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DETECTION OF MOVING OBJECT IN A VIDEO SEQUENCE

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Abstract

In computer vision application, object detection is fundamental and most important step for video analysis. It is commonly used in video surveillances, vehicle auto-navigation, motion capture in sports, child care applications. A common approach is to perform background subtraction, which identifies moving objects from the portion of a video frame that differs significantly from a background model. In this paper, moving object detection is done by using background subtraction. An algorithm is proposed for object detection. Object detection can be achieved by building a representation of the scene called the background model and then finding deviations from the model for each incoming frame. Any significant change in an image region from the background model signifies a moving object. It involves subtracting an image that contains the object, with the previous background image that has no foreground objects of interest. The area of the image plane where there is a significant difference within these images indicates the pixel location of the moving objects. These objects, which are represented by groups of pixel, are then separated from the background image by using threshold technique. Morphological operators are applied to get enhanced results. Algorithm is applied to three video sequences. Results show that algorithm is able to provide enhanced output.

Key terms: object detection, background subtraction, foreground, background model.

1. Introduction

A very fundamental and critical task in computer vision is detection of moving objects in a video sequence. Surveillance systems using CCTV have been commonly used for various purposes, for example for traffic and airport monitoring. An automatic object detection and tracking are necessary to monitor the object of interest in the environment continuously. There are several issues that need to be considered when developing intelligent monitoring systems, such as object detection, recognition and tracking. Background subtraction is one method that is used for object detection. Background subtraction procedure is comprised of two steps, building statistical representation of the background scene and detecting the foreground by subtracting the background from the scene. It is the process that separates the image into foreground and background [16] .First performs background modeling to yield reference model. Each video sequence is compared against the reference model to determine possible variation. The variation between current video frame to that of the reference frame in terms of pixels signify existence of moving objects. [17]

The difference and change in the environment make the task of background subtraction to be a challenging problem. There may be some illumination changes like sudden or gradual change due to lighting effect or due to sunlight in water. There may also some distracting motions like camera-shake, moving elevator, motion in water, weaving tree leaves. Environmental effects like dust particles in air, rain, fog in the environment create problem for background subtraction.
Background subtraction should detect real moving objects with high accuracy. It should extract pixels of moving objects with maximum possible pixels, avoiding static objects and noise. The main objective is to develop an algorithm that can efficiently detect moving object in a video sequence.

An object in image processing is an identifiable portion of an image that can be interpreted as a single unit or is an identifiable portion of an image that can be interpreted as a single unit.
Object detection is the process of identifying an object in image/video frame.
Applications Areas of Object Detection in Video

Motion-based recognition: It is used in human identification based on gait, automatic object detection, etc.

Automated surveillance: It involves monitoring a scene to detect suspicious activities or unlikely events in shopping malls, offices, banks, railway-stations, metro stations, border-security, corridor, fields or forests etc.

Human-computer interaction:It includes gesture recognition, eye gaze tracking for data input to computers.

Traffic monitoring**:** real-time gathering of traffic statistics to direct traffic flow.

Vehicle navigation**:** video-based path planning and obstacle avoidance capabilities are provided with the help of object detection.

Robot-Vision**:** It involves monitoring and handlimg robot activites.

Medical-Imaging**:** Detect & identify of tumor or other affected area in human body

