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Family Relationship Identification by Using Extract Feature of Gray Level Co-occurrence Matrix (GLCM) Based on Parents and Children Fingerprint

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ABSTRACT

This study aims to find out the relations correspondence by using Gray Level Co-occurrence Matrix (GLCM) feature on parents and children finger print. The analysis is conducted by using the finger print of parents and family in one family There are 30 families used as sample with 3 finger print consists of mothers, fathers, and children finger print. Fingerprints data were taken by fingerprint digital persona u are u 4500 SDK. Data analysis is conducted by finding the correlation value between parents and children fingerprint by using correlation coefficient that gained from extract feature GLCM, both for similar family and different family. The study shows that the use of GLCM Extract Feature, normality data, and Correlation Coefficient could identify the correspondence relations between parents and children fingerprint on similar and different family. GLCM with four features (correlation, homogeneity, energy and contrast) are used to give good result. The four sides (0^o, 45^o, 90^o and 135^o) are used. It shows that side 0^o gives the higher accurate identification compared to other sides.

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1. INTRODUCTION

Information technology increases so fast in some various aspect scuh asgovernment, factory, school, hospital and others. Thus, the security system such as fingerprint, authentication, and verification becomes an interesting issue. Fingerprint is categorized as one of the best identification tools for its uniqueness [1]-[2]. Many researches about combination development [3] and the accurate of extract feature [4] are conducted [3]. Moreover, texture analysis is conducted to gain the score that will be used in finding the correlation score of study object.

The other research that used wavelet and SVD method to identify the impact of genetics to the fingerprints. The research was conducted at 50 different fingerprints families. It found a high accuracy with 85%. The results showed that there were relationships between father and son = 0.3007 and the mother and children = 0.3448. While the relations value obtained on another family with father and son; mother and children = 0.2726 = 0.1747 [5].

In this research, fingerprint identification using extract feature is done to recognize the relations correspondence between parents and children. The result analysis consists of relations correspondence between the similar families with others. Extract feature method in this study uses the Gray Level Co-occurrence Matrix (GLCM) which combining the correlation analysis.

2. RELATED WORK

Fingerprint identification is a features of correlation coefficient of entropy and energy coefficients. Features can be calculated quickly through identification response. Techniques based on texture can prove more useful results than a standard based approach to detail when a fingerprint image captured using low lighting or noisy environment with small details that cannot be extracted [6].

Heritability fingerprints and dermatological are determined by calculating the coefficient of correlation *r* and the regression equation between parents and children from their families with other families [7]. Fingerprint needs to be improved using an algorithm to verify what have been served to increase alignment accuracy to overcome the shortcomings of previous methods due to poor image quality [8].

Parents with a particular fingerprint pattern have a relative high tendency to produce children with the same pattern. An inheritance fingerprint of all kinds of fingerprint occurs in the same way, with no fingerprints genetic similarity between parents and children in a variety of cases [9].

Distribution of the fingerprint pattern does not follow the trend of steady and regular. A survey was conducted in Ghana to validate the use of fingerprints to identify individuals who were brothers of a population. Of all the categories, the identity of the twins proved to have the same fingerprints. The possibilities of the two individuals have the same pattern (Q value) at the corresponding finger that is 77.8%. It is very large compared to the value of 42.5% which is obtained from twin brothers. In a family, there are various groups that a father with his son, a father with daughter, a mother and her son, and a mother with her daughter who has a value of 62.7%, 45.7%, 52.0% and 48.5%, respectively. It was difficult to distinguish between a biological child and not in a family [10].

3. RESEARCH METHOD

The research consists some parts such as exploring the background, puepose and scope of the study a literature was done to develop the understanding about the fingerprint feature extraction. Moreover, the study of literature was also conducted to find out the results of extract feature.

The second step of the study is data collecting on parents and children fingerprints. In the third phase is determining the pre-processing of each pixel fingerprint data. The researcher also implements histogram equalization method, the application used was C# based applications. In the fourth stage, GLCM feature extraction based C # applications. In the fifth stage normalization of data from the feature extraction. The step is to search the correlation between parents and children. Then the last stage is to draw conclusions and make suggestions. Figure 1 shows the steps of this research. The detail of these steps is described as follow.

