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Detection of Moving Object from Dynamic Scenes Using Multiple Color Space Histogram Model

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Abstract: *Moving object detection can be done by various methods like Background subtraction, frame differencing, optical flow method etc. All these are traditional methods which are widely used for moving object detection. Some of these traditional methods are based on assumption that background is stationary; and hence they cannot be applied to dynamic background i.e. changing background, whose background images change over time. Multiple color space histogram model is a great remedy to this problem. At first, this model converts each frame of a video sequence from RGB to HSV color space and then calculates the histogram of selected color components. Then we can detect an object using histogram superposition principle. At last, we can update MCSHM using the result of detection.*

Keywords: *dynamic background, moving object detection, histogram superposition principle, Multiple color space histogram model*

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I. Introduction

Intelligent monitoring system is an important research field in computer vision. It has wide range of applications. In this system, moving object detection is a fundamental and challenging step. Moving object detection is to detect moving objects in a series of video sequences. Moving object detection in dynamic scenes is one of the crucial tasks in many computer vision applications, including video processing, video surveillance and traffic monitoring [1-4]. The primary goal of motion detection is to detect motion of objects with respect to two consecutive frames. Detection of objects in motion from any video stream does not require any prior stored database but only multiple consecutive frames [5].

In various image processing applications, more attention is paid to the interested object rather than its location. The statistical histograms of the most dynamic backgrounds have favourable stability as well as they would change clearly only when big and contrasting objects enter or move out of the scenes. This is an important property for dynamic background. Dynamic scenes include two basic categories: one is caused by the motion of the camera due to vibration, rotation, translation and zoom. The other refers to the fixed camera with changing background, such as trees and water surface in the wind. The majority of security surveillance videos belong to second category [1].

There are many algorithms to detect objects in motion. Here, a fast and simple algorithm, which combines histograms in multiple color spaces and the superposition principle of statistical histogram, called Multiple Color Space Histogram Models (MCSHM) is used. MCSHM first calculates statistical histograms of many color components in multiple color space and then use the changes of statistical histograms to determine whether there is an object rather than the changes in pixels or pixel-level regions. Thus, the computational complexity becomes very low [1].

II. Previous Work

A number of methods to detect moving objects are materialised in the literature. We studied three methods and the limitations with those methods are here. Background subtraction method is widely used to detect moving objects but problem with this method is that, it can't deal with sudden, drastic lighting changes. Also, Frame differencing reveals poor performance in pulling out the complete shapes of certain types of moving objects. i.e. it is unable to detect the extra contour of moving object. Although The Optical flow method can detect the moving object in case the camera moves, it requires more time for its computation which is also very complex, and it is very sensitive to the noise. And optical flow estimation involves only local computation [2-12].

In contrast, MCSHM is a fast and simple algorithm. The model constitutes Histogram superposition principle and multiple color space. It simply calculates statistical histogram of many color components hence computational complexity is found very low. Previously, we have performed an experiment, in which we have taken 2 video frames into consideration. While performing an experiment care should be taken that the camera as well as background must be static. At first we converted first frame RGB color space to HSV color space; then calculated histograms of selected color components by applying Histogram Superposition Principle (HSP). The first frame should be captured when no moving object is there in the background; and in next frame the object should be appeared suddenly. And histograms of these two frames are compared. It shows abrupt variations in the histogram. This further leads to conclude that an object which is moving is appeared in the scene. In this paper we focus on the detection of moving object which is quietly based on multiple color space histogram model (MCSHM).

III. Multiple Color Space Histogram Model

Multiple Color Space: A color space is a specific organisation of colors. Multiple color space consists of more than one color spaces. Examples of color spaces are HSV,RGB, YUV, HIS, LAB etc. We can select a proper color space to portray the characteristics of an object according to characteristics of different color spaces. Suppose we have an image in RGB color space and we want to extract its Hue and Saturation then it is simply impossible. to achieve this we have to map this RGB image in HSV color space. Moreover, we can convert the image to other color spaces to pull out more color features. Here, The multiple color space is simply explained as converting an image into another appropriate color spaces, and digging out the color components which we want, into a new color space. This new color space is termed as multiple color space. We can fuse R, G, B, H and S color components into a particular color space to take out the color information that we want. As well, we can evade choosing the component which is of no use; for example, we can remove the V component in the HSV color space to decrease the effect of illumination changes. This confirms that the multiple color space is very flexible. It can merge any color components as required to attain the desired goal [1].

