Feature Extraction for Human Detection using HOG and CS-LBP methods

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ABSTRACT
Feature plays a very important role in the area of image processing. Before extracting features, image pre-processing technique like resizing is applied on the input image. Then, features are obtained by various feature extraction techniques. These features are then used for classification and recognition of the objects in an image. Features are useful in terms of space utilization, efficiency in classification and obviously the time in processing the image**,** as they define characteristics of an image. Extracting effective features is the key for accurately detecting humans in images. Extracted features should be discriminative, failure resistant to various changes and easy to compute. In this paper, center-symmetric local binary patterns (CS-LBP) and Histogram of oriented gradients (HOG) feature extraction methods are presented. HOG feature calculates the gradient magnitude and the gradient direction of the local image. The main drawback of HOG feature extraction is that, it produces too many feature patterns, difficult to analyse and is time consuming. The drawback of HOG is overcome by using CS-LBP method of feature extraction. The CS-LBP feature captures both gradient information and texture information. CS-LBP method produces less number of feature patterns which is easy to analyse and works well on flat image areas. Experiments on the INRIA pedestrian dataset show that, the CS-LBP method produces less number of feature patterns compare to HOG feature and gives better result that can be used for any image processing applications.

General Terms
Image Processing, Feature extraction.

Keywords
Histogram of Oriented Gradient (HOG), Center-Symmetric Local Binary Pattern (CS-LBP), INRIA pedestrian dataset.

1. INTRODUCTION
The extraction task transforms rich content of images into various content features. Feature extraction [1] is a process of extracting useful information from a query image [12]. This useful information is characteristics such as shape, colour, texture etc.., that are associated with an image which define objects precisely and uniquely. Feature extraction is a form of dimensionality reduction in both pattern recognition and image processing. One of the main goals of feature extraction is to obtain the compact set of features called feature vector without redundancy, which could reduce the time required by the algorithm for processing such data.

Feature extraction is the process of generating features [11] to be used in the selection and classification tasks. Extracted features (feature vector) should increase the classification rate of an object in an image [7] [8].

In this paper, features are extracted using the **HOG** and **CS-LBP.**

The Histogram of Oriented Gradient (HOG) [2] [5] is a good descriptor for human detection. HOG features are now widely used in object recognition and detection [6]. They describe body shape through the extraction of edge directions or gradient directions in the window. Each region of the window is divided into 64 blocks with each block having 32*32 in dimensions. Each block is composed of 2*2 cells. A histogram of oriented gradients is computed for each cell. The final descriptor is obtained by combining all the block features in a window. The main drawback of HOG is that, it produces too many feature patterns and is time consuming.

The drawback of HOG is overcome with the use of CS-LBP method [3] [4] for feature extraction. In CS-LBP [9], center-symmetric pairs of pixels are compared. In CS-LBP method, each pixel is compared against neighbourhood pixel in a diagonal manner and produces 16 different numbers of binary patterns and time consumption is less compared to HOG. CS-LBP [10] is more efficient than HOG since the diagonal elements are compared.

2. FRAMEWORK OF OUR APPROACH

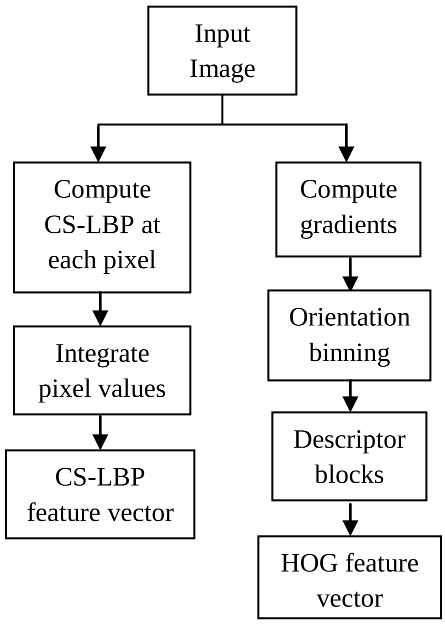

Figure 1: Framework of HOG and CS-LBP features

The proposed HOG and CS-LBP method for feature extraction are shown in the figure1. HOG calculates gradient magnitude and gradient angle for each pixel in a block. CS-LBP is computed by comparing only center-symmetric pairs of pixels to produce binary pattern. The detail steps of HOG and CS-LBP feature extraction methods are illustrated in section 2.1 and 2.2.

