Proceeding of the 2015 IEEE
International Conference on Information and Automation
Lijiang, China, August 2015

Region-Based Moving Object Detection using HU Moments

Yinglong Shen, Peipei Liu, Fushi Yao and Yunyi Liu

1.School of Computer, Electronics and Information, Guangxi University, Nanning 530004, China

2.Guangxi Key Laboratory of Multimedia Communications and Network Technology (Cultivating Base), Guangxi University, Nanning 530004, China

3.Guangxi Colleges and Universities Key Laboratory of Multimedia Communications and Information Processing, Guangxi University, Nanning 530004, China

liuyunyi@gxu.edu.cn

Abstract **- In this paper, a region-based moving object detection based on *hu* moments is concerned. Firstly, the feasibility analysis of *hu* moments in moving object detection is performed. Then a model of *hu* moments in moving object detection is presented and the performances are evaluated. The experiment results show that the *hu* moments can eliminate the large amount of noise caused by traditional Single Gaussian Model, and the *hu* moments with Single Gaussian Model work better than Gaussian Mixture Model.**

Index Terms - moving object detection; region-based; hu moments; single Gaussian model; GMM

I. Introduction

The methods of background subtraction can be divided into two classes: pixel based, region based. Most background subtraction methods based on pixel based, such as GMM [1, 2]. Modeling on pixel based can gain precise detection result about the moving object on single pixel. But the region based algorithms can obtain more information from the adjacent pixels to improve the detection results [3]. Also the region based can degenerate into region level modeling conveniently to reduce computation amount effectively.

In this paper a region based method of *hu* moments to detect moving object is concerned. To analyze the feasibility, the 11*11 areas are established to watch the *hu* moments in the cases of background and foreground with all frames. Then a model of foreground similarity for *hu* moments moving object detection is setup by Normalized Euclidean Distance between the initialization and object frames. Finally, the similarity indicator is input into the Single Gaussian Model to finish the last detection. The final experiment result shows that the proposed method can detect moving object perfectly, the detected moving object has less noise and has less hole inside.

The proposed algorithm workflow is as follow:

1: Calculating the *hu* moments of 11*11 connection areas of each pixel.

2: Calculating the indicator using *hu* moments of initialization and object frames.

3: Using the indicator for detecting moving object.

4: Putting the indictor into the single Gaussian model to detect moving object.

II. The HU Moments Algorithm

Hu proposed the *hu* moments in 1962[4], which are mainly used for pattern recognition. In mathematical statistics, moments are used for describing the distribution of random variable. The *hu* moments have invariants of translation, rotation and scale. Furthermore, they have the advantage of low computational complexity, and certain robustness to describe area. The *hu* moments are obtained as follows:

The origin moments m_{pq} defined as:

$$m_{pq} = \sum_x \sum_y x^p y^q I(x, y). \tag{1}$$

Where, $I(x, y)$ is the gray value of the image, x and y are the horizontal coordinate and vertical coordinate.

And the central moments can be described as.

$$u_{pq} = \sum_x \sum_y (x - \bar{x})^p (y - \bar{y})^q I(x, y). \tag{2}$$

Where, $\bar{x} = m_{10} / m_{00}$ and $\bar{y} = m_{01} / m_{00}$ (3)

Then, the standard central moments can be defined as:

$$\eta_{pq} = u_{pq} / {u_{00}}^{\gamma}. \tag{4}$$

Where, $\gamma = (p+q)/2 + 1$ and $p + q \geq 2$ (5)

From the above definition, the *hu* moments are obtained as:

$$M1 = \eta_{20} + \eta_{02} \tag{6}$$

$$M2 = (\eta_{20} - \eta_{02})^2 + 4{\eta_{11}}^2 \tag{7}$$

$$M3 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \tag{8}$$

$$M4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2 \quad (9)$$

The *hu* moments have invariants of translation, rotation and scale, and widely apply in recognize and track moving objects [5, 6].

III. The Feasibility Analysis of Applying Hu Moments

In this part, both the situations of background and foreground scenes are analyzed. The seven *hu* moments of the area marked with red rectangle are showed in Fig.1 and Fig.2.

