A Rapid Robust Pedestrians Target Detection and Extraction

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***Abstract*—To meet the public security and criminal investigation requirement, this paper studies detecting and tracking of human motion through related theories on image processing and pattern recognition. The video information is obtained from video monitoring system (VMS). Background modeling is based on mixture Gaussian model. The background subtraction is used for detecting moving targets, separating the targets from the background and meanwhile eliminating shadows. This method can also accomplish binarization and connectivity analysis of human targets, mark rectangular frame of the human body and extract human targets. Therefore the image region which appeals to the criminal investigation can be acquired. Experimental results show the good performance of the algorithm which lays a solid foundation for further study on target tracking and recognition.**

Keywords- Mixture Gaussian model, background subtraction, Shadow elimination, Binarization, connectivity analysis

I. INTRODUCTION

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Moving targets detection is the basic task of intelligent visual monitor system, and also the foundation of the follow-up target identifying and tracking. Three methods are normally used for the detection: frame difference, optical flow and background subtraction. Background subtraction is widely used because of its simple algorithm and excellent real-time performance. Background modeling refers to constructing the image of the background or namely a model to represent the background, which is the key technique of background subtraction.

It is significant to figure out how to construct the background model, considering that there are too many possible factors in a real situation that make it almost impossible for the background to keep absolutely still. For example, in the background there often exists slowly varying natural objects such as moving clouds, shaking branches and waving lake surfaces. These slow variations obey the normal distribution and their slow varying backgrounds obey different Gaussian models respectively whose parameters are varied. Therefore, a mixture Gaussian model can be established based on different Gaussian models of different objects. Consequently, a mixture model can be established for each pixel according to a range of Gaussian distributions, and a situation with several variations in one background can be processed. In this paper, the mixture Gaussian model algorithm stems from the adaptive background mixture models that Stauffer proposed in [1]. In [2], in the basis of background modeling, the background subtraction is realized and the moving target can be extracted before binarization and connectivity analysis can be accomplished and moving target like pedestrians can be acquired.

II. MIXTURE GAUSSIAN MODEL

In this paper, Pedestrians Target Detection adopts the background subtraction method based on mixture Gaussian model.

The algorithm in [3] is described below .

For pixel {X1, X2,⋯,Xt}, a mixture model established with K Gaussian distributions， we may derive this formula：

$$P(X_t)=\sum_{i=1}^{K}\omega_{i,t}*\eta(X_t,\mu_{i,t},\sum\nolimits_{i,t})$$

In this formula， $\omega_{i,t}$ stands for the weight. It is the proportion of the pixels whose gray values match the ith Gaussian distribution out of the whole background. It needs constant updating. The updating formula is

$$\omega_{k,t}=(1-\alpha)\omega_{k,t-1}+\alpha(M_{k,t})$$

When matching the kth model, M(k,t)=1, otherwise M(k,t)=0；

Rate of Weight , α , is set to an experiental value in the range from 0 to 1, for example, 0.03.

For those pixels whose gray values match the corresponding Gaussian distributions on 3 σ principle, $|X_t-u|\langle 3\sigma$, the mean and variance of these Gaussian distributions will be renewed according to this formula:

$$\mu_t=(1-\rho)\mu_{t-1}+\rho X_t$$

$$\sigma_t^2=(1-\rho)\sigma_{t-1}^2+\rho(X_t-\mu_t)^T(X_t-\mu_t)$$

$$\rho=\alpha\eta(X_t|\ \mu_k,\sigma_k)$$

Gaussian model：

$$\eta(X_t \left| \mu_k, \sigma_k \right.) = \frac{1}{\sqrt{2\pi}\sigma_k} \exp\left\{-\frac{(X_t-\mu_k)^2}{2\sigma_k^2}\right\}$$

If no Gaussian model matches the current pixel, the X_t Gaussian component that has the minimum weight will be replaced by a new Gaussian model.

Normalize all weights and compute ω/σ value of each Gaussian distribution. The higher the value is, the lower the deviation will be and the more possible that it is the background pixel. Otherwise, it is a moving target pixel. Generally , the ω/σ value has to be descending ordered so that it is possible to put the sum of the first m ratio in to judgment. If the sum is higher than the given threshold, it indicates that the pixel belongs to background . Otherwise it is a pixel of the target.

In this paper, a Mixture Gaussian model on R/G/B three color channels is established, so the colored moving images can be processed and the detection effect is enhanced. Only when a pixel matches no one of the three color components can it be decided as a target pixel.

III. PEDESTRIANS TARGET DETECTION AND SHADOW ELIMINATION

The procedure to adopt Mixture Gaussian modeling for the moving target detection and shadow suppression is described as below [4] [5].

