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Real Time Segmentation Algorithm for Complex Outdoor Conditions

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Abstract:
Automatic detection of moving objects in all weather condition is a critical task in many vision based safety applications. Moving object detection and segmentation in an outdoor environment, particularly under non ideal weather conditions and unfavorable luminance condition is still an active area in research. In the past, full-search sum of absolute difference algorithm is used to detect and segment the moving object under sudden changes in illumination, snowfall, fog etc.This algorithm is computationally expensive and inefficient for human and night time detection. So we propose a robust technique to detect and segment the human and other moving objects of interest in both day and night environment using CSCA (contrast and skin color analysis) algorithm, which not only reduces the false motion but improves the computational efficiency as well. Experimental result shows that our proposed CSCA algorithm is efficient in motion detection and segmentation in both day and night complex environment conditions and is suitable for real time implementation.

Key words*: challenging weather conditions, moving object detection, segmentation, night time surveillance*

1. Introduction

Intelligent visual surveillance systems deal with the real time monitoring of persistent and transient objects within a specific environment .Visual surveillance for humans and moving objects in dynamic scenes, is one of the most active research topics in computer vision . Visual surveillance in dynamic scenes has a wide range of potential applications, such as a security guard for communities and important buildings, traffic surveillance in cities and expressways, detection of military targets, etc The segmentation of moving objects in outdoor conditions is quite challenging due to various aspects such as unfavorable weather conditions, noisy low-quality videos, and dynamic background, Although there are many methods that deal with moving objects segmentation, there has been limited work to sudden environment changes , which is quite essential for practical deployment of surveillance systems [4].

Moving Object detecting and tracking are very important in any vision based surveillance system. There are Various approaches to object detection have been proposed for surveillance, including feature-based object detection, template-based object detection and background subtraction[3] or inter-frame difference-based detection .Most algorithms for object detection and tracking are designed for daytime visual surveillance[2]. However, night-time visual surveillance has gradually attracted more and more attention. In night time, the scene is completely dark, then it is necessary to use a thermal infrared camera. However, the cost of a thermal camera is too high for most surveillance applications. It is a great challenge to detect objects at night using ordinary CCTV cameras, because the images have low brightness, low contrast, low signal to noise ratio (SNR) and nearly no color information. In this paper we focus on outdoor scenes with low light levels, complex outdoor conditions etc to detect and track moving objects.

Feature-based, edge based and model-based are used for object detection and tracking. However, for outdoor night surveillance, the targets are in low contrast and low color saturation limit the applicability of feature-based or model-based approaches. For this reason, only object detection and tracking methods can be done based on inter-frame differences. An object is detected using inter-frame differences in each pixel values. This method is efficient and fast. This algorithm is applicable for outdoor object detection and tracking at night. The night-time images taken by a standard camera. The problems with low contrast are overcome using sub image inter-frame differences

In this paper, we propose an alternative technique to detect and segment the human and moving objects in both day and night time using CSCA algorithm The proposed algorithm is used for segmentation of human and moving objects from challenging outdoor day and night environment..The challenging outdoor conditions such as low light, complex weather conditions eg: heavy rain, snowfall or fog, which causes serious limitations to the visibility of moving objects, poor-quality and noisy gray scale videos, moving object and background with similar color and texture etc.