Animation**:** Detect and track the actions of animated object

2. Related work

A method based on statistic and was proposed by Wren et al. [7]. They have used a single Gaussian function to represent the intensity of background pixel. However, a complex environment hardly can be represented with only one Gaussian function. In work [8] mixture of Gaussian is used. Stauffer and Grimson [1] have used combinations of several Gaussian distributions to model the object and environment. They use a mixture of Gaussians to model the pixel color. In this method, a pixel in a current frame is checked against the background model by comparing it with every Gaussian in the model until a matching Gaussian is found. If a match is found, the mean and variance of the matched Gaussian is updated otherwise a new Gaussian with the mean equal to the current pixel color and some initial variance is introduced into the mixture. Classification of each pixel is based on whether the matched distribution represents the background process. Moving regions are detected using this approach. Zivkovic and Heijden [2] have proposed an online algorithm that can estimate the parameters of GMM and can simultaneously select the optimal number of Gaussian distributions. Baf et al. [3] have proposed a method to solve the problem of camera jitter, waving trees, and rippling water by using Type-2 Fuzzy Mixture of Gaussian. An adaptive Self-Organizing approach is proposed by Maddalena and Petrosino [4] to handle scenes containing moving backgrounds, gradual illumination variations. Then research [4] is improved further by using fuzzy to increase the robustness against false detections [5]. To improve the accuracy another approach [3] is by using Markov Random Field as post processing technique [6]. While Hoffman et al. have proposed Pixel-Based Adaptive Segmenter(PBAS) as non-parametric method to solve background subtraction problem and stated that PBAS has outperformed other methods.

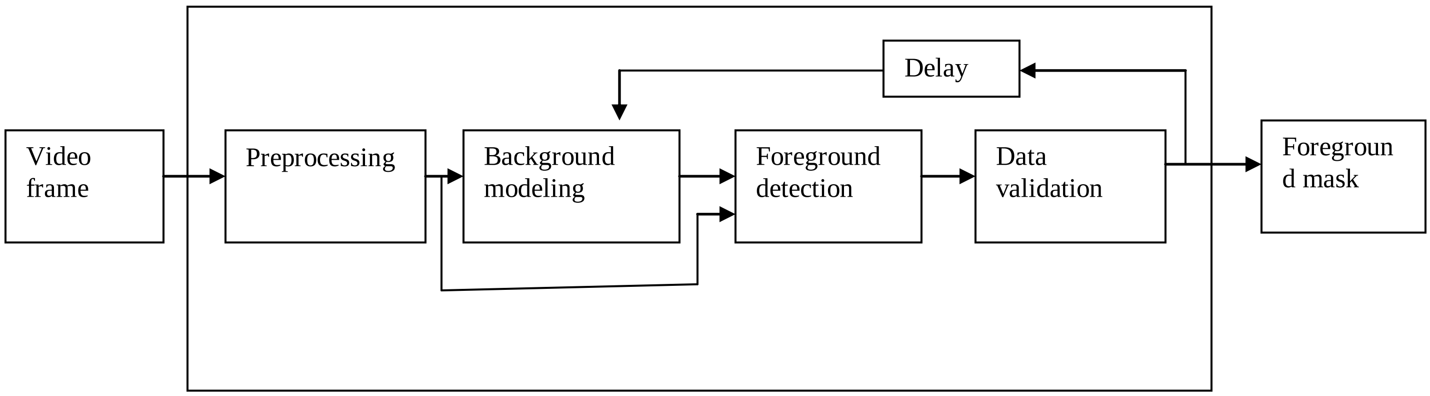
An adaptive learning rate for each Gaussian model to improve the convergence rate without affecting the stability was proposed by Lee [9]. He also incorporated Bayesian framework to isolate most likely background Gaussians and generate an intuitive representation of the believed-to-be background. The user-defined threshold in the original work is replaced with two parameters of the sigmoid function modeling the posterior probability of a Gaussian to be background. Although these parameters are trained from some commonly observed surveillance videos, both are inherently relying on the pro-portion by which a pixel is going to observe the background.
Shimada *et al.*[11] proposed an approach for improving the computational time of the (S&G) technique by reducing the number of concurrent models for a pixel through merging. Several multi-stage techniques are proposed to improve detection quality. Zeng and Lai [12] developed a two stage background classification procedure where the pixel-based GMM classifier is augmented with a region based classifier to remove the undesirable subtraction due to shadow, automatic white balance, and sudden illumination change. Huang *et al.*[13] addressed the same issue inversely by first dividing each scene into a set of motion coherent regions, then constructing pixel-based background model, and finally using these models to classify each region into background/foreground. Zhang and Chen [14] introduced support vector machine to further classify foreground pixels into motion/non-motion classes to reduce the false motion detection in complex background. Allili *et al.* [15] improved the detection quality in the presence of sudden illumination changes and shadows by generalizing the Gaussian to accommodate better fitting of the background model.

