Design and Simulation of a System for Object Tracking in Video

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Abstract

The aim of this paper work is to implement an efficient methodology to track the moving object present through a video sequence. Various image processing steps such as video preprocessing, Frame display, Background Subtraction, Segmentation [4] and tracking are performed. First, the videos are separated as frames and preprocessing method is used for the color conversion to subtract the foreground objects from the background. Background subtraction [2] is used to find the total or sudden change in intensity in the video. The segmentation module is executed to extract the boundary of the object from the background. Finally object tracking will be carried out using Optical flow method [7].

Keywords*: Background Subtraction, Segmentation, Frame display*

1. Introduction

In a tracking scenario, an object can be defined as anything that is of interest for further analysis. For instance, boats on the sea, fish inside an aquarium, vehicles on a road, planes in the air, people walking on a road, or bubbles in the water are a set of objects that may be important to track in a specific domain.

Object tracking is an important task within the field of computer vision. The proliferation of high-powered computers, the availability of high quality and inexpensive video cameras, and the increasing need for automated video analysis has generated a great deal of interest in object tracking algorithms. In its simplest form, tracking can be defined as the problem of estimating the trajectory of an object in the image plane as it moves around a scene.

Tracking of moving objects in a video sequence can be complex due to:

- noise in images,
- complex object motion,
- non-rigid or articulated nature of objects,
- partial and full object occlusions,
- complex object shapes,
- scene illumination changes, and
- real-time processing requirements.

In order to cope up with the above mentioned shortcomings, this paper presents an efficient methodology to track the moving object in a video by using image processing steps such as video processing, frame display, background subtraction, edge Detection, segmentation and tracking [7]. The object tracking has a wide area of applications, some of which are: human-computer interaction, security and surveillance, video communication and compression, augmented reality, traffic control, medical imaging and video editing.

2. Methodology

The main objective of this paper is to detect and track the moving object through video sequence. The proposed methodology for object detection in video sequence is shown in the figure.

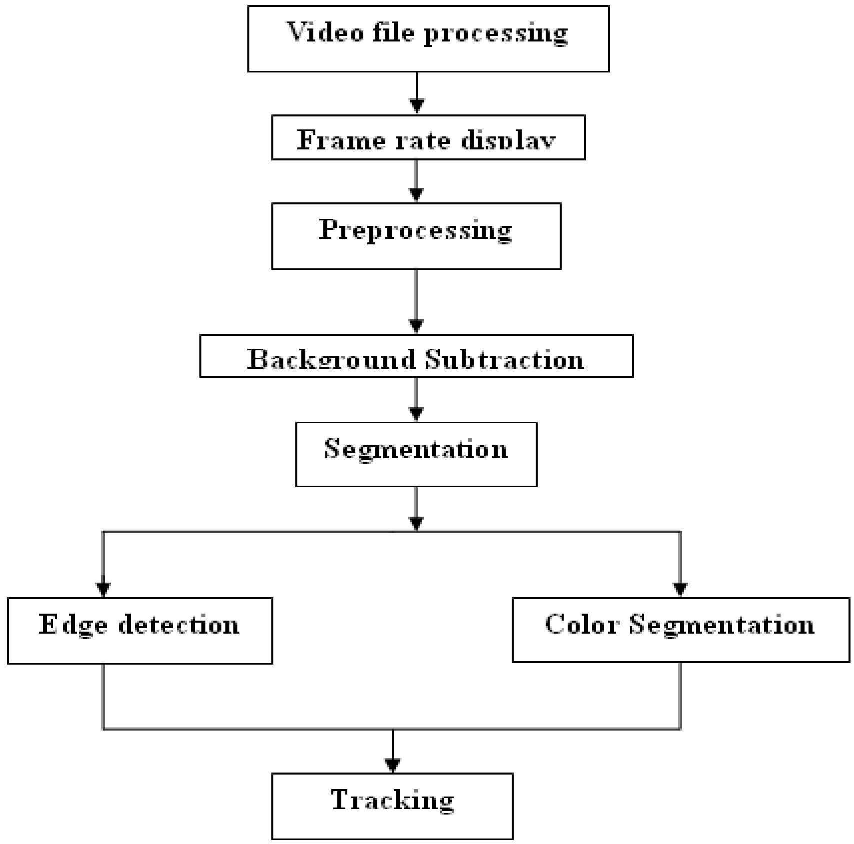


Figure 1. Flowchart of Object Detection in Video

Firstly, the video sequence is acquired from the infra-red camera. The video sequence is then being sampled into multiple frames. The more frames that have been sampled or grabbed, the better it is as this will increase the sensitivity and accuracy of the system. This enable detection for any slight movement that might occurs in the video sequence.

