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To cite this article: Agus Prijono *et al* 2018 *J. Phys.: Conf. Ser.* **954** 012014

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Verification Image of The Veins on The Back Palm with Modified Local Line Binary Pattern (MLLBP) and Histogram

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Abstract. The verification to person who is used today as a fingerprint, signature, personal identification number (PIN) in the bank system, identity cards, attendance, easily copied and forged. This causes the system not secure and is vulnerable to unauthorized persons to access the system. In this research will be implemented verification system using the image of the blood vessels in the back of the palms as recognition more difficult to imitate because it is located inside the human body so it is safer to use. The blood vessels located at the back of the human hand is unique, even humans twins have a different image of the blood vessels. Besides the image of the blood vessels do not depend on a person's age, so it can be used for long term, except in the case of an accident, or disease. Because of the unique vein pattern recognition can be used in a person. In this paper, we used a modification method to perform the introduction of a person based on the image of the blood vessel that is using Modified Local Line Binary Pattern (MLLBP). The process of matching blood vessel image feature extraction using Hamming Distance. Test case of verification is done by calculating the percentage of acceptance of the same person. Rejection error occurs if a person was not matched by the system with the data itself. The 10 person with 15 image compared to 5 image vein for each person is resulted 80,67% successful. Another test case of the verification is done by verified two image from different person .that is forgery, and the verification will be true if the system can rejection the image forgery. The ten different person is not verified and the result is obtained 94%.

1. Introduction

The biometric technology [1] has recently become a reliable technology to provide a high level of security in the system of recognition of a person. Among various biometric techniques and their characteristics are used to identify a person, biometric of the hand into one of the techniques most widely used and most successful. The parts of the hand that is often used for the introduction of a person's identity, among others, hand geometry, fingerprint, palm lines, the lines on the knuckles and blood vessels

Currently, the majority of a person through the hand's identifier device requires direct contact between the user's hands with the identification device to take pictures of the unique patterns of the user's hands. There are a number of problems in this regard, the first is the level of cleanliness of the



device that has been used many times by others, the problems will increase if there is a virus such as SARS can be transmitted by touching the rest of germs residing on the surface of recognition devices. The second problem is the rest of the hand imprint mold on the appliance can affect the accuracy of the system to recognize a person's identity. And the third is that biometrics can be easily forged. These problems can be overcome by using biometrics veins on the back palm. There are several supremacy used biometric vein, that is the first image captured using an infrared camera, so there is no direct contact between the equipment and the user, the second the blood vessels inside the human body so that its are difficult to counterfeit, the third blood vessels can be used for long term.

2. Vein as Biometric

Blood vessels are part of the circulatory system that transport blood throughout the body. There are three types of blood vessels, namely: the arteries that carry blood from the heart, the capillaries that serve as the actual exchange of water and chemicals between the blood and tissues, and the blood vessels of the vein that carries blood from the capillaries back to the heart.

One biometric technology that is currently being developed is based vein biometric technology. Each individual has a unique pattern of blood vessels even in twins, though, and does not change with age but it change after experiencing the process of surgery. The advantage of vein biometric is location of vein within the skin surface. The pattern of veins which are widely used in the biometric system is the pattern of blood vessels located in the hand i.e., the back palm, the palm, and the finger. Because of it lies within the human body causes the pattern of blood vessels is impossible to forge. Therefore it is developed into vein biometric.

In the biometric system, the pattern of blood vessels can be seen clearly using infrared light. Infrared [2] is electromagnetic radiation of a wavelength longer than visible light, but shorter than radio wave radiation.

Vein biometric is adequate to the criteria of good biometric because, universal which every human being has the hands and the blood vessels in it, unique which based on the above description of each individual has a unique pattern of blood vessels even in twins, permanent which pattern of blood vessels in the hand does not change with age, can be measured quantitatively by using the imaging device near - infrared (NIR) imaging patterns so that blood vessels can be extracted and features of blood vessels can be measured.

