Adaptive Background Subtraction In Images

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***Abstract*—: Selective background subtraction is the major problem associated with background subtraction technique. For foreground detection, background modeling is used in many different applications to subtract the background and detect foreground object in the image. There are many challenges in elaborating a good background subtraction algorithm and researcher have been appropriated to developing the new innovation and enhancement techniques to overcome all the limitations. In this paper, we present selective background subtraction technique to subtract unnecessary background from the foreground and background scene.**

Keywords— Background modelling, Selective Background Subtraction, Region of Interest

I. INTRODUCTION

Analysis and understanding of video sequences is an active research field. Many applications in this research area such as video surveillance, optical motion capture, Multimedia application are a need in the first step to detect the moving objects in the scene. So, the basic operation needed is the separation of the moving objects called “foreground” from the static information called the “background”. The easiest way to represent the background is to obtain a background image with the static object. In some critical conditions, the background is not present and it can be changed under real environment condition like sudden or gradual illumination changes, objects independence or removed from the scene. So, the background subtraction model must be more robust and accurate.

Two closely related problems to background subtraction are change detection and salient motion detection. Changes between two images are detected by change detection. So, background subtraction is a particular case when (1) one image is the background image and the other one is the current image, and (2) the changes are due to moving objects. On the other hand, salient motion detection has in view to find semantic regions and to filter out the insignificant areas. The idea of saliency motion detection is obtaining from the human visual system, where the first stage of human vision is a fast and simple pre-attentive process. So, salient motion detection can be estimated as a particular case of background subtraction. Subsequently, many background subtraction methods have been developed in the literary work to subtract the background and detect the foreground object. Most existing techniques are used to solve the background subtraction problem and subtract the whole background from the scene and detect the foreground object. [9]

In this paper, we proposed selective background subtraction method to subtract only selective background which is unnecessary in the image instead of subtracting the whole background from the scene. Many researchers are used different background subtraction techniques to removed whole background from the image and detect foreground object. But we used selective background subtraction approach to remove the only unnecessary background from the scene but when removing the unnecessary background from the scene then their black mask occurred on a background so we apply neighboring background on removing background black mask then we get output image with the corrected background and foreground object.

II. RELATED WORK

Background subtraction is a superior method for detecting foreground object as well as to model the background. Many contributions can be found using different background subtraction techniques for a different aspect. Shahrizat shaik et.al proposed Mixture of Gaussian (MoG) method. [1] MoG has the low rate of memory consumption, suitability, and complexity to detect dynamic object for the outdoor environment. This algorithm is more robust and adaptive in background subtraction method and it can handle multi-modal distributions. Mayssaa Al Najjar et.al presented hybrid adaptive detection technique [11] for real-time object detection of the outdoor environment with gradual illumination changes and waving tree branches. This technique integrates simple frame difference (FD), simple adaptive background subtraction (BS) and Mixture of Gaussian model (MoG). This technique requires fewer computations than MoG and gives faster response times while integrating these methods and producing better detection accuracy.

Pal et.al have proposed codebook background modeling and subtraction technique [12] to solve the challenges such as moving backgrounds and sudden and gradual illumination changes associated with the background modelling methods using the framework of codebook background modeling. They separate background image using image segmentation function and then use pseudo background layer to model the background with a codebook for each pixel in the image. Chen et.al used hierarchical background model [2] for the segmented region and pixel descriptors to detect foreground in video background subtraction. They used mean-shift algorithm to segments the background image into several regions. Then, a hierarchical model is created which is the combination of region model and pixel model. The region model is similar to the Gaussian mixture model and this Gaussian mixture model is build up from the histogram of a specific region. The pixel model is based on the co-occurrence of image variations described by the histogram of the oriented gradient of pixels in each region.

Zhipeng et.al have presented a selective Eigen background technique [10] for background modeling for crowded scenes. In this method, eigen background update virtual frames based on a frame selection map. Then, Eigen background describes the Eigen background selection map to select the background for each pixel. Intachak et.al [3] have developed real-time illumination feedback for adaptive background subtraction algorithm. This algorithm is used to solve sudden illumination changing problems at the outdoor environment in traffic video monitoring. R. Jenifa et.al presented Rapid Background Subtraction technique [4] to detect the dynamic objects quickly and accurately. This technique work on Bootstrapping, shadow detection, gradual and sudden illumination changes, the presence of waving tree and rainy day problems of background subtraction in the video. Guo et.al [5] proposed high-speed multi-layer codebook background subtraction technique. In this, they used multi-layer block-based codebook background model and feature of extraction block to solve the high-resolution video sequences problem for non-stationary background and it also improves the speed of the algorithm.

