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Performance Improvement on Edge-based Human Detection Using Local Contrast Enhancement

Xue Yuan, Xueye Wei, Yongduan Song

Center for Intelligent Systems and Renewable Energy

Beijing Jiaotong University, Beijing, China

E-mail: xyuan@bjtu.edu.cn

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Abstract. This paper presents a local contrast enhancement method, which is able to improve the detection performance of edge-based human detection. First, a neighborhood dependent local contrast enhancement method is used to enhance the images contrast. Next, the cascade AdaBoost classifier is used to discriminate between human and non-human. Experimental results show that the performance of our method is about 5% better than that of the conventional method.

Introduction

Due to the limited dynamic ranges of current imaging and display devices, images captured in real world scenes with high dynamic ranges usually exhibit poor visibility of either over exposure or shadows and low contrast, which may make important image features lost or hard to tell by human eyes. Computer vision algorithms also have difficulty processing those images [1-8]. To cope with this problem, various image processing techniques have been developed. Some of those techniques are spatially-independent methods, like gamma adjustment, logarithmic compression, histogram equalization, and levels/curves methods. Furthermore, a lot of advanced image enhancement techniques were proposed based on a deeper understanding of human vision system which is much more capable of handling scenes with high dynamic ranges, such as human visual system(HVS)-based image enhancement [1], Land's retinex model [3], Multi-scale Retinex [6], local contrast enhancement [2], Cascaded Multistep Binomial Filtering [4], Sub-histogram Equalization [8].

Robust detection of humans in images is important for many applications [10-18], such as visual surveillance, smart rooms, and driver assistance systems. Considerable progress has been made in detection and tracking of humans in video sequences. However, such methods are effective as long as the humans are segmented from simple background and changes in illumination are gradual, but for many applications the background may be complicated and sudden illumination changes occur, particularly in indoor scenes.

The problem of object detection and particularly human detection has received much attention from the computer vision community. In particular, Mohan et al. [10] detect humans as a combination of parts legs, torso, arms. Individual SVM detectors are trained for each of the parts, and their outputs are combined into a final classifier, after applying geometric constraints. Gavrila and Philomin [11] and Felzenszwalb [12] compare edge maps of human templates to edges found in images. Dalal and Triggs [13] use Histogram of Oriented Gradient (HOG) descriptors and Support Vector Machines (SVMs) for building a human detector. By tuning all the parameters of their HOG features, they compare the use of a variety of feature configurations to find the best configuration for human detection, on a challenging dataset of human figures. Munder and Gavrila [14] studied the problem of human classification with different features and classifiers. They find that local receptive fields can do a better job in representing humans and also SVMs and AdaBoost classifiers outperform the other classifiers tested.

In this paper, we adopt a local contrast enhancement method to enhance the contrast of the image. Using the contrast enhance method, the edges belong to human shape are emphasized, and the performance of the human detection is improved.

Image contrast Enhancement

In this research, we employ a window-scanning approach system, with a rectangle window of variable scales scanning densely on the image; the rectangular windows are classified as human and no-human. Some examples of such kind of human images are shown in Fig. 1 in which no human is detected. Why these humans aren't detected? As shown from the edges extracted from the images, we can see some edges belong to the human shape is too weak, and there are too many noise edges extracted from the background. In order to enhance the contrast of the image, we adopt the contrast enhancement method as follows.

Gaussian Filter. An isotropic Gaussian has the form:

$$G(x,y)=\frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{2\sigma^2}}$$

The low-pass versions I_{avg} which are computed using 2D convolution with a Gaussian kernel are computed, the example of the low-pass versions is illustrated in Fig. 2(b).

Computation the Different Image between the Original Image and the Low-pass Image. The local intensity variation I_v is defined as in:

$$I_v=\frac{I_{x,y}-I_{avg}}{255}$$

Where $I_{x,y}$ and I_{avg} are the original image and its low-pass version, respectively. The different image I_v between the enhanced image and the low-pass image is computed as illustrated in Fig. 2 (c), which accordingly represents a brighter or darker pixel compared with its neighbor pixels. The magnitude of the different determines the local contrast of an image, larger magnitude indicates higher contrast and vice versus.

Enhancement the Different Image. The different image I_v illustrated in Fig. 2 (c) is enhanced using the power law operation as described in:

$$\left|I_{v,En}\right|=\left|I_v\right|^{\beta} \tag{1}$$

where β is tunable for adjusting the image contrast and $\beta < 1$. Since β can be either an odd or even number, $|I_v|$ instead of I_v is used to keep the result of Eq. (1) positive Eq. (1) can increase low contrast (small$|I_v|$) while preserving high contrast (large$|I_v|$) because $0 \le I_v \le 1$. Based on the result of $|I_{v,EN}|$ and the sign of$|I_v|$, the enhanced local intensity variation $I_{V,EN}$ can be obtained by restoring the sign no matter β is odd or even:

$$I_{V,EN}=\left|I_{V,EN}\right|\bullet sign(I_V)$$

Where sign (.) is defined as:

$$\mathrm{si}\,gn(I_V)=\begin{cases}+ & if \quad I_V>0\\ 0 & if \quad I_V=0\\ - & if \quad I_V<0\end{cases}$$

The result of enhanced different image I_{en} is illustrated in Fig. 2 (d) where the edges (or features) are more obvious than those in Fig. 2 (c), which indicates larger intensity variation compared to that represented by low-pass image(Fig. 2 (b)).

