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OBJECT DETECTION AND SHADOW REMOVAL TECHNIQUES USING HISTOGRAM BASED APPROACHES FOR VIDEO SURVEILLANCE

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ABSTRACT

In video surveillance,detection and classification of moving objects is the major bottleneck in current state of art.Further, complexity increases if the objects present in the video sequence having shadow regions.This may affect the further actions such as tracking and classification.Histogram based adaptive background subtraction technique is proposed to detect moving objects.Moreover detected object has shadow regions and this shadow regions are removed by using HSV color space models. The results which obtained by applying the above algorithms in different datasets,defines the efficiency of the proposed methodology.

Keywords-Adaptive background subtraction, Histogram, HSVcolormodel,Objectdetection,Shadowremoval,Tracking

I.INTRODUCTION

Video surveillance systems is an active research topic,which offers the visual surveillance without human intervention. Video surveillance systems can able to identify the activities of both the intended and unintended objects. Video Surveillance system with computer vision algorithms are intelligent enough to detect,track and identifies the multiple moving objects without human operators.Some applications of Video surveillance systems are security, traffic surveillance, person identification and detection of anomalous behaviour[1].

Generally videoscontain two types of information:Visual features and Motion information.Motion information and Visual features such as texture,color and shape are used for detection and tracking of multiple moving objects from the video.Some of the object detection techniques are:BackgroundSubtraction,TemporalDifferencing,Statistical approaches and Optical flow[2][3][4].Background subtraction[3] is a conventional technique for object detection,whereobjects are detected by subtracting the input frames from the reference background.Moving objects are detected by taking pixel by pixel difference of two or three consecutives frames in a video is the

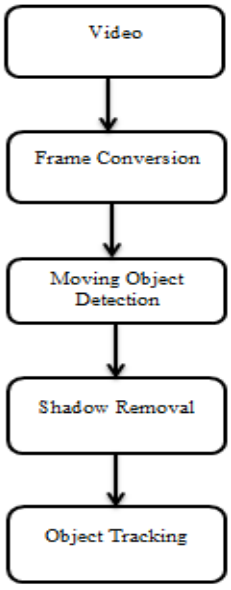
temporaldifferencing[4][8]technique.Instatisticalapproaches,individual pixels have been used to overcome the disadvantages of background subtraction method.This method dynamically updates the background image .Flow vectors of the moving object over time is utilized in the optical flow method to detect the moving the objects Velocity and direction of the moving objects can be calculated by using this method.

The extraction of the moving objects from video is affected by factors[1] such as illumination changes, dynamic background,occlusion,shadowsetc.Since shadows[2][3][4] are attached with the detectedobjects,it is often misinterpreted as foreground object.This will create inaccuracy in tracking[8],classification problems[1],object shape distortion and loss of textures in the background[6].Therefore distinguishing shadows from the moving objects is an important task.In the proposed method,histogram based adaptive background subtraction is the adopted for moving object detection.The affects occurs due to shadows have been overcame by using HSV color space model and tracking of the moving objects is done by using kalman filter[8].

II.PROPOSED METHOD

MOVING OBJECT DETECTION

Moving object detection by adaptive background subtraction is the process of segmenting the foreground objects from the background. Efficiency of an automated visual surveillance system is solely depends on its accurracy to detect moving objects[1]. Subsequent action such as tracking, analysis of the motion information of detected objects requires an accurate segmentation of the moving objects from the background.Moving object segmented by background subtraction is based on a comparison between the input frames and background frame.Basicallyinitial frame is assumed as the background frame[3][9] in conventional background subtraction techniques.Another approach for estimating the background frame is done by calculating the average of all frames in a video.



Adaptive background Subtraction is an improved agorithm for object detection using background subtraction with updationconstant.Mathematically,Initial background imageis estimated as,

$$B(x,y) = \sum_{i=1}^{n} \frac{I(x,y)}{n} \quad (1)$$

The updated background imageis estimated as,

$$U(x,y) = p * B(x,y) + (1-p) * I(x,y) \quad (2)$$

Mathematical expression for object detection with adaptive background subtraction is given as,

$$D(x,y) = U(x,y) - I(x,y) \quad (3)$$

where,B(x,y) is the initial background image,I(x,y) is the input frames from the video,nis the number of frames,U(x,y)is the updated background image,p is the updation constant and D(x,y) is the detected object from the adaptive background subtraction technique.
pistheconstantwhichisequalto 0.95,whichimpliesthatupdatedbackgroundis 95% of theoldbackground and 5% of thecurrentframeinformation.Thishelps in updatingthebackgroundimageforilluminationchanges.Theresultantimageisconvertedintobinaryimageusingthresholding. In the proposed method of histogram based adaptive background subtraction,threshold value is adopted from the histogram of D(x,y)Ifthethresholdvalueishigh,most of theintendedforegroundinformationwillvanish.Ifthethresholdvalueislow,itresults in false positives.Thereforethresholdvalueisselectedfromthehistogram in such a waythatitshouldnotcontaininformationaboutthebackgroundpixels.