Zhang et.al proposed Three-frame differencing and background subtraction algorithm [6] to detect a vehicle in traffic video monitoring. This method used a Gaussian mixture model to get background frame, then used background subtraction method and three frames differencing to extract and detect the vehicle in traffic video. Anandhalli et.al presented Improvised approach [7] using background subtraction method to detect a vehicle in traffic area to solve the problems of shadow detection in the real-time tracking system. M. Imran et.al used a low power background subtraction method [8] to reduce complexity and memory requirement in wireless vision sensor nodes, which are used for machine vision applications.

Chang et.al proposed the parallel design of background subtraction and template matching model [13]. They used this parallel approach to detect object and tracking system and improve the performance of tracking system. Lee et.al presented [14] low-cost background subtraction algorithm. In this algorithm, they used background sets with image-space and color-space reduction to reduced jittered and unsteady camera and color noise in the image to detect foreground from moving background. It also reduced the cost of the algorithm.

III. PROPOSED METHOD

Background subtraction process considers four major steps which are pre-processing, selective background modeling, and background and foreground detection and finally is data validation [bs5]. Fig. 1 depicted overall view of a generic process of selective background subtraction.

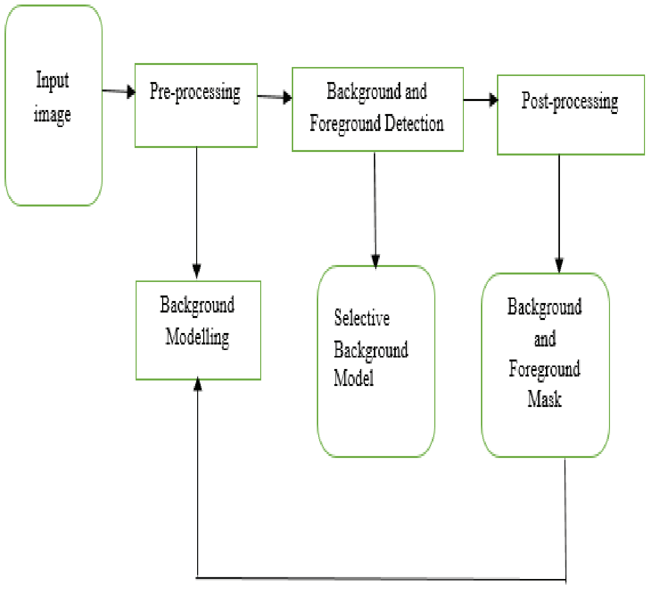


Fig. 1 Flow diagram of a generic process of selective background subtraction algorithm

A. *Pre-Processing*

Pre-processing is the process reading input image into a data format that can be used for the selective background modeling.

B. *Selective Background Modelling*

Background modelling is the heart of any background subtraction algorithm. In background modelling, we used selective background subtraction method to select the unnecessary background in the image and apply the binary mask for this selection. This binary mask is output for the next phase of foreground detection.

C. *Background and Foreground Detection*

The foreground and necessary background are separated from the selective background model after the step of selective background modelling. The method will classify the selective background and necessary background and foreground object by identifying it pixels from the input image.

D. *Data Validation*

Data validation stages examine the binary mask of background and foreground object with the input image and then remove the selective background and detect foreground object with a corrected background in the image.

The method proposed in this paper involves following processing levels. Fig. 2 depicted the overall view of a proposed algorithm.