In Fig.1, the results show that the values of the seven *hu* moments have no significant change when there is not moving objects appearing. In this case, the values of *hu* moments have two features. One is that it has very small value. The other one is that the *hu* moments have different magnitude. In Fig.2, it shows that the value of the *hu* moments all change significantly when there is a moving object appearing. These results show that the *hu* moments are the good choice for the moving object detection.

IV. The Model of Moving Object Detection with Hu Moments

To apply the *hu* moments, a similarity indicator D is defined as follows:

$$D = \sqrt{\sum_{i=1}^{k} \left((a_i - b_i)/s\right)^2}\ , \quad (10)$$

Where, s represents the standard deviation, a and b are the *hu* moments of the current and initialization frame, k is the order of *hu* moments.

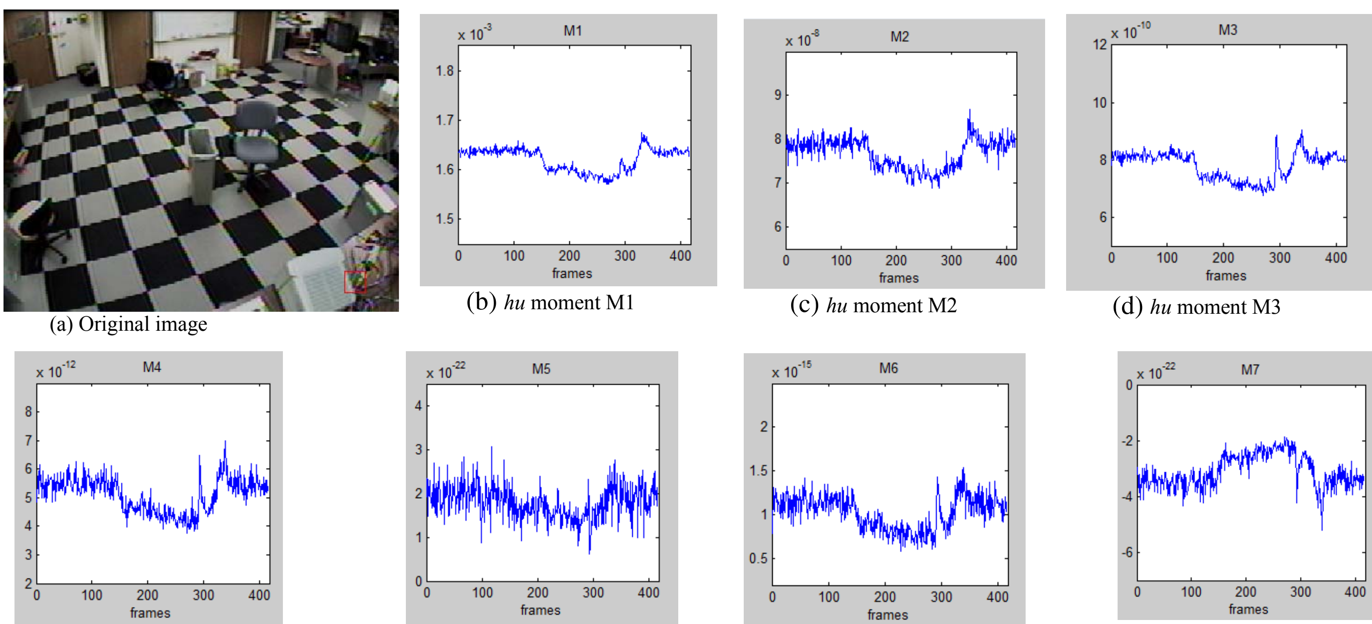
Simulation results of the similarity indicator are showed in Fig.3 and Fig.4. The experiment shows that the similarity indicator change significantly when the motion appears.

V. The Detection Model and Experiment Results

To apply the similarity indicator in different scene cases, the indicator is input into the single Gaussian model to obtain the finally result of moving object detection.