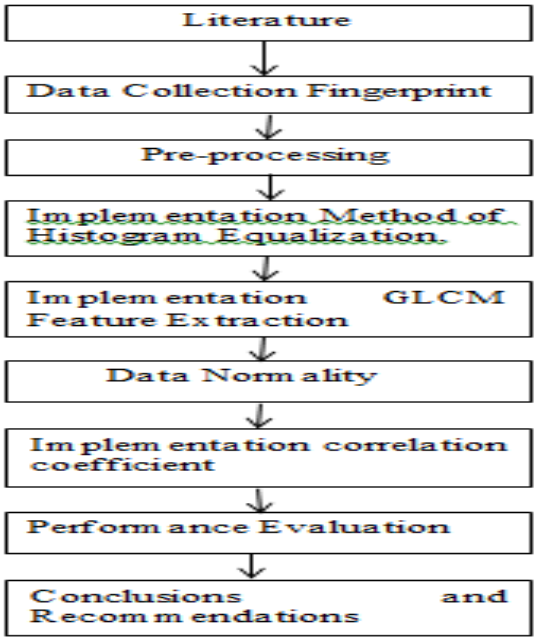


Figure 1. Research Procedures

a. Literature

The literature study was conducted to gain knowledge of fingerprint feature extraction using GLCM, convolution method was required to obtain information on the previous studies on fingerprint feature extraction.

b. Data Collection Fingerprint
At this step, data collection fingerprint children and older people are taken in directly by using a digital fingerprint persona u are u 4500 SDK.

c. Pre-processing
In the pre-processing step size in cropping fingerprint will be a few pixels to obtain the midpoint of the fingerprint.

d. Implementation Method of Histogram Equalization.
After literature study step done, the next step is the implementation of the histogram equalization. Use of the method histogram equalization on the extraction of fingerprint features are intended to reduce the noise in the image of the fingerprint, which is expected to improve the quality of the image when the feature extraction stage GLCM do.

e. Implementation GLCM Feature Extraction.
At this step, the fingerprint data extraction to get the value of his image, at this stage of the method used is the method of extracting features from GLCM.

f. Implementation correlation coefficient
At this step, the results of feature extraction and normalization then calculated the correlation between parents and children.

g. Performance Evaluation
At this step, histogram equalization, GLCM, normalization and correlation coefficient their performance will be evaluated, whether the method used is already giving results that are expected or not. From the results of these evaluations showed correlations between parent and child, so that the results can be made of decision-making and advice.

h. Conclusions and Recommendations
After the pre-processing step, implementation of the histogram, GLCM, normalization and correlation coefficient has been completed, further identification and evaluation has reached the goals that were set, then taken to a conclusion.

4. PROPOSED METHOD

The method proposed in this study is extracting feature method GLCM (Gray Level Co-occurrence Matrix). Extract feature is done to get the value of fingerprints of parents and children. After the extract feature is done then the value obtained is normalized to get the normal value of the extraction. The results of normality then compared with each of the features of the parents and children to find the correlation. Correlation coefficient was used to find the correlation value. Some of the features in the extract features using GLCM that will be used in this research were correlation, contrast, homogeneity, and energy such as shown Equation (1), Equation (2), Equation (3) and Equation (4):

$$\text{Correlation} \qquad f1 = \frac{\sum_i \sum_j (i-\mu_x).(j-\mu_y).p(i,j)}{\sqrt{\sigma_x \sigma_y}} \tag{1}$$

Where:

i = row
j = columns
p = GLCM matrix

$$\text{Contrast} \qquad f2 = \sum_i \sum_j (i-j)^2.p(i,j) \tag{2}$$

Measuring the spatial frequency of the image and the difference GLCM moment. The difference is meant a difference of its high and low pixel. Contrast will be 0 if the pixel neighborhoods have the same value.

$$\text{Homogeneity} \qquad f3 = \sum_i \sum_j \frac{\mathrm{p}(i,j)}{1+(i-j)^2} \tag{3}$$

The value was very sensitive to the value around the main diagonal. It will has a high value when all the pixels have the same value. The opposite of contrast will have a great value if it has the same pixel value at the time of valuable energy.

