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Salient Approach for Motion Detection in Real Time Domain

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ABSTRACT: In today's world CCTV's are being invested in almost every place be it shopping complex, hospitals, schools or someone's home. It helps in recording any apprehensive activity taking place, but the most important inconvenience of CCTV cameras is that it records for the entire time, the moment it is enabled. This process misspends a lot of memory since the camera is on unnecessarily moreover CCTV camera does not have an alarming system by which whenever there is any dubious activity it can alert the possessor. Therefore, there is a necessity of a system in which the camera will record only when there is a motion in the frame of the camera. For this an innovative real time, based algorithm is effectuated which uses various methods to detect motion in real time domain and enable the camera to record whenever there is a motion hence reducing memory wastage. This algorithm incorporates the temporal differencing method, optical flow method, double background filtering, morphological processing method to attain optimal performance. The most exceptional advantage of this method is that the it does not need to have the knowledge about the background model from thousands of images and it can handle immediate changes in the image without preexisting knowledge of the shape and size of the object. This method also takes less guesstimation time as compared to the diverse real time based motion detection algorithms available. The algorithm is enforced in a simulation environment and theproductiveness of this method is indicated in this paper. The evaluation results are proclaimed in this paper.

KEYWORDS: Temporal Difference, Double Background Filtering, Optical Flow, Morphological Processing

I. INTRODUCTION

Over the past few decades, a lot of interest has been given to the idea of motion detection by computer researchers and image processing technocrats due to its application in various domains such as surveillance purposes [1], systems monitoring traffic [2] and recognition of sign languages.

Despite the ongoing and finished research, this area still has a lot of potential and development needs to be done in this area so as to increase its robustness in the various complex environments it is being used. Several different techniques have been used for motion detection and tracking in [3]- [9], among them the three most important techniques being utilized are Temporal Difference, Double Background Filtering and Optical Flow. Temporal differencing [10] is used to detect the motion of an object by calculating the frame difference of the existing frame and the reference frame. This approach is the most common approach being used to detect the motion. This method is extremely adaptive to the dynamic changes in the environment, but it usually does a poor job in extracting the exact shape and size of the moving objects. Background subtraction [11] is an extensively used approach in image processing. In this method, the

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foreground objects of an image are extracted for further processing. This method is applicable wherein the camera should be stable, which means the background is constant with respect to the foreground. This method is also known as foreground detection and it finds a wide application in surveillance tracking. When the environment becomes crowded and the background is not visible clearly then the background subtraction method is of no use.

At that time, optical flow method is used to calculate the approximate motion performed by the local image and it also depicts the value by which every image pixel changes between next images. Optical flow method is complex to carry out but it provides accurate results as this method is independent of the background of an image. The main idea of this paper is to incorporate the advantages of the above-mentioned methods. In this paper, collaboration of temporal difference and background subtraction method along with morphological operator is implemented. The optical flow method will be carried out in future when we will be using this algorithm for crowded environment where the background is not feasible. The primary goal of the above-mentioned algorithm is to effectively separate the background noise and information in the foreground and thereby detect the motion of an object with precision. First, the Temporal Difference method is carried out to determine the moving object and track its motion. Secondly, DBF is done to which is nothing but median filtering to eliminate the background noise present and keep a constant background image to declaim changes in environmental varying conditions. The morphological processing is combined with DBF, later to gain better results.

II. OVERVIEW OF THE METHOD

The mechanism depicted in the flow chart which follows this paragraph Fig.1. It is seen that, the entire algorithm constitutes of three steps: (1) Temporal difference, which has been incorporated to find out the object's motion in initial stage; (2) DBF with is implemented in combination with Morphological processes in order to clear the unwanted noise in the background and information of the foreground motion is also recorded; (3) The position where motion takes place or is detected is enclosed in a red bounding box. The experimental output in figures (a) to (h) shows a few images that support the grasping of the processes that are involved in the proposed method.

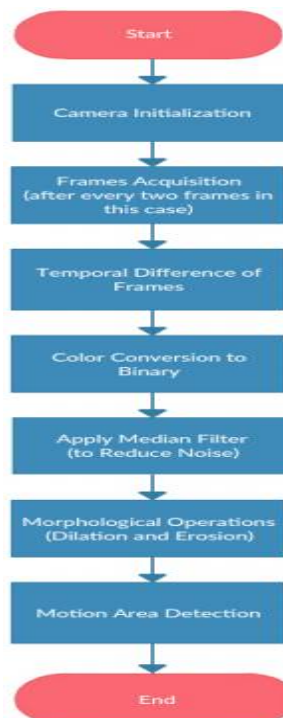


Fig-1: Flowchart of Motion Detection

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1. TEMPORAL DIFFERENCE

Temporal Difference is a very simple method that predicts an entity which depends on future values for a given signal. Basically, this approach is based on difference between the two frames, wherein this approach aims at detecting moving objects and/or regions by taking the difference between two to three consecutive frames in a video sequence. This approach is very adaptable in case of environments having dynamic nature, but it is usually unable to extract the complete shape of certain moving objects.