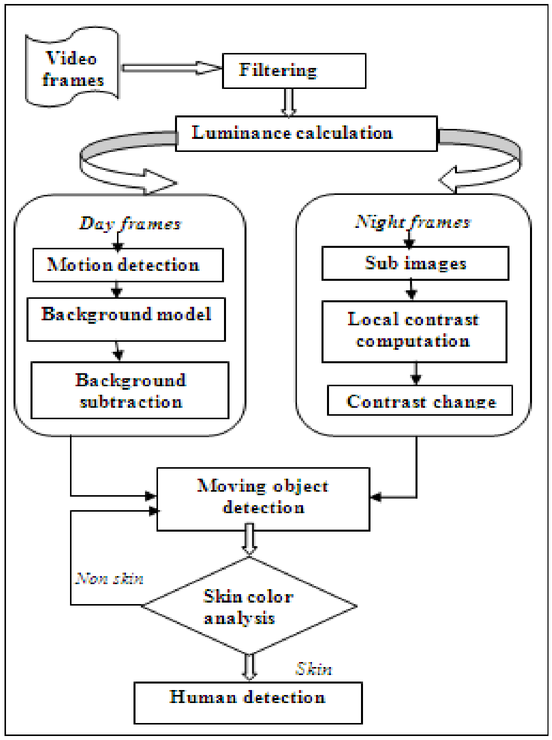

Figure 1: Flowchart of Proposed CSCA Algorithm

Our real-time segmentation algorithm not only localize the human and moving object of interest in both day and night time but suppresses the noise that is introduced due to poor quality low resolution videos. In addition, it reduces the false motion due to nonconductive weather condition such as change in illumination and snowy or foggy weather**.**

2. Motion Detection

There are several approaches for motion detection and segmentation. Block-based motion estimation is an efficient approach for identifying moving regions between video frames. Motion can be determined by matching the blocks of the reference frame (previous frame) with the current frame. If the matched block is being not in the same location, then identify the presence of motion in the region. The motion vectors are used to identify the location of the movement; such blocks are considered as moving regions

To compute the motion between frames, we divide the reference frame *Rf* into nonoverlapping candidate blocks *Cb*, which can be identified as

$Cb\ (p, q)$, i.e., $Rf = \{Cb\ (p, q),(p, q) \in \phi\}$,

Where ϕ represents the total number of blocks in the *x*- and *y*-axes, given as $\phi = \{(p, q)|0 \leq p \leq Wx - 1,\ 0 \leq q \leq Wy - 1|\}$, and *Wx* and *Wy* are the numbers of blocks in the *x*- and *y*-axes, respectively

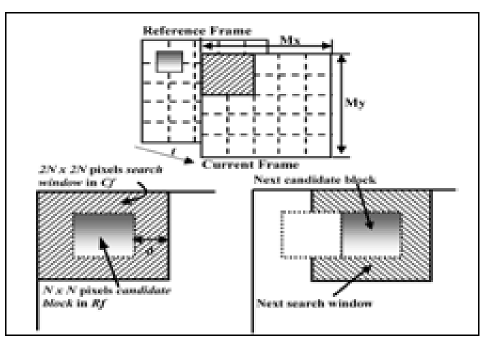

Figure 2: Motion detection using a candidate block and search window

In the fig: 2 shows, every candidate block carries out the search within a specified area of the current frame, called a search window. We divide *Cf* into overlapped search windows of size $2N \times 2N$. The overlapping of the search windows ensures that the motion observed on the boundary of two search regions can effectively be identified.

3. Background Modeling Using Adaptive Threshold

Frame-difference-based approaches are commonly used for differentiating between foreground and background. These approaches either make use of a threshold value that is predetermined or fixed value is suitable for stationary background only. To obtain appropriate threshold, a lot of experimentation must be conducted on each video sequence. However, because the outdoor sequences have dynamic background that varies from frame to frame, even an empirically determined single value proves to be ineffective. Therefore, an adaptive threshold that is derived from every frame being processed that can effectively differentiate foreground from background. Frame-based adaptive threshold that can be used to retain only the motion of the object of interest.

To compute background modeling from the dynamic environment. We convert the frames from color to grayscale and take two frames each from sequence with swaying leaves, fog, snowfall, and heavy snowfall to compute the motion energy as follows.

Consider the frames to be of size $Mx \times My$. Let $I(x, y)$ denote the pixel intensity at location (x, y), $t1$ and $t2$ denote time; then, the motion energy at every pixel location is computed as

$ME\ x,y = |I(x, y, t1) - I(x, y, t2)|$.

