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비디오 시퀀스에서 움직임 정보를 이용한 침입탐지 알고리즘

Intrusion Detection Algorithm based on Motion Information in Video Sequence

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요 약

비디오 감시 장치는 사회안전망 구축분야에서 다양하게 응용되고 있다. 본 논문은 고정 카메라에서 취득된 시각정보를 이용한 침입 탐지 알고리즘을 제안하였다. 제안한 알고리즘은 비디오 시퀀스에서 AMF를 이용하여 모델링된 배경으로부터 물체 프레임 후보를 찾아내고, 감지된 물체는 움직임 정보의 분석으로 계산된다. 움직임 검출은 RGB 공간에서 2D 물체의 상대적 크기로 결정하였으며 물체 감지를 위한 임계값은 실험적인 방법으로 결정하였다. 실험 결과, 시·공간적 후보 정보들이 급격히 변화할 때, 물체 감지의 성능이 우수함을 확인할 수 있었다.

Abstract

Video surveillance is widely used in establishing the societal security network. In this paper, intrusion detection based on visual information acquired by static camera is proposed. Proposed approach uses background model constructed by approximated median filter(AMF) to find a foreground candidate, and detected object is calculated by analyzing motion information. Motion detection is determined by the relative size of 2D object in RGB space, finally, the threshold value for detecting object is determined by heuristic method. Experimental results showed that the performance of intrusion detection is better one when the spatio-temporal candidate informations change abruptly.

Key words : intrusion detection, AMF, detected object

I. Introduction

Video surveillance is used to maintain social control and prevent different anomalies such as crime, an abnormal human position or behavior and traffic violation by using different techniques. Especially, the 8'th international meeting of ISO/TC 223 Societal Security have potentially reviewed and reported the new work item proposals [1]. Intrusion detection is a complex problem that can be solved by using visual applications. It is a challenging problem due to some factors: human can be in different clothes, take different poses and have class variations. Once human is detected, depending on the application, the surveillance system can go into the details of understanding the human activity [2].

A proposed approach uses motion information from

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video sequence to detect intrusion. Background subtraction techniques finds the foreground object from the video. The background model uses Approximated Median Filter (AMF) in RGB space at each pixel for constructing background scene that is continually updated [3]. Pixels detected by algorithm are considered as region of interest. When new object detected, frames would be captured for blob analysing and constructing boundaries for tracking. At this stage additional procedure can be included if require.

The organization of the paper is as follows: in section Ⅱ a description of research is given. In section Ⅲ, results of approach are presented. Finally section Ⅳ is devoted to conclusion.

Ⅱ. Proposed intrusion detection method in a video sequence

The main goal of proposed method is to detect new object in filmed video sequences. Therefor all frames goes through special validation procedure where we check them for new object presence. In order to cut down validation time and detect motion, input information is reduced by separating foreground and background scene. An overall description of algorithm is given below.

Initialization.
X is a test sequences in RGB space.
B is a description of background scene in RGB space.
F is foreground object in RGB space.
W - width, H- height
DI - dilation image
1) Background modelling.
B={}
2) Foreground detection.
FOR x=1 to width
FOR y=1 to height
IF all pixels of test sequence are within distance τ of corresponding background value B(x,y) THEN
F(x,y)=0
ELSE
F(x,y)=X(x,y)

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F(x,y)=X(x,y)
3) Background updating.
IF a pixel value in the current frame has a value larger than the corresponding background pixel THEN B(x,y) is incremented by one
ELSE
B(x,y) is decremented by one.
4) F converted to binary image.
5) Morphological operation:
a) Dilation with structural element ,
IF $SE_{i,j}$ *overlaps 1-valued pixels in the frame*
$bw(x,y)=1$
ELSE
$bw(x,y)=0$
b) Filling holes
IF pixel is on the border of f
$f_m(x,y)=1-f(x,y)$
ELSE
$f_m(x,y)=0$
c) $f_m.*bw(x,y)$
6) IF detected object < 15000 pixels THEN remove it
ELSE construct boundaries

The separation was done by background subtraction. Input frames are compared with background model and classified as foreground and background. We have used an assumption that region of interest is moving relative to it's background, while background remains stationary. Therefor foreground pixel can be defined as in eq. 1. The foreground pixel are detected by calculating the Euclidean norm at time t:

$$F_{(x,y)} = \begin{cases} I_t(x,y), & \| I_t(x,y) - B_t(x,y) \| > T_e \\ B_t(x,y), & otherwise \end{cases} \quad (1)$$

where I_t is the pixel intensity value, B_t is the background intensity value at time t and T_e is the foreground threshold.

$$I_t(x,y) = \begin{bmatrix} I_R(x,y) \\ I_G(x,y) \\ I_B(x,y) \end{bmatrix} \quad (2)$$

where, R, G, B are components of a color image.

The most tricky thing here is handling background. [4]. The background description can be done in several ways and the most primitive and simple way is taking a snapshot of scene without any foreground object. The method is used in frame differencing but it is not appropriate for complex scene because background can change over time.

We have implemented an approach in which background can adopt to its changing through time, background modelling was based on Approximated Median filter (AMF). AMF had been previously used for classification system and urban traffic monitoring [5]-[6].

