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Various Motion Cues Detection in Videos

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ABSTRACT: Under video processing most of research work consists of detecting objects exhibiting anomalous behaviour. In this paper we present a method to detect anomaly within a video on the basis of combination of motion and appearance of moving objects. Our method comprises of combination of three techniques that are: optical flow to detect motion, colour detection and speed detection. All three approaches are being applied on frames and frames then converted into a continuous video. Anomaly detection on basis of these three parameters can be of great application for traffic cameras or videos to detect vehicles of particular colour, their direction of motion and speed.

KEYWORDS: surveillance, spatial saliency, temporal saliency.

I. INTRODUCTION

Video surveillance is examining activities, events, changes in a particular situation or any kind of change in information for the benefit of humans by managing, tracking and guiding them, if surveillance done through video cameras termed as video surveillance. Anything that deviates from its normal or expected behaviour is coined as term anomaly.

Under video surveillance number of parameters was achieved at both offline as well as online. The benefits of video surveillance can be widely applied on traffic surveillance on our roads, which can be a great aid in improving traffic conditions. Day by day with the increasing modernisation number on vehicles on roads are also increasing.

But at the same time traffic is becoming unsmooth as well as unregulated. People often takes their vehicle in wrong direction against one-way roads to save few minutes as well as breaking speed limits is most common these days and breaking most of the traffic rules. Some violations such as speed limit crossing by vehicles can-not be properly estimated by human detection, it needs technical equipments. Surveillance camera can come out as great advantage in sorting out the problem mentioned. They can compute an appropriate estimation of vehicle speed as well as contains a recording of the vehicle passing by with their current speed.

Anomaly can be detected either on basis of motion of moving object or by object's appearance. Many researchers have worked in this area and provide a numerous solution for detection in crowded or un-crowded scenes and by using supervised, semi-supervised or unsupervised approaches. K. Kalirajan in his proposed approach [1] gave a solution for detecting motion by using background subtraction. D.SenthamaraiKannan in his methodology [2] detected colour by using frame subtraction as well as deal with problems in colour detection such as captured colour variation while the intensity of light changes. Ying Zhang in his proposed approach [8] detected anomalous objects by combining parameters of motion and appearance detection. He used size and motion of moving object to detect anomalous object and considered a fixed dimension region, objects falling out of that particular region are considered as anomalous.

Our proposed approach is a semi-supervised detection at crowded place. It detects anomalous object by combing motion and appearance three parameters: moving object along with its direction, colour detection and speed detection. By combining three parameters anomaly detection became more refined and can have greater number of applications. In our approach motion along with direction is detected by optical flow method by taking the change in intensity of light by moving objects and background as stationary. Colour detection is being performed by subtracting a particular colour frame from rest of the scene and finding parameters of that particular colour object. Further by taking the centre points of the coloured moving objects in consecutive frames the speed of respective moving object is calculated as well indicated on that moving object. First the video is being split into a number of frames. All three detection techniques are being performed on every frame and result of every technique presented on the frame without hiding the outcomes

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of other technique to get a combined result of all three. Then these frames are joined again to form video with a rate equal to frame rate of video and finally a video is composed showing all three parameters i.e. direction, colour and speed.

II. RELATED WORK

This section holds for the related work on various anomaly detection techniques during the previous years. Anomaly detection can be applied on the basis of motion and appearance. Anomaly detection is basically divided into three categories. Three categories are supervised detection, semi-supervised detection and unsupervised detection. Out of which majority work done is on supervised and unsupervised detection.

There are basically two phases under supervised detection first is training or learning second is detection. In supervised detection first the model prepared needs to be trained on both normal scenes as well as scenes containing objects depicting anomalous behaviour. Supervised detection [3] needs a predefined dataset to work on. Anything that falls out of dataset will not be evaluated. If supervised detection is applied, firstly a few number of data sets need to be inputted for training purpose, to find out anomalous event or object, which increases a lot of computational load. Unsupervised detection on the other hand consists of only detection no training phase is required. It has wide applications and computational load is also less in this approach. Unsupervised detection composed of machine learning or statistical detection. Specific parameters are defined at first and hence anomaly detection can be on the basis whether the object satisfies these parameters or not. Many researchers have worked in these areas and are still working but unsupervised detection is the preferred by most.