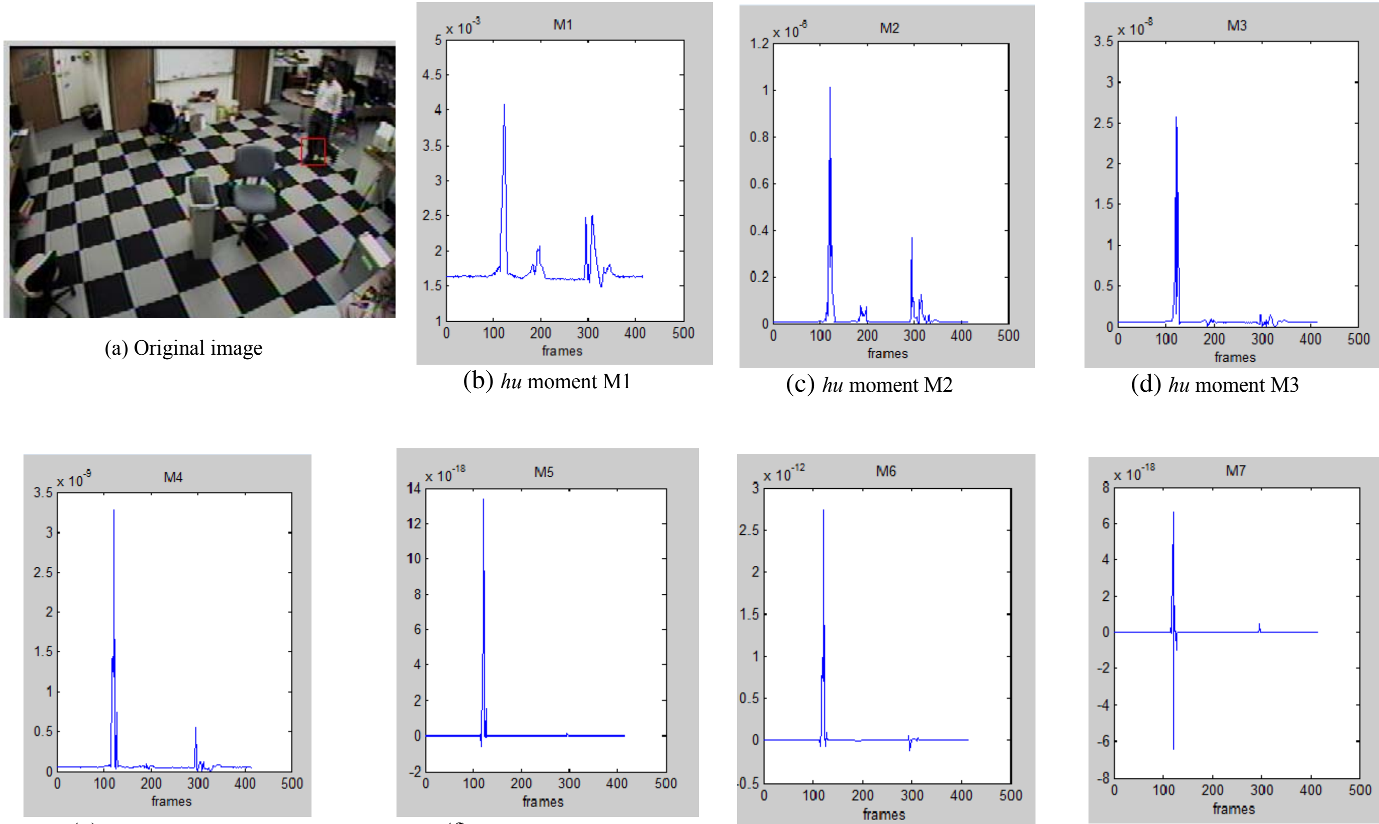
In this paper, a single Gaussian model is set up for each pixel which has 11*11 connected pixels. To get the mean value and variance of the background model, the parameters are train in the first ten frames.

To compare the proposed algorithm with others, the experiment results are showed as follows Fig.5.



