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Computer Vision-based Crowd Attention Detection System

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***Abstract*: With the rapid growth of population and human activities, video surveillance system for analysis of crowd has attracted much attention in the field of Computer Vision. Public Requirements or management in the high-density crowd becomes a significant challenge due to the exclusive number of individuals, extreme clusters and complexity of sensors. In the past decade, researchers have made great progress in the Computer Vision community for intelligent video services. The proposed system uses some applications for analyzing crowd attention based on face detection technology and realize a crowd attention detection system using Haar-like features an Adaboost algorithm. The system consists of an image acquisition module, face detection module, display module, and data analysis module. Using the camera, combined with software named AMcap, the system captures images of crowed during the display of a video regularly. Then, the system detects the faces which are being concerned about this attractive video in images, circling and counting them. In addition, the system displays the data change graph of the crowd face at different moments and finally calculates the mathematical expected value of crowd attention for further processing such as Big Data technology.**

***Keywords*: Face Detection, Image Processing, Detection Analysis**

1. Introduction

With the constant development of science and technology, face detection technology has been applied to various fields. For example, face detection can greatly improve the efficiency in the security check. The application of face detection instead of the traditional fingerprint attendance can improve authenticity in automatic attendance. But the application of this technology in the attention of the crowd is very rare. A few years ago, domestic university researchers have improved the algorithm which uses face detection technology to analyze the crowd attention for billboards. In addition, some researchers also use this technology in the field of education to analyze the concentration of students and so on.

Every learning algorithm tends to suit some problem types better than others, and typically has many different parameters and configurations to adjust before it achieves optimal performance on a dataset, AdaBoost (with decision trees as the weak learners) is often referred to as the best out-of-the- box classifier. When used with decision tree learning, information gathered at each stage of the AdaBoost algorithm about the relative 'hardness' of each training sample is fed into the tree growing algorithm such that later trees tend to focus on harder-to-classify examples.

2. Methodology

The system selects a particular place such as the classroom. During the video, the image acquisition module captures images of the crowd regularly by a camera and AMcap software. Face detection module analyses the attention data of the crowd in a different time period, circles the faces in the images and counts the faces. Face detection is done by using a classification algorithm known as Adaboost. Using a large number of basic classifiers which have simple abilities and boosting them with a certain method so that they can form a strong classifier with a strong ability of classification. Then some strong classifiers are cascaded into a stage classifier to perform image search and detection. The display module displays dynamic images and dynamic data change graph of the crowd face at different moments. Data analysis module calculates the mathematical expected value of crowd attention during this period of time so that the data can be used for further analysis. The mathematical expected value of the data which the system has calculated finally is based on the mathematical expected value of face in each picture. The specific way of calculation is as follows:

$$X\_final = \sum_{i=1}^{N} \frac{X\_per}{N} \quad (1)$$

In formula (1), X_final represents the final mathematical expected value calculated by the system, N represents the total number of pictures involved in the face detection, and X_per represents the mathematical expected value of the number of faces detected in each picture. X_per is calculated by the formula (2).

$$X_{per} = \frac{num\_face}{r\_total} \quad (2)$$

In the formula, num_face represents the number of faces detected in a picture, r_total represents the actual number of People in a picture.

3. Application of face detection technology in obtaining crowd attention data

This system adopts the open source library named OpenCV. It is a cross-platform computer vision library based on the BSD license. It plays an important role in image processing, signal processing, and other fields. This paper uses open- source visual library source code which has realized cascade classifier based on Haar-like features an Adaboost Algorithm. It can detect the faces of the image accurately. Using the camera, combined with software named AMcap, the system captures images of crowed during the display of a video regularly. Then, the system processes images by Gamma correction, Gauss filtering, image sharpening, and Histogram Equalization, detecting the faces which are being concerned about this attractive video in images, circling and counting them. At the same time, the system still displays the data change graph of the crowd face at different moments, and finally calculates the mathematical expected value of crowd attention for further processing. The basic flow chart is shown in fig. 1.