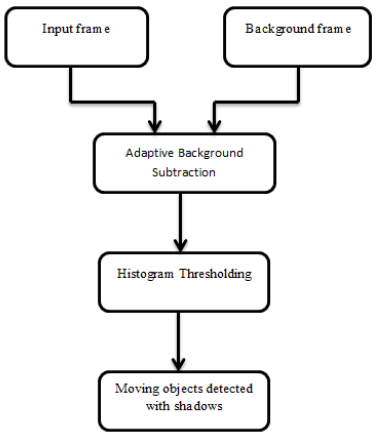


Fig.2.Block diagram of Histogram based adaptive background subtraction for object detection

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SHADOW REMOVAL

Shadows are the region of relative darkness which occurs when an object totally orpartially occludes direct light from a light source[2][3][4].There are two types of shadows:Self shadows and Cast shadows.
Self Shadows :It occurs on the objects,which occluding the light.It do not have hard boundary known as vague.
Cast Shadows :It is generated by objects on the ground or other objects in the scene.Cast shadows contains clearly defined boundariesboundaries.It is again classified as Umbra and Penumbra[5].Since it is identified as pixels of the moving objects, more important thanself shadows.It brings serious problem to moving object extraction because of the false classification of shadows as intended objects. Due to the presence of shadows,various problems arises in video surveillance applications.

Shadows degrades the performance of object localization, segmentation, object detection, and tracking. Various problems[4] occurs due to the presence of shadows are listed below:
i. Objects merge with each other objects in the frame

ii.Changes in the moving object shapes .

iii.False detection of background as foreground

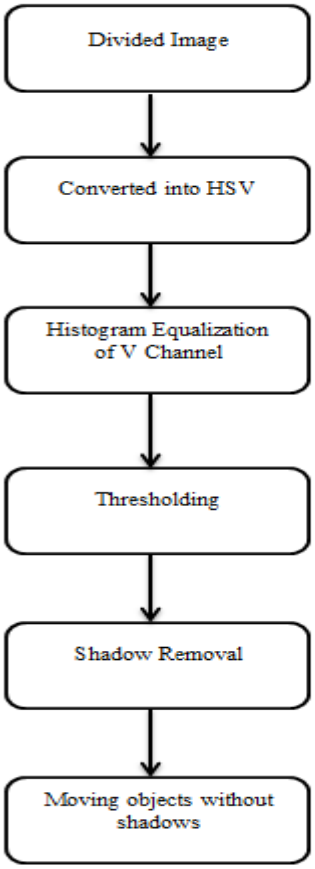


Fig.3.Block diagram of shadow removal technique

Shadow removal by HSV color space model is used in the proposed method.In HSV color model,H stands for Hue,S stands for Saturation and V stands for value.Hue value defines the purity of the color,the term saturation defines the amount of white light mixed with the original color and the term value gives the intensity of the color.In the proposed method to eliminate the effect of shadows.Inputframes,Background image and Binary image from theprevious object detection is used as input to the shadow removal process

$$I_{div} = \frac{I(x,y)}{U(x,y)} (4)$$

where,I_{div} is the divided image

I(x, y)is the input frames from the video

U(x,y) is the updated backgroundimage

Divided image is used to highlight the homogenous property of the shadows.The divided image is converted from RGB into HSV. Histogram equalization of V-channel is used to determine the threshold value.Mean value of the V-channel is adopted as threshold value to eradicate the effects of shadows

TRACKING

Object tracking is used to find out activities of the intended objects.It is very beneficial for detecting intruders in video surveillance system.Kalman filter[5][8][9] is used for tracking in the proposed method. This algorithm works in a two phases:Prediction phase & Correction phase.In the prediction step, the Kalman filter produces estimates of the current state variables, along with uncertainties.Once the outcome of the next measurement is estimated, these measurements are updated using a weighted average, and more weight being given to estimates with higher certainty.

III.RESULTS AND CONCLUSION

In the proposed method,three different datasets are used.Specifications for the videos are :Total number of frames in video-1 is 89 ,video-2 contains 95 frames and video-3 has 67 frames.Video-1 has a frame rate of 18 frames per second,video-2 with 17 frames per second and video-3 contains 20 frames per second.Fig.4. shows the frames extracted from the input video,which is the initial process in the proposed methodology.

FRAME CONVERSION

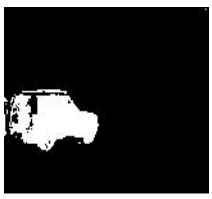
(a) (b)

(c)

Fig.4.Frame Conversion (a) Video-1 (b) Video-2 (c) Video-3

GROUND TRUTH IMAGE

(a) (b)



(c)

Fig.5.Ground truth images of the input frames(a) Video-1 (b) Video-2 (c) Video-3

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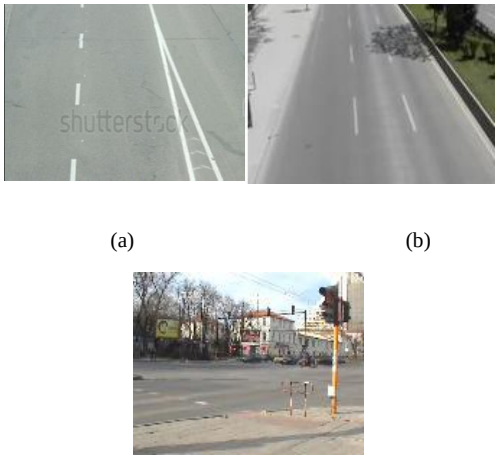
BACKGROUND IMAGE



