Accredited Ranking SINTA 2
Decree of the Director General of Higher Education, Research, and Technology, No. 158/E/KPT/2021
Validity period from Volume 5 Number 2 of 2021 to Volume 10 Number 1 of 2026

Published online on: **http://jurnal.iaii.or.id**

JURNAL RESTI
(Rekayasa Sistem dan Teknologi Informasi)
Vol. 6 No. 6 (2022) 939 - 944 ISSN Media Electronic: 2580-0760

The Application of The Manhattan Method to Human Face Recognition

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Abstract

In face recognition, the input image used will be converted into a simple image, which will then be analyzed. The analysis was carried out by calculating the distance of data similarity. In the process of measuring data similarity distances, they often experience problems implementing complex algorithm formulas. This research will solve this problem by implementing the Manhattan method as a method of measuring data similarity distances. In this study, it is hoped that the Manhattan method can be used properly in the process of matching test images and training images by calculating the proximity distance between the two variables. The distance sought is the shortest distance; the smaller the distance obtained, the higher the level of data compatibility. The image used in this study was converted into grayscale to facilitate the facial recognition process by thresholding, namely the process of converting a grayscale image into a binary image. The binary image of the test data is compared with the binary image of the training data. The image used in this study is in the Joint Photographic Experts Group (JPEG) format. Testing was carried out with 20 respondents, with each having two training images and two test images. The research was conducted by conducting experiments as many as 20 times. Facial recognition research using the Manhattan method obtains an accuracy of 70%. The image lighting used as the dataset influenced the accuracy results obtained in this study. Based on the results of this study, it can be concluded that the Manhattan method is not good for use in facial recognition research with poor lighting.

Keywords: *face, detection, manhattan, image*

1. Introduction

The face is one of the markers of identity in humans. Face recognition is a system that can be used for individual recognition [1] because the face is a distinguishing feature of each individual In general, recognizing individuals can be done by looking at the face.

In current technological developments, facial recognition systems are widely used for identification and security [2]. Image processing is currently a widely developed application in aspects of life including archeology, astronomy, and biomedicine. Image processing can be done by changing complex input images into simple images to facilitate the analysis process. The analysis was carried out by measuring the distance of data similarity. An algorithmic formula can be used to calculate the distance of data similarity. In measuring distances, there are often problems with the formula being too complicated. In previous research [3] Face recognition is done using LBP for feature extraction without being equipped with grayscale. This research is equipped with a grayscale process to increase the accuracy of the system when performing face recognition. Previous research stated that the Manhattan method can be used to perform face recognition [4] So in this study, the Manhattan method was used as a method for performing facial recognition. The Manhattan method is used to find the distance of data similarity [5][6]. This method is one that is often used to conduct research to determine the similarity between two objects [7]. In previous studies, the Manhattan method was better than the Euclidean method [8]. The Manhattan method is easier to implement on the system because it has simpler equations than the Euclidean method.

The first step in this research is to use images as training data and test data. The next step is to change the training image and test image to grayscale [8] [9]. The grayscale image is then converted into a binary image using a thresholding process [11]. Furthermore, the binary image values from the training and test data are entered into the Manhattan calculation.

The image in this study uses the Joint Photographic Experts Group (JPEG) format with 20 respondents as the research object. The image was generated using the

Accepted: 07-07-2022 | Received in revised: 12-11-2022 | Published: 28-12-2022

Samsung A51 smartphone camera, which has a main camera resolution of 48 MP.

The Acer processor Intel(R) Core(TM) i5-7200U laptop, 4 GB of memory, the Windows 10 operating system, and the Matlab 2015a application were used in this study [11][12] which is supported by graphical mathematics software and has programming capabilities [14][15][16].

In previous research, face recognition was carried out using the Euclidean method with a formula that looked complicated to people outside their field. The Manhattan method was used in this study, which has a simpler calculation formula than the previous method. The problem to be examined in this study is the use of the Manhattan method in face recognition for the image lighting conditions used, namely sufficient lighting and insufficient lighting.

The purpose of this research is to apply the Manhattan method to recognize facial images and determine the level of accuracy of this method in facial recognition. This research was conducted to determine the matching of test images and training images with a dataset using 20 respondents. Because the image was taken directly, only 20 people were tested in this study.