Dan Xu in his paper [9] detected anomaly in crowded and conflicted scenes of a video by using activity pattern discovery taking both local and global regions. Taking both time and space gradients he designed unified energy function based on activity patterns to identify anomaly. But to design energy function some frames needed to be worked on to find function and energy function applied on one may or may not work on other. Ying Zhang in his paper [8] proposed a method cut-bin for motion detection and support vector data description (SVDD) for appearance. Then both the methods are combined in this paper to get both motion and appearance detection at the same time. In his work size parameter of appearance is detected and object which falls out of the specified size are considered as anomalous. Weixin Li in his paper [6] detected and localizes anomaly in crowded scenes. This detector method works for both anomalies in appearance as well as different texture model that are dynamic one. Model is to implement normal behaviour model by learning from trained data sets and also works on discrete spatial saliency. Common problem resolved or dealt in the paper is the probabilistic nature of anomalous object. Secondly, normal model has a variety of diversities which needed to be defined prior to application of model. Huma Ramzan and Ahmad R. Shahid in their work [7] differentiate moving pedestrian from moving traffic. This model identifies moving pedestrian between moving vehicles which can reduce chances of accident up to large extent. This method first finds pedestrian using optical flow method and then combines outcomes of optical flow with histogram oriented approach i.e. HOG features. Constance S. Royden and Michael A. Holloway in their paper [10] detected moving object using optical flow method but they applied method in neural networks. They used speed and direction tuned operators to detect moving objects within a scene by training different layers of artificial neurons and comparing output of different layers with each other.

In our proposed method we combined motion detection with size and colour of object i.e. combining motion detection and appearance detection. All the three are applied on frames of video and the resultant frames are then converted into video. Our approach can work equally well on crowded scenes.

III. PROPOSED METHOD

Our method works on offline videos but can be further developed for online videos also. First of all the video on which anomaly detection is to be performed should have a format compatible with the MATLAB (MATLAB is the 4th generation language of technical computing, Maths-work developed this language entirely and can be used for implementing algorithms, plotting, mapping, combining electronics data with computer science terms etc.) version.

We have to first have to read the video from its source into our program. Then fragment the video into frames and split these frames by applying operations on them differently. These frames are then resized to fit into holding capacity of MATLAB version. Then first by applying optical flow, moving objects are detected along with their respective

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direction. Restoring the results of optical flow colour detection (i.e. detecting a particular colour object) is applied on these frames. Later on speed of moving objects is evaluated and displayed. Finally outcomes of all three are restored and these frames are again converted into continuous video with a frame rate equal to original video. Details of all three methods are discussed in the subsections below.

A. OPTICAL FLOW

Optic means light and flow means movement, optical flow whole is movement of light. Optical flow detection is detecting the apparent motion of objects at corner, centres, edges etc. by the change in intensity of light. In 1940's the concept of optical flow was introduced by James J. Gibson. Optical flow method calculates or evaluates the motion by drawing a comparison between pixel locations in two different frames. Two frames are taken of a video at a very small time distance suppose one is at time t and other at time $t + \Delta t$. With time and space coordinates derivatives of every pixel location in frame are then taken. Suppose at any time instant taking coordinates of any pixel be (x, y, t) and Let their intensity be denoted by $I(x, y, t)$. Suppose if the pixel moved a small distance in next frame be $\Delta x, \Delta y$ and Δt then assuming intensity difference to be very small between frames

$$I(x, y, t) = I(x + \Delta x, y + \Delta y, t + \Delta t) \text{-----(1)}$$

On expansion

$$I(x + \Delta x, y + \Delta y, t + \Delta t) = I(x, y, t) + \partial I / \partial x \Delta x + \partial I / \partial y \Delta y + \partial I / \partial t \Delta t \text{-----(2)}$$

On comparing equations 1 & 2 we get

$$\partial I / \partial x \Delta x + \partial I / \partial y \Delta y + \partial I / \partial t \Delta t = 0 \text{-----(3)}$$