Histogram Superposition Principle: Histogram is a graphical representation of distribution of pixel intensities in an image. Histogram superposition principle is based on the statistical characteristics of the histogram which can be explained as; histogram is the statistical result of each pixel intensity in the image and any changes in a pixel will affect the histogram. Eq.(1) describes the impact on the histogram [1].

$$H_{new} = H - P + R \tag{1}$$

Where,

H_{new} = The histogram after superposition,

H = The original histogram,

P = The histogram of the pixel set before the pixel intensities change

R = The histogram of the pixel set after the pixel intensities change.

This expression can be interpreted as H_{new} equaling H minus P plus R.

Multiple Color Space Histogram Model: The below flow diagram describes the actual process of moving object detection using MCSHM. We have N no. of video frames which are input of this model. At first, we get the first video frame H then we convert this RGB frame into HSV color space. Then we get next successive frame P before pixel intensity changes and convert this frame also from RGB to HSV color space. Now get another next frame R after pixel intensity changes and convert this frame also from RGB to HSV color space. At last, calculate Histogram after superposition by using equation(1). And detect moving object using Histogram Superposition Principle. Then update the model using the result.

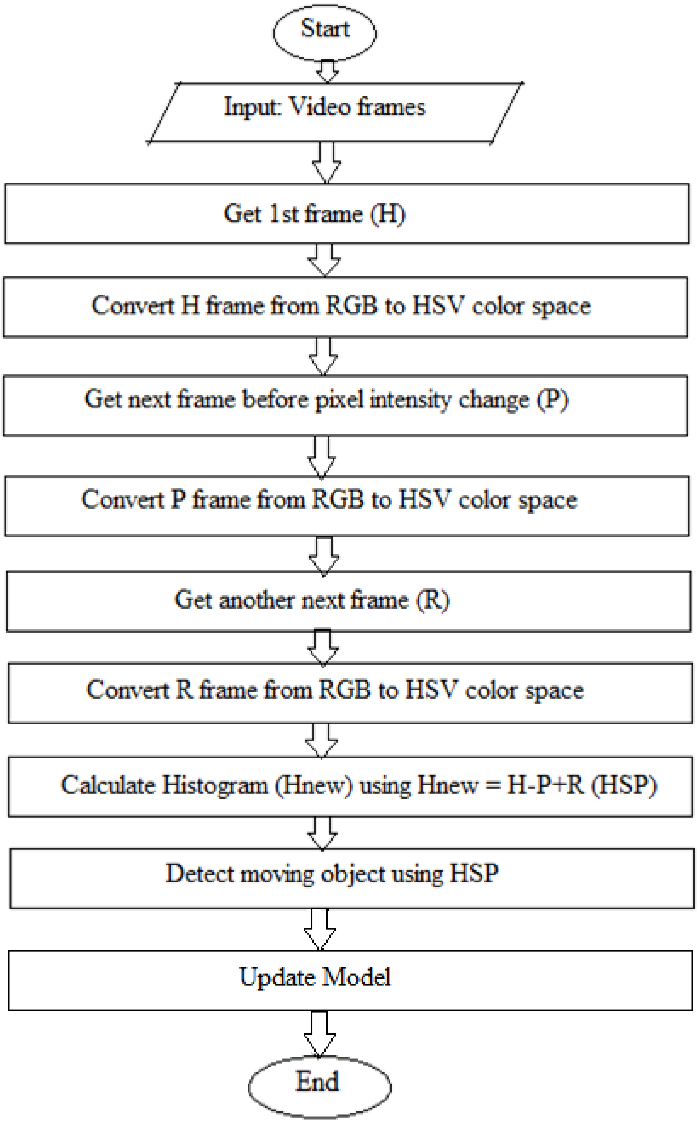

Fig 1. Flow diagram of MCSHM

IV. Methodology

The basic aim of Multiple Color Space Histogram Model is to construct a fast, simple and robust algorithm for detecting moving objects in dynamic scenes. Multiple color space histogram model consists of combination of histograms in multiple color spaces and the superposition principle of statistical histogram.

This model first calculates statistical histograms of many color components in multiple color space. Then, the variations in statistical histograms is used to detect whether there is an object and not the changes in pixels or pixel level regions.