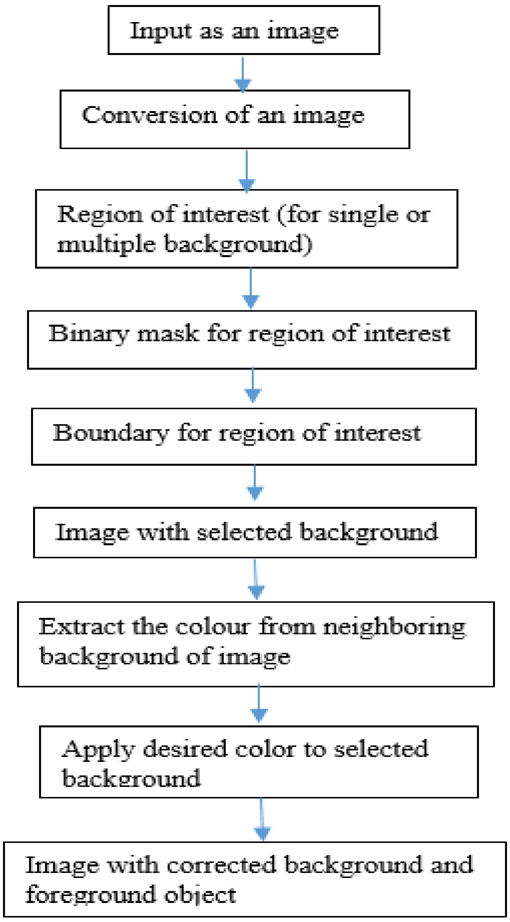


Fig. 2 Flow diagram of proposed algorithm

Firstly, we take input as an image then convert this image into the greyscale image or in HSV image where the greyscale image is one in which carries intensity information of each pixel representing the amount of light. Draw the region of interest using freehand region on the greyscale image and HSV image to select background which is unnecessary in the image. Draw single or multiple regions for background selection. Once select the background which is unnecessary in the image then create a binary mask for the freehand region. The Binary mask can separate the foreground and selective background region by applying the mask as a black color outside the region of interest and white color inside the region of interest.

After creating a binary mask for a region of interest create a boundary for selected background area. Because of the boundary the region which is selected to remove is highlighted in the image and then discarded the region from the image. Display image with the separation of foreground and the background object. When the selected background is removed from the image then instead of background there will be a mask on background area in the image. To fill that background mask area here extracted the color from neighboring background which necessary in the image and applied that color to the background mask which remaining as a black patch in the image.

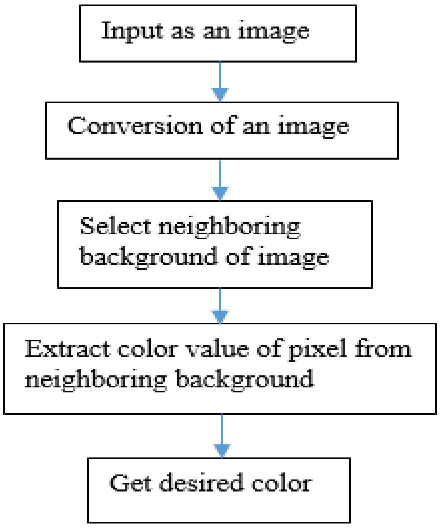


Fig. 3 Flow diagram for Extraction of color

In this, Extraction of color algorithm calculates the color value of the pixel which is selected from the greyscale image or HSV image. In this pixel calculate red, green, blue color values from specified pixel image. These value of the pixel is desired color for background mask. Then this desired color is applied to the background mask or black patch which occurred after removing the unnecessary background in the image. Display the image with color inside the region which is corrected background and foreground image.

IV. PERFORMANCE EVALUATION

A. Robustness to Noise

It is defined as the behavior of the algorithm to noisy sequence i.e. determining how efficiently the region of interest is detected by the algorithm by adapt to noise automatically, as regions of interest are selected from noisy pixel values.

B. Object Independence

This is defined as determining the number of constraints that can be applied to the condition of the object. This is used to determine the effectiveness of the algorithm to cast the region of interest of required class and dimension. For the image, according to the parameters affecting the scene, its models are created varying from the most general to an accurate one. As the accuracy level goes on increasing, the complexity of the algorithm to be developed also increases.

C. Computational Cost

Computational cost is related to the evaluation of the cost. Thus the proposed method reduces computational cost. It is further based on the time and the resources required by the algorithm respectively. For determining the accuracy, as the number of methods in the algorithm increases, the computational load also increases.

D. Chromatic ROI

This represents the contents of color under the region of interest. Color inside the region is based on the image type like RGB image, GRAY image and HSV image.

E. Camouflouge ROI

It tells more about the attached or overlapping region of interest. One or more region are attached to each other else two or more region overlap on each other.

F. Surface Topology ROI

This helps to find out if the image surface is plain or textured.