(a) (b)

Fig.6.Background Image (a) Video-1 (b) Video-2 (c) Video-3

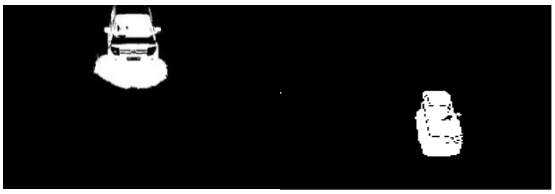
The figure.6.shows the background image which estimated by taking the mean of all frames with updation constant p to improve the accuracy in adaptively varying backgrounds

OBJECT DETECTION

Moving objects are detected from the video sequence are shown in figure.7. It is obtained by comparing the difference between the updated background frame and the input frame.

SHADOW REMOVAL

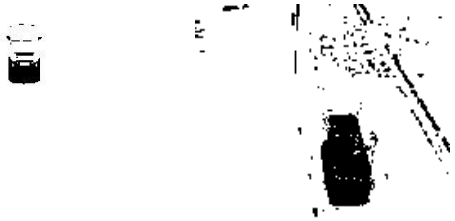
Homogeneity property of the divided image and the mean intensity value of V-channel from the HSV color space is used as threshold value to remove the shadow regions from the detected objects.Moving objects without shadows is shown in figure.8



(a) (b)

(c)

Fig.7.Moving objects detected with shadows(a) Video-1 (b) Video-2 (c) Video-3



(a) (b)

(c)

Fig.8.Moving objects detected without shadows (a) Video-1 (b) Video-2 (C) Video-3

TRACKING

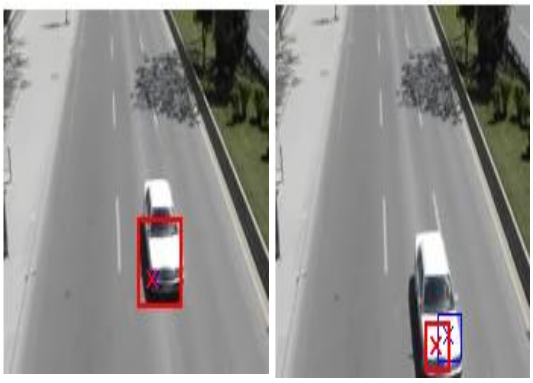


Fig.9.Kalman Tracking

Centroid values of the moving objects detected without shadows is used to track the objects.The blue color bounding box in the figure.9 indicates the tracking point for predicted phase and the red color bounding box in figure.9 indicates the tracking point for corrected phase

COMPARISION(WITH AND WITHOUT SHADOWS)

(a)(b)

Fig.10.Comparison of (a) moving objects with shadows and (b) moving objects without shadows

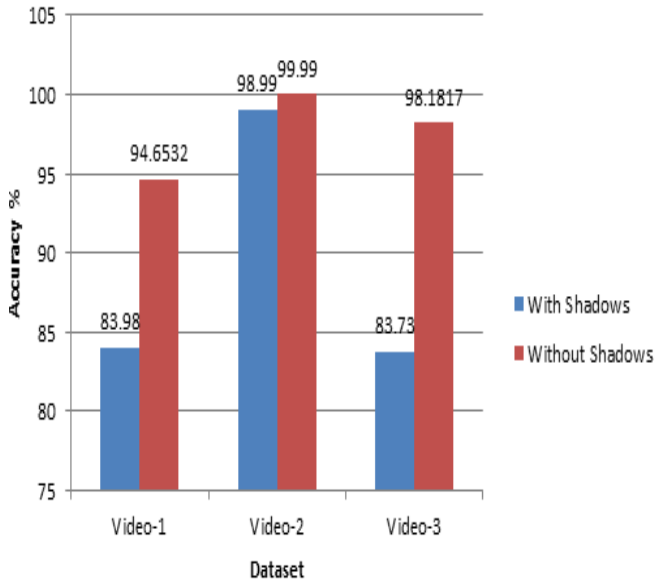


Fig.11.Comparison chart (with and without shadow)

From the figure.10, it is inferred that the shadow regions are accurately removed with this proposed methodolgy and thereby accuracy is increased.Figure.11, shows the detection accuracy for different datasets and detection accuracy is estimated by performing the XOR operation on ground truth images and frames with and without shadow regions

IV.CONCLUSION

The proposed method extracts the moving objects and shadow regions are eliminated to improve the efficiency of further actions such as tracking and classification.Shadow regions are removed statistically by calculating the mean intensity of V-channel estimated from the HSV color space of the divided image.In future works,features are extracted from the detected objects and the moving objects are classified into slow and fast objects such as human and vehicles for Intelligent traffic monitoring systems.

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