Block Diagram:

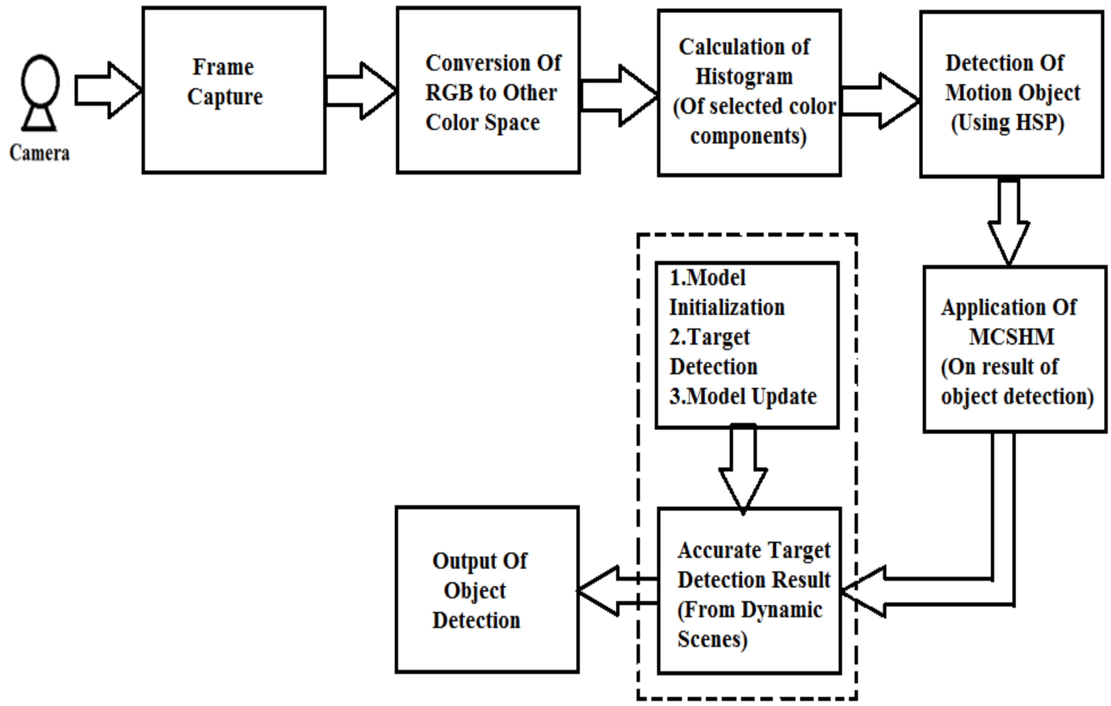

Fig 2: Block Diagram of Methodology

The basic steps are as follows:

a) Camera: Dynamic scenes consist of two types one is due to moving camera due to vibration and another refers to the Fixed camera with changing background. Here we are dealing with fixed camera.

b) Frame capture: capture N frames of video sequence to obtain stable background model.

c) RGB to other color space conversion: Convert each frame from RGB color space to an appropriate color space.

d) Calculation Of Histogram: Then calculate statistical histograms of many color components in multiple color space. And choose appropriate one.

e) Target detection: Then find the changes in statistical histograms to detect whether there is an object or not. Then detect an object using statistical histogram superposition principle. Here we compare the new histogram i.e H_{new} (eq.1) to the MCSHM; as it describes the intensity of changes.

f) Application Of MCSHM: Then apply Multiple color space Histogram Model on the result of motion object detection.

g) Accurate Target Detection Result:

1. Model initialization: At first convert each frame from RGB color space to other color spaces and calculate histograms of selected color components. Thus we get background histogram model.

2. Target detection: Then find the changes in statistical histograms to detect whether there is an object or not. Then detect an object using statistical histogram superposition principle.

3. Model update: And update multiple color space histogram model by the result of detection. This update of the background model depends on the detection results.

h) Output: Thus we get an output of moving object detection from dynamic scenes using multiple color space histogram model.

V. Experiment and Results

We have performed an experiment. Here we have taken 3 frames of a video sequence. Original video frame with no object is as shown in figure 3 below. Then we converted the original frame which is in RGB format, to the HSV color space. And then we calculated the histogram of selected color components and Histogram superposition principle (HSP) is applied over the frame. Fig.3 shows the results when background is stable and no moving object is there. When object appears, abrupt variations in histogram are found; as shown in below fig.4. Fig 4 and 5 shows the two successive frames appears after first frame. These two figures depict that the moving object is slightly found in the scenario.