This approach, however, is highly effective in static environments. The above-mentioned method or absolute differencing is highly apt at giving the introductory coarse motion area in the frame. In our approach, we have taken two images of the given formats after frames interval of two frames which can also be explained as image at time 't' and next subsequent image frame at 't+1' time. Name these images as I(x,y,t) for the first acquired image and for the second frame this could be called I(x,y,t+1). The difference between these images is calculated by taking the difference between the respective frames pixel values and storing it in a new matrix called Id. The Id stores the absolute difference values and is generated from the image statistic. In many applications, a coefficient with a fixed weight is used to compute the temporal difference image Id(x, y, t). This is used to detect slow motion or temporarily stopped objects in the frames. Following are the equations that are incorporated:

$$I_d(x, y, t + 1) = \begin{cases} 255 & \text{if } (I_a(x, y, t + 1) > T_d) \\ 0 & \text{Otherwise} \end{cases} \quad (1)$$

and

$$I_a(x, y, t + 1) = (1 - w)I_a(x, y, t) + w |I(x, y, t + 1) - I(x, y, t)| \quad (2)$$

and

$$T_d = 3 \times \text{mean}(I_a(x, y, t + 1)) \quad (3)$$

'w' is a positive real number less than 1 and is used to describe the range of temporal differencing of images. Ia (x, y, t + 1) is initially made an empty image. It is observed that the adaptive threshold can control or reduce the noise to a great limit. However, in case the backdrop is not uniform, the method of temporal difference will be very affected to the random motion and it becomes hard to comprehend the possible motion.

2. BACKGROUND SUBTRACTION

Background differencing is an extremely efficient image segmentation technique applicable for a static background frame. In this technique, the principle incorporated is to use the model of the background. With respect to the background model, the current frame is compared to a reference. This helps detect the foreground objects present in the scene. This method is flexible and fast, but the background is required to be stationary, along with the camera.

A.DOUBLE BACKGROUND FILTERING

DBF or Double Background Filtering method is an effective tool that helps get rid of background noise and interference. It is also helpful in separating out the moving objects from the background in an image. It keeps the background image stable so as to address changes in the various different changing conditions. Double Background

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Filtering method can also be combined with Morphological processing methods in order to achieve better and improved outcome.

3. MORPHOLOGICAL IMAGE PROCESSING

Morphology in mathematical terms is a non linear approach developed and implemented from the set theory and geometry sections of mathematics. Morphological image processing is based on this mathematical morphology. Morphology for digital image processing is nothing but a combination of certain techniques to achieve desired results. These techniques are extremely robust and find applications in a variety of areas like image processing, machine vision and pattern recognition. This technique suppresses the noise and at the same time, preserves the main shape.

Mathematical morphology does not include multiplication and division. The primary mathematical operations in morphology is subtraction and addition. Then there are other operations incorporated as well, such as maximum and minimum operations. Dilation and erosion are the two most basic and fundamental morphological operations to be implemented, and these form the backbone of many morphological algorithms.

$A \oplus B$ is termed as Dilation of a set A by another set B which is taken as the structure set. Set B is first made to reflect about its own origin and then the result is made to be translated by x.

$$A \oplus B = \{x | (B)_x \cap A \neq \emptyset\}$$

Here, we can make the presumption that B denotes reflection of B and $(B)_x$ denotes translation of B by x.

$A \ominus B$ denotes the Erosion of A by B. It is the set of all x such that B translated by x is completely contained in A

$$A \ominus B = \{x | (B)_x \subseteq A\}$$

It can be noted that the boundary of A can be expanded by Dilation of A by B and similarly, the boundary of A can be shrunk by Erosion of A by B.

