Shadow Removal from Videos Using Intensity Based K-Mean Clustering Algorithm

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Abstract. This paper introduces a hybrid approach that is based on color information that utilizes background subtraction technique, a mask and K-Mean clustering algorithm. This hybrid approach efficiently removes artifacts caused by lightening changes such as highlight, reflection, and shadows of moving objects from segmentation. We first create a mask by assigning values to R, G and B channels utilizing the shadow properties to this RGB color individually, and then we apply a K-Mean clustering algorithm to this mask for efficient removal. Simulation results from several video sequences with different scene conditions clearly reveal the effectiveness and robustness of the proposed algorithm.

Keywords: Background subtraction; K-Mean clustering; RGB color model; shadow removal.

1 Introduction

Detecting object in motion is the fundamental step for applications such as automated video surveillance, traffic monitoring, security system that require being robust against change in illumination conditions. Pixel level information is acquired by using Gaussian mixture model and the pixel’s connectivity is characterized by Markov random field in [1]. However, [2] suggests extracting two binary maps: one containing the foreground with shadow and the other containing some part of the foreground without shadow. A binary image is created from these two maps, and some inequality is being applied thereafter to the purpose of removing the shadow. The proposal of [3] is to use potential function to each pixel to find out the connectivity with the neighboring pixels. An object having sharp and irregular edges can contain a shadow without an edge [4]. In this paper, we propose a hybrid method to eliminate the lightening effects from the moving objects. By using frame averaging background subtraction technique with running Gaussian average filter, we can eliminate some sort of effects like highlight, small objects reflections etc. To remove artifacts like large cast shadows, we combine the K-Mean clustering algorithm along with the background subtraction technique to make the real time detection process more robust and efficient against changing scene conditions. First we apply background subtraction technique to the original video file to remove redundancy. Then, we assign values to R, G and B channels individually, and finally, K-Mean clustering algorithm is applied to extract the objects in motion.
2 Proposed Algorithm

Step 1: First the original image is acquired in RGB format.
Step 2: The background is modeled by computing the mean and standard deviation of each pixel for 100 frames.
Step 3: The background is updated over time by using the running average filter with different learning rates, $\alpha$. In this work, we have taken the value of $\alpha$ as 0.004, for better quality of the output.

$$D_{t+1}(R,G,B) = \alpha I_t(R,G,B) + (1-\alpha) D_t(R,G,B)$$  \hspace{1cm} (1)

Step 4: Two thresholds are selected by the following manner:
   - For upper threshold, $T_u$: $C(I) = A(I) + S$
   - For lower threshold, $T_l$: $C(I) = A(I) - S$

   where $C(I)$ is the threshold image, $A(I)$ is the input image and $S$ is the color value. The output threshold is just the addition or subtraction of a specific color value to each element of the source image. Here we have chosen the color value as 5.

Step 5: Now the extraction is carried out like this way, if $T_u < \text{pixel weight} < T_l$, the pixels are considered to be foreground instead of background. Here $T_u$ indicates upper threshold and $T_l$ lower threshold.

Step 6: After foreground extraction, we create RGB mask by applying threshold values on R, G and B channels independently. Pixels closely related to the RGB mask are detected as shadow elements.

Step 7: The remaining darkest shadow portions are removed by using the K-mean clustering algorithm. Among the cluster centers, one belongs to the shadow region and the remaining centers are from object and background region. The number of clusters, iterations and the membership function are selected randomly. The value of membership function is 0.03 and ten iterations are used for the work.

Step 8: Finally the moving object is extracted by merging the pixels belong to the cluster closely related to the shadow portion with the cluster contains background pixels.

3 Results and Discussions

Three videos are used to test the performance of our proposed method as is shown in figure 1. The algorithm has been implemented in the C++ environment using OpenCV library.

It can be exposed that the proposed hybrid method is very effective and efficient in object detection. Moreover, it also proves its efficiency in abolishing any kind of artifacts caused by the lightening conditions in moving object detection.

4 Conclusions
In this paper, we propose a hybrid system to remove shadow from moving object for a real time system in order to increase system’s accuracy. The hybrid system first uses frame averaging background subtraction technique with running Gaussian averaging filter to remove objects highlight, small bright cast shadow and occlusion of surroundings. To pull out the large dark cast shadow from the foreground, we utilize the shadow characteristics to RGB color model and apply K-Mean clustering algorithm, which partitions the shadow portion from the object region. Experimental results also demonstrate the effectiveness of the proposed methodology to reduce the lightening artifacts that to make the real time applications more reliable and robust against changing conditions.

Fig. 1 Simulation results (a), (b) and (c) at the top are the images of three video sequences. (d), (e) and (f) are the results of the proposed hybrid method accordingly.

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References