

Fingerprint Pattern Recognition Using LVQ

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Abstract: Various ways are developed to determine a person's personality. One was the use of neural networks to determine the human fingerprint patterns. This method is associated with dermatoglyphics. Dermatoglyphics is the study of human fingerprints and relation to aspects of a person's behavior. Fingerprint pattern everyone has its uniqueness. According to Dermatoglyphics science, fingerprint patterns can be used to understand the nature of a person's inborn. These properties include self-potential, personality, and preferences of the person. Meanwhile, the thickness and size of a person's fingerprint will continue to increase with age. However, will not change the pattern and shape of the fingerprint itself, unless the person has an accident that causes severely injured the finger. Learning Vector Quantization can be used to recognize the shape of a person's fingerprint. It helps the dermatoglyphics to determine the model of the personality of the person.

Keywords: LVQ, Dermatoglyphics, Fingerprint, Neural Network

I. Introduction

Developments in the field of information technology is very fast, especially in the field of the digital world [1][2]. The changes have had a considerable impact. One of them with their digitalized image data. With the image processing, a variety of patterns can be recognized easily. One of them is the shape of the fingerprint pattern. Fingerprints have a pattern of its own, especially in the ridges of the fingerprint. Differences in the pattern of the fingerprint can be used as identification of humans. With the fingerprint, the data themselves may not be confused with other data.

Biometric identification is always applied to check the authenticity of a person to enter into a security system. The identification of fingerprint pattern can be applied by using fuzzy techniques [7][8][9][10] as well. Fingerprints are one of the patterns used for biometric scanning. Fingerprints are used because they are the same, none of the people on this earth. Fingerprint pattern is unique. It is also often used for someone to recognize the nature of the human being. There are several categories of fingerprint patterns that reflect specific properties. To test these properties need a system that can recognize a person's fingerprint pattern. The introduction of the system requires trials and samples to reduce errors. Pattern recognition algorithms that involve certain developing very rapidly. This development created the science of artificial neural networks in pattern recognition fingerprint. It can perform fingerprint pattern recognition process with two stages, learning, and testing. This model is the model of how the human thinks. The algorithm used is Learning Vector Quantization (LVQ) which is an artificial neural network supervised learning process. This algorithm is expected fingerprint recognition can be accomplished quickly and accurately. In this study, LVQ will be used to train the fingerprint data by a certain amount and then will be compared with fingerprints tested. The experiments are performed by comparing the variable value changes with the degree of fit LVQ fingerprint patterns from the sample.

II. Theories

Fingerprints have four basic dermatoglyphic patterns already formulated. The pattern is a Whorl or Swirl, Arch, Loop, and Delta. Besides, some other patterns are variations of the four combinations of these patterns.

Whorl

Whorl is a form of spiral, bulls-eye, or double loop fingerprint as shown in Figure 1. Whorl has dots stand out and contrast and can be seen easily. The spiral pattern and a bulls-eye are exactly congruent in its interpretation, but that both give a little more focus. Everywhere in the hands, whorl highlight and emphasize to specific regions, making it a priority area in living subjects.



Fig. 1 Whorl Fingerprint

Arch

The Arch pattern as shown in Figure 2 is seen as a Flat Arch is or Tented Arch. The arch pattern indicates traditional values and high morals. In almost all cases, the moral values are, to some people in the past in which they have been humiliated. People with this pattern having trouble seeing the negative traits of their own, and to understand that the past that they lock on the stain or the shame is just an experience that is required for the full development of personality. People with flat Arch follow the tradition with a bit of independent thinking, while those with patterns Tented Arch revealed an intellectual depth.



PLAIN ARCH

Fig. 2 Arch Fingerprint

Loop

It can rise toward the fingertips, or down towards the wrist. Common Loop move toward the thumb, while Radial Loop moves directing the tip to the side of the finger. The most common type of fingerprint is Common Loop. These patterns reveal the ability to use a variety of ideas from various sources of ideas, and combine these ideas with their way. Loop expresses a natural follower. The desire to lead others more often. However, not everyone has a common pattern Loop can lead.