4. Background Substration

Background subtraction [3] is a class of techniques for segmenting out objects of interest in a scene for applications such as surveillance. There are many challenges in developing a good background subtraction algorithm. First, it must be robust against changes in illumination. Second, it should avoid detecting non-stationary background objects and shadows cast by moving objects. A good background model should also react quickly to changes in background and adapt itself to accommodate changes occurring in the background such as moving of a stationary chair from one place to another. It should also have a good foreground detection rate and the processing time for background subtraction should be real-time

5. Moving Objects in Night Time Detection

The traditional object detection algorithms do not perform very well at night. Here we make use of some idea from human perception. In the human visual system, contrast plays an important role in detecting objects especially at night and similar to the human discrimination model-based on contrast and motion; we propose novel object detection and tracking method for outdoor night surveillance. The method has two stages. In the first stage, objects are detected using contrast changes measured by taking sub-image inter frame differences. In the second stage, motion prediction and spatial nearest neighbor data association are used to track Objects and give feedback to the first stage. Experimental comparisons with other methods show that our method is effective for object detecting and tracking at night.

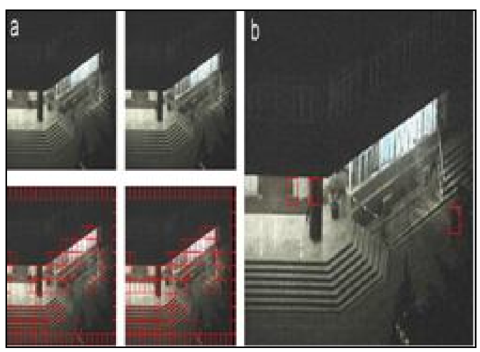

Figure 3: Object detection :(a) object detection based on contrast and (b) moving object detection based on contrast change

6. Human Detection In Dynamic Background

In this paper human detection system is proposed and implemented using a skin region analysis method. Human skin detection is very popular in many applications, particularly in video surveillance. Based on background subtraction and skin color analysis used to detect the human skin region.

Background subtraction method [3] is used to detect moving object from the background model . There are three basic steps included in background subtraction method.

- A background model is established according to the temporal sequence of the frames
- The moving objects are detected based on the difference between the current frame and the background model.
- The background model is updated periodically to adapt the outdoor changing environment.

Fig: 4 shows the details step of background subtraction. From the input video frame, pre-processing is a data mining technique that involves transforming raw data into a understandable format. In background modeling, the new video frame are being and background are being calculated where it provides statistical description Unidentified pixel in the video frame in the background will be the output as a binary candidate foreground mask at foreground detection step. Data validation stages function as an examiner where it examines candidate mask and eliminate pixel that are not related with target moving objects and only provide the foreground masks output.

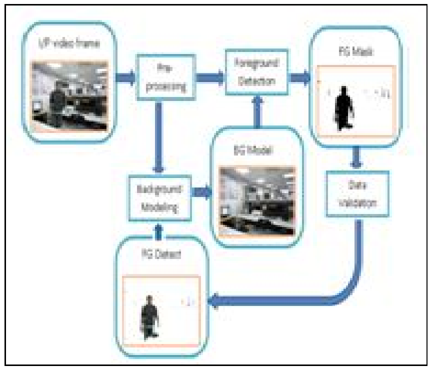

Figure 4: Three main processes background subtraction flow: Background modeling, moving object detected, and updates Periodically background model

6.1. Skin Color Method

Skin color method is used to detecting human skin region which helps to detect the human from the complex environment. Skin Color is an important feature of human detection.

Color processing is much faster than processing other facial features. Under certain lighting conditions, color isorientation invariant. This property makes motion estimation much easier. Different cameras produce significantly different color values even for the same person under the same lighting conditions and skin color differs from person to person. In order to use color as a feature for human tracking, we have to solve these problems. It is also robust towards changes in orientation and scaling and can tolerate occlusion well.

Most of the research in skin color based face localization and detection is based on RGB, YCbCr and HIS color spaces A disadvantage of the color cue is its sensitivity to illumination color changes and, especially in the case of RGB, sensitivity to illumination intensity. One way to increase tolerance towards intensity changes in images is to transform the RGB image into a YCbCr color space whose intensity and chromaticity are separate and use only chromaticity part for detection.

