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Background modeling in video surveillance by using parallel computing

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Abstract

In the last years, the research of extraction the movable object from video sequence in application of computer vision become wide spread and well-known . in this paper the extraction of background model by using parallel computing is done by two steps : the first one using non-linear buffer to extraction frame from video sequence depending on the number of frame whether it is even or odd . the goal of this step is obtaining initial background when over half of training sequence contains foreground object . in the second step , The execution time of the traditional K-mean has been improved to obtain initial background through perform the k-mean by using parallel computing where the time has been minimized to 50% of the conventional time of k-mean .

Keywords : background subtraction ,video surveillance , k-mean , multithread .

نمذجة الخلفية في المراقبة بالفيديو عن طريق استخدام الحوسبة المتوازية

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الخلاصة

في السنوات الاخيرة ، اصبح البحث في استخراج الاجسام المتحركة من سلسلة الفيديو في تطبيقات رؤيه الكمبيوتر جداً مشهور . في هذا البحث عملية استخراج (background model) بأستخدام المعالجة المتوازية حيث يكون العمل بخطوتين الاولى هي استخدام (non–linear buffer) في استخراج (frame) من سلسله الفيديو بالاعتماد على رقم المشهد (frame) اذا كان زوجي او فردي الهدف من هذه الخطوة هو الحصول على خلفية المشهد عندما اكثر من نصف سلسلة التدريب تحتوي على جزء متحرك ، في الخطوة الثانية تم تحسين وقت تنفيذ (k–mean) للحصول على خلفية المشهد وذلك تم من خلال تنفيذ (k–mean) باستخدام المعالجة المتوازية . حيث تم تقليل الوقت الى 50% من وقت تنفيذ (k–mean) التقليديه

1. Introduction

The identification of moving items in a video stream is an important and crucial issue in video monitoring, traffic surveillance and analyzing, detection and tracking of individuals, in addition to gesture identification in human-machine interaction. A widely used method for the identification of moving items is subtraction of the background, where every one of the video frames undergoes a comparison to a reference or back-ground model. Pixels in the current frame which noticeably deviate from the background are considered as moving items. Those “foreground” pixels are processed more

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for item localizing and tracking. Due to the fact that background subtraction is typically the initial stage in several of the computer vision applications, it's necessary that the obtained foreground pixels precisely be mapping to the moving item of concern. Today video surveillance system It is useful in all the areas such as residence, malls, hospitals, airports to detect a real time moving object and to analyze that object[1].Extracting the background is a valuable step of the techniques of moving item detection which are quite beneficial in monitoring systems. Moving item detection algorithm is simple in the case where a clean background image is present. Approach of background extracting during training stream and updating it while the input frame stream is known as background modeling [2].The easiest method of modeling the background is via acquiring a background image that does not have any moving item in it. In some of the environments, a stationary background isn't present due to the fact that the background dynamically varies because of varying lighting or moving items. Thus, the background representation structure has to be strong and adaptive for the sake of addressing those issues. Getting over those challenges, several background subtraction approaches have been modeled through the recent years. Several background modeling approaches have been improved and the newest survey may be found in[3]. Those background modeling approaches might be divided into the following types: Basic Background Modeling [4, 5], Statistical Background Modeling [6], Fuzzy Background Modeling [2] and Background Estimation [7] .

Each one of those modeling methods is utilized in background subtraction context that presents the following phases and issues: background modeling, background initialization, maintenance of the background, detection of the foreground, choosing the property size (pixel, a block or a cluster), choosing the property type (color properties, edge properties, stereo properties, motion properties and properties of texture). The development of a background subtraction approach, all those choices set the robustness of the approach to the critical cases which happen in video stream : Noise image because of low quality image source (NI), Camera jitter (CJ), Camera automatic adjustments (CA), Time of the day (TD), Light switch (LS), Bootstrapping (B) ,Camouflage (C), Foreground aperture(FA), Moved background objects (MO), Inserted background objects (IBO) ,Multimodal background (MB), Waking foreground object (WFO), Sleeping foreground object (SFO) and Shadows (S).