(a) Original image (b) *hu* moment M1 (c) *hu* moment M2 (d) *hu* moment M3 (e) *hu* moment M4 (f) *hu* moment M5 (g) *hu* moment M6 (h) *hu* moment M7

Fig.1. The *hu* moments with background area



(a) Original image (b) *hu* moment M1 (c) *hu* moment M2 (d) *hu* moment M3

(e) *hu* moment M4 (f) *hu* moment M5 (g) *hu* moment M6 (h) *hu* moment M7

Fig.2. The *hu* moments with foreground area

In the Fig.5 (b), the result is obtained by traditional Single Gaussian Model. In this case, there are too many noises to get clear detection objects.

In the Fig.5 (c) and Fig.5 (d), the scene is processed by *hu* moments similarity indicator with fix threshold. It is obviously that the fix threshold cannot adapt to the changing conditions.

In the Fig.5 (e), the image is made by the MOG2 class in the Emgu CV which is a cross platform .Net wrapper to the OpenCV image processing library. The MOG2 is a Gaussian Mixture-based Background/Foreground Segmentation algorithm. In this case, because of the foreground has the similar colors with the background, it lose the first detection target.

Then, the proposed algorithm input the *hu* moments similarity indicator into the single Gaussian model and obtain cleaner moving object detection. The proposed algorithm can adapt the changing conditions by the single Gaussian model, and avoid similar colors confused by applying the information of connected pixels in *hu* moments.

Finally, we choose 20 pixel points from each frame in the video randomly, these points are detected whether they are background or not, then comparing with the previously established foreground and background library, and gaining the false detecting rate. The detected video has 416 frames. The false detecting rates of GMM and the proposed algorithm are as TABLE I, which shows that the proposed algorithm has higher accuracy than the GMM.

VI. Conclusion

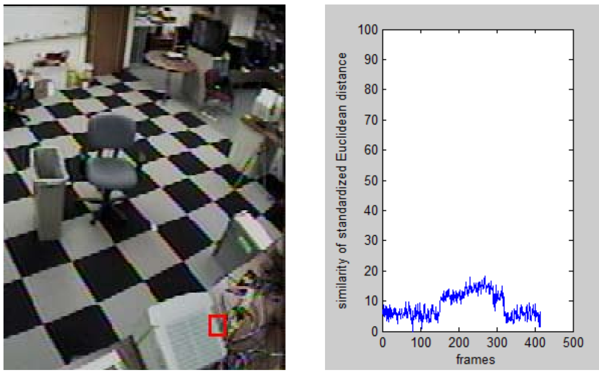
In this paper, a region-based moving object detection based on *hu* moments is proposed. Firstly, by the feasibility analysis, it shows that the *hu* moments all change significantly when the moving object appear. These results show that the *hu* moments are the good choice for the moving object detection. Then, to apply the *hu* moments, a similarity indicator is defined in this paper. Finally, the similarity indicator is input into the single Gaussian model to obtain cleaner moving object detection.

The experiment results show that the *hu* moments can eliminate the large amount of noise caused by traditional Single Gaussian Model. Also, the proposed algorithm can avoid similar colors confused by applying the information of connected pixels in *hu* moments.

Most of all, the proposed algorithm is applying the technology of object recognition. The idea in this paper can provide an opportunity to merge the moving object detection and recognition in the same processing step which reducing system complexity significantly.

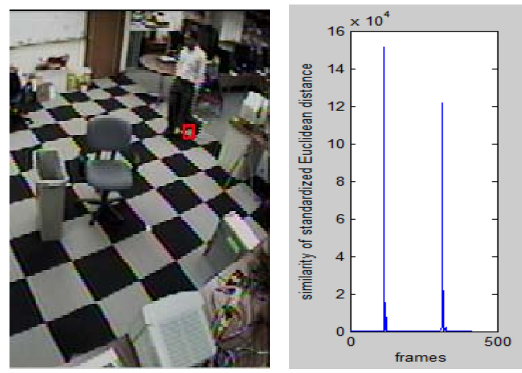
TABLE I. FALSE DETECTING RATE

Algorithm type	Frames	Total detected point numbers	False detected point numbers	False detecting rate
GMM	416	8320	263	0.0216
The proposed algorithm	416	8320	97	0.0117