3. Image Processing of Vein Image

Definition image processing itself is a two-dimensional image processing using a computer. Image processing is done with the aim of getting the results as expected. Based on the objective, digital image processing can be divided into several types, among others: eliminating noise in an image, improving the quality of the image by increasing or decreasing the contrast, segmentation image which divides the image into sections, analysing image by using feature extraction image for recognition and identification the objects.

Image quality improvement is one of the initial processes in image processing. Image quality improvement is needed because often the image of an object has a poor quality, for example, the image is too dark or too light, the image less sharp, and blur. There are several techniques to improve the image, such techniques gaussian low pass filter, high pass filter, and median filter.

3.1. Median Filter

At a median filter, a "window" contains a number of pixels. The window is shifted from point to point on the entire image area. On each shift created a new window. The midpoint of this window amended by the median value of the window. For example, review the window in the form of groups of pixels (square shaded) on an image in Figure 1 (a). A pixel that is being processed is an intensity of 35. Sort of pixels - the pixel

9 10 10 10 **10** 10 11 12 35

The median of the group is 10 (in bold). The midpoint of the window (35) is now replaced with the median value (10). Results of the median filter are shown in Figure 1 (b). Thus, the median filter removes the pixel values are very different from its neighboring pixels.

13	10	15	14	18
12	10	10	10	15
11	11	35	10	10
13	9	12	10	12
13	12	9	8	10

(a) Midpoint pixel value 35

(b) 35 replace with median 3 x 3 pixel

Figure. 1 Removal of noise with a 3x3 median filter

3.2. Feature Extraction Using Modified Local Line Binary Pattern (MLLBP)

Feature extraction is a process of making characteristic/feature of a form, in this case, is the picture/image. Feature value obtained will be analysed for further processing. Feature extraction is done by counting the number of dots or pixels that encountered in any of checks carried out in various directions tracing checks on Cartesian coordinates of the digital image is analysed, namely vertical, horizontal, diagonal right and left diagonal.

Features a unique characteristic of an object/image. Features can be divided into two, namely: features of "natural": part of the image, such as brightness and edges of objects, and features "artificial": features that are obtained with certain operations on the image, for example, gray level histogram.

The feature extraction is the process to get characteristic features that distinguish an object with other objects. Extraction feature method Local Line Binary Pattern [3] is a proposed method for the extraction of better features and generate a higher level of recognition than the previous method, namely the Local Binary Pattern (LBP). One advantage of this LLBP method is able to confirm the change of image intensity like dots, edges, and corners. LLBP Operator consists of two components, namely a horizontal component and a vertical component. The magnitude of LLBP obtained by calculating the binary code sequence from the second component.

The basic idea of the method LLBP similar to the original method is Local Binary Pattern (LBP), but the difference is: neighbourhood shape is a straight line with a length of N pixels, unlike in the LBP of the square.

Binary weight distribution starting from the left or right side that are adjacent to the central pixel (2^0) toward the tip end of the left or right pixel. Start from the centre pixel $\left(2^{\lceil \frac{N}{2} \rceil - 2}\right)$, for example $N = 15$ then $\left(2^{\lceil \frac{15}{2} \rceil - 2}\right) = 2^6$ with $\lceil x \rceil$ is ceiling function, namely the function to take the smallest integer greater than or equal to x .