2. Related work

One of the most method of background subtraction was clustering , Cluster structures consider that every one of the pixels in the frame can be represented temporally via clusters[8]. In 2005 Butler et al. [9] proposed an approach which represents every one of the pixels in the frame with a cluster set. The background initialization is achieved offline. The clusters are arranged with respect to the possibility that they construct the background and are trained to deal with back-ground and illumination changes. New pixels undergo matching with the mapping set of clusters and are classified depending on whether the matching cluster is considered to be part of the background. To improve the robustness, In 2011 Duan et al. [10] used a genetic K-means approach. The concept is alleviating the drawbacks of the conventional K-means that has randomness and locality aspects which cause lacking in the overall optimizing.

At 2014Sinha et al. [11]. new Video Segmentation performs a decomposing of image frames into background and foreground. In this study, a mix of simplified mean-shift filter and K-Means clustering are utilized to model the background.

On the other hand , Codebook models: in 2004 Kim et al. [12] suggested modeling the background with the use of a codebook model. For every one of the pixels, a code-book is generated and includes one or more code-words. Samples at every one of the pixels are clustered into the group of code-words according to a color distortion measurement combined with bounds of brightness. The number of code-words differs following the pixel's activities. The clusters identified with code-words don't particularity need to be corresponding to single Gaussian or other parametric distributions. The back-ground is encoded according to a pixel-by-pixel approach. Detecting includes testing of the difference of the current image from the back-ground structure according to differences in color and brightness. Another clustering approach in 2006 M. Xiao et al. [13] " Basic sequential clustering "was developed according to the presumption that the back-ground wouldn't be the portions appearing in the stream for a short period of time. At first, pixels intensities are divided according to an online clustering structure. After that, cluster centers and appearance likelihoods of every one of the clusters are computed. Lastly, one or multi intensity clusters with the appearance likelihood larger than a threshold are chosen to be the back-ground pixel intensity value

3. K-means clustering algorithm

This approach (Mac Queen, 1967) is one of the simplest un-supervised learning algorithms which answer the well-known clustering issue technique commonly used which is simple and a fast method. It is easy to implement and has small number of iterations. K-means is another clustering. The stages of the method are the following [14]:

Step1. Select the number k of clusters, arbitrarily or according to some heuristics.
Step2. Produce k number of clusters and choose the center of each cluster.
Step3. Give every pixel of the image to the clusters which diminish the distance between the pixel and the center of the cluster (Distance is the squared or absolute difference between a pixel and a center).
Step4. Re-calculate the cluster center via averaging all cluster pixels.
Step5. Re-do steps 2 and 3 till a convergence is reached (for instance, the center of the cluster stays un-changed).

4. Software and hardware requirement

The proposed approach was tested on video data obtained from ATON Dataset test images from its source website [15]. that utilized in video surveillance evaluating the resulted images of this data set are 320 x240 pixel . this data set includes multiple video sequence of in-door or outdoor sequence in video monitoring area .

Where test-bed consisted of processor Intel® core ™ i3-3120M CPU @ 2.50GH_Z and installed memory : 4 GB (2.58 usable) and system type 32-bit operating system. All algorithms were implemented in c# .