Radial Loop

Radial Loop is the pattern swooping entering and departing from the thumb side of the hand. If the Common Loop show a mix of other styles, Radial Loop reveals the ability to create a style or an entirely new system. This person has a visual memory sharp, able to remember not only images but also actions and emotions that accompany the images earlier. As with all other signs, Radial Loop applies to any field or finger on it was found that sign.

Double Loop

Double Loop mostly misunderstood by almost all markings dermatoglyphic. In general, interpret the same as the Double Loop-whorl whorl another, with the main difference: Up to personality developed will tend strongly towards the statement exaggeration, manipulation, and subversive actions in the area of life. For example, someone with Double Loop on her thumbs may be in his early use of deception to help fulfill their wishes against the other. The owner of this hand lines drawn toward an exciting career, which with ordinary effort can be realized easily.



RADIAL LOOP

Fig. 3 Radial Loop Fingerprint

Delta

Delta is a cluster that contained in the estuary of the river water flowing into the sea or lake is always carrying mud and stones that eventually formed a group of islands called delta. Delta actual fingerprint is a point / line found on the center line of type parting lines. Delta is a focal point located at the front center of the separation of the staple lines. Staple line painting is the two deepest lines of some lines are lined up (parallel) and separating and (likely) covers basic painting (pattern area). Principal painting is a regional / white room surrounded by a line of type lines in which the room is a painting of lines fingerprints. In reality, not all fingerprints have Delta, but there is also a fingerprint that has more than one delta. Figure 4 show where the delta is.



Fig. 4 Delta Fingerprint

III. Related Works

Previous research has been done that has been linked to personality analysis or fingerprint analysis. Shitala Prasad [4] predict a person's personality by analyzing handwriting in a digital form using the six traits that the font size, the slope of the letters and words, basic words, writing pressure, the space between letters and words. Experiments carried out in two stages, the first stage (A) using 2/3 of the sample data as training data and 1/3 the data as test data. This stage uses the 100 respondents, of which two-thirds of the sample data and the results of psychological handwriting used to train the system and the data 1/3 handwriting samples tested to determine its accuracy, the results obtained 90.3% accuracy. The second phase (B) using the data as a test data and sample data used to train the rest of the system, the accuracy of the results obtained 93.86%. The linkages quantitative parameters Dermatoglyphics, i.e., the number of strokes lines (ridge) a-b fingerprints, and ATD angle to diagnose patients with bronchial asthma [5]. Some ridges a-b high, can be used as diagnostic criteria for patients with bronchial asthma.

The fingerprint patterns is to identify the level of intelligence with parameters ridge count (the number of strokes fingerprints), the number of strokes (ridges) between triradius A, B, C, D on the palms and the left hand corner of the ATD with the right hand. The sample used were 70 people who had a high IQ (superior intelligence) and the 400 people who have moderate or ordinary intelligence. The method used is the method of statistical analysis of variance and discriminant analysis conclusions obtained is a level of intelligence to grow in line with increasing ridge count (strokes fingerprints) and a decrease in the angle ATD palms [3]. The fingerprint classification method designed agglomerative hierarchical clustering techniques with FPROCK method that classifies the image with the concept of neighborhood each object [6]. The performance of the classification technique is measured by False Acceptance Rate and accuracy dataset variety of sizes. FPROCK technique can identify 6 class at 97.3% accuracy rate. While other classification techniques can be classified only five classes with an accuracy of 80% to 94.8%.

IV. Methodology

Learning Vector quantization is a method in the Neural Network to conduct supervised learning on the layer. Pattern classification methods with each unit-output represent a particular class or a particular category. Weight vector of an output unit that became the benchmark for the class / category is represented by the output. The approach taken is to classify the input vector based on the proximity of the input vector to the weights.