2.1 Histogram Of Oriented Gradient (HOG)

HOG feature is an excellent descriptor, which calculates the gradient magnitude and the gradient direction of an input image [2] [5]. It has shown great success in object detection and recognition. The main idea behind HOG features is that object appearance and shape are characterized by the distribution of edge directions. This is implemented by dividing the image window into 64 blocks where each block is composed of 2*2 cells. For each pixel in a cell, histogram of gradient direction or edge orientation is calculated. The combined histogram entries form the descriptor blocks which is referred to as *Histogram of Oriented Gradient (HOG)* descriptors. The following are the steps in HOG:

2.1.1 Gradient computation

The gradient computation is done in two steps: the first step of gradient computation is the computation of centered mask. The most common method to compute centered mask is to apply 1-D centered mask value along horizontal and vertical directions. This is done to smooth the color or intensity data of the image.

The second step of gradient computation is to find the gradient angle and gradient magnitude for each pixel in a cell.

2.1.2 Orientation binning

The orientation binning involves creating the cell histograms. After calculating gradient magnitude and gradient angle for each pixel in a cell, magnitude value is assigned to bin ranging from 0-180 degrees. Higher magnitude values are considered as a part of edge directions and lighter values are discarded.

The gradient used in conjunction with 9 histogram channels (0^0-20^0,20^0-40^0,40^0-60^0,60^0-80^0,80^0-100^0,100^0-120^0,120^0-140^0,140^0-160^0,160^0-180^0) performs best in the human detection.

2.1.3 Descriptor blocks

Features are extracted from each cell, and cells are concatenated to each other to construct a block descriptor. The final descriptor is obtained by the concatenation of all the blocks features in the window.

2.2 Center-Symmetric Local Binary Pattern (CS-LBP)

Center-symmetric local binary pattern (CS-LBP) method is used for extracting features for each pixel of the region [3] [4]. In CS-LBP [9], center-symmetric pairs of pixels are compared to produce more compact binary patterns as shown in Figure 2. As can be seen in figure 2, for 8 neighbors (no-n7), CS-LBP produces only 16 different binary patterns. Small threshold value is used to obtain the robustness on flat image regions.

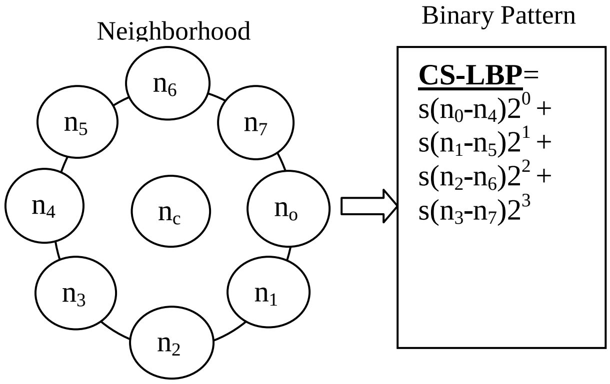

Figure 2: Feature extraction using CS-LBP

Center-Symmetric Local Binary Pattern is defined as:

$$\text{CS-LBP}_{R,N,T}(x,y) = \sum_{i=0}^{(N/2)-1} s(n_i - n_{i+(N/2)})2^i \qquad \text{……..Equ (1)}$$

……..Eqa 1

Where,
$\mathbf{n_i}$ and $\mathbf{n_{i+(N/2)}}$ correspond to the values of center-symmetric pairs of pixels.
N is the number of neighborhood pixels.
R is the radius of equally spaced pixels on a circle.
T is the threshold value

Threshold value T of 0.1, radius of 2 and neighborhood size of 8 is used. All the experiments presented in this paper are carried out for these parameters ($CS - LBP2, 8, 0.1$) which gave the best result for the given test data. CS-LBP produces less number of binary patterns; works well with different texture and efficiency is more than compared to HOG method

3. RESULTS AND DISCUSSION

3.1 Specification of Dataset

The publicly available INRIA person dataset is used in this work which contains images in png format as shown in Figure 3:

Figure 3: INRIA person dataset

3.2 Training and Evaluation

Training samples are chosen and re-size into 256*256 pixels. Divide each sample into 64 blocks. For each blocks, feature extraction is done using HOG and CS-LBP. The overall process is shown in Figure 4.

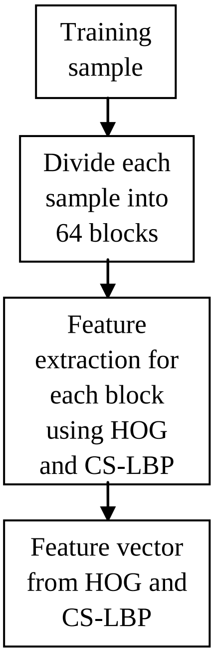

Figure 4: The entire training process

3.3 Results after Extracting Features using HOG

Features are extracted for each block using HOG for the image shown in Figure 3. HOG produces 81 different feature values per block and is summarized in Table 1. The graphical representation of HOG feature values are shown in figure 5.