Energy $f4 = \sum_i \sum_j p(i-j)^2$ (4)

To measure uniformity or often so called the second angular moment. Energy will have a high value when the pixel values are similar to one another would otherwise be of little value indicates the value of GLCM normalization is heterogeneous. The maximum value of the energy was 1, which means the distribution of pixels in a state of constant or in the form (not random).

5. RESULT AND DISCUSSION

This chapter focuses on the steps of study namely, pre-processing (resizing and cropping), filtering, and GLCM extract feature with four features, namely correlation, energy and homogeneity, contrast, normality, and then calculating the correlation between the fingerprint image of parents and children by using correlation coefficient.

5.1. Preprocessing (resizing and cropping)

The acquisition process is performed using an image of the fingerprint U Are 450. The image obtained from the image-making process is an image with a size of 154 x 192 pixels, to accelerate the computing process performed downsizing the image to 150 x 150 pixels. In Figure 2 is an example of the image acquisition.



Figure 2. Preprocessing (Resize dan Cropping)



Figure 3. Fingerprint Core Point

In this study, the stage of cropping was conducted to get the core point of the fingerprint image. Image acquisition based core point made to accelerate the process of feature extraction algorithms. For more details about the core point is shown in Figure 3.

5.2. Filtering

At this stage, the filtering is very important to reduce the interference of the fingerprint. The filter used in this study is the use of histogram equalization. Histogram equalization was selected for the results given by equalization histogram method that improve the quality of the image, so that the information in the image looks more visible.

5.3. GLCM Extract Feature

Fingerprint image that filtered by using histogram equalization then extract feature process was performed in this research using GLCM with 4 angles were 0^o, 45^o, 90^o and 135^o, then the features used were correlation, energy, homogeneity and contrast. Before doing extract feature the fingerprint image was filtered by using the histogram equalization to reduce disruption to the fingerprint image. Before the features GLCM calculated, at first fingerprint image that cropped and filtered then imported, like the Figure 4.

Figure 4 showed the fingerprint image did not show the results of each feature, to see the results of the features of each image, select one side.The results of the calculation of the features can be seen in Figure 5, by first selecting one of the sides. Figure 5 displays the results of the image which is inserted by selecting one of the sides, the study using 4 features of GLCM i.e. correlation, homogeneity, energy and contrast. The results of the feature values is then normalized to get the smallest then calculated the correlation among the value of correlation, homogeneity, contrast and energy of family and children's fingerprints.

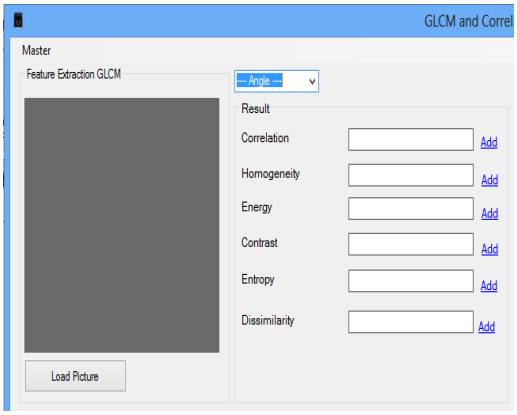


Figure 4. Main view after fingerprint is inserted

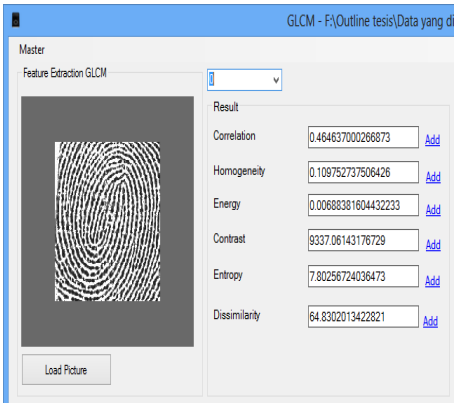


Figure 5. GLCM Extract feature

5.4. Data Normality

The process of data normality of extract feature GLCM is done to get the normal value. It is necessary to normalize the data to obtain normal data. The results of extract features that normalized then calculated the correlation between the features of the fingerprint parents and children by using correlation coefficient method.

5.5. Correlation Coefficient

In this phase, the process of calculating the value of extract feature will be calculated the value of correlation between the values of the features of children with their parents. The correlation value is calculated by using the correlation coefficient. Before performing calculations, the result of extract feature GLCM should be normalized. The result of normality then inserted into coefficient correlation application to obtain correlation values between parents and children.