In the second step, after separating the video into frames, calculate the frame rate display and translate the original image into a grayscale image. In computing, a grayscale digital image is an image in which the value of each pixel is a single sample. Displayed images of this sort are typically composed of shades of gray, varying from black at the weakest intensity to white at the strongest.

Now the frames have to go through the same chain of preprocessing steps. This is done to remove the noise level from the images and to improve the results of later processing (for example, edge detection on an image).

In the next step, Background Subtraction algorithm is used to find the total or sudden change in intensity in the video. The background segmentation module is executed to extract the boundary of the image. This step can be performed by using segmentation based on edge detection or color segmentation.

Finally, the object tracking will be carried out using the Optical flow method.

3. Steps of Operation

3.1. Frame Display

Frame rate or frame frequency is the frequency at which an imaging device produces unique consecutive images, frames that applies equally well to compute graphics, video cameras, film cameras and motion capture system. Frame rate is most often expressed in frames per second and is also uttered in progressive scan monitors as Hertz (Hz).The frame rate display block calculates and displays the average update rate of the input signals. For example, if the block displays 20 then the model is updating the input signal 20 times every second. This block is also used to check the video frame rate of the simulation to control the specified number of video frames.

3.2. Grayscaling

Once the frames are grabbed, each frame has to go through the same chain of processing. The first process is gray scaling [6]. In computing, a grayscale digital image is an image in which the value of each pixel is a single sample. Displayed images of this sort are typically composed of shades of gray, varying from black at the weakest intensity to white at the strongest, though in principle the samples could be displayed as shades of any color, or even coded with various colors for different intensities. Grayscale images intended for visual display are typically stored with 8 bits per sampled pixel, which allows 256 intensities to be recorded, typically on a non-linear scale.

Figure 2. (a)Original Image (b)Grayscale Image

3.3. Preprocessing

Preprocessing is any form of signal processing for which the output is an image or video in order to improve or change some quality of the input. Preprocessing is mainly performed to improve the raw image by suppressing noise and to enhance the contrast of the image. It also performs the task of isolating objects of interest in the image. Preprocessing helps to improve the video or image such that it increases the chance for success of other processes.

3.4. Background Subtraction

Background subtraction is a commonly used class of techniques for segmenting out objects of interest in a scene for applications such as surveillance. Background subtraction identifies moving objects from the portion of a video frame that differs significantly from a background model. The concept of background subtraction revolves around the simple technique of subtracting the observed image from the estimated image and thresholding the result to generate the objects of interest. The areas of the image plane where there is a significant difference between the observed and estimated images indicate the location of the objects of interest.

In this algorithm, the background models are simultaneously kept, a primary, a secondary and an old background. The primary background is updated at every time interval. Once the model estimates the background, it subtracts the background from each video frame to produce foreground images. By thresholding and performing morphological closing on each foreground image, the model produces binary feature images.

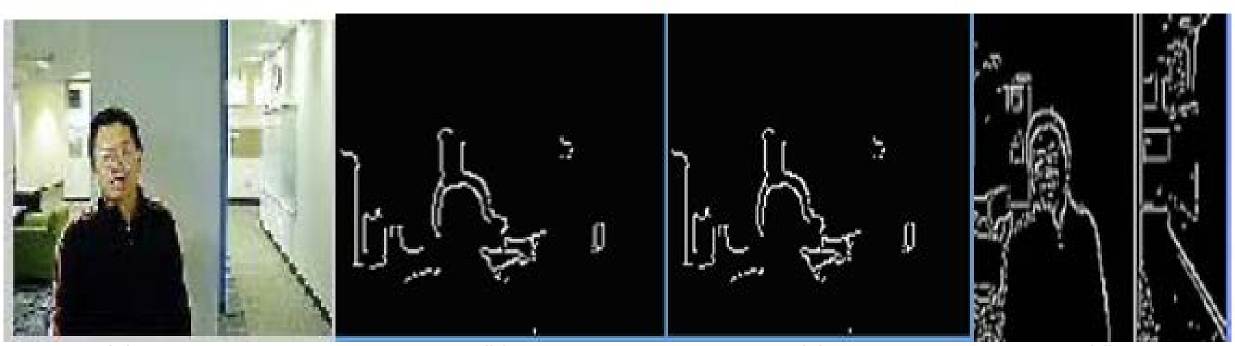
Figure 3. Background Subtraction

3.5. Image Segmentation

The processing of subdividing the image into its constituent parts or object is called image segmentation. The aim of image segmentation algorithms is to partition the image into perceptually similar regions. Every segmentation algorithm addresses two problems, the criteria for a good partition and the method for achieving efficient partitioning. The segmentation process helps in the extraction of information about the shape of moving object in the video sequences.

