Eye-blink Detection Based on SVM

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Overview

Alternative for Face Detection

- "haarcascade_frontalface" model provided by OpenCV
- Cascade classifier with HOG features provided by Dlib
- My model(Lack of database)

Eye Location Method

Dlib C++ Library provides the model of facial landmark detection, which can be used for eye location, whose accuracy is also suitable for this project.

Drawbacks:

- Redundant Computation.
- Low Speed
- Poor Accuracy under low resolution

What is LBP

LBP is a kind of method to reconstruct the original image. For every pixel, we compare it with other 8 pixels around it, and get a 8-bit binary array, which is the representation of the original pixel. The output of LBP processing is a new way to express the image.

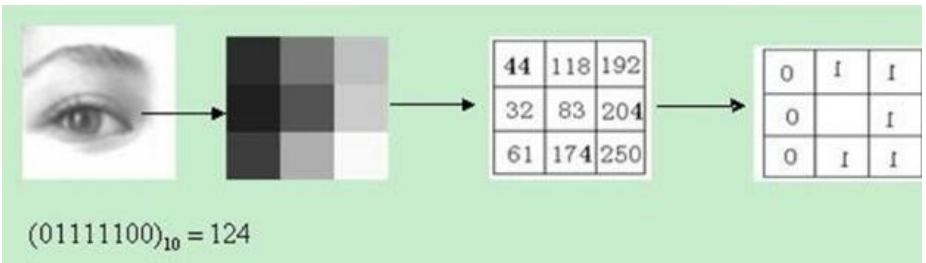

Figure: Calculate Process

[1]

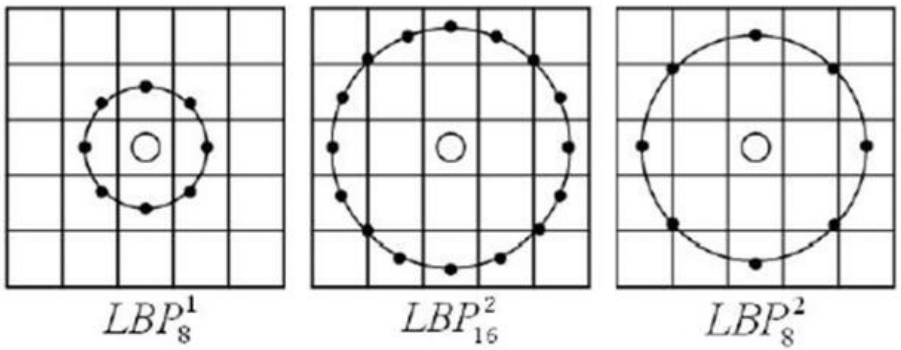

Figure: Complex LBP

[1]

Improved Pattern of LBP

Rotation Invariance Pattern

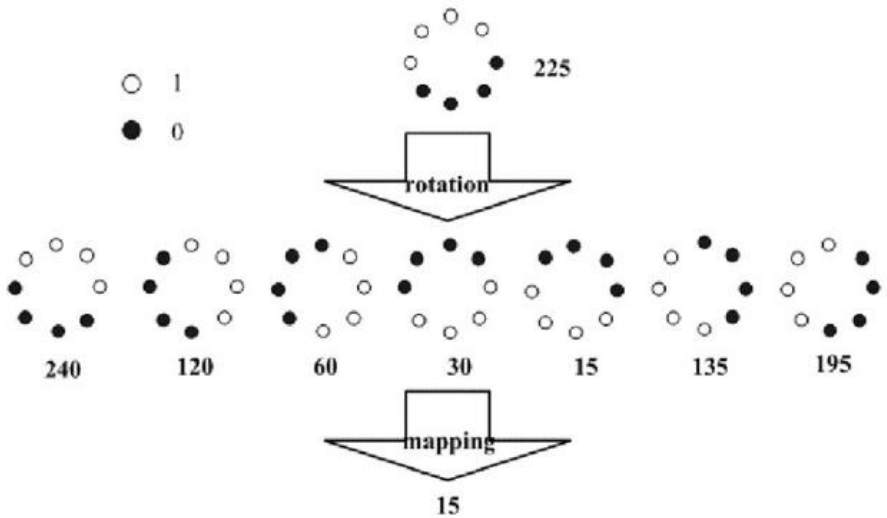

Figure: Example

[1]

Uniform Pattern

Connect the beginning of the binary sequence with the end, and the original sequence is changed to a circle.
According to the number of hops(0 to 1 or 1 to 0), we divide the sequence into 3 classes.