Enhancement Result. The intensity image with enhanced local contrast can be achieved by adding I_{en} to I_{avg} as illustrated in Fig. 2 (e).

As shown from Fig. 2 (c) and Fig. 2 (d), the local contrast of an image is enhanced, and the edges (or features) illustrated in Fig.2 (d) are more obvious than those in Fig. 2 (c). Using this method is able to improve the performance of system effectively.

Human DEtection

Extraction Edge-based Descriptors. In this research, we used HOG descriptors. HOG descriptor [12] has several advantages. It captures the gradient structure that is characteristic of the human shape. First, magnitude $m(x,y)$ and orientation $\theta(x,y)$ of the gradients are computed as follows.

$$m(x,y)=\sqrt{f_x(x,y)^2+f_y(x,y)^2}$$

$$\theta(x,y)=\tan^{-1}\frac{f_y(x,y)}{f_x(x,y)}$$

$$f_x(x,y)=L(x+1,y)-L(x-1,y)$$

$$f_y(x,y)=L(x,y+1)-L(x,y-1)$$

Each detection window is divided into cells of size 5×5 pixels and each group of 3×3 cells is integrated into a block in a sliding fashion, so that the blocks overlap with each other. Each cell consists of a 9-bin histogram of HOG features. Each block contains a concatenated vector of all its cells. The feature of one block (81 feature vectors) of block can represent feature vectors that are normalized to an L_2 unit length.

Construction of Classifier. This section describes the construction of the classifier for human detection. The cascade AdaBoost classifier is used. The final strong classifier $H(x)$ is a linear combination of T weak classifiers $h_t(x)$:

$$H(x)=sign(\sum_{t=1}^{T}\alpha_t h_t(x))$$

Where α_t is the weight of the training data, and t is number of round. The cascade AdaBoost classifier is used to reduce the number of false positives [10].

Experimental Results

Experimental Overview. The enhancement of the visual quality of digital images is usually applied to improve the performance of computer vision algorithms. Inspired by this relation, the image enhancement technique was used as an image preprocessor for a human detection algorithm. The original images and the enhanced images produced by the proposed algorithm were examined by the human detection algorithm to evaluate the detection rate change due to the improved visual quality of those images. The sample human images were manually captured in Beijing Jiaotong university. We have selected a total of 800 human images for the experiment. These include 370 human images of indoor scenes, 430 human images of outdoor scenes. The training data consisted of 5,000 positive images and 5,000 negative images.

Experimental Results. Fig. 3 shows the experimental results. With a false negative rate of 10%, our method has a about 5% lower miss rate than the system not using any image contrast enhancement method.

Conclusions

This paper presented a method of image contrast enhancement, which improves the detection performance of edge-based human detection. Using our proposed method can emphasize the edges belong to the human shape. Therefore, our method can detect human effectively.

References

[1] K. A. Panetta, E. J. Wharton and S. S. Agaian, ”Human Visual System-Based Image Enhancement and Logarithmic Contrast Measure”,IEEE Trans. Systems, Man, and Cybernetics, 38(1), pp. 174-188, 2008.

[2] L. Tao, M Seow and V. K. Asari, ”Nonlinear Image Enhancement to Improve Face Detection in Complex Lighting Environment”, International Journal of Computational Intelligence Research, 2(3), pp.327-336, 2006.

[3] D. Geronimo, A. M. Lo, and A. D. Sappa,”Survey of Pedestrian Detection for Advanced Driver Assistance Systems”, IEEE Trans Pattern Anal. Machine Intell, 32(7), pp. 1239-58, 2010.

[4] F. Lamberti, B. Montrucchio and A. Sanna,”CMBFHE: a Novel Contrast Enhancement Technique based on Cascaded Multistep Binomial Filtering Histogram Equalization”, IEEE Trans Consumer Electronics, 52(3), pp. 966-974, 2006.

[5] K. Panetta, E. Wharton and S. Agaian, ”Human Visual System-Based Image Enhancement and Logarithmic Contrast Measure”, IEEE Trans. Syst Man Cybern B Cybern, 38(1), pp. 174-88, 2008.

[6] Jobson DJ, Rahman Z and W. GA,” Properties and performance of a Center/Surround Retinex”, IEEE Trans. Image Process, 6(3), pp451-62, 1997.