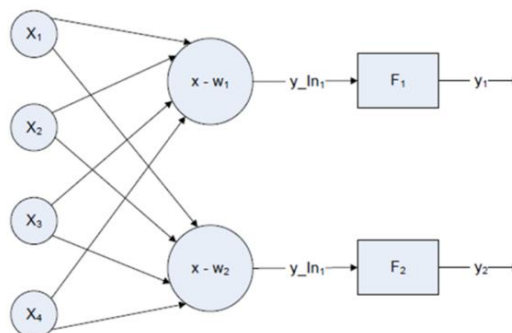


Fig. 5 LVQ Architecture

Figure 5 is an example of LVQ network structure which has four input layer with two units of neurons in the output layer. w_1 and w_2 are the weight that connects the input layer to the output layer. Each activation function F mapping each y_{in} to classification y_1 or y_2 . In F_1 , if $|x-w_1| < |x-w_2|$ then y_{in1} mapped to $y_1 = 1$ and mapped to $y_1 = 0$ if otherwise. This condition also applies in F_2 , with appropriate conditions.

LVQ Algorithm:

- ❖ Initialization
 - Initialization of Vector Reference
 - Learning rate initialization $\alpha = 0$
- ❖ If the condition of the wrong stop, do steps 2-6
- ❖ For each training vector, do steps 3-4
- ❖ Get the value j that $\| X \| w_j$ minimum worth
- ❖ Update the weights w_j
 - If $T = C_j$ then $w_j = w_j + \alpha (x-w_j)$
 - If $T \neq C_j$ then $w_j = w_j - \alpha (x-w_j)$
- ❖ Update the value of learning rate
- ❖ Test the stop condition

Test the stop condition can be made based on a certain number of iterations (from step 1) or after the pace of learning has reached a very small price.

Where:

- X = training vector
($x_1, \dots, x_i, \dots, x_n$)
- T = category vector correct training for training
- W_j = weight vector for the j -th output unit
($w_{1j}, \dots, w_{ij}, \dots, w_{nj}$)
- C_j = category or class represented by the unit value of the output j
- $\| X-w_j \|$ = Euclidean distances between vectors and vector enter the weight of the unit output j .

V. Evaluation

In this section, there are three fingerprint samples. There are Arch, Loop and Whorl. The dimension is 128 x 128 pixel. These figures below represent the samples.



Fig. 6 Arch



Fig. 7 Loop



Fig. 8 Whorl

The samples are converted into binary vector (v[0], v[1],...,v[16383]). There are 16384 numbers to be filled with 0 or 1 where 0 represents the white color and 1 to the black one.

Input Parameter:

EPOCH : 10
Learning Rate : 0.05
LR Reduction : 0.1

Training Result:

EPOCH : 1

```
=====
W1 : 96,2029105588807
W2 : 63,6945837571767
W3 : 71,6449579523919
Max : W3

W1 : 63,6945837571767
W2 : 85,463442476886
W3 : 63,3506116781836
Max : W3

W1 : 71,6449579523919
W2 : 63,3324561342761
W3 : 92,7327207624153
Max : W2
```

EPOCH : 2

```
=====
W1 : 96,2029105588807
W2 : 64,1155207418617
W3 : 72,6291608102379
Max : W3

W1 : 63,6945837571767
W2 : 84,4946743883874
W3 : 64,5940974470564
Max : W1

W1 : 71,2917246249516
W2 : 65,2859096589798
W3 : 91,8878197178523
Max : W2
```

EPOCH : 3

```
=====
W1 : 94,979418823236
W2 : 64,4732425119125
W3 : 73,8518464562668
Max : W3

W1 : 64,8314352764163
W2 : 83,6574817335572
W3 : 64,5579106638941
Max : W3

W1 : 71,2917246249516
W2 : 66,9109015781391
W3 : 90,1954553444742
Max : W2
```