- 0 hop (2)
- 2 hops (56)
- others (1)

Strength of LBP

- The processing is much simple than HOG, and has a good performance.
- LBP features is insensitive to illumination. This characteristic has two strength: on the one hand, it means we don't care too much about illumination when taking photos. On the other hand, it means that we don't need to take in more data or train an independent model for low light levels.
- There are two more improved version of LBP, and they are insensitive to the rotation of images, which can suit more situations.

Feature Extraction

LBP is another description of the original image, and we usually use the gray-level histogram of LBP as the feature. To keep more details, we cut the LBP map into several blocks, calculate the histogram of each block, and connect the results together. Doing this, we can get higher dimensional features.

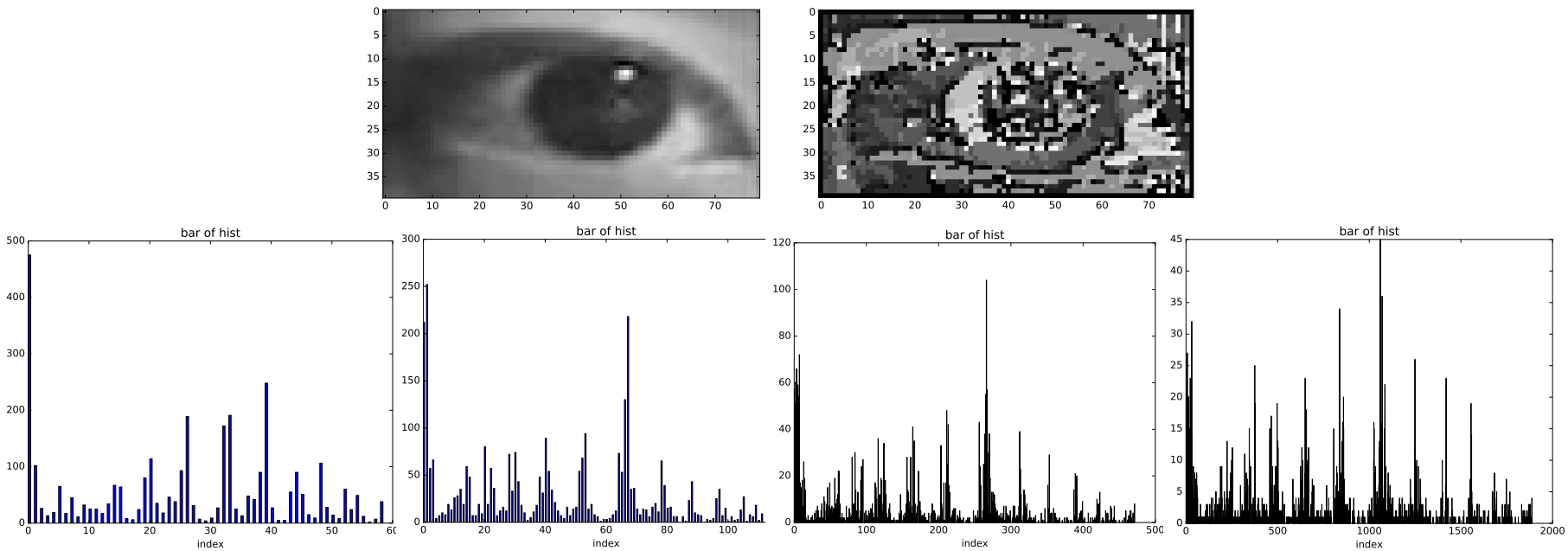

Figure: (a)an open eye. (b)the U-LBP of (a) (c)the histogram of (a). (d)the histogram of (e) with 1×2 blocks. (f)the histogram of (a) with 2×4 blocks. (g)the histogram of (a) with 4×8 blocks.