G. Accuracy Metrics

For the work presented in this paper, accuracy is used as the basis for comparison. The concept of accuracy refers to the quality of information provided by an edge map or modified edge map. The assessment of the edge map accuracy is necessary. Good Detection is defined as the probability of the selective background pixels not being classified as either foreground or background. This term is represented as *TP* (True Positive). The value of this term should be high, as less selective background pixels will be classified as foreground or background pixels; the number of true negatives (TN), which counts the number of correctly not detected selective background pixels. As per false positive and false negative metrics, false is the area, positive means selective background pixels and negative is non-selective background pixels. Thus *FP* means, selective background pixels (P) from non-selective background area (F, false area selected) but in this method false positive is not applicable because here proposed method work on selective region instead of the whole image; and similarly *FN* means, non-selective background pixel (N) area is false i.e. selective background area (F).

The metric percentage correct classification (PCC) is mostly used to calculate the performance of the algorithm.

$$PCC = (TP + TN)/(TP + TN + FN) \quad (1)$$

The PCC should be high, in order to minimize errors. The false alarm rate (FAR) is measured by the term Good Discrimination which is the probability of non-selective background pixels being classified as selective background pixels.

$$FAR = FN / (FN + TP) \quad (2)$$

The FAR value should be low to get high accuracy.

V. RESULTS

A. Experimental Results

The proposed method was implemented using different input images and its correctness was verified using the accuracy metric PCC and FAR explained above. The PCCs (Percentage of Correct Classification) shows the result from 99% to 100% and FAR (False Alarm Rate) result ranges from 0% to 1% for different inputs.

The Processing speed of the proposed method is measured in seconds. The experiments were performed on the platform of 2.00 GHz Intel Core i3 CPU, 8 GB of RAM using Matlab implementation. The experimental results show that the speed ranges from 0 seconds to 2 seconds depending upon the region of interest of the image.

B. Comparative Analysis

For determining the results of performance of the proposed method are compared with existing background subtraction method named Median Filter Background Subtraction.

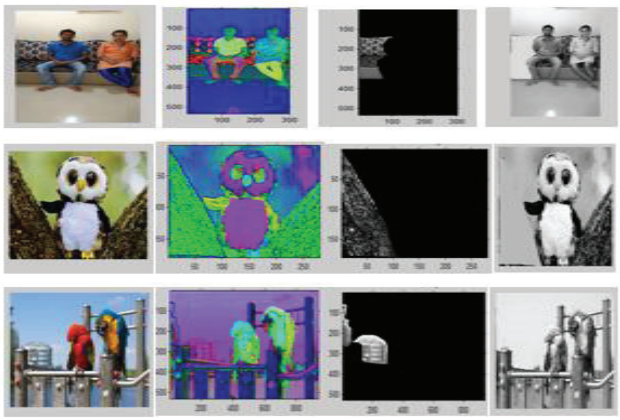
Median filter background subtraction technique worked on the whole background.it subtracts the whole background of the image and proposed method subtract only selective background which is unwanted in the image. The results are shown in the form of PCC metric, false rate and speed of the algorithm.

Features	**Median filter background subtraction**		**Selective background subtraction**	
	HSV image	**Gray image**	**HSV image**	**Gray image**
PCC (%)	99.39	99.98	99.89	99.29
FAR (%)	0.60	0.00	0.16	0.71
Speed (seconds)	2.28	2.47	0.17	0.271

C. Performance Parameters

1) HSV Images:

In this, we convert the original image into HSV image and take the value image of HSV image then apply the proposed algorithm on value image and select the single or multiple backgrounds of the image which is unnecessary in the image and removed that selected background and then we get corrected image with corrected background and foreground.

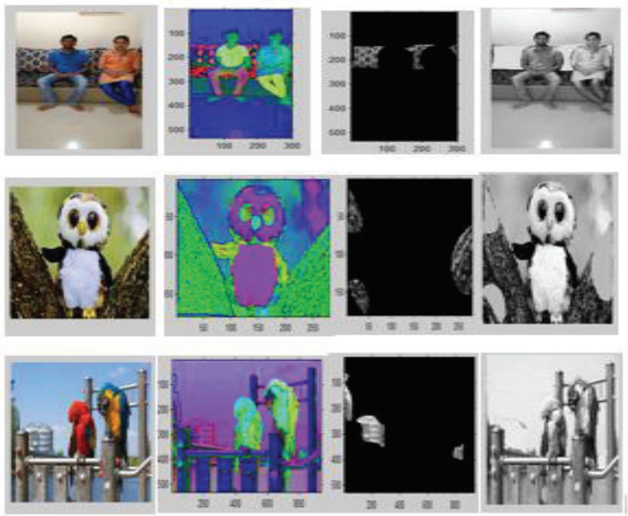


(a) (b) (c) (d)