		column																	
		...	20	21	22	23	24	25	26	27	28	29	30	31	32	33			
row	:	200	252	252	30	35	78	150	100	190	190	252	250	250	252	100	0	2^6	
	144	180	76	34	190	190	160	160	250	178	178	107	250	178	252	250	1	2^5	
	145	190	30	160	252	62	252	190	71	190	160	178	252	250	100	178	0	2^4	
	146	200	175	100	62	62	107	190	220	160	100	160	100	160	107	178	1	2^3	
	147	187	100	203	62	71	71	71	62	107	160	160	190	190	160	160	0	2^2	
	148	177	190	62	62	252	107	71	87	160	107	252	160	160	160	160	0	2^1	
	149	160	178	62	100	190	190	252	160	160	160	71	71	160	160	160	1	2^0	
	150	200	140	179	138	191	233	162	146	60	71	149	164	203	183	206	146		
	151	250	252	178	190	190	71	187	107	71	160	160	190	250	107	107	107	2^0	
	152	250	178	252	250	187	71	187	240	250	107	250	190	250	107	107	1	2^1	
	153	250	178	62	71	71	187	187	250	187	187	187	252	250	107	107	1	2^2	
	154	252	160	178	252	62	187	187	215	187	190	250	107	107	107	190	1	2^3	
	155	178	62	62	160	160	187	100	112	190	220	220	190	220	220	160	0	2^4	
	156	62	178	178	252	100	187	187	208	250	220	220	250	252	220	252	1	2^5	
	157	178	160	187	187	100	187	100	200	220	220	220	250	220	160	220	1	2^6	
		200	140	179	138	191	233	162	146	60	71	149	164	203	183	206	LLBP _{v15,8} (26,150)		
		1	0	1	0	1	1	1		0	0	1	1	1	1	1	=(1+8+32)+(2+4+8+32+64)		
																	=151		
		2^6	2^5	2^4	2^3	2^2	2^1	2^0		2^0	2^1	2^2	2^3	2^4	2^5	2^6			
		LLBP _{h15,8} (26,150) = (1+2+4+16+64)+(4+8+16+32+64) = 211																	
		LLBP _{15,8} (26,150) = $\sqrt{151^2 + 211^2}$ = 259																	

Figure 2. Illustration LLBP Operator

In LLBP algorithm, the first is to determine the binary code line in horizontal and vertical directions separately and then calculate the value of a magnitude that characterizes image intensity changes such as edges and corners. This can be expressed mathematically in equation (1) to (4).

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \quad (1)$$

$$LLBP_{hN,c}(x, y) = \sum_{n=1}^{n=c-1} s(h_n - h_c) 2^{c-n-1} + \sum_{n=c+1}^{n=N} s(h_n - h_c) 2^{n-c-1} \quad (2)$$

$$LLBP_{vN,c}(x, y) = \sum_{n=1}^{n=c-1} s(v_n - v_c) 2^{c-n-1} + \sum_{n=c+1}^{n=N} s(v_n - v_c) 2^{n-c-1} \quad (3)$$

$$LLBP_m = \sqrt{LLBP_h^2 + LLBP_v^2} \quad (4)$$

Note:

N: is the length of the line in pixels

h_n : pixel intensity values - pixel along the horizontal row

v_n : pixel intensity values - pixel along the vertical row

$$c = \left\lceil \frac{N}{2} \right\rceil \quad (5)$$

where:

c is the position of the center pixel intensity values

h_c : pixel intensity values at the center coordinates (x_c, y_c) in horizontal row

v_c : Pixel intensity value at the center coordinates (x_c, y_c) in a vertical row

$s(x)$: define a function threshold (barrier), this function will be worth 1 when $x \geq 0$ and will be 0 when $x < 0$

LLBP_h: LLBP feature values in the horizontal direction

LLBP_v: LLBP feature values in the vertical direction

LLBP_m: the value of the magnitude of LLBP

Based on the equation (1) and (2), the horizontal component of LLBP (LLBP_h) extract the binary code of N-1 bits of each pixel. The same number of bits extracted by the vertical component of LLBP (LLBP_v) based on the equation (1) and (3). Thus, by combining the binary code of (LLBP_h) and (LLBP_v), a total of LLBP binary code for each - each pixel is 2 (N-1).

From Figure 2, the binary sequence of horizontal components are defined from left to right as 1010111.001111₂ and the vertical component is defined from top to bottom as 0101001.0111011₂. Therefore, the binary code of LLBP is 1010111001111101010010111011₂. Each binary code both horizontally and vertically are converted to decimal numbers with the following calculation:

For the horizontal component of the binary sequence to the left and right of the centre pixel: 1010111₂ = $(1 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 64 + 16 + 0 + 0 + 4 + 2 + 1 = 87_{10}$

For the horizontal component of the binary sequence to the right of the centre pixel: 0011111₂ = $(0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 0 + 0 + 16 + 8 + 4 + 2 + 1 = 29_{10}$

