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Performance Analysis of Spatial Color Information for Object Detection Using Background Subtraction

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Abstract

Object detection, which is a primary yet important step in applications including video surveillance, gets difficult when the video of outdoor environment is influenced by illumination and weather changes. Background Subtraction is the method frequently used for in such cases. In this paper, enhanced BS method namely Extended Frame Differencing Method (EFDM) and Extended Histogram Differencing Method (EHDM) using spatial color information are proposed to improve the accuracy and computational efficiency of object detection in real time and outdoor environment. The effects of different spatial color information for the proposed methods are compared and analyzed. The spatial information used in the analysis includes RGB, HSV, CIELab, CIELuv, YCrCb color models. The results show that EFDM and EHDM present better results with HSV spatial color information.

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1. Introduction

Detecting objects, and its features, through the frames of any video is a primary task in any image-based applications such as visual surveillance, gestural human-machine interface, video editing, motion capture, medical and meteorological applications, etc., [12]. In order to understand such high level applications, it is imperative to comprehend basic computer vision tasks such as motion detection, tracking targets, labeling parts, and interpret the interactions between people or objects. Recent years have seen rapid development in the state-of-the-art technologies for these computer vision problems.

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Considering a video sequence from a stationary camera overlooking traffic in an outdoor environment, an object detecting algorithm should adapt to various levels of illumination at different times of the day and handle adverse weather conditions that modify the image content [10,11]. Use of different cameras affects the color values as well. Further movement of an object can cause blurring of colors.

Background Subtraction (BS) has been used for years in many computer vision systems as an initial preprocessing step for object detection and tracking [12]. The results of the existing algorithms are fairly good; in addition, many of them run in real-time [1-5], but are susceptible to both global and local illumination changes such as shadows and headlight glares. These cause the subsequent processes, e.g. tracking, recognition, etc., to fail. The accuracy and efficiency of the detection are clearly very crucial to those tasks.

There are several BS Techniques suited for different scenarios with each having their own draw backs [6]. The Frame Differencing methods of BS with pixel to pixel comparison of two images were proposed for detecting objects [1-4]. Muhammad Nawaz et al., [5], and Michel Mason et al., [7] considered histogram related operations for BS using region based method. Being able to detect shadows of object in the images are also very useful to many applications especially in Shadow detection. Advance BS techniques can also help in detecting and eliminating shadows of objects in images [10]. Most of the applications require BS in an outdoor environment such as vehicle detection, pedestrian detection, motion detection etc., In such applications, priority needs to be given for illumination changes caused in the images due to environmental factors. Bo Yang et al [11] proposed a BS that adheres to illumination changes. There are other techniques for object detection in addition to BS which use spatial or frequency information [14] of the image. Various methods have used the color information in their object detecting algorithms [7-9].

The remainder of the paper is organized as follows: Existing BS algorithms are discussed in Section 2. The proposed extended methods are given in Section 3. The performance analysis of spatial color information is presented in Section 4 and finally, the conclusion in Section 5.

2. Background subtraction for object detection

Any video is a consecutive sequence of images or frames from which objects in the video can be detected. BS is the commonly used object detection technique followed in any image or a segment of the image (Region of Interest) .The detection of motions can be achieved by taking a frame as background and comparing subsequent frames with it. This process is called *Background Subtraction (BS)* [1-2]. In general, Subtraction of any two images involves techniques to identify the change or variation in their intensity levels. Two images from the video used for subtraction are defined as background and foreground image. The background image is a reference image comprising of static scenes with which the foreground image, comprising of any type of moving objects, are compared. The resultant image of BS is called Differenced Image (DI).

2.1 Spatial Background Subtraction using Frame Differencing Method (FDM)

The spatial information of any image comprises of color information stored in three different components (color channels) for each pixel, which are interpreted as coordinates in some color space. Most of the existing methods for BS [1-6] convert this spatial color information of background and foreground image to either grey image of 0-255 intensity levels or binary image with two intensity levels [1-6].

The existing FDM of Pixel based BS [1, 2, 6] is modified and given in the Equation (1)

$$S(i,j) = |B(i,j) - F(i,j)| \quad (1)$$

where S*(i,j)* denotes pixel intensity of the DI at the i^{th} row and j^{th} column of the image. *B(i,j)* and *F(i,j)* denote the pixel intensity resolution of i^{th} row and j^{th} column of the background and foreground images respectively. The DI- 'S' has pixel intensities equal to the difference of the pixel intensities in the background and foreground image.

2.2 Spatial Background Subtraction using Histogram Differencing Method (HDM)