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MONITORING SYSTEM FOR DETECTION OF OVER SPEED OBJECT

Abdulrahman D. Khalaf **Ali M. Sagheer**

College of Computer,Al-Anbar University, Iraq

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ABSTRACT

This paper introduces a system, which can be applied for monitoring of the speed of moving objects using a single camera. The Monitoring System is developed to monitor one moving object at a time with its speed being monitoring using a sequence of video frames. Field test has been conducted to capture real-life data and the processed results are presented. Multiple moving objects and noisy data problems are considered.The proposed system depends on evaluating the position and the orientation of moving objects in real world according to suitable reference point, on the screen, which can be selected by the user (static object).

Introduction

Image-based multimedia data can be treated in many different ways. One approach is to consider visual properties of images such as color, texture, shape, and so on. Another approach is to consider the semantic composition of images in terms of the individual objects contained in them and the spatial relationships among these objects [1].

The preceding examples deal with static image data (e.g. photographs, drawings) where the main relationships among objects are spatial. In dynamic image data (e.g. video, animation) the relationships include not only spatial, but also temporal and spatiotemporal ones. Since video retrieval based on moving objects requires the manipulation of large volumes of both spatial and temporal information, one might expect some help from the substantial body of research in spatial databases and temporal databases.

* Corresponding author at: College of Computer,Al-Anbar University, Iraq, Iraq.E-mail address: abdulrahman_khalaf@yahoo.com

A model for moving objects must be able to deal with both the movement of individual objects and the dynamically changing relationships among objects [2].

Image Processing

Image processing is computer imaging where the application involves a human being in the visual loop. In other words, the images are to be examined and acted upon by people. These types of applications require some understanding of how the human visual system operates. The major topics within the field of image processing include image restoration, image enhancement, and image compression. As was previously mentioned, image analysis is often used, as preliminary work in the development of image processing algorithms, but the primary distinction between computer vision and image processing is that the output image is to be used by a human being.

Image restoration is the process of taking an image with some known, or estimated, degradation, and restoring it to its original appearance. Image restoration is often used in the Held of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed. Image enhancement involves taking an image and improving it visually, typically by taking advantages of the human visual system's response. One of the simplest and often most dramatic enhancement techniques are to simply stretch the control of an image. Enhancement methods tend to be problem specific.

Image compression involves reducing the typically massive amount of data needed to represent an image. This is done by eliminating data that are visually unnecessary and by taking advantage of the redundancy that is inherent in most images.

In preprocessing computer imaging it is important to denote the resolution definition. Resolution of any image can be defined as the number of digit per inch (DPI) [3].

Image Representation

The image can be accessed as a two-dimensional array of data, where each data point is referred to as a pixel (picture element). For digital images the following notation will be used:

$I(r, c)$ = the brightness of the image at the point(r, c), where r = *row* and c = *column*. This image model is for monochrome (one color) , that is what normally referred to as (black and white) image data, but there are other types of image data that require extensions or modifications to this model, these image types are:

Binary Images

Binary images are the simplest type of images and can take on two values, typically black and white, or (0 and 1). A binary image is referred to as a 1-bit/pixel image because it takes only 1 binary digit to represent each pixel. These types of images are most frequently used in computer vision applications where the only information required for the task is general shape, or outline information.

Binary images are often created from gray-scale images via a threshold operation, where every pixel above the threshold value is turned white '1' and those below it are turned black '0' [3].

Gray-Scale Images

Gray-Scale Images are referred to as monochrome, or one color images. They contain brightness information only, no color information. The number of bits used for each pixel determines the number of different brightness levels available.

The typical image contains 8 bits/pixel data, which allows us to have 256 (0-255) different brightness (gray) levels [3].

Color Images

Color images can be modeled as three band monochrome image data, where each band of data corresponds to a different data color.

Typically color images are represented as red, green and blue, or RGB images. Using the 8-bits/pixel 8 bit for each of the three-color band (red, green and blue) [3].

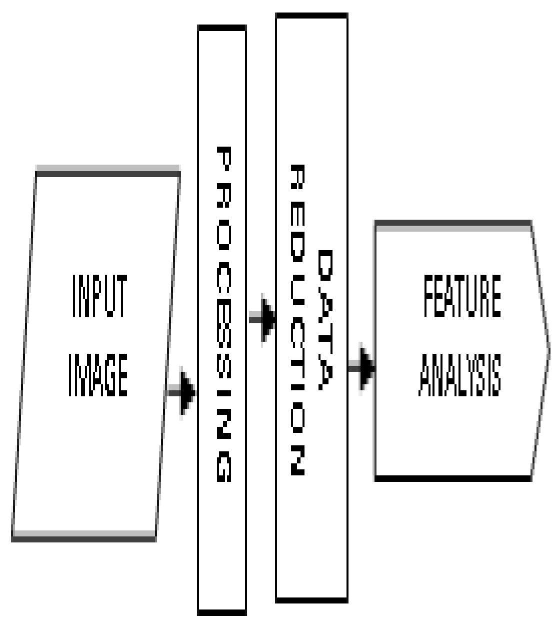


Figure (1) Image analysis

Image Analysis

Image analysis involves manipulating the image data to determine exactly the information necessary to solve a computer imaging problem. Image analysis is primary a data reduction process. Images contain enormous amount of data, typically in the order of hundreds of kilobytes or even megabytes.