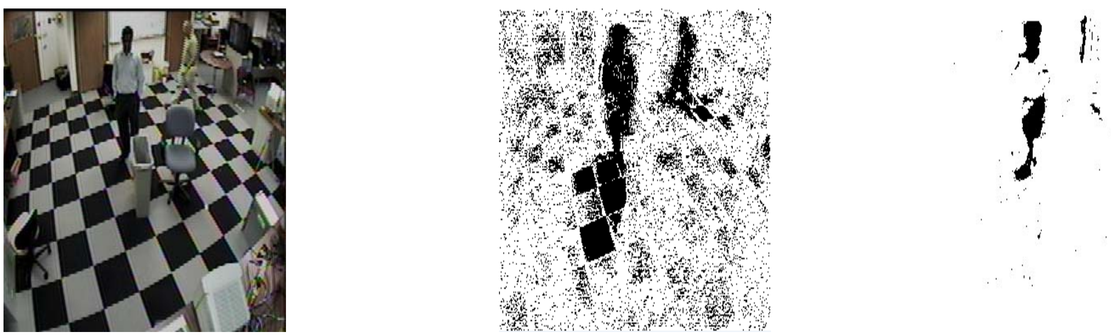
(a) Original image (b) similarity indicator

Fig.3. The similarity indicator with background area

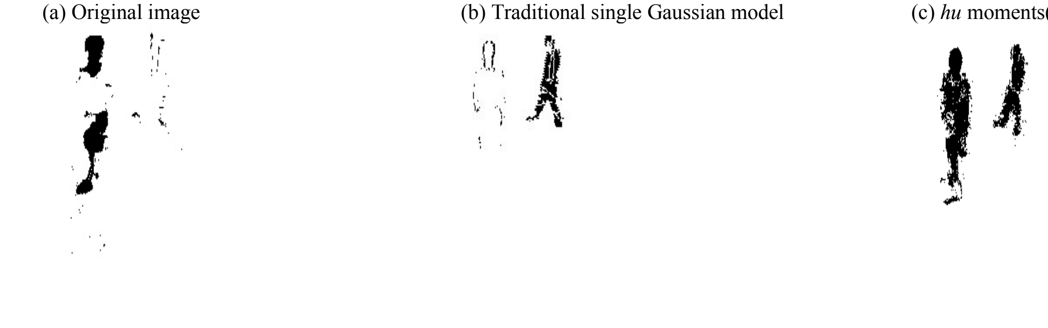


(a) Original image (b) similarity indicator

Fig.4. The similarity indicator with foreground area



(a) Original image (b) Traditional single Gaussian model (c) *hu* moments(Threshold=500)



(d) *hu* moments(Threshold=1000) (e) GMM (By MOG2 in Emgu CV) (f) Algorithm in this paper

Fig.5. Experiment results

REFERENCE

[1] C .Stauffer, W.E.L. Grimson, "Adaptive background mixture models for real-time tracking," Computer Vision and Pattern Recognition, 2(6):23-25, 1999.

[2] Zoran Zivkovic, Ferdinand van der Heijden, "Efficient adaptive density estimation per image pixel for the task of background subtraction," Pattern Recognition Letters, pp.773-780, 2006.

[3] Daniel Berjón, Carlos Cuevas, Francisco Morán, and Narciso García, "Region-based Moving Object Detection Using Spatially Conditioned Nonparametric Models in a GPU," IEEE International Conference on Consumer Electronics, pp.359-360, 2014.

[4] M.K. Hu, "Visual Pattern Recognition by Moment Invariants", IRE Trans. Inform. Th.,8, pp.179-187, 1962.

[5] Pattanachai, N. ; Covavisaruch, N. ; Sinthanayothin, C. Tooth recognition in dental radiographs via Hu's moment invariants[C]. Computer, Telecommunications and Information Technology (ECTI-CON), 2012， pp. 1-4

[6] Yun Liu . Yanmin Yin. Shujun Zhang . Hand Gesture Recognition Based on HU Moments in Interaction of Virtual Reality[C]. Intelligent Human-Machine Systems and Cybernetics (IHMSC), 2012,Vol 1， pp. 145-148.