6.2. YCbCr Color Space

YCbCr is a color spaces used as a part of image pipeline in video and digital photography systems The Y in YCbCr denotes the luminance component, and Cb and Cr represent the chrominance factors.

The YCbCr space was chosen for six reasons:

- The luminance component (Y) of YCbCr is independent of the color, so can be adopted to solve the illumination variation problem and it is easy to program.
- The skin color cluster is more compact in YCbCr than in other color space.
- YCbCr has the smallest overlap between skin and non-skin data in under various illumination conditions.
- YCbCr is broadly utilized in video compression standards (e.g., MPEG and JPEG).
- YCbCr is a family of color spaces used in video systems. YCbCr was defined for standard-definition television use in the ITU-R BT.601 standard for use with digital component video.

7. Expirimental Details and Performance Evaluation

The proposed algorithm has been implemented in MATLAB Simulink on a Core 2 Duo, 2.93-GHz processor with 3 GB random access Memory, grayscale videos are used for processing. In case of red–green–blue (RGB) frames, it is transformed to grayscale frames. Temporal difference and Gaussian-based background modeling [4] are commonly used methods for moving object detection. We have tested the proposed method on various publicly available outdoor road traffic sequences with challenging background conditions.

Fig:5 shows the input videos capture from various complex outdoor conditions, e.g., rain, heavy snowfall, or fog, which cause serious limitation to the visibility of moving objects after capturing the videos we have to remove the noise caused due to different environmental conditions .here we are using median filtering to remove noise. Median filtering helps to initialize the background model. Estimation in order to achieve a good segmentation in an outdoor environment, it is necessary to have a background model. Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel.

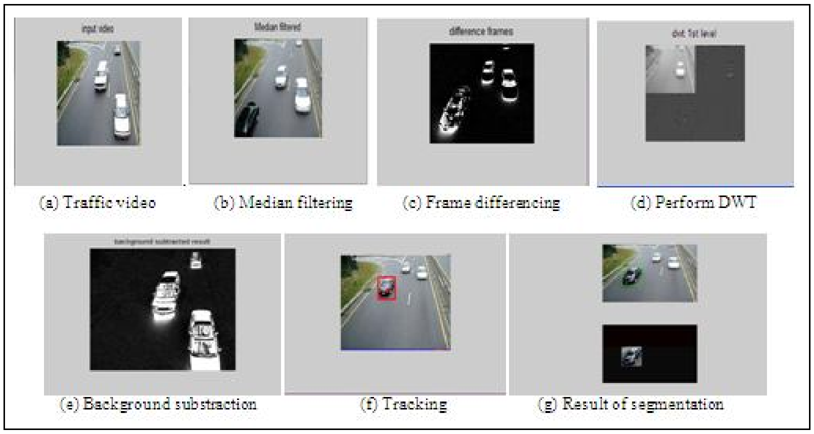

Figure 5: Outdoor traffic

However, with median filtering, the value of an output pixel is determined by the *median* of the neighborhood pixels, rather than the mean. The median is much less sensitive than the mean to extreme values (called *outliers*). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image.fig (b) shows the filtering the input video frames. Frame-difference-based approach is used for differentiating between foreground and background. These approaches make use of a threshold value that is predetermined or fixed value is suitable for stationary background only. The outdoor sequences have dynamic background that varies from frame to frame; even an empirically determined single value proves to be ineffective. Therefore, an adaptive threshold that is derived from every frame being processed that can effectively differentiate foreground from background is necessary. This frame-based adaptive threshold that can be used to retain only the motion of the object of interest.fig (c) shows the frame difference from the sequences of video frame.DWT of an image is illustrated in Fig.:(d) Discrete wavelet transform is used (DWT) to detect and track moving objects. After discrete wavelet transform, we are using background subtraction for the object recognition. background subtraction is a widely used approach for detecting moving objects.in this approach moving objects are detected by subtracting the current frame from the background frame.fig:(e) shows the background subtraction. Moving objects are detected by using background subtraction, and then we have to track this moving object .fig.6 shows the tracking the moving objects after the background subtraction.fig :(f). shows the segmentation result of moving objects in various outdoor conditions. Our proposed algorithm suppresses all the false motion caused by complex environment conditions.