Fig. 4 (a) Input image (b) HSV image (c) Single selective background (d) Image with color inside the background region

TABLE I. SINGLE SELECTION (HSV IMAGES)

Features	**Single selection of HSV images**		
	Image1	***Image2***	***Image3***
PCC (%)	99.89	100	100
FAR (%)	0.16	0	0
Speed (second)	0.17	0.169	0.244



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

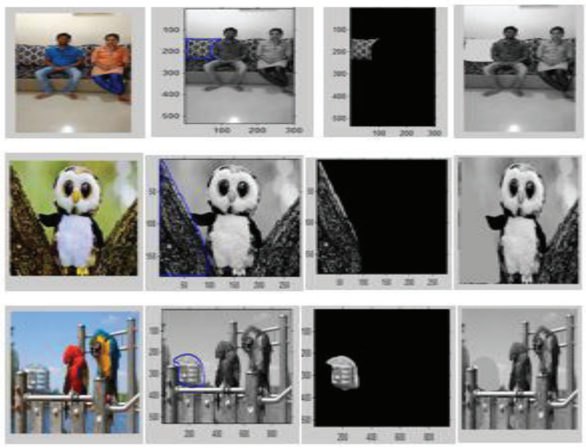
Fig. 5 (a) Input image (b) HSV image (c) Multiple selection on HSV Image (d) Image with color inside the background region

TABLE II. MULTIPLE SELECTION (HSV IMAGES)

Features	**Single selection of HSV images**		
	Image1	***Image2***	***Image3***
PCC (%)	99.86	100	100
FAR (%)	0.14	0	0
Speed (second)	0.18	0.22	0.28

2) Gray Images:

In this, we convert the original image into gray images and apply the proposed algorithm on gray scale image then select single or multiple backgrounds which is unnecessary in the image and remove that selected background and then we get corrected image with corrected background and foreground.

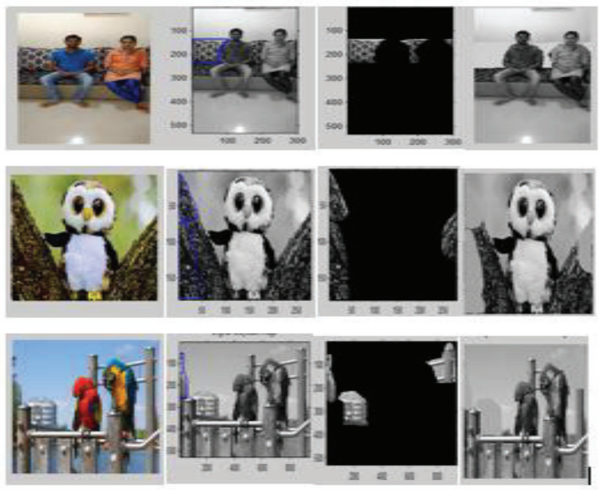


(a) (b) (c) (d)

Fig. 6 (a) Input image (b) Gray image (c) single selection on gray image (d) Image with color inside the background region

TABLE III. SINGLE SELECTION (GRAY IMAGES)

Features	**Single selection of Gray images**		
	Image1	***Image2***	***Image3***
PCC (%)	99.29	99.99	100
FAR (%)	0.71	0.00	0
Speed (second)	0.27	0.16	0.23



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

Fig. 7 (a) Input image (b) Gray image (c) Multiple selections on Gray image (d) Image with color inside the background region

TABLE IV. MULTIPLE SELECTION (GRAY IMAGES)

Features	Single selection of Gray images		
	Image1	***Image2***	***Image3***
PCC (%)	99.39	100	100
FAR (%)	0.61	0	0
Speed (second)	0.17	0.15	0.20

VI. CONCLUSION

In this paper, a selective background subtraction technique was proposed to subtract only selective background which is unwanted in the image instead of subtracting the whole background. The proposed method worked on different input images which are then converted to grayscale and HSV images. Performance of the proposed method is calculated in terms of accuracy and speed. The maximum average of percentage correct classification is 99.99% and 99.89%, and false alarm rate is 0.61% and 0.71% and an averaging speed of the algorithm is 0.27 and 0.28 per seconds for different input images, respectively.

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