Multiple View based Object Recognition using Color Distribution for Automatic Surveillance System

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Abstract This paper proposes method to recognize object and select camera based on multiple cameras for automatic surveillance system. The proposed methods consist of recognition part and camera switching part. In the recognition part, it recognize whether tracked person bring an object in/out. The system is composed of three main steps which are detection, correspondence, and recognition. The first step is to detect moving object using background subtraction. The multiple background model and temporal difference model are generated from image sequence. In the second step, we find a correspondence of objects under different cameras by maximum likelihood. The final step is to recognize the object using difference of distributions of detected object over time. In the camera switching part, it is to select dominant cameras for supporting automatic surveillance system. We use the number of detected label and the size of detected objects for selecting cameras. The proposed method is verified with image sequence in three cases which are set in the text.

1 Introduction

Recently, the multiple cameras based intelligent system such as automatic surveillance system, robot town, u-city and intelligent room is eagerly investigated on the computer vision society [1-4]. We need to solve several problems (calibration, switching, correspondence, synchronization) and algorithms (detection, recognition, and tracking) for designing those systems. Among them, we set up the problems which are object recognition and camera switching.

The Fig. 1 shows the concept for proposed surveillance system. When many cameras are installed in the different spaces (1, ⋯, N), the processor should to execute human tracking continuously even though whole cameras are not calibrated. It also needs to understand monitoring area itself, e.g., person takes a bag off the room. If we have a lot of cameras in a space, we do not need to know information of whole cameras. Therefore, the method of camera switching is also useful for supporting surveillance system.

From those reason, this paper proposes a method of object recognition and camera switching. In the object recognition part, we firstly detect and track moving object. The detected person then is matched between multiple cameras by the ratio of detected objects. The difference of two distribution of object in same camera over time is used to recognize an object. In the camera switching part, we use the number of label and
the ratio of detected region in an image to select dominant cameras.

This paper consist of five sections as follows: In section 2, the detection of moving object is explained. We then present the method to find correspondence between multiple views. We describe a method to recognize an object in section 3. The method for camera switching is presented in section 4. The experimental results and conclusion are explained in section 5 and 6, respectively.

2 Object Detection and Correspondence between Multiple Views

We need to solve correspondence problem for using multiple camera system. Firstly, moving objects are detected by background subtraction with multiple background model and temporal difference [5, 6]. The detected object in a camera then is matched with another camera by maximum likelihood of color distribution [6].

2.1 Object Detection

The moving object is detected by background subtraction. Multiple background model and temporal difference are generated from image sequence. The process of object detection is as shown in Fig. 2.

The background subtraction is executed based on gray scale image. Temporal difference is jointly used after background subtraction for removing noises. Detected regions are divided using labeling as each person. The result of detection process is as shown in Fig. 3.

2.2 Correspondence between Multiple Views

The color space is converted into HSI color space. The region of detected object is segmented by a criterion which consists of color range of HSI and context information. Segmented regions are represented as a Gaussian distribution. Therefore, we are able to estimate Gaussian mixture model (GMM) from distribution of blobs in each color channel as shown in Fig. 4.

The distributions in each channel have weight value. That is, an object is represented as a model which has color distribution and weight value. The objects between multiple views are matched by the ratio of GMMs.

3 Object Recognition

Each object is represented as a GMM from the section 2.2. We therefore are able to check a difference of distribution among consecutive two frames in a camera. If the distribution difference of each channel is satisfied with specific ranges, we regard the status of person as having been changed. From this information, the system recognize whether person
bring an object in/out.

4 Camera Switching

We do not need to use whole cameras installed for automatic surveillance system. The images from dominant cameras are only used to understand specific spaces. For that reason, we use the number of labels and the size of detected object in each image to select specific cameras.

5 Experiments

The seven cameras are installed in a room ($S_{lab}$) and the corridor ($S_{cor}$) for experiment as shown in Fig. 5. Same-typed cameras are used and image sequence is acquired in each camera with 15 frames per second. Then, we consider specific case that a person brings an object in and out. For verifying proposed method, we acquire image sequence in three cases with different color cloths and objects.

6 Conclusions

This paper proposed the method about object recognition and camera switching for supporting automatic surveillance system. We confirmed the performance of the proposed method with image sequence in three cases. Because our proposed method is based on color information so that the system cannot recognize an object when the user wear the same colored cloths which is similar to the color of nearby object. For solving this problem, we need to model each object for robust recognition in future works.

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References


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