Figure 6 shows an example of the calculation result of the correlation coefficient application, before the application issued the results, it must first be filled feature values between parents and children. The calculation is done one by one put children first feature followed by including features a father, after the feature parents and children entered one by one and then click add data followed by pressing the calculate button , and wait for the result of the application of correlation coefficient.

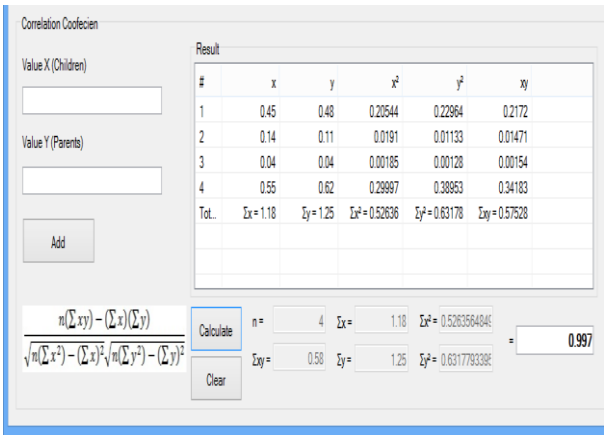


Figure 6. Correlation Coefficient Calculation Results

5.6. Evaluation of Similar Family

The data used in this study is from 30 families, then the results will be grouped into two, namely the identification of attachment to the same family and the comparison between families with others that selected randomly. Comparisons are made to get the result if the method of extracting features of GLCM can differentiate between the fingerprints of the same family and different family, in this case to be used as a comparison that the fingerprint data of children. The results of GLCM extract feature with 4 features (energy, correlation, homogeneity and contrast) and normalization are used to obtain the correlation between parents and children from each family. To obtain a correlation value is calculated using the correlation coefficient.

Among 30 trials experiments in the same family, the correlation of each features the fingerprint parents and children showed accuracy of 0^o = 73% = 26% 45^o, 90^o and 135^o = 16% = 25%. Results are determined based on common values accuracy of the first digit of the correlation between the child and the father, son and mother. The results of different correlations between children and their families are considered to be fail after gainng two results. The following results are identified based on the average of the correlation between parents and children in the same family.

From Figure 7 can be seen with a 0° angle after averaged obtain the highest accuracy results for the same family, the same family for their similarity correlation values between parents and children. As for the angle of 45^o, 90^o and 135^o visible differences in the accuracy of results, it is proving a corner with an angle 0^o highest identification results. Calculating the value of the average correlation to the same family are, for the angle 0°: the father - son = 0824 and the mother - child = 0.809, the results of this correlation value to 0° angle in the same family is quite high. As for 45^o are: father - mother = 0.629 and the mother - child = 0.641, and for the 90° angle is: the father - son = 0.676 and the mother - child = 0602. Then to 135^o angle is: the father - son = 0525 and the mother - child = 0562.

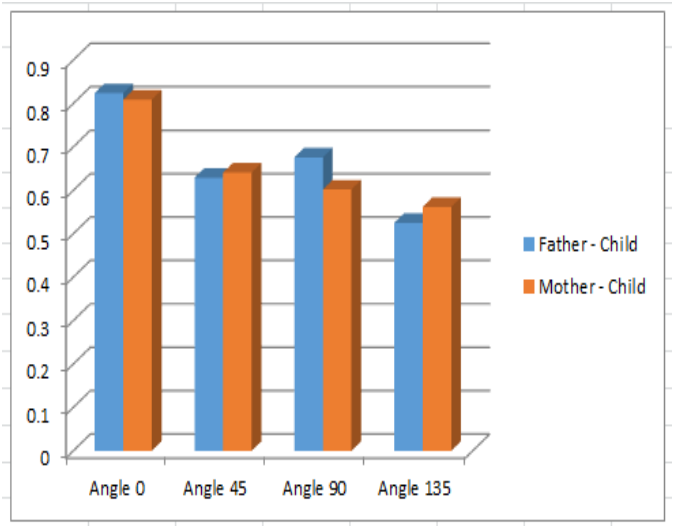


Figure 7. The average value of the correlation for the same family

5.7. Evaluation of Different Family

After obtaining successful correlation results, it compares with the other families that is the son of a family. There is different correlatios between one family and others. The results were 0^o = 70%, 45^o = 26%, 90^o = 16% and 135^o = 26%. The following results are identified based on the average of the correlation between parents and children in different families were selected randomly. There is different correlation value of different family. The data used as a comparison is a data that have a similarity with his or her family. Figure 8 shows the correlation of similar family.

