Comparision Between Local Binary Pattern and Centre Symmetric Local Binary Pattern

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***Abstract*—This abstract provides an overview of the fundamental principles behind LBP and its extension, CS-LBP, highlighting their ability to capture distinctive texture patterns in images efficiently. The combination of simplicity, computational efficiency, and effectiveness in various image analysis tasks establishes LBP and CS-LBP as valuable tools in the field of computer vision.**

***Index Terms*—Image Processing, center symmetric local binary pattren, local binary pattern,**

I. Introduction

Local Binary Patterns (LBP) and Center-Symmetric Local Binary Patterns (CS-LBP) are powerful and computationally efficient texture descriptors widely employed in computer vision and image analysis applications.LBP characterizes the local patterns of pixel intensities in an image by comparing each pixel with its neighboring pixels, encoding the relationships as binary patterns. This method has demonstrated its effectiveness in various tasks, including texture classification, face recognition, and object detection. CS-LBP extends the concept of LBP by introducing center-symmetry constraints, enhancing the descriptor's discriminative power. In CS-LBP, the binary patterns are defined based on the comparison of pixel values in a circular region around the central pixel, enforcing symmetry in the encoding process. This refinement not only captures local texture information but also incorporates rotational invariance, making CS-LBP particularly suitable for applications where robustness to orientation changes is crucial.

II. Methodology

A. Local Binary Pattern

LBP proposed by Ojala et al. as early as 1996 has been widely used for face recognition and showed its high discriminative power for texture classification under complex illumination. LBP is a non-parametric operator that is described as an ordered set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels. Figure 1 shows the original LBP template window with a size of 3*3, and the LBP code is shown in figure 2

where x_c corresponds to the grey value of a center pixel, to the grey value of the eight surrounding pixels. P represents the total number of the center pixel's surrounding pixels and is equal to 8 for the original LBP operator. R is the radius of the LPB template and is equal to 1 for the original LBP

$$LBP_{\mathrm{P,R}} = \sum_{i=0}^{\mathrm{P}-1} s\left(x_i - x_c\right) 2^i$$

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

Fig. 1: Equation for LBP code

operator. The calculation procedure of one LBP code example is illustrated in Figure 3. For any pixel, the original LBP operator only accounts for its relative relationship with its neighbor pixels, which makes itself insensitive to illumination intensities. The original LBP operator extracts local features

x_0	x_1	x_2
x_7	x_c	x_3
x_6	x_5	x_4

Fig. 2: Template of LBP window

by utilizing a template window with a size of 3*3, and it may confront with the problem that the range is too small to meet the needs of texture feature extraction with different sizes. Therefore, Ojala et al. extended the original LBP operator to a circular LBP operator that can be of different sizes, and its calculation procedure is the same as that of the original LBP operator. Several circular LBP operators with different values of P and R are shown in Figure 3.

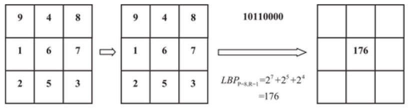


Fig. 3: Calculation Procedure for LBP

B. Center Symmetric Local Binary Pattren

CS-LBP extends the concept of LBP by introducing center-symmetry constraints, enhancing the descriptor's discriminative power. In CS-LBP, the binary patterns are defined based on the comparison of pixel values in a circular region around the central pixel, enforcing symmetry in the encoding process. This refinement not only captures local texture information but also incorporates rotational invariance, making CS-LBP particularly suitable for applications where robustness to orientation changes is crucial.The CS-LBP code can be expressed as shown in Figure 4 The original LBP and its extended circular

$$\mathrm{CS-LBP} = \sum_{i=0}^{P/2-1} s\left(x_i - x_{i+P/2}\right) 2^i, \quad P = 8$$

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

Fig. 4: Equations for CS-LBP code

ones mainly compare the local center pixel's grey value with each grey value of its surrounding pixels and represent the image's local features by their relative variations. Because of its simple calculation process, strong local description ability for texture details, and good robustness to complex illuminations, LBP is widely used in image recognition and many other fields. However, if evaluating the effect of the original LBP and its extended circular ones, the grey values between the center pixel and all of its surrounding neighbor pixels should be compared, and then rather long histograms may be produced but difficult to use in the context of a region. To address the problem, an improved LBP called CS-LBP was

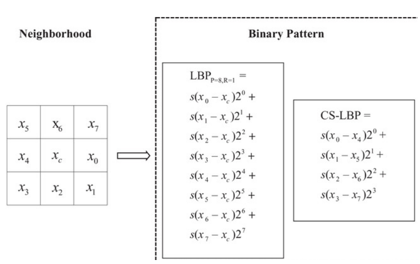
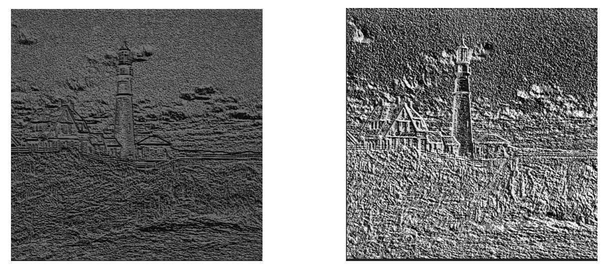


Fig. 5

proposed which modified the scheme of comparing the pixels in the neighborhood instead of comparing each pixel with the center pixel and center-symmetric pairs of pixels are compared as illustrated in Figure 5.

III. Results

Fig. 6: Input Image



(a) LBP(P=8,R=1) Image (b) CS-LBP Image

Fig. 7: Corresponding Feature images of input Lena image

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Time taken for lbp: 9.693876028060913
Time taken for cslbp: 1.522404432296753
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Fig. 8: Time complexity for LBP and CS-LBP

IV. Conclusion

It can be seen that for eight neighbours, LBP produces 256 (28) different binary patterns, whereas for CS-LBP this number is only 16 (24). Therefore, CS-LBP can effectively reduce the number of comparisons, and improve computational efficiency.

References

[1] Chen, T., et al.: A novel face recognition method based on the fusion of LBP and HOG. IET Image Process. 15, 3559–3572 (2021). https://doi.org/10.1049/ipr2.12192