching, (b) Image after contrast stretching

After contrast stretching image, then the edge detection (edge detection) step usingSobel technique to make it more accurate in measuring because this image is converted into a line, as shown in Figure 7:

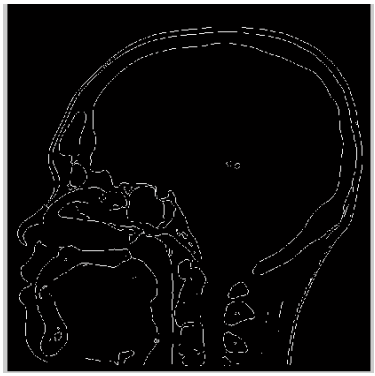

Figure7. Image resulted from Sobel Detection

After contrast stretching, the image is measured by placing points on the anthropologist position. Placement anthropologists point shown in Figure 8:

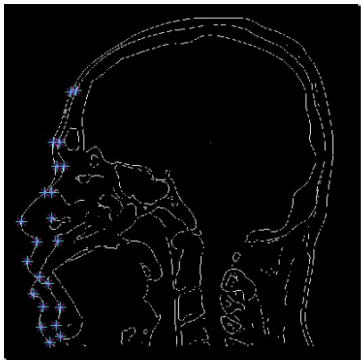

FIgure8. Measurement on Anthropologist Points

Steps in measurement:
From the results of the measurements tested on 10 images, it selected two pictures for the training data to be averaged, where two training data has the shortest thick and distance point anthropologists and the longest anthropologists point to avoid extrapolation. Then 8 data testing are measured the length between any anthropologist to get every point spacing anthropologist lagrange interpolation into the skin, then the results were compared between the thick skin of lagrange interpolationand the truth thick skin. The results of measurement of the thickness of the skull anthropologists point to the actual skin for two training data is shown in Table 1

Table 1.Thickness Measurement of anthropologists point to the training data

No Image	Skull to Skin Actual Distance for Data Training (mm)									
Data Training	G-G'	No-No'	Ne-Ne'	S-S'	Mp-Mp'	Ls-Ls'	Li-Li'	Su-Su'	Mp-Mp'	Gn-Gn'
Image 1	3,1	3,9	3,7	21,5	14,2	10,4	10,6	10,9	8,4	5
Image 2	3,9	5,45	3	19,35	10,2	6,85	12,05	10	10,35	5,7

The results of the measurement of the distance between the point of anthropologists are shown in Table 2 :

Tabel 2.Measurement bentween Anthropologist points

No Image	Antropolog Points Distance (mm)									
	M-G	G-No	No-Ne	Ne-S	S-Mp	Mp-Ls	Ls-Li	Li -Su	Su-Mp	Mp-Gn
Image 1	28,5	16,2	22	14,5	10,1	18,6	10,7	11,7	12,8	8,8
Image 2	28,3	13,8	18	18,5	13,9	21,4	14,9	13,9	16,4	7,9
Image 3	29,9	13,7	19,4	18,5	12	23,8	14,6	12,5	13,4	6,7
Image 4	29,7	19,9	16,5	11,5	10,2	18,7	17,2	21,2	9,9	8,7
Image 5	30,9	23,9	13,7	18,5	14,4	21	13,9	14,7	17,8	7,9
Image 6	33,4	20,1	16,4	20,2	10,7	17,3	16,8	17,4	11,9	8,5
Image 7	33,5	19,4	27,5	15,7	15	23,2	17	11,6	13,4	9,1
Image 8	27,8	13,4	23,4	18,1	14	26,1	18,2	14,2	16,2	9,3

From the above table can be seen the average distance image 1 to 8 from point 1 until 10 namely: Metopian with glabella (MG) 30.1 mm, glabella and Nassion (GN) of 17.6 mm, Nation and Nasale (No-ne) 19.6 mm, Nasale and Supracanine (Ne-S) 16.9 mm, Supracanine and Mid-philtrum (S-Mp) 12.5 mm, Mid-philtrum and Labiale Superius (Mp-Ls) 21.3 mm, Labiale Superius and Labiale Inferius (Ls-Li) 15.4 mm, Labiale Inferius and supramentale (Li-Su) 14.7 mm, supramentale and Mental Protubance (Su-Mp) 14 mm, Mental Protubance and Gnathion (MP- Gn) 8.4 mm. Then measuring the distance between the long or thick skull into the skin or in the study manual measurements using CT Scan machine.The measurement results are shown in Table 4:

Normalization Data antropolog points length

Tabel 3.Normalization Data antropolog points length

No Image	Antropolog Points Distance (mm)									
	M-G	G-No	No-Ne	Ne-S	S-Mp	Mp-Ls	Ls-Li	Li -Su	Su-Mp	Mp-Gn
Image 1	0,9	0,5	0,7	0,4	0,3	0,6	0,3	0,4	0,4	0,3
Image 2	0,8	0,4	0,5	0,6	0,4	0,6	0,4	0,4	0,5	0,2
Image 3	0,9	0,4	0,6	0,6	0,4	0,7	0,4	0,4	0,4	0,2
Image 4	0,9	0,6	0,5	0,3	0,3	0,6	0,5	0,6	0,3	0,3
Image 5	0,9	0,7	0,4	0,6	0,4	0,6	0,4	0,4	0,5	0,2
Image 6	1	0,6	0,5	0,6	0,3	0,5	0,5	0,5	0,4	0,3
Image 7	1	0,6	0,8	0,5	0,5	0,7	0,5	0,4	0,4	0,3
Image 8	0,8	0,4	0,7	0,5	0,4	0,8	0,5	0,4	0,5	0,3

Tabel 4.The Distance between skull to skin

No Image	The Distance between skull to skin (mm)										
	M-M'	G-G'	No-No'	Ne-Ne'	S-S'	Mp-Mp'	Ls-Ls'	Li-Li'	Su-Su'	Mp-Mp'	Gn-Gn'
Image 1	3,5	3,7	5	4,4	17,8	8,4	8	9,7	9,6	9,5	5,9
Image 2	3,4	3,5	5,1	4,4	18,1	11,2	7,5	10,4	10,6	8,7	6,7
Image 3	3,3	3,5	5,5	3,3	20,6	12,4	10,1	11,8	10,6	10,3	5,5
Image 4	3,2	3,3	4,5	3,9	17,4	14	6,8	10,6	15,2	7,7	5,2
Image 5	3,5	3,9	3,9	4	21,8	12,8	8,5	10,1	9,6	9,5	5,2
Image 6	3,2	3,3	3,9	3,4	21,2	15,6	12,3	11,1	12,2	7,3	4,8
Image 7	3,5	4	4,5	3,9	17,8	14,5	9,6	12	10,1	8,5	7,7
Image 8	3,2	3,4	4,4	2,8	21,3	13,2	7	12,5	10	9	5,1

From the table above it can be seen that within the thick skin of the skull of each point average anthropologist namely glabella (G-G ') 3.5 mm, Nassion (N-N') of 4.6 mm, Nasale (Ne-Ne ') 3 , 8 mm, Supracanine (S-S ') of 19.5 mm, Mid-philtrum (Mp-Mp') 12.8 mm, Labiale Superius (Ls-Ls ') of 8.7 mm, Labiale Inferius (Li-Li') 11 mm, supramentale (Su-Su ') of 10.9 mm, Mental Protubance (Mp-Mp') 8.8 mm, Gnathion (Gn-Gn ') 5.8 mm. By using a reference point on the anthropologist length of each point can be found in the results of measurements of the distance between the skullto the skin using lagrange interpolation. Lagrange interpolation measurement results are shown in Table 4:

Table5.Measurements of the skull to the skin using Lagrange interpolation.

No Image	Distance Skull to the skin with interpolation Lagrange (mm)									
	G-G'	No-No'	Ne-Ne'	S-S'	Mp-Mp'	Ls-Ls'	Li-Li'	Su-Su'	Mp-Mp'	Gn-Gn'
Image 1	3,3	4,6	3,8	12,4	14,6	8	9,4	10,9	11,4	5,9
Image 2	3,3	4,5	4,3	25	13,8	7,8	10,5	11,1	9,6	5,9
Image 3	3,5	4,6	4,1	22,2	13,3	8,1	10,8	11	9,9	5,9
Image 4	3,5	4,7	3,9	26	17	8,4	9,9	11,1	10,2	5,8
Image 5	3,6	4,2	3,6	17,6	9,8	9,1	11,1	10,6	7,7	5,7
Image 6	3,9	4,6	3,4	15,4	10	8,2	11	10,5	8,7	5,6
Image 7	3,5	4,7	4,3	25,6	15,6	8,2	9,8	11	10,8	6,1
Image 8	3,3	4,4	4,3	21,2	11,7	9,2	11	10,2	7,1	5,5

From the above table can be seen within the average range of the skull to the skin with lagrange interpolation image 1 to 8 from the first point until 10 namely: glabella (G-G ') 3.5 mm, Nassion (N-N') 4 , 5 mm, Nasale (Ne-Ne ') 3.9 mm, Supracanine (S-S') of 20.6 mm, Mid-

philtrum (Mp-Mp ') of 13.2 mm, Labiale Superius (Ls-Ls') 8.4 mm, Labiale Inferius (Li-Li ') of 10.4 mm, supramentale (Su-Su') of 10.8 mm, Mental Protubance (Mp-Mp ') 9.4 mm, Gnathion (Gn-Gn') 5.8 mm.