Below figure:6 shows the experimental results of human detection.fig(a) shows the input video from the outdoor environment, then performs the median filtering for removing noise shows in fig (b). Skin color method is used to detecting human skin region which helps to detect the human from the complex outdoor environment. For human detection, we have to convert the RGB image from RGB color space to YCbCr color. Because RGB color space is very sensitive to illumination. In the case of complex outdoor environment, background is dynamic, that varies from frame to frame. fig(c)shows the conversion of RGB to YCbCr color space. Perform discrete cosine transform (DCT) for human detection .and the background subtraction fig (d) is used to segment the moving human.fig (e) shows the tracking the human after performing the background subtraction.

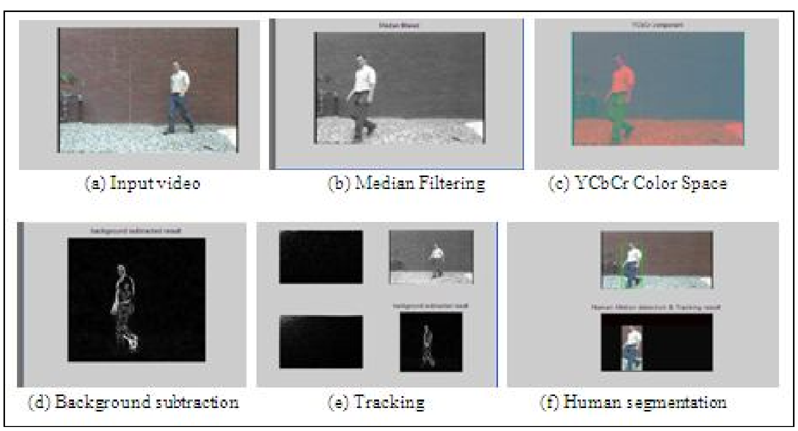

Figure 6: Human Detection

The results of proposed algorithm for night time object detection and tracking are assessed. The night scene videos are captured by standard CCD cameras with a frame size of 320 × 240 pixels. The effectiveness of the proposed method is verified by the detection results and tracking results. The experiments also verify the low computational cost of the algorithms.

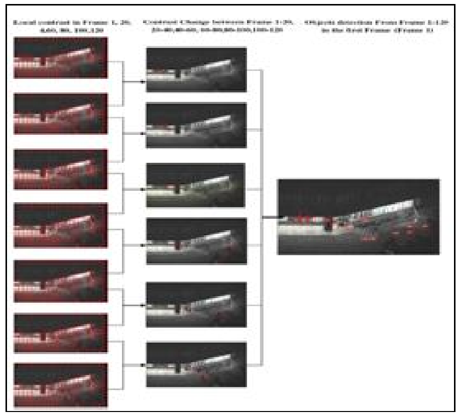

Figure 7: Detection results for frames 1–120

First column: visible objects found by local contrast computation. Second column: interesting objects detected by changing contrast saliency. Third column: consecutive detection results from frame 1 to 120.The object detection algorithm is tested on the sequence "*two person at night*" from frame 1 to 120.

Fig: 7 gives the detection results for frames 1–120. The first column is the local contrast computation result for frames 1, 20, 40, 60, 80, 100, 120. The moving objects and other visible content are detected in this step. The second column is the contrast change result between the successive frames 1, 20, 40, 60, 80, 100, 120. The changes are detected. All the detection results from frame 1 to 120 are plotted on one frame as the third column in Fig. 7. It is clear that the moving objects are accurately located in all the frames

8. Conclusion and Future Work

In this paper, propose a segmentation algorithm for human and moving object detection from challenging outdoor day and night environment. The algorithm was tested using traffic videos with challenging outdoor conditions such as heavy snow fall, poor visibility due to fog, swaying leaves. Human and moving objects are detected based on the contrast and skin color analysis .our segmentation algorithm suppresses all the noise introduced due to poor visibility and reduces the false motion due to nonconductive weather conditions. Further investigation is being conducted for improving performance from high-level object recognition and tracking.

9. References

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