5. Proposed approach

This paper aims to improve the already existing video surveillance system where based on improved original k - mean method , a modification process was carried out its time feature , multithreading was installed for the sake of reducing the duration taken to find the background model , improved the k-mean has been done by perform in parallel . This process was performed in two stage :

Stage 1 : Extraction or preprocessing : this stage involved input of the video stream in order to receive an output of array of image (frame) , it was achieve through loading video and checking the frame number . if the frame number was even then two frame would be neglected and stored one frame in array . on the other hand . if the frame number was odd then one frame would be neglected and stored one frame in array , as show in algorithm (1) .

as result the outcome will be a buffer of 100 frame and stored in an array . while the frame number was reached to 250 . which leads to obtain a solution to find a 1st background structure when over a half of the training buffer contains foreground items.

this operation is called (non-linear buffer) The algorithm (1) explain steps of extraction frame and stored them in array

Algorithm (1) non-linear buffer
Input : Training video (width =320, Height=250) : N : number of frame in buffer
Output : array of frame

Begin
STEP 1: T= 0 , I=0 // T : time , I: index of frame
STEP 2: Repeat
Capture frame (T) from video
Set frame to array of frame
T++
   If (T is even)
    T++
End if
T ++
I++
Until (I < N)
End

Stage 2 : involve the enhancement of standard k- mean by using multithread , this is done in many steps as following : first divided each frame with dimension (320x240) in buffer by divided the width by (80) pixel and divided the height by (80) pixel to obtain sub _ frame with dimension of (80x80) pixel . next all part of frame send to thread to treat it isolated from another in parallel manner . the goal of this step was reduce the execution time of k mean .as show in Figure- 1 :

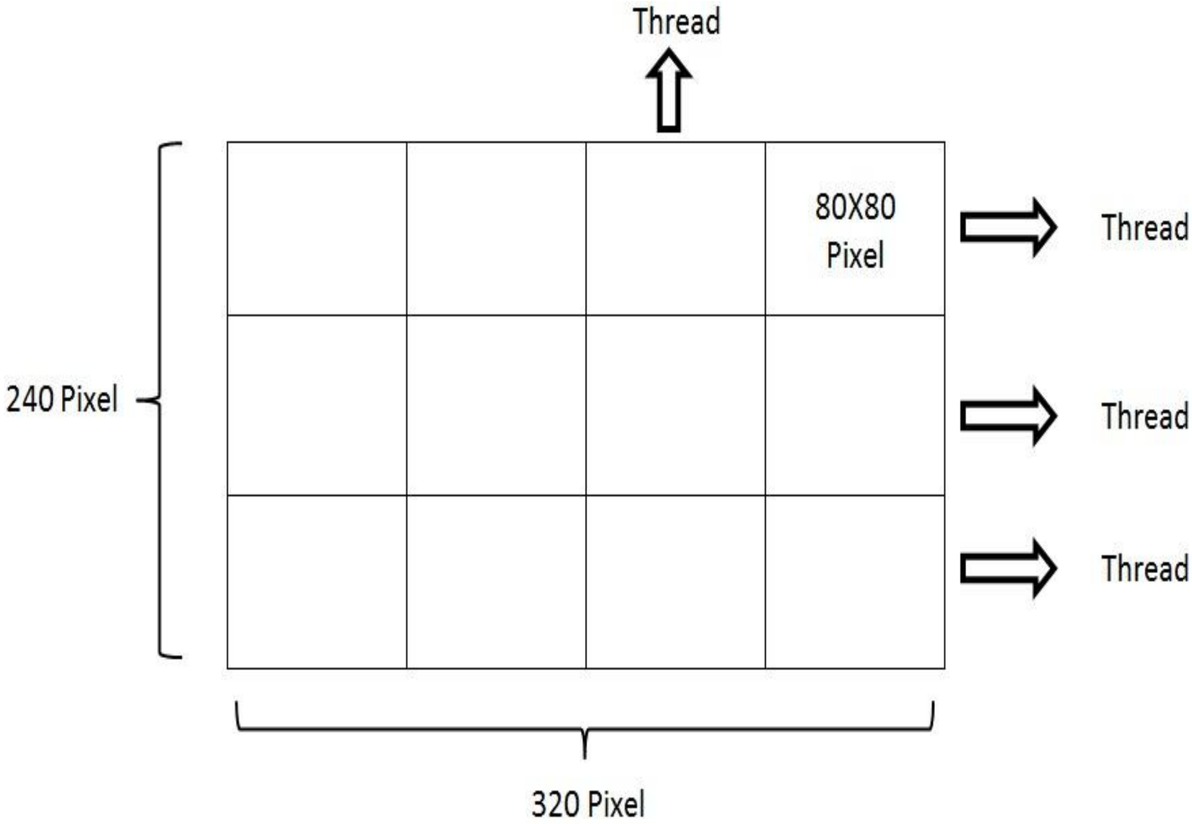

Figure 1- parallel computing of k-mean by using multithread.