By adding these two decimal values, then the values obtained LLBP the horizontal direction, namely: $87_{10} + 29_{10} = 116_{10}$

For the vertical component of the binary sequence the top of the centre pixel 0101001₂ = $(0 \times 2^6) + (1 \times 2^5) + (0 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) = 0 + 32 + 0 + 8 + 0 + 0 + 1 = 41_{10}$

For binary sequences vertical component lower part of the centre pixel:

0111011₂ = $(0 \times 2^6) + (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 0 + 32 + 16 + 8 + 0 + 2 + 1 = 59_{10}$

By adding these two decimal values, then the values obtained LLBP in the vertical direction, namely: $41_{10} + 59_{10} = 100_{10}$

From a decimal value LLBP_v and LLBP_h already acquired can be calculated the value of the magnitude of LLBP, namely: $LLBP_m = \sqrt{(116)^2 + (100)^2} = 155$

After all the pixel value is counted with LLBP, the next process is to divided the LLBP value to be 10 x 10 block, and we have one block is 15 x 15 pixel. Each block is counted the histogram distribution and this value of histogram distribution will be counted with Hamming distance to know how similarity each block one image extracted with each block another image extracted . This process is called Modified Local Line Binary Pattern.

3.3. Hamming Distance

Hamming distance is used to determine the degree of similarity between the binary code histogram distribution image extracted with binary code histogram distribution image contained in the database. The similarity between the binary code histogram distribution of the image that will be tested with the binary code histogram distribution from the image contained in the database measured using a calculation Hamming Distance (HD). Hamming Distance is one of the testing methods to find how similar a vector to the other vector based on the value of proximity. If the value of the proximity is smaller, meaning the greater the similarity the two vectors, on the contrary, if the value is bigger means both vector similarity is smaller.

The formula for the calculation of Hamming Distance given in equation 6.

$$HD = \frac{\|(\text{codeA} \otimes \text{codeB})\|}{\text{codeLength}} \quad (6)$$

Operator $\otimes$ is an Exclusive-OR Boolean operator between a couple of bits - the bits that correspond to. Code A is code sequence tested binary image, while the code B is a row of binary code from the

image that was in the database. Code Length is the length of the binary code from the image to be tested. Here is an example of calculating Hamming Distance between two different codes, namely:

Hamming Distance between 11001101 and 10110010 is 7

Hamming Distance between 10111010 and 10010010 is 2

Figure 3 shows the block diagram realization equipment for verification image of the vein.

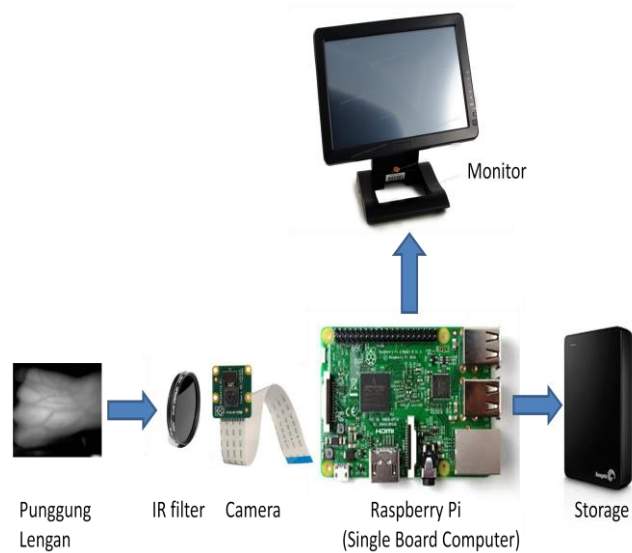


Figure 3. Block Diagram Realisation Equipment

4. Test Cases

Data collection was performed against 16 person and each person is done taking 20 pictures (V01 s / d V20), meaning a total of 320 images. In Figure 4 we look the position of the hand looks towards the camera.