3. Background subtraction

Background subtraction is a widely used approach for detecting moving objects from static cameras. Identification of moving object from a video sequence is a very critical and important task. It is also called as foreground detection. It is done when image of interest is a part of video stream. Background subtraction is used for separating foreground object from the background. In this method first the background is modeled and then foreground object is detected by subtracting the foreground scene from the background scene. The name “background subtraction" comes from the simple procedure of subtracting the current image from the modeled image and then threshold the result to generate the foreground objects. Change of illumination of the environment, rippling water and waving trees are the problems that are encountered during background subtraction

There are four steps under background subtraction method:

a) Pre-processing
b) Background modeling
c) Foreground detection
d) Data validation



Background subtraction generally consists of four steps.

Preprocessing, background modeling, foreground detection and data validation.
a) Preprocessing is a collection of tasks that are applied on raw data video in order to convert raw input video into a format that can be processed further properly.
b) In background modeling, background is modeled from the preceding scenes.
c) In foreground detection. Foreground object is detected by performing subtraction.
d) In data validation, extra pixels are eliminated that are not a part of moving object and it then outputs the foreground mask.

4. Proposed background subtraction method for object detection

A method is developed which is able to detect all the foreground or moving objects in video frames. Background subtraction suffers from various problems such as illumination changes like sudden or gradual change due to lighting effect or due to sunlight in water. There may also some distracting motions like camera-shake, moving elevator, motion in water, weaving tree leaves ,environmental effects like dust particles in air, rain, fog. In the proposed algorithm, morphology operators and connected component analysis is done in order to get enhanced results.

Proposed algorithm identifies the moving objects by using background subtraction, where each video frame is compared against a reference or background model. First background model is created, then difference of the incoming frame and background model is calculated. If difference is greater than the threshold value then the pixel is considered as foreground pixel otherwise pixel is considered as background pixel. Binary morphological operators are applied and connected component analysis is done. It is followed by hole filling. Erosion is applied and dilation is done to get the resultant moving object.

Algorithm:

1. For each background frames, model the background

$$BN(x,y) = BN(x,y) + \frac{1}{N}\sum_{i=1}^{N} B(x,y), \quad \forall \text{N}$$

   Where, initially BN(x,y)=0
2. Select Threshold Value, Thres
3. For each foreground frames

   3.1 Read foreground frame, I(x, y)

   3.2 Subtract Background modeled frame BM(x, y) from foreground frames, I(x, y)

   D(x,y)= |I(x,y) – BN(x,y)|

   3.2 Clasify each pixel as

   foreground or background

   If D(x, y) >= Thres

   D(x, y) = Foreground pixel

   else

   D(x, y) = Background pixel

   end

4. Apply binary morphology using ‘spur’, ‘majority’ and then evaluate connected component.
5. For each Connected Component object

5.1 If (ObjectSize < filterSize)

bgframe = 0;

end

5.2 outframe = 1 – bgframe;