2. Research Methods

The flow of the system in this study begins with the preprocessing stage, which is the stage used to prepare input images in order to increase precision and accuracy in carrying out the classification process that will be carried out. The primary goal of performing the preprocessing stage is to process the data to produce data that meets the requirements. Next is the processing stage, which includes the grayscale, thresholding, and introduction stages of the Manhattan algorithm. The dataset used in this study is a set of facial images taken directly from a total of 20 respondents. Respondents were chosen randomly. The image was taken using the Samsung A51 smartphone camera, which has a 48-megapixel main camera resolution. The system flow can be seen in Figure 1.

The steps used in this research method are as follows:
1) Input photos into the application as training data.
2) Input photos into the application as test data.
3) Convert the photo to grayscale using a grayscale scaling process.
4) Converting grayscale photos to binary images.
5) Calculate the distance between the test image, which has become a binary image, and the training data image.

2.1. Graycale

A grayscale image only requires an intensity value for each pixel used as a single value, while a color image requires three intensity values for each pixel. Conversion from RGB image to grayscale in equation (1):

$$Iy = 0{,}333Fr + 0{,}5Fg + 0{,}1666Fb \quad (1)$$

Fr is the intensity of red (red), Fg is the intensity of green (green), Fb is the intensity of blue (blue), and Iy is the intensity of gray (gray), which is equivalent to the RGB level.

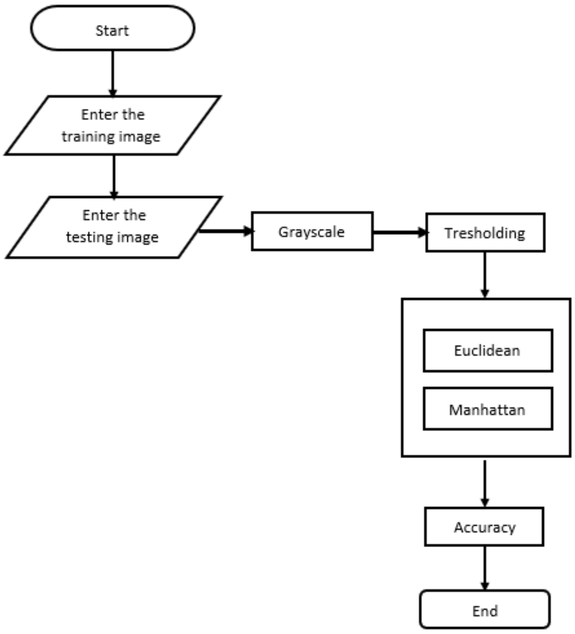

Figure 1. System Flow

2.2. Tresholding

In the transcoding stage, the grayscale image is converted to a binary image. Binary images only have two possible values for each pixel, namely black and white. Each pixel in the image will be marked as a pixel object with a value of 1, while a background pixel has a value of 0. Image segmentation based on object and background pixels can be expressed mathematically as (2):

$$g(x,y) = \begin{Bmatrix} 1 \; if \; f(x,y) \geq T \\ 0 \; if \; f(x,y) < T \end{Bmatrix} \quad (2)$$

Based on equation (2), g(x, y) is a grayscale image, f(x, y) is converted to a binary image, and T is the threshold value.

2.3. Manhattan

At this stage, a distance measurement will be carried out; the distance sought is the closest distance. If the value obtained is large, the level of similarity between the two objects will be smaller. Sebaliknya, jika nilai yang didapatkan kecil maka tingkat kemiripan antara kedua objek akan semakin besar. Conversely, if the value obtained is small, the level of similarity between

DOI: https://doi.org/10.29207/resti.v6i6.4265

the two objects will be even greater. Equation (3) can be used to calculate Manhattan distance:

$$d(x,y) = \sum_{i=1}^{n} |x_i - y_i| \quad (3)$$

Based on equation (3), d is the distance between x and y, x is the input data, y is the weight, n is the amount of data, x_i is the i-th data, and y_i is the i-weight.