Other important morphological operations incorporated are 'opening' and 'closing'. Simply put, Opening is nothing but a Dilation operation preceded by an Erosion operation. The structuring element for both Dilation and Erosion operations remains same. So, we can say that A is said to be opened by B if A is first Eroded by B and then the next operation performed is the Dilation of the result obtained in the previous operation, by B.

$$A \circ B = (A \ominus B) \oplus B$$

Closing operation is nothing but the Opening operation performed backwards. The structuring element is kept the same in this case as well for both the operations performed. A is said to be closed by B if B first dilates A, and the result obtained in the previous step is then eroded by B

$$A \bullet B = (A \oplus B) \ominus B$$

Opening helps to smoothen out the contours of an object and eliminate thin unwanted protrusions. Closing also smoothen the contours of the object, but unlike an 'opening', it combines narrow breaks and long and thin gulfs. It also fills gaps in the contours and eliminates small holes.

In our project, we have incorporated three morphological process to effectively carry out the image and video processing. The morphological processes we have employed in our project are Dilation of the image, followed by Opening and closing morphological operations to smoothen out contours and obtain desired results. Dilation process is incorporated in the image frames for accumulation of first five frames of optical flow which is after the first step of Double background filtering.

Opening and Closing are employed within the image for the last three frames of optical flow, which is implemented after the second step of the Double background filtering method. The Opening operator cancels out all the unwanted noise from the image frames and the Closing operator is used immediately after the desired holes and gaps in the frames have been filled up.

DBF method with morphological processing is an extremely helpful tool to conserve the moving object area and get rid of the unwanted noise completely from the background interference. The result of this processing technique has a lot of

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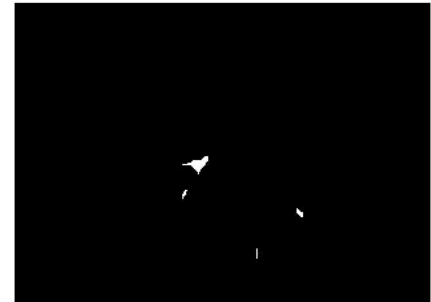
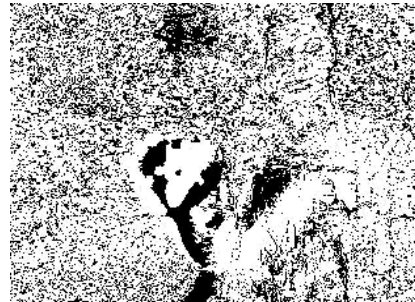
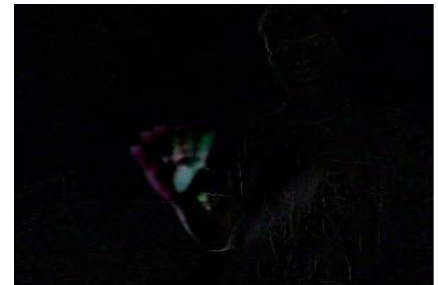
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potential and can be extremely helpful for the further advancements in areas for motion detection and can be used to gain highly satisfying results.

III. EXPERIMENTAL RESULTS

The figures show the detection and tracking of the object using the above-mentioned algorithm. The images have been captured via a surveillance camera and Temporal Differencing of the frames has been carried out. Noise is removed from the images using suitable filters, here being Double Background Filter. Next, morphological operations have been carried out and finally the motion of the foreground object is detected, without much focus on the background. The following images depict the flow of the algorithm.



Figures show the result of the experiment in the order of the algorithm procedure.

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(a) shows the acquiring of the 1st frame through the camera. (b) shows the 2nd frame acquisition through the camera. (c) is the Temporal Differencing, or the absolute differencing between the two acquired frames. (d) indicates the Temporal Difference in gray level, to process computation. (e) is median filtering to remove noise and (f) is erosion operation on binary image of the difference image frame. (g) indicates the application of morphological operations (dilation after erosion) and (h) is the highlighted region of the area of detected motion from the live video feed

IV. CONCLUSION

Implementation of the above mentioned algorithm has been successful in MATLAB platform. The input video image size taken is around 480X640 pixels. 30FPS (Frames per Second) is the size of the sample rate. In this paper, a novel approach is used for real time motion detection using temporal differencing and double background filtering method along with addition of the Morphological processes. Temporal differencing [10] has been incorporated to detect any motion of an object by calculating the frame difference of the existing frame and the reference frame. Background subtraction [11] is an extensively used approach in image processing. In this method, the foreground objects of an image are extracted for further processing. The primary focus and aim of this algorithm is to effectively differentiate out the background noise and the information at the foreground. Finally, the main motive is to detect a moving object with precision. The tests carried out are an indication to the fact that the algorithm can accurately track and recognize the motion of an object in a video.

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