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Procedia Computer Science 93 (2016) 478 – 485

Procedia Computer Science

6th International Conference On Advances In Computing & Communications, ICACC 2016, 6-8 September 2016, Cochin, India

A Modified frame difference method using correlation coefficient for background subtraction

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Abstract

Background subtraction is one of the most important step in video surveillance which is used in a number of real life applications such as surveillance, human machine interaction, optical motion capture and intelligent visual observation of animals, insects. Background subtraction is one of the preliminary stages which are used to differentiate the foreground objects from the relatively stationary background. Normally a pixel is considered as foreground if its value is greater than its value in the reference image. Hence, every pixel has to be compared to find the foreground and background pixel. This paper presents a technique which improves the frame difference method by first classifying the blocks in the frame as background and others using correlation coefficient. Further refinement is performed by performing pixel-level classification on blocks which are not considered as background. Experiments are conducted on standard data-sets and the performance measures shows good results in some critical conditions.

Peer-review under responsibility of the Organizing Committee of ICACC 2016

Keywords: Background Subtraction; Frame Difference; Correlation Coefficient;

1. Introduction

In the field of computer vision, background subtraction is a crucial task. It provides essential real-time information for many different applications such as video surveillance[1, 2, 3] human computer interactions and video indexing and retrieval, optical motion capture, and intelligent visual observation of animals, insects[4]. Object detection, tracking, human action and activity recognition are the steps involved in video surveillance system. For object detection, the first step is to locate the objects in the video sequences which are acquired through static

Peer-review under responsibility of the Organizing Committee of ICACC 2016
doi:10.1016/j.procs.2016.07.236

cameras with a fixed background. To identify the object of interest, a popular and efficient approach is called background subtraction is necessary. Most of the background subtraction methods are very challenging in detection of accurate foreground objects and background subtraction at various critical conditions. Thus, they require high detection rate and low computational time for background subtraction.

In recent years, many background subtraction models are proposed and a recent survey is found in[4]. Some of the traditional basic background models based on Mean[5], Median[6], Histogram[7], Pixel intensity classification[8, 9, 10] and pixel change classification[11], MoG model[12], Codebook model[13], SACON[14] and texture model[15] are used in recent years. Most commonly used method for moving foreground objects is frame difference method[16]. In frame difference method, the background image is assumed to be the frame at time t. Pixels are labeled as foreground or background based on thresholding the absolute intensity difference between frames at time $t+1$ and the background image. This method works well if the foreground intensity is sufficiently different than the background. Moreover, this approach detects foreground objects based on decision made at the pixel level.

In this work, a modified frame difference method is proposed which uses the information available in the regions of the images and in individual pixels in order to categorize the pixels as foreground or background. The similarity between block from a frame and the background is measured using correlation coefficient. The blocks which are highly correlated are considered as background blocks. For the remaining blocks, pixel wise comparison is made to classify them as foreground and background. On the one hand, using block-wise categorization accelerates the background subtraction and on the other hand the accuracy of detecting foreground and background is improved by correlation analysis. The performance of the proposed method is evaluated by applying the method on standard datasets. The rest of this paper is organized as follows. In section 2, proposed methodology is described in detail. In section 3, experimental results and performance analysis are presented. Finally, section 4 concludes the work with possible extensions.

2. Proposed Methodology

2.1. Correlation Coefficient Analysis

In general, correlation coefficient is a measure of relationship between two variables and gives the result in single value r [17]. It gives a measure of the strength of association between two variables. The correlation coefficient r ranges from +1 to -1. A positive value of r indicates that either variables increase or decrease together, whereas a negative value of r indicates that as one variable increases, the other decreases and vice versa. If the value of r is 0, it means that there is no linear relationship between both the variables. In the proposed method the correlation coefficient between a block in the current frame and the corresponding block in the background image is computed. The correlation coefficient, is given by[17]

$$\rho(X,B) = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\sum_m \sum_n (A_{mn} - \bar{A})^2 \sum_m \sum_n (B_{mn} - \bar{B})^2}} \qquad (1)$$

When m, n represents the width and height of the block.

- A is the current image block
- B is the background image block
- $\bar{A}$ is the mean of pixels in current image block
- $\bar{B}$ is the mean of pixels in the background image block
- The value of the correlation coefficient between a block in the current image and the corresponding block in the background image can be used to measure the degree of correlation between these two blocks.