Figure 4. Position the hand looks towards the camera

After that, the captured image from the camera will be cropped into 150 X 150 pixels image as shown in Figure 5 (a). Then the image quality improvement process is carried out as shown in Figure 5 (b). Furthermore, the feature extraction process is carried out so it looks like in Figure 5 (c).

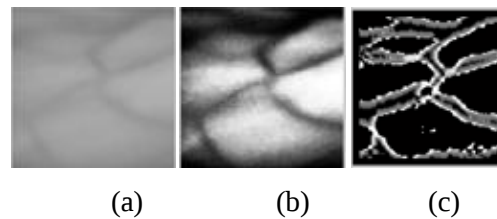


Figure 5. (a) the capture image from camera (b) the improvement image (c) The feature extraction image

Then the next process, the data matrix image with 150×150 pixels, divided into blocks numbered 10×10 , meaning there are 100 blocks and each block have 15×15 pixels. From each block to get the process done histogram. Then from the histogram which will be calculated Hamming distance value.

Here is a table of determining the maximum value Hamming Distance of 5 vein image (V01 / V05) each of the 16 respondents. Suppose of first person, image vein 1 (V01) calculated the value of Hamming Distance for image 2 until image 5 (V02 until V05), then the image vein 2 (V02) calculated the value of Hamming Distance for image 3 until image 5 (V03 until V05), vein image 3 (V03) is calculated Hamming value Distance for image 4 and image 5 image (V04 and V05), and image vein 4 (V04) is calculated Hamming value Distance for image 5 (V05). Hamming value of 10 Distance then specified maximum value. Furthermore, the maximum value determination Hamming also Distance for person 2 until 16.

Hamming Distance Based on the maximum value, it will be tested image data of 6 until 20 (v06 until V20) of each person.

Figure 6 shows Percentage Successful Recognition the results of the verification data of the image of the 10 person.

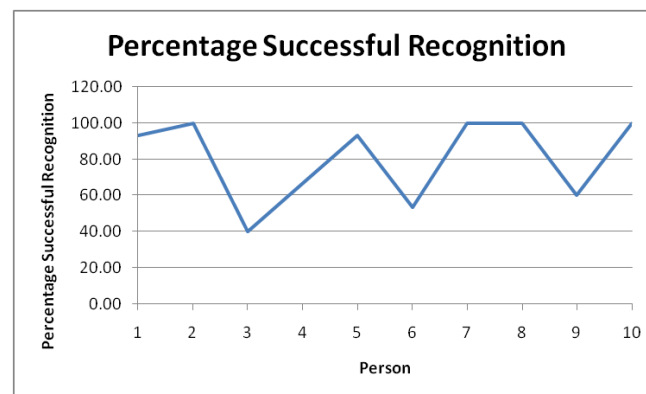


Figure 6. Percentage Successful Recognition

Figure 7 shows Percentage Successful Rejection the tested image data of different people and the obtained results are as follows:

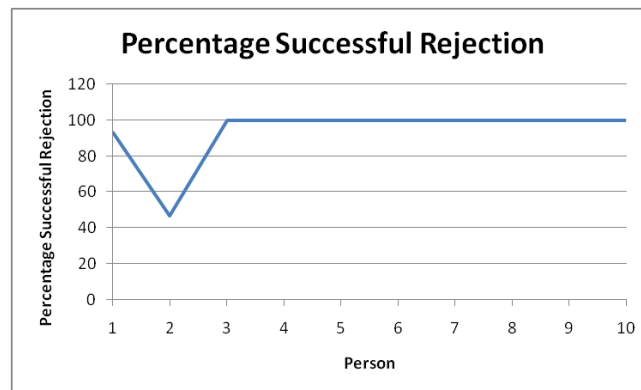


Figure 7. Percentage Successful Rejection

5. Conclusion

Test case of verification is done by calculating the percentage of acceptance of the same person. Rejection error occurs if a person was not matched by the system with the data itself. The 10 person with 15 image compared to 5 image vein for each person is resulted 80,67% successful. Another test case of the verification is done by verified two image from different person .that is forgery, and the verification will be true if the system can rejection the image forgery. The ten different person is not verified and the result is obtained 94%.

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