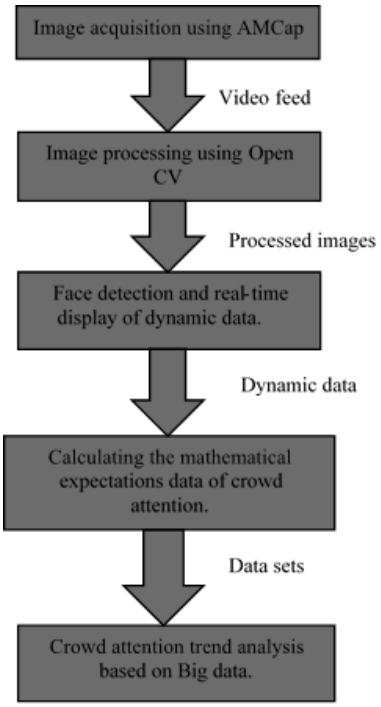

Fig. 1. Basic flow diagram of the system

Step 1: Gamma correction

The image processing needs to do Gamma correction first. Gamma correction is a nonlinear operation of the input images gray value so that the gray value of the output images and input images are exponential. Compared with the original image, the dark gray color of the image after Gamma correction is improved.

Step 2: Gauss filtering transform

In order to reduce the noise of the image, besides the Gamma correction, Gauss filtering transform is also necessary. Gauss Filter is a linear smoothing filter. It can be used to eliminate Gauss noise and is widely used in image processing.

Step 3: Image sharpening

Image sharpening compensates for the contours of the image. It can enhance the edge and the gray level jump part of the image so that the image becomes clear.

Step 4: Histogram Equalization

After the first three items are processed, the Histogram Equalization is also needed. Histogram Equalization increases much the local contrast of images, especially when the contrast of the useful data is fairly close. With this method the brightness can be better distributed over the histogram.

Step 5: Loading OpenCV Libraries

After four kinds of transformation, using classifiers which have been trained by OpenCV to detect faces in images and mark them.

Fig. 2. The results of face detection when the attention is high at the moment

Fig. 3. The results of face detection when the attention is low at the moment

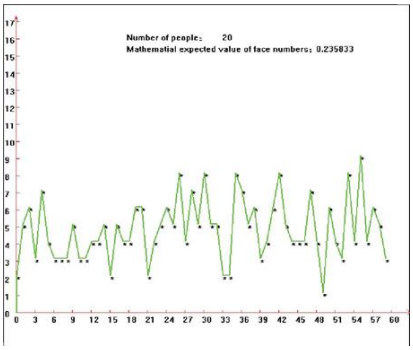

Fig. 4. Dynamic data change graph of the crowd face at different moments

4. Experimental results and analysis

In Fig. 2, the number of faces circled is 8, occupying more than half of the total number in the picture. It shows that at that time the video can raise high crowd attention. In sharp contrast, only 2 faces were detected in Figure 3. It shows that at that time the video cannot raise high crowd attention. From the two pictures, we can see some students on the distant are still focus on the video, but their faces are rarely detected.

Fig. 4 is dynamic data change graphs of the crowd face at different moments during the display of video. The video is about 45 minutes. The system obtains a picture of the crowded state every 40 seconds and takes 60 pictures for face detection in total. As long as the face is detected, we can think that this person is being focused on the video. The whole process will show an intuitive dynamic result. From the dynamic curve, we can see that the average value of crowd attention is low at the beginning of the video.

However, the average value of crowd attention is high in the latter part. The result indicates that the video is not attractive to the crowd in the beginning. As time goes, the crowd gradually finds that the video is interesting. More and more people are willing to watch the video, and crowd attention increases accordingly.

In addition, the system also calculates the mathematical expected value of crowed faces (or called probe rate) which represents crowd attention. Then, we can use Big Data technology to deal with the data and to get the crowd attention trends for a long time.

Through the above experiment, we can find that the system can easily, accurately and intuitively detect the crowd attention data. It will be of great help to business, security and other sectors.

5. Conclusion and future work

Through using face detection technology based on OpenCV library and Adaboost algorithm, we put forward a method to realize an intelligent crowd attention detection system. Compared to the traditional way of getting people's attention, this system is more reliable and flexible. Putting this system into use, the corresponding sectors can obtain crowd attention information as soon as possible so that they can take what they need.

For the mathematical expected value which represents crowd attention calculated by the system, we can use Big Data technology to deal with it to get the crowd attention trends for a long time so that we can predict the crowd's psychological and behavior more accurately. It can promote the development of the required industries, make social stability better and better.

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