2.4. Accuracy

The accuracy of the facial recognition system in this study can be calculated using equation (4):

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+TN+FP} x100\% \quad (4)$$

True Positive (TP) is a face image that is in a database and can be recognized by the system according to the dataset. False Positive (FP) is a facial image in the database that the system cannot identify based on the dataset. True Negative (TN) is a face image that is not in the database and has been identified as unknown. False negative (FN) is a face image that is not in the database but can be identified with other data in the dataset.

3. Results and Discussions

This study uses 20 respondents as a dataset, with each respondent having two images for training data and two images for test data. The test images used were images with sufficient lighting and images with less lighting. The image was taken with the Samsung A51 smartphone camera, which has a 48-megapixel main camera resolution. The image used has a size of 719x719 pixels. At this stage, facial recognition testing was carried out using the Manhattan method. The Matlab 2015a application was used to run the tests, which used an Intel(R) Core(TM) i5-7200U CPU at 2.50 GHz and 4 GB of memory. The test results can be seen in Table 1.

Table 1.Test Table

No	Training Image	Testing Image	Face Detected	
			Yes	No
1			√	-
			-	√
2			√	-
			√	-
3			√	-
			-	√
4			√	-
			-	√
5			√	-
			√	-
6			√	-

DOI: https://doi.org/10.29207/resti.v6i6.4265

			-	√
7			√	-
			-	√
8			√	-
			-	√
9			√	-
			-	√
10			√	-
				√
11			√	-
				√
12			√	-
			√	-
13			√	-
				√
14			√	-
			√	-
15			√	-

DOI: https://doi.org/10.29207/resti.v6i6.4265

Based on Table 1, the test was carried out using two training datasets and two test datasets. In the test data, two images are used, namely the image in sufficient lighting conditions and the image in poor lighting conditions. The first test image is an image taken in sufficient lighting conditions, and the second test image is an image taken in insufficient lighting conditions. From the tests that have been carried out, it can be seen that the facial recognition system using the Manhattan method is not good when used in face recognition when the image lighting conditions are not good. Of the 40 experiments that have been carried out, there are 12 times when the faces are not the same, which is caused by a lack of lighting when taking the image. The value of the Manhattan calculation results can be seen in Table 2 and Table 3. The calculation results are obtained from equation (3). In Table 2, as an example, five test data points are presented, where the image used is the first image for each respondent, which is an image with sufficient lighting. Table 3, as an example, is presented with five test data points where the image used is the second image for each respondent, which is an image with low lighting.

Table 2. Table of Test Result Values for the Enough Lighting Image

Training Image	Testing Image				
	1a	2a	3a	4a	5a
1a	62097	254927	287214	258624	192406
1b	29333	250119	276030	253276	190566
2a	242332	71888	161125	198713	271555
2b	245452	63468	156583	196319	272123
3a	277532	154990	90471	162583	327853
3b	289378	164140	103133	158841	342869
4a	244664	202126	160863	141089	315111
4b	249186	189814	148811	162833	313157
5a	193984	276130	338889	303363	59095
5b	197631	277175	340358	304480	50726
6a	156447	273403	322894	290652	118434
6b	143850	280842	324747	265035	147551
7a	255545	287667	280988	258418	232212
7b	244901	292893	287908	271940	226276
8a	260830	246010	225193	219619	266555
8b	262881	247391	230288	232186	261178
9a	157371	251049	252022	219360	230982
9b	139945	250033	265120	240320	220488
10a	184423	263715	278648	259380	164622
10b	176109	284115	313902	258108	167276
11a	170727	286509	337020	270948	136984
11b	201290	270898	301067	265887	162563
12a	201681	303603	330688	285934	135716
12b	214428	278968	299017	273495	164921
13a	251051	277419	243176	214278	256832
13b	268690	274896	237939	203763	277471
14a	291439	244055	210022	198126	289080
14b	308670	244898	194277	209051	298873
15a	290075	213201	232858	234034	287746
15b	300689	219013	229642	244856	293666
16a	156447	273403	322894	290652	118434
16b	244958	252222	279293	256683	242627
17a	198955	287223	310380	268892	185404
17b	199686	272836	309501	252325	195197
18a	308601	223657	230684	225646	251940
18b	328103	229089	209216	209526	265384
19a	163801	235389	261798	235442	192362
19b	158023	240237	263892	243562	193898
20a	202437	289015	318940	249076	158336
20b	205705	289341	319880	243552	159440