Dividing above equation by Δt we get

$$\partial I / \partial x (\Delta x / \Delta t) + \partial I / \partial y (\Delta y / \Delta t) + \partial I / \partial t (\Delta t / \Delta t) = 0 \text{-----(4)}$$

Or

$$\partial I / \partial x V_x + \partial I / \partial y V_y + \partial I / \partial t * 1 = 0 \text{-----(5)}$$

Since differentiation of distance with time is taken as velocity so, $(\Delta x / \Delta t)$ is replace by V_x and $(\Delta y / \Delta t)$ is replaced by V_y .

Let the derivative of image at (x, y, t) be written as I_x, I_y and I_t . Then equation 5 becomes

$$I_x V_x + I_y V_y + I_t = 0$$

Or

$$I_x * V_x + I_y * V_y = -I_t \text{-----(6)}$$

But the single equation has more number of unknowns, hence aperture problem exists. Hence it is solved by applying least square method. For every pixel within the window optical flow equation is

$$I_x(q_1) + I_y(q_1) = -I_t(q_1)$$

$$I_x(q_2) + I_y(q_2) = -I_t(q_2)$$

$$I_x(q_3) + I_y(q_3) = -I_t(q_3)$$

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$$I_x(q_n) + I_y(q_n) = -I_t(q_n)$$

Where q_1, q_2, q_3, \dots are the pixels that are inside the window converting equation into matrix form we get

$$A v = b$$

Where

$$I_x(q_1) + I_y(q_1)$$

$$I_x(q_2) + I_y(q_2)$$

$$I_x(q_3) + I_y(q_3)$$

A =

.

.

.

$$I_x(q_n) + I_y(q_n)$$

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$$V = \begin{matrix} V_x \\ V_y \end{matrix}$$

$$B = \begin{matrix} -I_t(q_1) \\ -I_t(q_2) \\ -I_t(q_3) \\ \cdot \\ \cdot \\ \cdot \\ -I_t(q_n) \end{matrix}$$

Now $v = A^{-1} * b$.

After calculating partial derivatives of every pixel (with respect to x, y and t) of image using convolution function in MATLAB and taking b as $-I_t$, values of I_x , I_y are assigned to A to form matrix. Then A^{-1} is evaluated using pinv function and A^{-1} is multiplied by b to get the velocity vector. Size limitation is needed so a window size is kept fixed at the starting of program. Then by using quiver plot direction of moving objects are retained on the second frame by using hold on function and direction are plotted from original position in image heading arrow towards the change that is recorded in v matrix. By the procedure direction of moving objects are retained on every second frame of the two consecutive frame compared.

B. COLOUR DETECTION

Colour is what different object reflects and their wavelengths entering our eyes depict the type of colour we are able to see. Colour is the characteristic on ethnic visual perception described through colour categories, including names such as red, yellow, purple, yet blue. This understanding on coloration derives from the excitement concerning cone cells among the human sight by means of electromagnetic radiation into the spectrum on light. Colour categories yet physical specifications on shade are related with objects thru the wavelength over the mild to that amount is reflected beyond them. This anxiety is governed by the object's bodily properties such so light absorption, outflow spectra, etc. The erudition of colour is every now and then called chromatics, colorimetry, or absolutely colour science. It consists of the grasp over colour by using the human attention and brain, the origin about colour in materials, shade idea between art, still the physics over electromagnetic smearing within the scene spread (that is, such as is regularly referred according to absolutely as like light).

Colour detection in MATLAB [11] is detecting a particular colour object from the image. In case of videos colour detection is applied on the frames taken from the video. For tracking a particular colour car in traffic it can be of great benefit and will detect the object separating the rest of the background from that particular colour or neglecting the rest. But colour detection has nothing concerned with motion it will detect the particular coloured object whether in motion or stationary.