AMF maintains a background model by using next simple procedure:

$$B_t(x,y,c) = \begin{cases} B_t = B_t + 1 & \text{if } I_t > B_t \\ B_t = B_t - 1 & otherwise \end{cases} \quad (3)$$

If a pixel value in the current frame has a value larger than the corresponding background pixel, the background pixel is incremented by 1.

Otherwise the background is decremented by one. In this way input data comes to a state when half of pixels are greater then the background and half are less than the background.

The foreground threshold T_e determined experimentally. The parameter is adaptive, if the object movements are fast, then T_e can be kept small, otherwise T_e should be kept large [7-10]. For human motion in-doors sequence $T_e = 26$.

In further step we obtained binary blobs and analyzed their area. Some additional morphological operations are done to improve output of background subtraction.

A dilation procedure is applied to detected objects and holes are filled according to eq. 3

$$f_m(x,y) = \begin{cases} 1 - f(x,y), & \text{if } (x,y) \text{ is on the border of } f \\ 0, & otherwise \end{cases} \quad (4)$$

If blob's area (connected components) is less then 15 000 pixel we suppose that it is a false object and remove it. All isolated pixel (individual 1's that are surrounded by 0's) were removed.

Ⅲ. Experimental Results

Intrusion detection was conducted by using Matlab Image Acquisition toolbox, test was performed on Intel Processor 2.83 GHz. We acquired RGB video sequence with one and two human motion in-doors reconstructed video sequence in fig. 1.

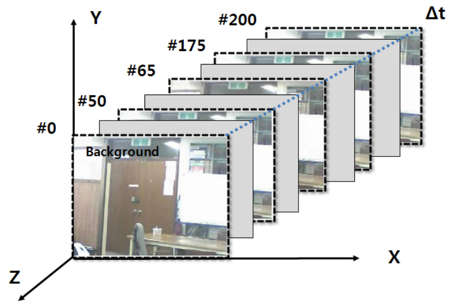


그림 1. 재구성된 비디오 시퀀스
Fig. 1. Reconstructed video sequences

Changes that were detected by detection procedure were represented in Fig. 3. The background scene modelling was implemented by using approximated median filter (AMF), though it has a good performance it adapts very slowly to large changes in background and is sensitive to environmental noise.

Since the amount of background update (+1 or -1) is independent of the foreground pixels, it is robust enough to perform our tasks. The only drawback is that it adapts slowly toward a large change in background the camera should be carefully positioned. All others motion segmentation details are described in a section Ⅱ and III.

Fig. 2 illustrates extracted frames from an acquired video sequences. Frames #50, 65, 175 and 200 are example of frames with object, namely, no object and two objects (or human) in frame.

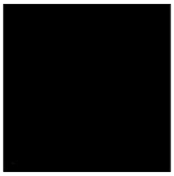

(a) frame #50

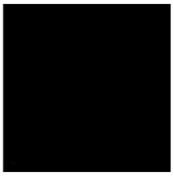

(b) frame #65


(c) frame #175


(d) frame #200

그림 2. 비디오시퀀스의 샘플 프레임
Fig. 2. The samples of video sequence


(a) frame #50


(b) frame #65


(c) frame #175

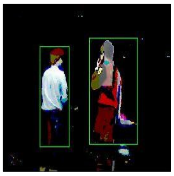

(d) frame #200

그림 3. 물체검출 결과
Fig. 3. The result of object detection

Fig. 3 shows detected changes in these frames with constructed bounding box . The result of one detected human in-doors is represented in frame #175. For detected changes whose area more then 15000 pixels boundaries is constructed, fig. 3.

In fig. 4 detected area is considered as intrusion if object's area is more then 15,000 pixel. First frames is equal to zero, that means that frames don't contain any objects. Output of these frames is black screen (all pixel's values are equal to zero) as in fig. 2 (frame# 50).

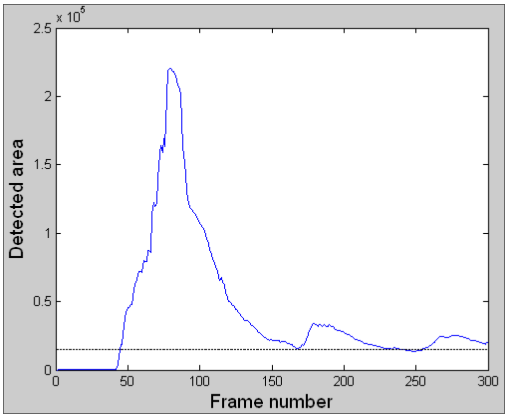


그림. 4. 비디오 프레임에서 물체출현 영역
Fig. 4. Appearance area of object in video frames

Large changes detected in video sequence in frames #50-150 represent a large object that was relatively close to camera (static camera was positioned too low, a walking human closed all scene) fig. 4 (first peak). In fig. 5 frame #100 illustrates first peak in Fig. 4. Another peak is reported in fig. 5, frame #180.


(a) frame #100


(b) frame #180

그림 5. 피크 물체 프레임 예
Fig. 5. Examples of peak object frame

Ⅳ. Conclusion

In this paper we have developed an intrusion detection approach in RGB video sequences. Approach includes AMF techniques to model background. Objects detection was based on background subtraction procedure. After motion pixels had been defined bounding box construction was implemented, all changes were captured for further processing.

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