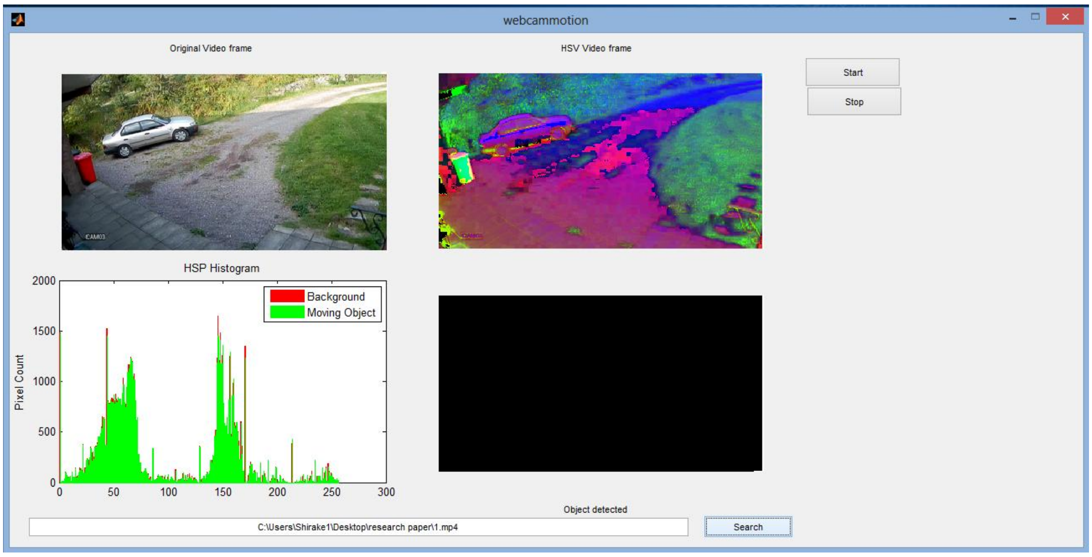

Fig 3 Static background with no moving object

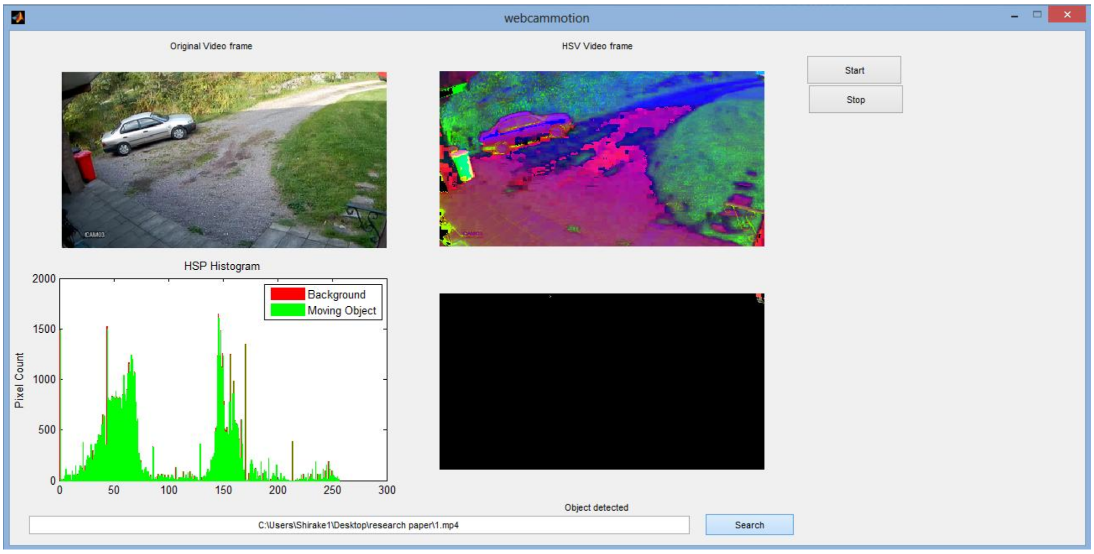

Fig 4 Next frame when moving object appears

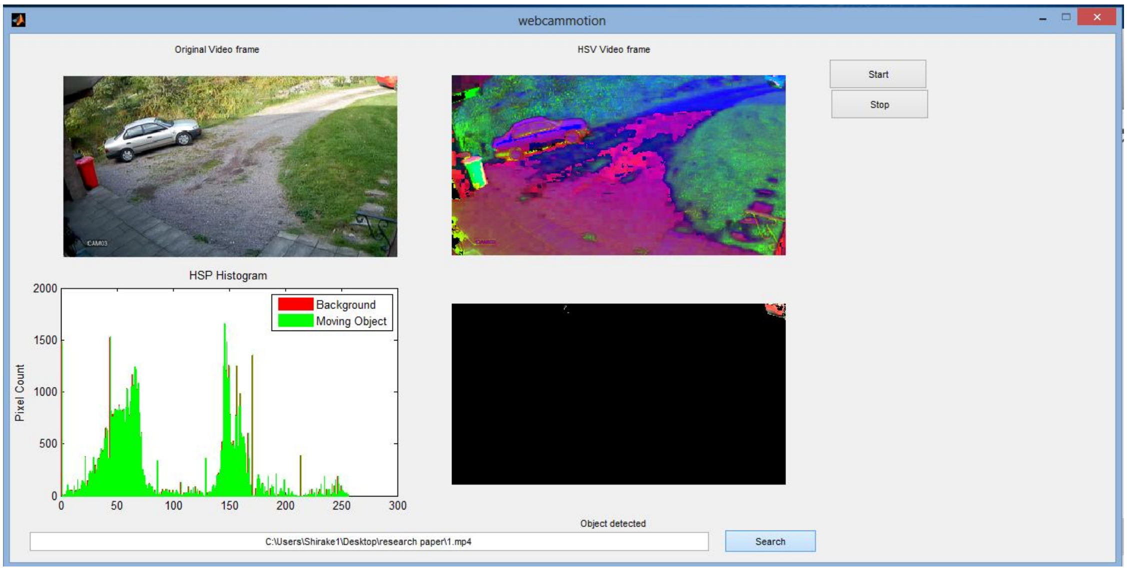

Fig.5 Next successive frame when object can be detected

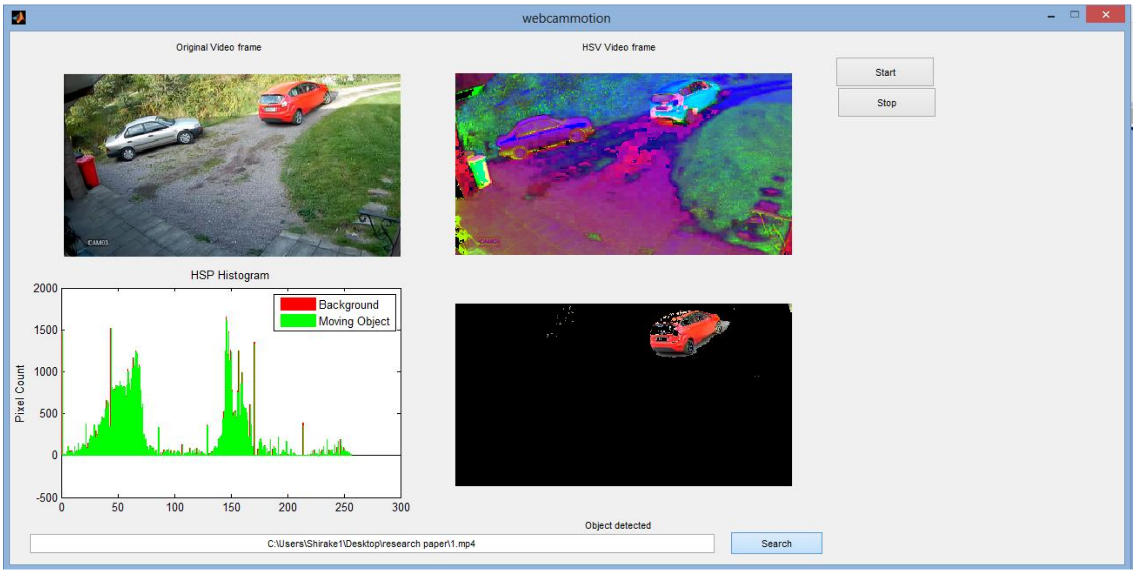

Fig.6 Detected Object

When we applied histogram superposition principle to the next frame, moving object is detected using multiple color space histogram model as shown in above figures 5 and 6. Fig 6 exhibits that the moving object is fully detected.

VI. Performance Analysis

Here we are using a fixed camera to capture video frame sequence. After that we convert each frame from RGB color space to other appropriate color space. Then we calculate histograms of selected color components and compare them. After comparing we can find the change in histogram if there is an object appears. In such a way we detect the moving object. This moving object detection technique can be used in different applications for example; Video surveillance, Video processing, In traffic monitoring system, people counting, In banks, stadiums, railway/metro stations for suspicious person detection, Parking management, face detection and content based video retrieval etc.

VII. Conclusion

In this paper, we studied a model for detecting whether a moving object appeared in dynamic scenes. This model is the combination of multiple color space and histogram superposition principle. In this algorithm, the background model is updated frame-by-frame. Our method also forms the background based on histogram which is different from the pixel-level modelling method. Hence, the computational complexity of the model is very low. Also it is very flexible. Selecting appropriate color components can boost the strength of our method. But there are still some difficulties. i.e. maximum how many color spaces can be selected is unpredictable. Also problem in selecting appropriate color components for different scenes, because different color components are not related to each other so each color should be uniquely expressed in terms of the value of each component of a color space. Also how many color components from each color space are selected i.e. weighing the contribution of different color components is also challenging task. and determining the value of threshold is also difficult.

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