Eye Detection and Attention Recognition Based on OPENCV

Lina Shang, Cui Zhang and Guangchun Gao

ABSTRACT

Artificial intelligence and computer science and technology developed rapidly. Computer vision technology has also made considerable progress. Human eye detection, human eye recognition and tracking also have significant application value and research significance. Based on OPENCV platform, this paper implements human face detection. The edge of the eye and pupil was extracted by sobel edge detection algorithm. According to the position of the pupil in the eye, the attention of the human eye can be obtained.¹

INTRODUCTION

Human eye detection based on computer vision technology to non-invasive and convenient and accurate characteristics in psychology, cognitive science, human-computer interaction, medical physiology, market research and public security and other fields has obtained the widespread application. The uniqueness of eye image and the characteristics of the eye movement are the key clues to the technology of human face detection [1], face recognition [2], human eye tracking [3], expression understanding and behavior recognition.

EYE DETECTION ALGORITHM

This system uses the human eye detection algorithm based on AdaBoost. Boosting is a fusion of multiple classifiers in order to improve the classification

¹ Lina Shang, Cui Zhang, Guangchun Gao, School of Information & Electrical Engineering, Zhejiang University City College, Hang Zhou, Zhejiang, China.
performance of the common methods. Boosting algorithm core is to adopt a
different subset iterative training weak classifier, and classification results weighted
training samples, sample to emphasize classification by mistake.

Aimed at Boosting algorithm to solve practical problems need to predict in
advance when the classifier learning error rate upper limit, Freund and Schapire
applies weighted voting and online distribution problem of Boosting framework.
This adaptive enhancement algorithm need not predict the prior knowledge of the
weak classifier, become the most widely used method of Boosting.

Boosting algorithm is the main principle: Given the \( n \) training sample
\( \{x_1, x_2, \cdots, x_n\} \) and its tag \( \{y_1, y_2, \cdots, y_n\} \), \( y_i \in \{-1, +1\} \), the process of making the
decision using the AdaBoost algorithm cascade \( M \) weak classifier is as follows:

1. Initializing the weight of training samples, putting the weights of each sample as
   \( W_i = \frac{1}{n}, i = 1, \cdots, n \).
2. Constructing \( M \) weakly classifier according to data feature, the
   output of sample \( x_i \) in the \( m \) weak classifier with
   \( f_m(x_i) \in \{-1, +1\} (m = 1, \cdots, M) \), for each weak classifier repeat the following two processes:
   a. Using the \( W_i \) weighted sample set to train the weak classifier, the classification
      error rate of the \( m \) classifier is \( e_m \),
      \[
      e_m = \sum_{i=1}^{n} W_i \cdot \left| \frac{y_i - f_m(x_i)}{2} \right| 
      
      (1)
      \]
      According to the classification error rate, the weight of the \( m \) classifier is
      updated as follows:
      \[
      W_i = \frac{W_i \exp \left[ -y_i f_m(x_i) \alpha_m \right]}{\sum_{i=1}^{n} W_i \exp \left[ -y_i f_m(x_i) \alpha_m \right]}
      \]
      \[
      \alpha_m = \log \left[ \frac{(1-e_m)/e_m}{2} \right] 
      
      (2)
      \]

3. The output of the classifier after cascade is
   \[
   H(x) = \operatorname{Sgn} \left\{ \sum_{m=1}^{M} \alpha_m f_m(x) \right\}.
   \] The error
   of the classifier \( H(x) \) is a monotone function and satisfies the following formula
   \[
   \frac{1}{n} \sum_{i=1}^{n} \left| H(x_i) - y_i \right| / 2 \leq \frac{1}{n} \sum_{i=1}^{n} \exp \left[ -y_i \sum_{m=1}^{M} \alpha_m f_m(x) \right] 
   
   (4)
   \]
The AdaBoost algorithm can adjust the weight of the sample according to the classification error rate of the weak classifier. As long as the classification ability of each weak classifier is better than the random guess, the upper bound of the training error can decrease with the increase of the number of weakly classifier to enough low. The strong classifier constructed by AdaBoost algorithm has the minimum error rate, which is the error detection rate. Increasing the number of weak classifiers can reduce the error detection rate, but also increase the computation time. Reducing the classifier threshold can improve the detection rate, but also increase the error detection rate. These factors should be balanced in specific applications.

Related in many pattern recognition applications, linear and single decision tree classifier, simple neurons after weak classifier by adopting the idea of AdaBoost cascade can effectively improve classification performance, and while the number of weak classifier is larger also not easy to lead to severe learning problems.

EXPERIMENTAL RESULTS

Based on OPENCV design implementation, this system can detect different face to the human eye chart of gaze direction, front view as shown in figure 1.

![Figure 1. Front view.](Image)

![Figure 2. Eye image edge detection results.](Image)

Images of different attention of the human eye using the Sobel edge detection are shown in figure 6. According to the eye of the pupil, it presents a round shape and in the middle of the eye, the non-circular appearance and the position of the left and right Angle of the eye can be used to determine the direction of the eye.
CONCLUSIONS

In many cases, the attention test of the human eye has high application value, which can be used to detect the driver's attention program, the concentration of the students' listening, and the degree of attention of the pedestrian to the advertisement. Therefore, the attention of the human eye has a wide application prospect.

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