after that for every pixel in location p(x,y) in sub _ frame taken the value of 100 pixel form buffer. then store in array (Array_Pixels) and applying the k-mean on array. where (12) thread working to gathers that lead to perform k-mean on (12) array at the same time . It must be noted Through experiments this paper found the optimizing number of (k) is (3) because increment the (k) lead to increase number of iteration only with same accuracy of initial background image .

the outcome of this step was clustering (100) value of pixel at location (x,y) in three cluster . later find the largest cluster that have the maximum number of member . then find the mean of largest cluster and put the mean value in initial background in corresponding location p(x,y) for each pixel in sub_ frame .

after that wait to complete each sub_ frame that was treat in thread , finally find the background image by construction of all sub_ frame . the benefits of using multithread was increase of performance that are possible when going from a single threaded , sequential application to a multithreaded parallel . in fact reduce the time of finding the initial background to half as show in section (5) . this stage explain in the following algorithm (training algorithm) .

Algorithm (2) Training Algorithm

Input : Training video (width =320, Height=250)

Output: Background Model as image.

Begin
Step 1: Chose 100 frames between first 250 Frames, by using algorithm(1) for non-linear buffer
Step 2: generate number of object according to the width and height of frame // Figure-1
Step 3: Each object work with sub of frame.
Step 4 : **For i=**first_sub_width to end_sub_width
For j =first_sub_height to end_sub_height
1- For k= 0 to number_frames
vector Array_Pixels = pixel(k,I,j)
End for K
2- Applying K mean on vector Array_Pixel by following parameter(data = Array_Pixels, Number of Clusters = 3 ,Number of iterations = 100).
3- Result of K mean the vector (Array_Pixels) assign to 3 clusters.
4- Compute the number of Pixels in each Cluster.
5- Find the Average of Pixels in the cluster have maximum number of Pixels.
6- Store the average in Background model.
End For j
End for i
Step 5: Waiting until finish all Threads.
End

6. Result and discussion

The implementation of the proposed algorithm is evaluated against the traditional K-mean algorithm . Five different cases were used in the experimental tests using different data sets were the frame dimension is 320 x 240 and the frame rate was 10 in four case and 14 in one case . by applying the modification algorithm on this case that elucidate the time to find the initial background was reduce to half .

This proposed method has been done in two steps: firstly used **non-linear buffer** to extraction video frame and store them in array of frame that used later in next step. the aim of this step was to find a 1st background structure when over a half of the training contains sequence foreground items. The Figure-1 show the different between used sequences buffering frame and the buffer by used non-linear buffer that proposed in this paper .

(a) **(b)**

Figure 1- initial background (a): buffer using first 100 frame, (b): buffer using proposed method

Secondly step was perform the original k-mean in parallel the aim of this step was to reduce the time of executed k-mean that was used to generate the initial background that used in the next processing background maintenance , foreground detected and background update . To compare the original k-mean with k-mean perform in parallel that proposed in this paper.where used five case has been taken from data set. Where (**FPS**) refers to **F**rame **P**er **S**econd.