6. Fill the holes in outframe ,

   filled frame = fill the holes in outframe

7. Apply erosion to holefilled frame ,

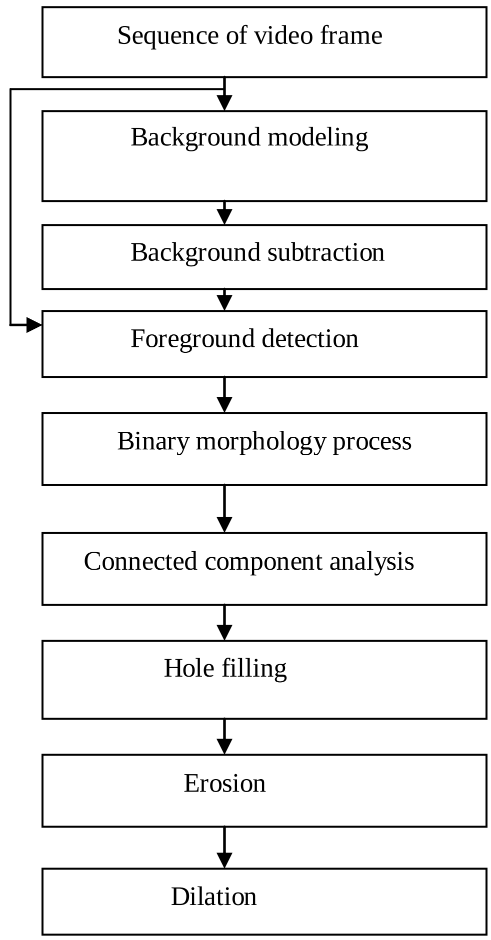
   Erodeframe =erode(filled frame, se)

8. Apply dilation on eroded frame

   Dilateframe= dilate(filled frame,se)

9. Print the frame

   Finalframe = dilateframe



Block diagram of proposed algorithm

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5. Result Analysis

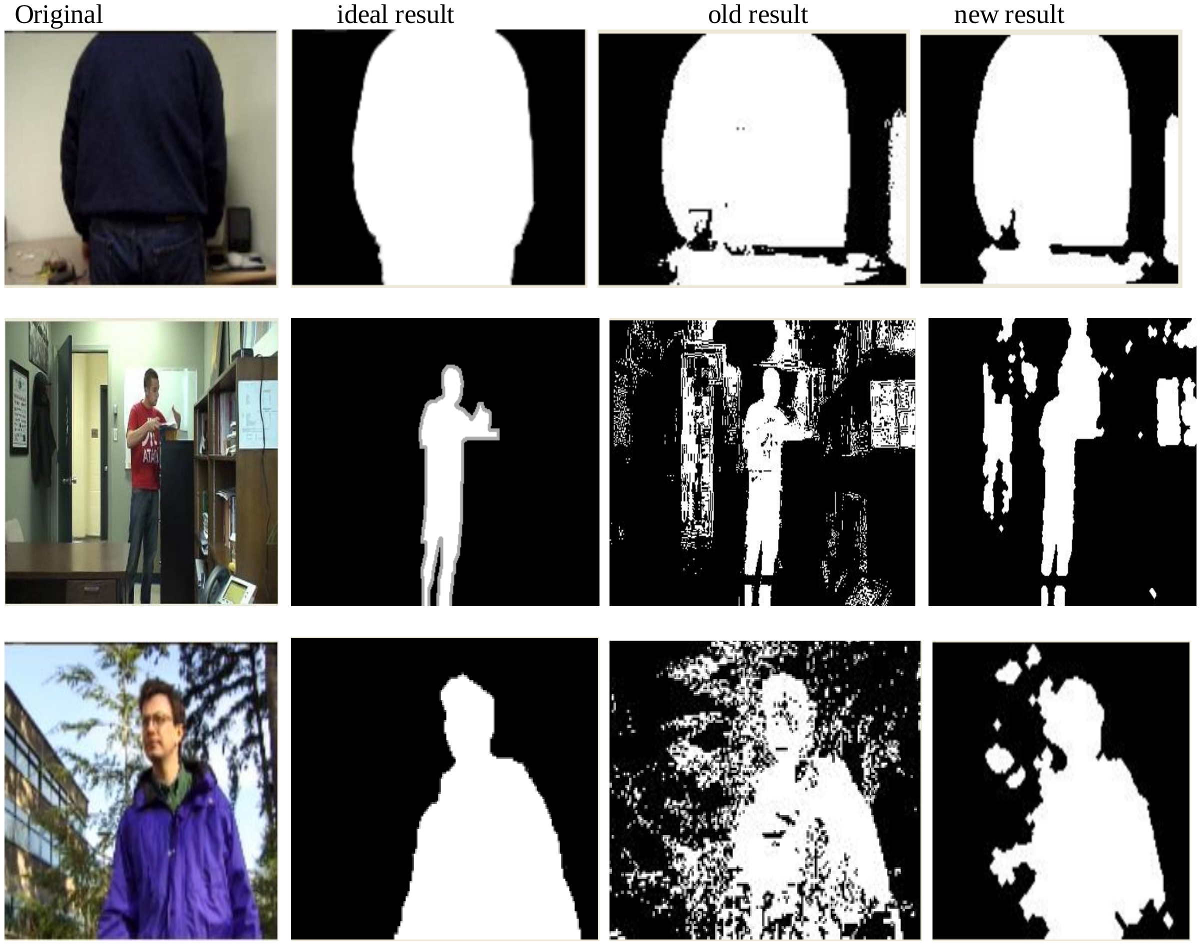
Morphological operators are used to carry out this experiment. The proposed model work for object detections which suits real life such as surveillances system, robotics, medical imaging and is coded in Matlab and it runs on Window 7. Some evaluation parameters are used such as, Background Subtraction, morphological operations to get better resultant images.