EPOCH : 4

```
=====
W1   :    94,979418823236
W2   :    64,7791258083964
W3   :    74,4662009083135
Max  :    W3

W1   :    64,8314352764163
W2   :    82,9311611692216
W3   :    65,4681394369323
Max  :    W1

W1   :    71,0172757890635
W2   :    68,2766831767992
W3   :    89,586769334485
Max  :    W2
```

EPOCH : 5

```
=====
W1   :    94,0220661307755
W2   :    65,0421138542461
W3   :    75,3686721266498
Max  :    W3

W1   :    65,6973535102458
W2   :    82,2987894398208
W3   :    65,4107208423767
Max  :    W3

W1   :    71,0172757890635
W2   :    69,4344907189694
W3   :    88,330624672591
Max  :    W2
```

EPOCH : 6

```
=====
W1   :    94,0220661307755
W2   :    65,269317872934
W3   :    75,7667249725151
Max  :    W3

W1   :    65,6973535102458
W2   :    81,7464394113101
W3   :    66,0934192726768
Max  :    W1

W1   :    70,8023360370648
W2   :    70,4231262073374
W3   :    87,8833859679634
Max  :    W2
```

EPOCH : 7

```
=====
W1   :    93,268048329676
W2   :    65,4664514717543
W3   :    76,4483983864839
Max  :    W3
W1   :    66,3653317941401
W2   :    81,2625758553348
```

W3 : 66,0308043811068
Max : W3

W1 : 70,8023360370648
W2 : 71,2725458245539
W3 : 86,9358127091439
Max : W1

EPOCH : 8

=====

W1 : 92,7586912359887
W2 : 65,4664514717543
W3 : 76,7142975886221
Max : W3

W1 : 66,2865367571388
W2 : 81,2625758553348
W3 : 66,5520464354352
Max : W1

W1 : 71,3677269180747
W2 : 71,2725458245539
W3 : 86,6016510553595
Max : W2

EPOCH : 9

=====

W1 : 92,1706559556189
W2 : 65,6209995301784
W3 : 77,2377788803101
Max : W3

W1 : 66,8094261851265
W2 : 80,8801858207332
W3 : 66,4918373225648
Max : W3

W1 : 71,3677269180747
W2 : 71,9332209561111
W3 : 85,877285998367
Max : W1

EPOCH : 10

=====

W1 : 91,7772250077996
W2 : 65,6209995301784
W3 : 77,4200680670207
Max : W3

W1 : 66,7364976522469
W2 : 80,8801858207332
W3 : 66,8951161322839
Max : W1
W1 : 71,8025165865998
W2 : 71,9332209561111
W3 : 85,6240631534816
Max : W1

There are ten loops for EPOCH = 10 and each loop consists of three classes. Every class has a maximum weight. After the training result has been done, the test for the fingerprint is performed.



Fig. 9 Test fingerprint 1



Fig. 10 Test fingerprint 2

Figure 9 and 10 are the test fingerprints. They will be tested to the training data where it would be closer.

Test Result:

TEST : 1 (Figure 9)

```
=====
W1      :      67.1055702707148
W2      :      62.6290900983341
W3      :      66.8636888870920
Max     :      W1
```

TEST : 2 (Figure 10)

```
=====
W1      :      70.2808924695356
W2      :      64.5118337314814
W3      :      69.3663784430469
Max     :      W1
```

From both tests, the result of each test is close to the Arch fingerprint. If it is seen by naked eyes, it is close to the Arch as well (Figure 2 and Figure 6). It proved that the test is highly accurate.

VI. Conclusion

The development of a classification system fingerprint patterns for identification via fingerprint acquisition stages and phases of classification has a significant role to assist in the investigation related to the digital data. Acquisition stages using a fingerprint scanner, followed by fingerprint feature extraction, the training process, the process of classification and identification of personality based on the pattern classification results. LVQ algorithm has a good degree of fit to recognize the fingerprint pattern is more inclined to go. This level of accuracy can be set to specify the input parameters include EPOCH, Learning Rate, and LR Reduction. By determining the combination of a good result was obtained closer to the truth.

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