Table 1: Feature values obtained using HOG

	Number of features per block using HOG					
Number of blocks per image	**SL NO**	**Feature 1**	**Feature 2**	**Feature 3**	**. . . .**	**Feature 81**
	Block 1	0.13669	0.06881	0.7777		0.25474
	Block 2	0.25246	0.13609	0.7332		0.49128
	Block 3	0.1678	0.10596	0.6853		0.44900
	⋮					
	Block 64	0.18674	0.04688	0.7688		0.66528

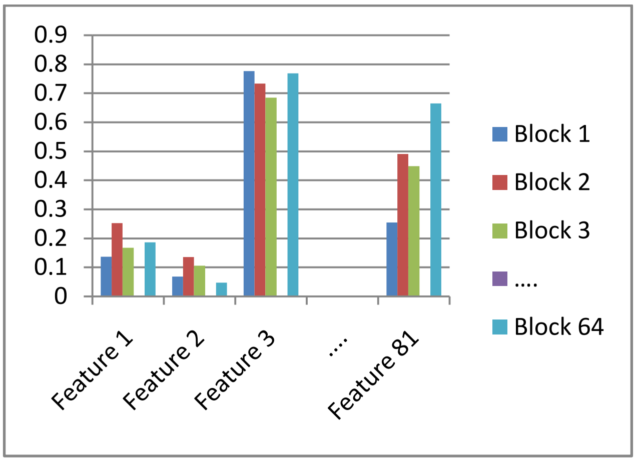

Figure 5: Graphical representation of HOG features

3.4 Results after Extracting Features using CS-LBP

Features are extracted for each block using CS-LBP for image shown in Figure 3. CS-LBP produces 16 different features per block and is summarized in Table 2. The graphical representation of CS-LBP features are shown in figure 6.

Table 2: Feature values obtained using CS-LBP

	Number of features per block using CS-LBP					
Number of blocks per image	**SL NO**	**Feature 1**	**Feature 2**	**Feature 3**	**. . . .**	**Feature 16**
	Block 1	353	273	60		326
	Block 2	325	213	62		233
	Block 3	500	199	71		347
	⋮					
	Block 64	397	335	61		168

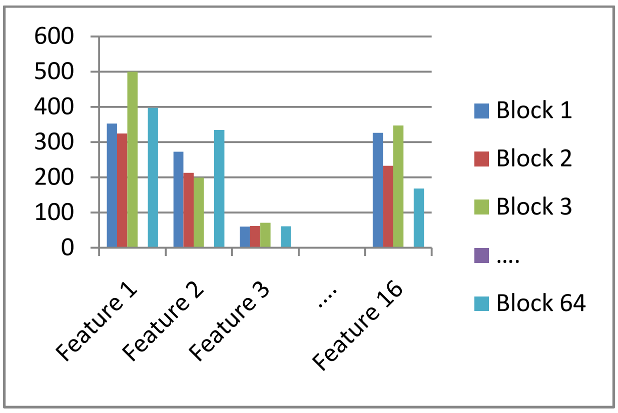

Figure 6: Graphical representation of CS-LBP features

3.5 Discussion

Figure 3 shows the original image of INRIA person dataset. Table 1 shows feature values for 64 blocks of an image shown in Figure 3 obtained using HOG method. Figure 5 shows the graphical representation of HOG features summarized in table 1. HOG calculates gradient direction or edge direction for each pixel in an image. Feature extraction using HOG is difficult to analyze because it produces more number of feature patterns and it might effect for classification. Also extracting features using HOG is time consuming.

Table 2 shows feature values for 64 blocks of an image shown in Figure 3 obtained using CS-LBP method. Figure 6 shows the graphical representation of CS-LBP features summarized in table 2. The CS-LBP feature captures both gradient information and texture information by comparing center-symmetric pairs of pixels. Feature extraction using CS-LBP is easy to analyze because it produces less number of feature patterns and it might give better result for classification. Also extracting features using CS-LBP is less time consuming than HOG. From the experimental results it can be observed that the extraction of features using CS-LBP is more efficient than HOG.

4. CONCLUSION

In this paper, an attempt is made to extract features using HOG and CS-LBP method. In HOG, gradient angle and magnitude is computed for each pixel in a block and assigning gradient magnitude to bin to get feature vector. In CS-LBP method, each pixel is compared against neighborhood pixel in a diagonal manner and produces less number of binary patterns.

The extraction of features using HOG method is difficult to analyze because it produces more number of feature patterns and it might effect for classification. Also extracting features using HOG is time consuming. Feature extraction using CS-LBP is easy to analyze because it produces less number of feature patterns and it might give better result for classification. Also extracting features using CS-LBP is less time consuming than HOG. Hence feature extraction using CS-LBP gives efficient result compare to HOG.

5. FUTURE WORK

In this paper, features are extracted using center-symmetric local binary pattern (CS-LBP) method. In future, center-symmetric local ternary pattern (CS-LTP) can be used for still better detection than compare to CS-LBP method.

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