Test cases

Three publicly available datasets are used: camouflage dataset, office dataset and waving trees dataset which have video frame sequences. In Camouflage a person walks in front of a monitor, which has rolling interference bars on the screen. The bars include similar color to the person's clothing. In office a person enters a room, takes a book from the shelf, opens it and then puts the book back and walks out of the room. In Waving Trees a tree is swaying and a person walks in front of the tree.

At threshold 0.10

Original ideal result old result new result

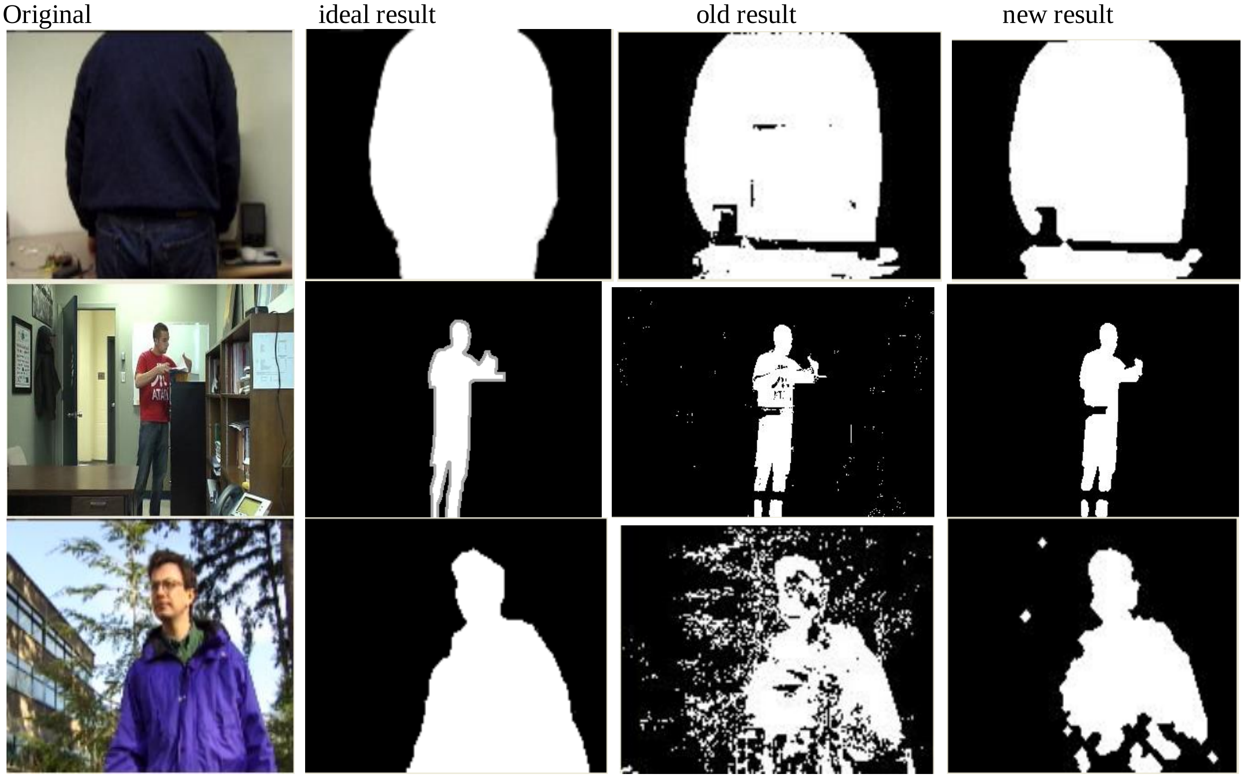


At threshold 0.12

Original ideal result old result new result

At threshold 0.15

Original ideal result old result new result



ERROR MEASUREMENT AT DIFFERENT THRESHOLD

Table 1: Percentage error measurement at threshold 0.10

Problem type	Algorithm	FP_ERROR	FN_ERROR	TOTALERROR
CAMOUFLAGE	OLD	3.3177	1.0469	4.3646
	NEW	4.0156	0.9479	4.9635
OFFICE	OLD	7.7674	0.1852	7.9525
	NEW	8.3669	0.0822	8.4491
WAVING TREES	OLD	7.3021	3.0313	10.3333
	NEW	4.0990	1.4583	5.5573

Table 2: Percentage error measurement at threshold 0.12

Problem type	Algorithm	FP_ERROR	FN_ERROR	TOTAL ERROR
CAMOUFLAGE	OLD	1.7917	1.2396	3.0313
	NEW	1.5260	0.9844	2.5104
OFFICE	OLD	0.7998	0.2535	1.0532
	NEW	0	0.1597	0.1597
WAVING TREES	OLD	6.1094	3.5260	9.6354
	NEW	2.5677	3.3906	5.9583

Table 3: Percentage error measurement at threshold 0.15

Problem type	Algorithm	FP_ERROR	FN_ERROR	TOTAL ERROR
CAMOUFLAGE	OLD	0.9010	1.5365	2.4375
	NEW	0.8438	1.4479	2.2917
OFFICE	OLD	0.0972	0.3854	0.4826
	NEW	0	0.2975	0.2975
WAVING TREES	OLD	4.4115	4.2240	8.6354
	NEW	0.6406	4.6406	5.2813

6. Conclusion and future work

In real world applications, waving trees, rippling water, slow moving objects and illumination changes create problem for background subtraction. An algorithm is proposed to filter out the problems. An approach capable of detecting human motion and extracting object information which involves human as object is described. The algorithm involves modeling of the desired background as a reference model. This reference model is later used in background subtraction to produce foreground pixels which is deviation of the current frame from the reference frame. This algorithm is applied to three video sequences and the results are compared with the previous results. Different values of thresholds are applied to the video sequences. Results are enhanced to a large extent at threshold value 0.12. This algorithm detects the object efficiently and it is able to enhance the results.

In future object detection can be done by using moving cameras with moving background. Detection of moving object is done; tracking of objects is the next step after detection. There are three key steps in video analysis: detection of interesting moving objects, tracking of such objects from frame to frame and analysis of object tracks to recognize their behavior. Every tracking method requires an object detection mechanism either in every frame or when the object first appears in the video.

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