(1) Input video signal and preprocess;

(2) Initialization

```
{ describe the initialization of the parameters of K
  Gaussian processes of R/G/B three color
  component; K=5;
  Define row, col, K as the row number, the
  column number and the number of Gaussian
  distributions;
  Initialize mean avg[][] and variance sigma[][];
  Initialize weight;
  Initialize other parameters; }
```

（3）For each frame, detect the movement:

```
For (each frame){
   For (each pixel){ Judge whether the current
   pixel match the background model and
   decide weather it is a target pixel or a fixed
   pixel;
      IF(no Gaussian distribution matches the
      current pixel)
      {
            If （ Gaussian model not
            completely constructed）{add a
            new Gaussian distribution, the
            mean of which is the current
            pixel value and has the larger
            variance and smaller weight; }
            Else （ Gaussian model
completely constructed）
            {the last Gaussian model is
            replaced by the current Gaussian
            distribution, the mean of which is
            the current pixel value and has
            the larger variance and smaller
            weight; }
      }
      ELSE
      { define this pixel as background;
        Update the most matching Gaussian
model;
        Update the weight:
        weight[i][k] =(1-
alpha)*weight[i][k]+alpha;
        compute model updating factor beta, the
        better the match, the smaller the
        correction;
        compute Gaussian probability-density
     function;
        avg[i][k]=(1-
        beta)*avg[i][k]+beta*imgData[k];
        sigma[i][k]=sqrt((1-
        beta)*sigma[i][k]*sigma[i][k]
              +beta*temp*temp);
        lower other background weight;
       weight[i][k] =(1-alpha)*weight[i][k];

      }
   }
}
```

(4)define R、G、B as three color component of each pixel，and suppress the shadow[6] ;

```
s=(R+G+B)/3;r=R/(R+G+B);g=G/(R+G+B);
      sb=(bkR+bkG+bkB)/3;rb=bkR/(bkR+bkG
+bkB);
      gb=bkG/(bkR+bkG+bkB);
      if((s/sb)>=Alpha && (s/sb)<=Beta)
        {
          if(fabs(r-rb)<=Gamma1 && fabs(g-
gb)<=Gamma2)
            {decide the shadow pixel,
suppress; }
        }    .
```

IV. EXPERIMENT RESULT

The experiments reported in this paper have been conducted on the video sequence of the station platform which is often used in remote monitoring test.. The software platform is VC and tested on intel PC with OPENCV IDE (integrated development environment). Video data of each frame is read by relevant interface functions of OPENCV. In order to get clear effect, we have randomly chosen several frames in the original video. The moving target is macerde with red rectangle as shown in Fig.1. Fig.2 is the binarization of human targets. Besides, the background images which is constructed by Mixture Gaussian Model is printed as in Fig.3.(See following figures)

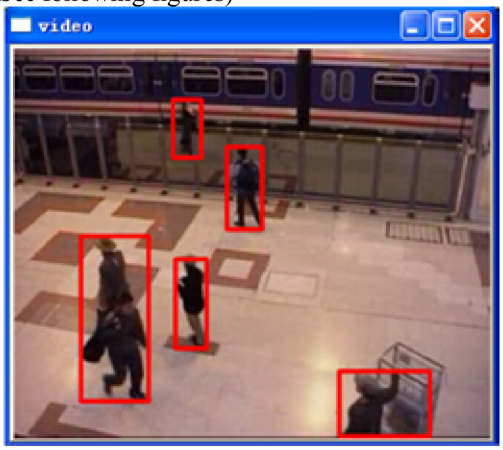

Figure 1. original image with red rectangles

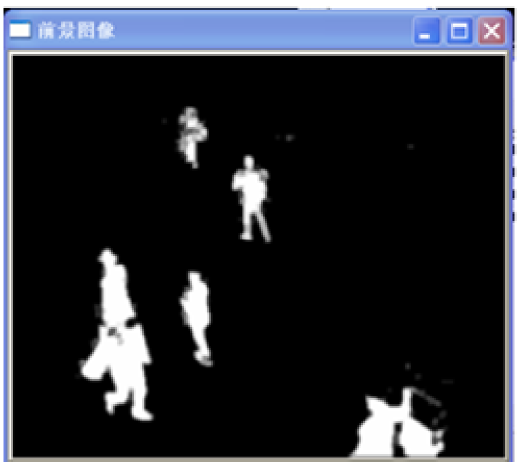

Figure 2. the binarization of human moving targets

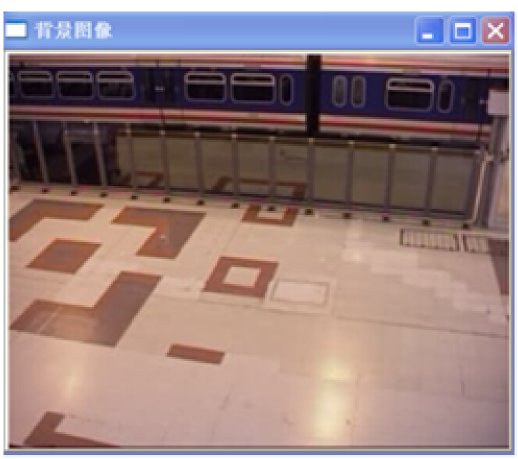

Figure 3. the background image model

As can be seen from the figures, the detection effect is pretty satisfying. Even when the human target can be detected accurately even under the circumstances of varying illumination, or strong clutter and noise.

V. CONCLUSION

This paper firstly analyze the designing principle of the Mixture Gaussian Model, then expound main tasks of the model construction and the software system implementation. Focused on the algorithm implementation, the overall designing idea and the implementation scheme are discussed, including the background model construction, shadow suppression, binaryzation and connectivity analysis. Besides, Chapter 5 has illustrated the experimental results. The randomly chosen figures fully demonstrate the validity and real-time feature of this method, which lays a solid foundation for further study on intelligent visual monitor.

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