Table- 1 explain the result of executed original k-mean and perform k-mean in parallel by using multithread which has been done on many case as following :

Table 1- explain the result of used k-mean in parallel

Case	Width	height	FPS	Standard k-mean	Improved k- mean	Time reduction
High way III	320	240	10	48 sec	**25 sec**	**23 sec**
Hall way	320	240	10	55 sec	**28 sec**	**27 sec**
Intelligent room	320	240	10	41 sec	**23 sec**	**18 sec**
Laboratory	320	240	10	45 sec	**24 sec**	**21 sec**
High way II	320	240	14	53 sec	**26 sec**	**27 sec**

7. Conclusion

It can be seen that the proposed method gives comparable results even though it doesn't require complicated computations or manipulations. This paper introduced an enhancement version of the k-mean algorithm . the enhancement refers to running time , where the enhancement comes from the considerable reduction of execution time of traditional k-mean . Experiments were performed on many case of video from data set . The testing showed that there was about 50% gain in time when simplified computation for proposed approach was used rather than traditional K-mean approach. with the same accuracy of background modeling . The method is easily understandable to non-mathematicians.

References

1. Desai , H. M. and Gandhi ,V. **2014**. A Survey: Background Subtraction Techniques **,** *International Journal of Scientific & Engineering Research*, **5**(12): 1365 .
2. Sigari,M.H , Mozayani,N. and Pourreza ,H. R **. 2008.** Fuzzy Running Average and Fuzzy Background Subtraction: Concepts and Application . *IJCSNS International Journal of Computer Science and Network Security*, **8**(2): 138 .
3. Bouwmans, T. , El-Baf, F. and Vachon,B. **2009**. Statistical background modeling for foreground detection: A survey. *Handbook of Pattern Recognition and Computer Vision* **.** *World Scientific Publishing* , **4**(3): 181 – 199 .
4. Lee,B. and Hedley, M. **2002**. Background Estimation for Video Surveillance**.** Image and Vision Computing , New Zealand, *IVCNZ*, **5**(2): 315 – 320.
5. McFarlane, N. and Schofield, C. **1995**. Segmentation and tracking of piglets in images. *British Machine Vision and Applications*, *BMVA*, **8** : 187 – 193 .
6. Stauffer, C. and Grimson ,W. **1999** . Adaptive background mixture models for real-time tracking. Conference on Computer Vision and Pattern Recognition, *CVPR*: 246 – 252 .
7. Messelodi, S. , Modena, C. , Segata,N. and Zanin,M. **2005**. A Kalman filter based background updating algorithm robust to sharp illumination changes. *ICIAP*, **3617**: 163-170.
8. Bouwmans, T., Porikli,F. , Höferlin , B. and acavant**,**A. V. 2015. *Background Modeling and Foreground Detection for Video Surveillance***.** CRC Press. E-book.
9. Butler, D., Bove, V. and Shridharan, S. **2005**. Real time adaptive foreground/background segmentation. *EURASIP*, **14**: 2292–2304.

10. Duan, X., Sun, G. and Yang,T. **2011**. Moving target detection based on genetic k-means algorithm . *International Conference on Communication Technology Proceedings, ICCT*. 978-1-61284-307-0/11/$26.00 ©2011 IEEE: 819-822.
11. Sinha, S. and Mareboyana,M. **2014**. Video Segmentation into Background and Foreground Using Simplified Mean Shift Filter and K-Means Clustering . ASEE . University of Bridgeport.
12. Kim, K. , Chalidabhongse, T. , Harwood, D. and Davis**,** L. **2004**. Background modeling and subtraction by codebook construction. *IEEE* International Conference on Image Processing, 7803(8SS4): 3061-3064 .
13. Xiao, M., Han, C. and Kang,X. **2006**. A background reconstruction for dynamic scenes. International Conference on Information Fusion , ICIF: 1-6 .
14. Jipkate, B. R. and Gohokar,V. **2012**. A Comparative Analysis of Fuzzy C-Means Clustering and K Means Clustering Algorithms . *IJCER*, **2**(3): 737-739 .
15. ATON Dataset : http://cvrr.ucsd.edu/aton/shadow/index.html