Strength of SVM

- SVM can get pretty good results even if the number of training data is small. As my hypothesis, if the model will be trained for every new users, we have to update the training database from camera. To satisfy the convenience of users, we can't shoot too much time, at most 2 minutes either for open eyes or close eyes, which means that for each user, we have a small database to train the model.
- SVM has much less parameters than convolutional neural network(CNN) does, so the speed of detection is faster and the necessary memory space for model is also very small.
- Instead of put the whole image to the model, we can extract the features in advance, which can represent the image and have some pretty good characters.

Parameters for SVM

Parameter	Value
Kernel Function	Linear/Gaussian
C	default 1.0
k	number of classification
γ	default $\frac{1}{k}$

Hypothesis

One Model Suits One User

- Reasonable
- Simplify the model
- Less Training Data
- Higher Accuracy

Results of LBP

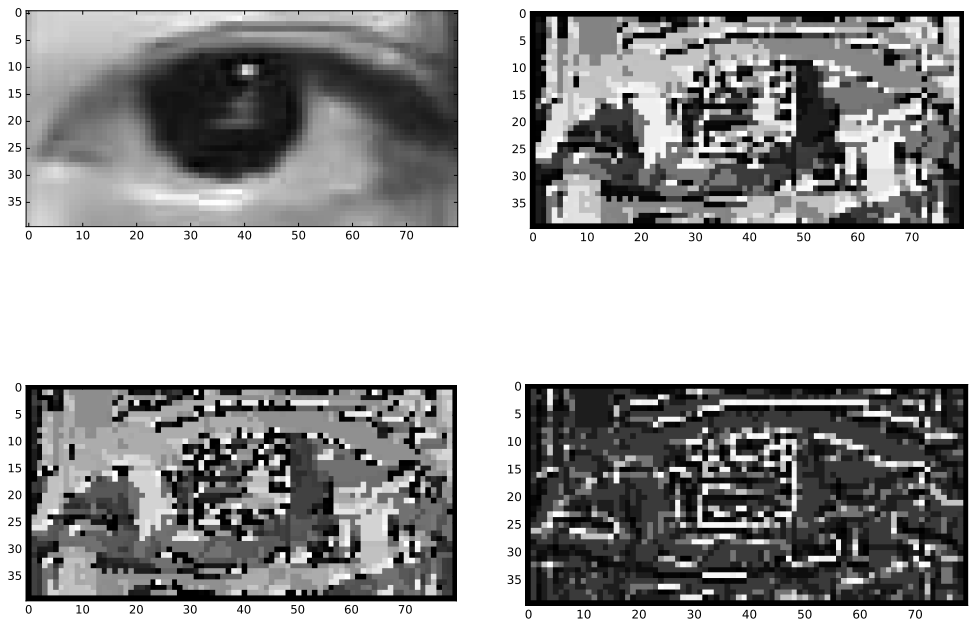

Figure: (a)the cropped eyes. (b)the original LBP of (a). (c)the Uniform Pattern LBP of (a). (d)the Rotation Invariance Pattern LBP of (a).

Results of SVM

Test on the number of blocks

Table: Experiment for blocks

Blocks	Training Accuracy	Val Accuracy
1×2	81.30%	66.58%
2×4	99.97%	91.23%
4×8	100%	93.33%
8×16	100%	90.16%

Results of SVM

SVM Parameters & Accuracy

Table: Experiment for kernel function

Kernel	Parameters	Val Accuracy
Linear(auto)	$C = 0.1$	93.33%
Linear	$C = 0.5$	92.77%
Linear	$C = 1$	92.77%
Gaussian(auto)	$C = 2.5, \gamma = 10^{-4}$	95.55%
Gaussian	$C = 2.5, \gamma = 0.5$	49.9%
Gaussian	$C = 1, \gamma = 10^{-4}$	95.81%
Gaussian	$C = 0.5, \gamma = 10^{-4}$	95.08%

References


"Feature extraction of objective detection: Lbp."
http://blog.csdn.net/zouxy09/article/details/7929531.

The End