For applying colour detection to a video frame first of all the video frame needed to be converted into a gray scale image from the coloured image. Then the gray sale image is subtracted from the coloured image depicting dimensions of that particular colour that needed to be detected such as for colour red we use $(:,:,1)$. As a result image is holding only that coloured component which we need to be detected. But due to subtraction somewhat noise gets introduced into the image which is to be removed by using a noise filter such as medfilt2. Now the gray scale image is to be converted to binary image which has a benefit of converting luminance points greater than one equal to one and less than one equal to zero. Now labels of all the connected objects in the image needed to be collected under a heading for further operation can be 4 if mentioned or default is 8 by using bwlabel. Next step is the dimensions of the labels of the connected objects with connected properties i.e. position, dimensions etc. Position of that particular coloured object is obtained, now to mark the object on the image (coloured one) draw a shape according to size of object which suits the best can be circle or rectangle on the object using insert shape or can use rectangle function also. Program is dynamic as can detect any colour on that image by simply changing the dimensions of the colour need to be detected can be modified to detect any colour of choice.

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C. SPEED DETECTION

Speed is basically the rate at which an object is moving with respect to time. Speed detection is an important parameter in traffic analysis. Speed is basically the distance travelled in a particular time interval. S.I. unit of speed is kilometre per hour. It is a scalar quantity if direction is added to the speed it becomes velocity [4][12].

Surveillance cameras that are able to capture speed of moving objects are most commonly used by traffic police to detect speed of vehicles and which makes easy for traffic man to capture one who are crossing the speed limit. But the speed detection we are applied is on the particular coloured object. That is speed of only those vehicles of particular colour will be displayed that we want to detect. For this we performed colour detection first. Then apply speed detection to that particular moving object. For speed detection we need two consecutive frames as used in optical flow. Speed detection can be performed by detecting the change in position of pixels and also by taking that as distance moved by object by the pixel position in one frame to the pixel position the other consecutive frame. Then we detected particular colour objects in both the frames as well found the centroids of the object which can be done using region props with properties as centroids. Once centroids i.e. the centre point coordinates of the moving objects are obtained then formula on centroids for first and second frame is applied to calculate speed of moving object i.e.

$$\text{Speed} = \text{sqrt}(\text{sum}((\text{centroids}(k,:) - \text{centroids1}(k,:))^2))$$

Where centroids1 are the centre points of moving objects in first frame and centroids are the centre points of the same moving objects in the second frame.

When speed of moving object is achieved it can be displayed on frame accordingly on that particular moving object by using insert shape at the object's centre position.

D. Conversion of frames into video

All the three methods or the overall approach is being applied on frames of video taken from a video set and the resultant frames are then converted into video again. The process consists of two parts i.e. firstly conversion of videos into frames and then on second half conversion of frames again into video. A temporary folder is created such that it must contain another sub folder. Then the video was read from its source and then different frames are taken from the video in the form of loop and then all the three techniques were applied on the frames. Snapshot of each resultant frame is taken. From there starts the second half i.e. storing of frames then conversion of frames into video. Resultant frames should be assigned names in their order and should have an extension of 'jpg' and stored in the sub folder of the temporary folder. In next step all the files with '.jpg' extension are found and then the set of images is converted into an array. Now a video AVI file is created by using a video writer. Such that the frame rate of new video must be equal to the frame rate of the video from which the frames are being taken. The video file created above is opened and every image or snapshot is loaded in the temporary folder into the video file by applying loop, after its completion the video file is closed. The video file thus created is opened with all its frames from all sources. The video file is then played using movie function which is the finalized video containing required number of frames on which detection is being applied and which is having a frame rate equal to that of original video. Hence the new output video shows outcomes of all the three detection techniques on each and every frame with successful implication of our proposed approach.

IV. RESULT

This section shows different frames taken from resultant video showing all three patterns of motion and anomaly detection i.e. motion, colour and appearance. The proposed approach is dynamic, works on both crowded as well as uncrowded scenes and can be applied on different videos by making a slight change in parameters only. Also the approach can be diversified to take a number of patterns different from the three taken above.