Tabel 3. Table of Test Result Values for Low Lighting Image

Training Image	Testing Image				
	1b	2b	3b	4b	5b
1a	276335	284745	297551	282520	228189
1b	272379	286019	299051	280614	234853
2a	131320	133220	140898	156397	304268
2b	130502	133468	138360	157557	304996
3a	149170	157220	150754	230971	371504
3b	139434	151384	139260	220387	365428
4a	219562	226758	230428	270923	342480
4b	212398	210626	217134	252381	340368
5a	344498	351226	361588	270733	120386
5b	345255	351817	361973	271490	113301
6a	361921	371077	385139	286680	155399
6b	352626	358712	372932	270137	176906
7a	319695	327141	329391	336334	226205
7b	341791	340597	343935	327536	233455
8a	227074	238764	242814	319825	304028
8b	240465	251387	254599	306230	292821
9a	270811	289327	302373	297794	269823
9b	266861	281789	293103	295190	265997
10a	327127	344147	351187	301996	221595
10b	344805	352387	366405	301106	196337
11a	334137	349743	354191	309792	153681
11b	308834	337674	336962	310445	198862
12a	328671	328455	328587	284874	133429
12b	287886	301664	294620	298177	165820
13a	267977	277839	279761	321944	263887
13b	256704	261838	263324	309887	274134
14a	204145	219271	216197	303854	294487
14b	218872	224608	225564	304841	307282
15a	240519	233639	235341	261010	281527
15b	241091	235357	237555	264192	287071
16a	361921	371077	385139	286680	155399
16b	276936	290424	301302	263911	260098

DOI: https://doi.org/10.29207/resti.v6i6.4265

17a	308455	316849	318205	329656	189685
17b	287658	306042	306062	315135	193182
18a	212387	234051	226563	252352	252085
18b	221873	229525	219435	255824	252115
19a	255821	277941	278765	251316	228221
19b	272551	290909	290669	255890	234509
20a	317293	339095	338271	317746	167245
20b	319445	338483	338287	309900	162403

Based on Table 2 and Table 3, to determine the match of faces, look at the smallest results from the columns in Table 2 and Table 3. The green cells indicate that the experiment obtained the same test-face results as the training faces, while the red cells indicate that the experiment obtained facial results. The test is not the same as the training scenario. Thresholding is a criterion used to obtain the values in Table 2 and Table 3, where the grayscale image will be converted to a binary image before Manhattan calculations are performed. Based on the tests that have been carried out, the values of the test variables with TP = 28, FP = 12, TN = 0, and FN = 0 obtained accuracy based on equation (4) as follows:

$$\text{Accuracy} = \frac{28+0}{28+12+0+0} x100\% = 70\%$$

Based on the tests that have been carried out 40 times using 20 respondents, the accuracy of the system in performing face recognition is 70%. Based on the accuracy that has been obtained, it can be concluded that the Manhattan method is not suitable for recognizing faces in low-light images.

4. Conclusion

Face recognition research using the Manhattan method has been carried out using a dataset of 20 respondents, with each respondent having two training images and two test images. The test images used were images with sufficient lighting and images with less lighting. The criteria used in this study is thresholding, which is the stage of changing a grayscale image into a binary image to facilitate the extraction process. This research produces an accuracy rate of 70%. Based on these results, it can be concluded that this method is not suitable for performing face recognition with images that are poorly lit.

As recommendations for furthering this research, it is suggested that in future studies, methods that improve system performance in recognizing images with low lighting be included. The addition of methods to reduce noise in the image can also be used to improve the results of the Manhattan method. Increasing the percentage of facial recognition can be done by applying normalization or preprocessing steps.

Acknowledgment

I would like to thank the Ahmad Dahlan University Master of Informatics study program for facilitating the Research Laboratory as a forum for researchers to develop journal research and complete this research.

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DOI: https://doi.org/10.29207/resti.v6i6.4265