3.5.1. Segmentation using Edge Detection: Edge detection[7] is one of the most commonly used image segmentation methods in object detection. Since edges contain some of the most useful information in an image can be used to extract boundaries of each different object in an image. In grayscale image, an edge may be defined as the local discontinuity in the intensity values (grey values) that exceeds a given threshold. For color frames, similar edge detection methods can be applied to the intensity component of the image.

Many edge detection algorithms have been developed which include Sobel, Roberts, and canny edge detectors. The Sobel method finds edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient of image is maximum. The Canny method finds edges by looking for local maxima of the gradient of image. The Roberts method finds edges using the Roberts approximation to the derivative. It returns edges at those points where the gradient of the image is maximum.



(a) (b) (c) (d)

Figure 4. Segmentation based on Edge Detection(A)Original Image(B)Robert's Operator(C)Sobel Operator(D)Canny Operator

3.5.2. Color Segmentation: The Color Segmentation algorithm considered here is based on the similarity property. Thersholding technique is used to segment the object from the image. Thresholding is an operation in which a reference gray level is selected using histogram such that the object and the background can be separated. The result of this process is binary image, where pixel values equal to 1 indicate potential skin color locations.

The Color Segmentation [4] filters and performs morphological operations on each binary image, which creates the refined binary images shown in the Skin region window. The Color segmentation/Region filtering subsystem uses the Blob analysis block and the extract face and hand subsystem to determine the location of the person's face and hand in each binary image. The Display results/Mark image subsystem uses this location information to draw bounding boxes around these regions.

Figure 5. Color Segmentation based on Region Filtering

3.6. Object Tracking

The aim of an object tracker is to generate the trajectory of an object over time by locating its position in every frame of the video. Object tracker may also provide the complete region in the image that is occupied by the object at every time instant. This model uses an optical flow estimation technique to track the desired object in each frame of the video sequence.

Optical flow is the pattern of apparent motion of objects, surfaces, and edges in a visual scene caused by the relative motion between an observer (an eye or a camera) and the scene. It reflects the frame variation caused by motion in a definite time interval .Optical flow methods are used for generating the dense flow fields by computing the flow vector of each pixel under the brightness constancy constraint,
$I(x, y, t) - I(x + dx, y + dy, t + dt) = 0$.

This computation is always carried out in the neighborhood of the pixel either algebraically or geometrically. By thresholding and performing morphological closing operation on the motion vectors, the model produces binary feature images.

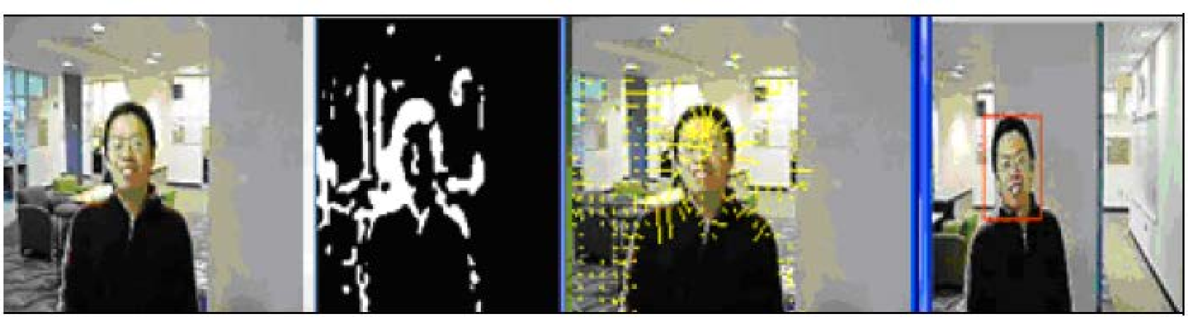


Figure 6. Object Tracking based on Optical Flow

4. Conclusion

In the proposed work, an efficient methodology for the detection and description of moving objects in video scenes has been presented. The task of detecting motion is achieved by using MATLAB coding in comparing the reference frame, with every new frame of the video(Background Subtraction), the detection of motion is achieved by segmentation process of the video. Recognization of object in an image can be performed using Optical flow method. The algorithms described in this paper are easy to implement and are suitable for general video object trajectories detection and descriptions.

Object detection is necessary for surveillance applications, for guidance of autonomous vehicles, for efficient video compression, for smart tracking of moving objects, for automatic target recognition (ATR) systems and for many other applications. In all of the above applications, the proposed algorithm can provide higher quality solution with better computation efficiency.

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