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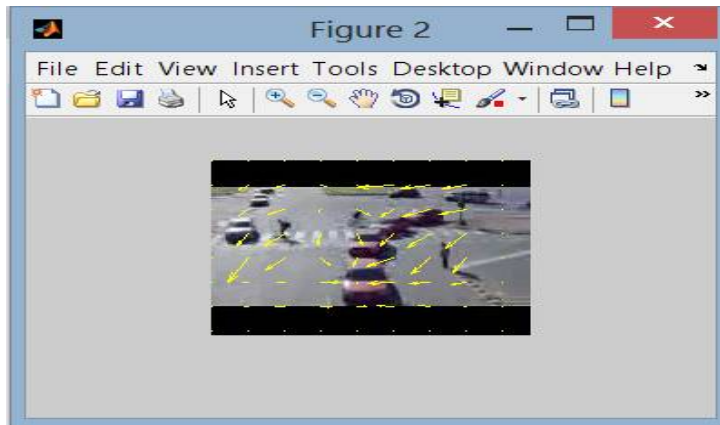


Figure.6. Direction of moving object on video frame.

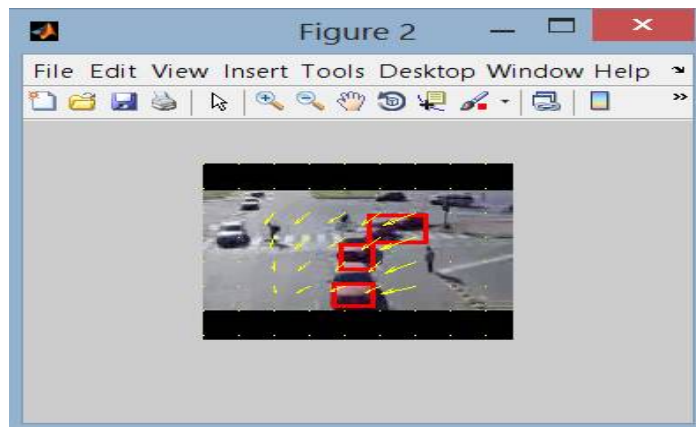


Figure.7. Direction along with colour detection on frame.

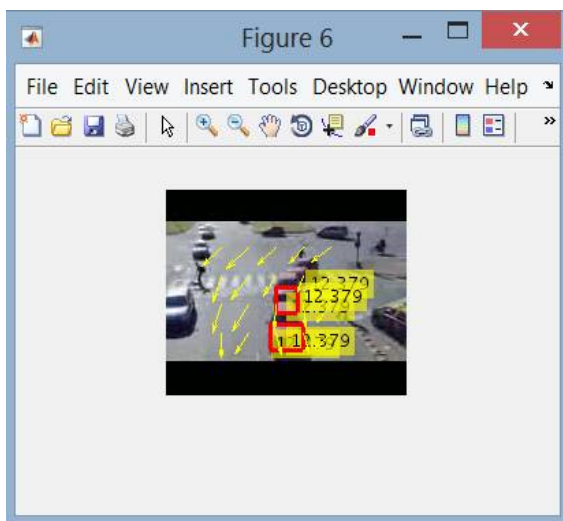


Figure.8.

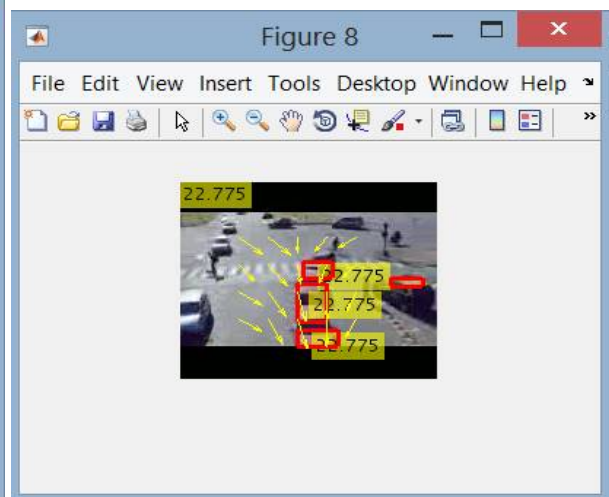


Figure.9.

Figure 8, 9 shows different frames taken from video on which proposed approach is applied.

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