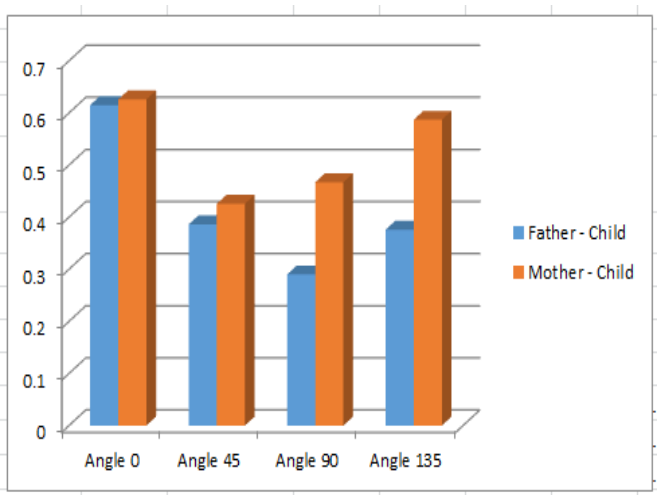


Figure 8. The average correlation values for different families

It can be seen with a 0° angle after averaged obtained different results for different families. 0^o angle is the angle the highest identification results. The value of the average correlation to the same family are, for the angle 0°: the father - son = 0615 and the mother - child = 0626, the results of this correlation value to 0° angle in different families is quite high. As for 45^o are: father - mother = 0.386 and the mother - child = 0.425, and for the 90° angle is: the father - son = 0.290 and the mother - child = 0467. Then to 135^o angle is: the father - son = 0376 and the mother - child = 0587.

Figure 9 shows a comparison chart between the same families with different families. For the same family, the correlation between father - child and mother - child have shared values. Then to a different family, the correlation between father - child and mother - the child has a different correlation values. The comparison of both visible angle is 0° angle provide identification results with the highest accuracy rate compared to the other angle.

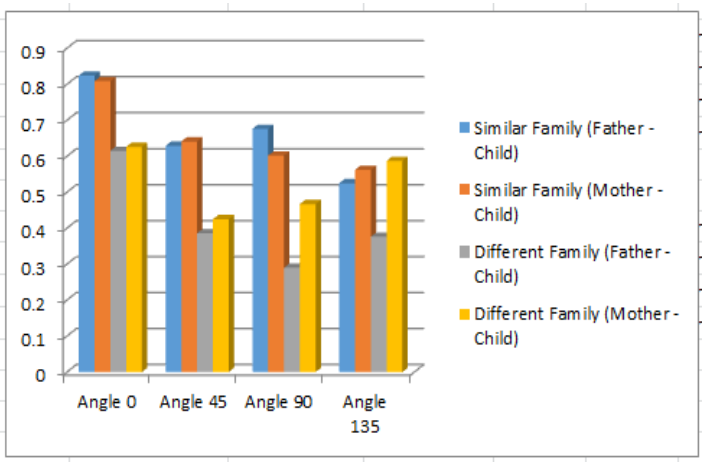


Figure 9. Comparison between similar and different family chart

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6. CONCLUSION

Image processing method using gray level co-occurrence matrix (GLCM), normalization and correlation coefficient can be implemented in the application for identifying fingerprints relationship between parents and children in the same family and different family. GLCM methods, normalization and correlation coefficient were depreciated in this study were able to identify the attachment relationship between fingerprints of parents and children in the same family and comparing the different families were selected randomly. GLCM with four features, namely correlation, contrast, homogeneity and energy give good results and from the 4 corners used is 0^o, 45^o, 90^o and 135^o have different different results. The use of angle 0^o provide identification results with the highest accuracy compared to other angles.

The applications can be developed by adding searching system of fingerprint core point and normality feature that can be imported from Excel. The result of comparison with blood sample should be conducted in each family to ensure the used method was valid.

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