[7] K. L. Chung and W. J. Yang, ”Efficient edge-preserving algorithm for color contrast enhancement with application to color image segmentation”, Journal of Visual Communication and Image Representation, 19(5), pp. 299-310, 2008.

[8] H. Yoon and Y. Han, ”Image contrast enhancement based subhistogram equalization technique without over-equalization noise”,World Academy of Science, Engineering and Technology, 50, pp.176-182, 2009.

[9] A. K. Jai, Fundamentals of Digital Image Processing, Prentice-Hall,1989.

[10] Mohan, C. Papageorgiou, and T. Poggio,”Example-based object detection in images by components”, IEEE Trans. Pattern Analysis and Machine Intelligence, 23(4), pp. 349-361, 2001.

[11] D. Gavrila and V. Philomin, ”Real-time object detection for smart vehicles”, In Proc. 7th ICCV, pages 87-93, 1999.

[12] P. Felzenszwalb,”Learning Models for Object Recognition”, In Proc. Conf. Computer Vision and Pattern Recognition, pages 56-62, 2001.

[13] N. Dalal and B. Triggs, ”Histograms of oriented gradients for human detection”, In Proc. IEEE Comput. Soc. Conf. Comput. Vision and Pattern Recognition, 2005.

[14] S. Munder and D. Gavrila,”An experimental study on pedestrian classification”, IEEE Trans. Pattern Analysis and Machine Intelligence, 28(11), 1863-1868, 2006.

[15] D.Comaniciu and P. Meer, ”Mean shift: A robust approach toward feature space analysis”, IEEE Trans. Pattern Anal. Machine Intell. Vol 24(5), pp. 603-619, 2002.

[16] P. Viola and M. Jones. ”Rapid object detection using a boosted cascade of simple features”, IEEE Computer Vision and Pattern Recognition, pp. 511-518, 2001.

[17] Leibe, A. Leonardis, B. Schiele. ”Robust Object Detection With Interleaved Categorization and Segmentation”, International journal of computer vision, 77(1), pp. 259-289, 2008.

Figure 1. Human detection in original images (failed detection).(Top) Original Images, (Bottom) The edge images of original images

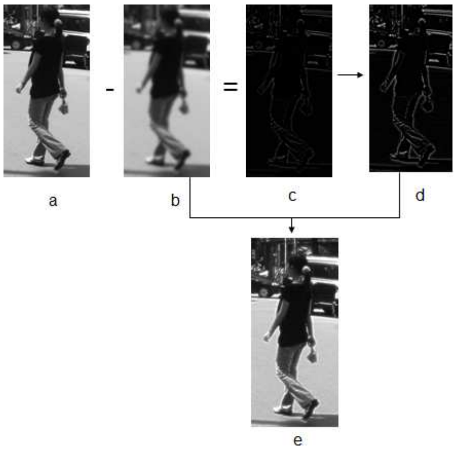

Figure 2. The process of local contrast enhancement..

Figure 3. The results of local contrast enhancement.(Top) Emphasized images using local contrast enhancement, (Bottom) The edge images of emphasized

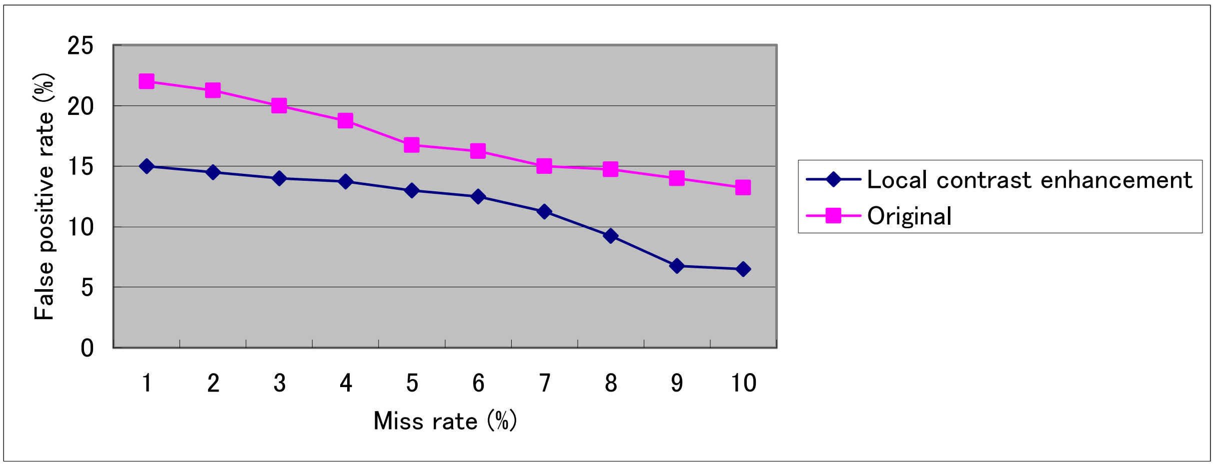

Figure 4. Human detection result .