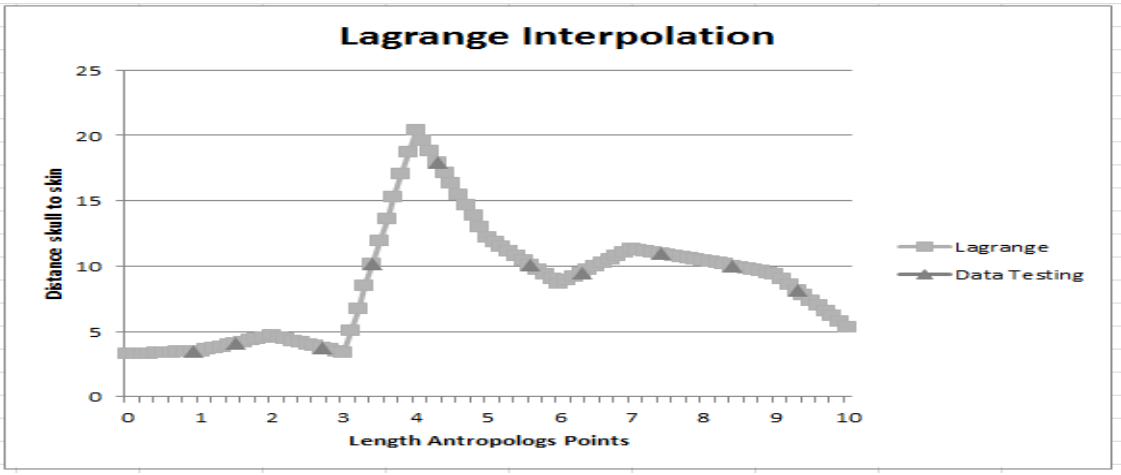

Figure 9 the Distance between anthropologist point and the actual distance

To know the difference and Lagrange interpolation accuracy, distance or width of each anthropologist point measured using Lagrange interpolation will be compared to the length of the actual object, the difference in the measurement of the Lagrange interpolation are shown in Table 4.

Tabel 6.Accuracy and difference in distance measurement from skull to the skin.

No Citra	The Different between real distance with Lagrange Interpolation (mm)										Akurasi (%)
	G-G'	No-No'	Ne-Ne'	S-S'	Mp-Mp'	Ls-Ls'	Li-Li'	Su-Su'	Mp-Mp'	Gn-Gn'	
CItra 1	-0,4	-0,4	-0,6	-5,4	6,2	0	-0,3	1,3	1,9	0	82,7
Citra 2	-0,2	-0,6	-0,1	6,9	2,6	0,3	0,1	0,5	0,9	-0,8	88,7
CItra 3	0	-0,9	0,8	1,6	0,9	-2	-1	0,4	-0,4	0,4	90,1
CItra 4	0,2	0,2	0	8,6	3	1,6	-0,7	-4,1	2,5	0,6	81,8
CItra 5	-0,3	0,3	-0,4	-4,2	-3	0,6	1	1	-1,8	0,5	87,6
CItra 6	0,6	0,7	0	-5,8	-5,6	-4,1	-0,1	-1,7	1,4	0,8	81,7
CItra 7	-0,5	0,2	0,4	7,8	1,1	-1,4	-2,2	0,9	2,3	-1,6	83,2
CItra 8	-0,1	0	1,5	-0,1	-1,5	2,2	-1,5	0,2	-1,9	0,4	85,7

From the table above it can be seen that the accuracy lagrange interpolation ranging from image 1 is 82.7%, image 2is 88.7%, image 3 is 90.1%, image 4 is 81.8%, image 5 is 87.6%, image 6 is76 , 5%, image 7 is 83.2%, image 8 is 85.7%. the accuracy between manual measurement and measurement using lagrange interpolation shown in Figure 1.

It can be seen from the graph above, the average accuracy of the lagrange method ie 84.5%

4. CONCLUSION

In this research, the method for measuring the thickness of point anthropologists iin human skulls using lagrange interpolation generate an average accuracy about 84.5% with the highest accuracy on the image 3 (90.1%) and the lowest accuracy on the image 6 (76.5%).

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