In image processing applications, image analysis methods may be used to help determine the type of processing required and the specific parameters needed for that processing. For example determining the degradation function for an image restoration procedure, developing enhancement algorithm and determining exactly what information is visually important for an image task.

The image analysis process, illustrated in Figure(1) can be broken down into three primary stages [3].

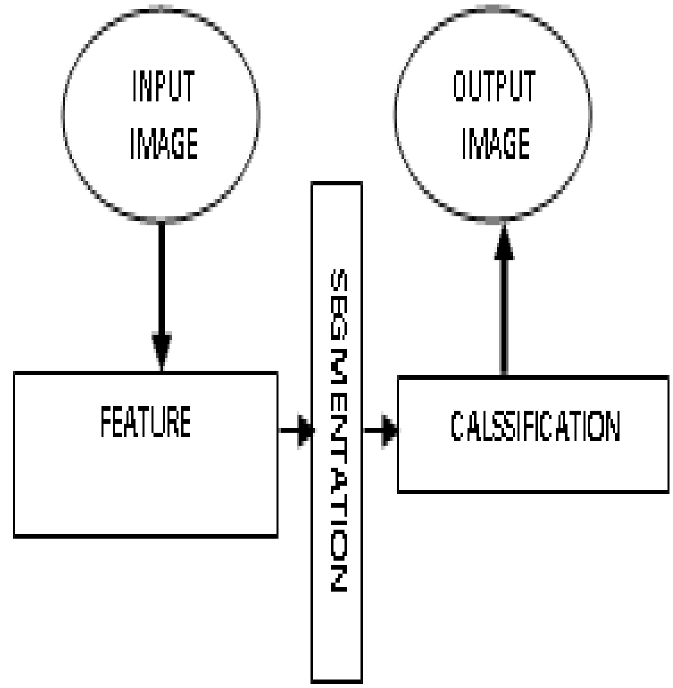
1- Preprocessing is the stage where the requirements are typically obvious and simple, such as the elimination of image information that is not required for the application preprocessing is used to remove noise and eliminate irrelevant, visually unnecessary information. Noise is unwanted information that can result from the image acquision process

2- Data reduction involves either reducing the data in the spatial domain or transforming it into another domain called the frequency domain, and then extracting features for the analysis process.

3- Feature analysis, the features extracted by the data reduction process are examined and evaluated for their use in the application.

Image Analysis Techniques

The ultimate aim of a large number of image processing applications is to extract important features from image data. Image analysis basically involves the study of feature extraction, segmentation, and classification technique, as shown in Figure(2) [6].



Figure(2) Image Analysis Techniques

Edge Detection Techniques

In Image Processing, an edge is the boundary between an object and its background. They represent the frontier for single objects. Therefore, if the edges of image's objects can be identified with precision, all the objects can be located and their properties such as area, perimeter, shape, etc, can be calculated. Edge detection is an essential tool for computer vision and image processing [2].

After the application of an edge detector technique, the objects have been isolated, and only the boundaries between the regions are identified. Edge detection is the process of locating the edge pixels. Then an edge enhancement will increase the contrast between the edges and the background in such a way that edges becomes more visible [11].In addition, edge tracing is the process of following the edges, usually collecting the edge pixels into a list.

A model of an edge can be ideally represented by the Step edge, which is simply a change in gray level occurring at one location. The step edge is an ideal model because in a real image never a change in a gray level occurs in the extreme left side of a pixel due to noise and illumination disturbances. Due to digitization, it is unlikely that the image will be sampled in such a way that all of the edges happen to correspond exactly with a pixel boundary [12].

Gray-level Segmentation Techniques

Thresholding or gray-level segmentation is an essential concept related with image processing and computer vision. Thresholding is a conversion between a gray-scale image and a believe image. Believe image is a monochrome image only composed of black and white pixels. It should contain the most essential information of the image (i.e., number, position and shape of objects), but is not comparable with the information offered by the gray-scale image [2].

Because of its intuitive properties and simplicity of implementation, image thresholding enjoys a central position in applications of image segmentation [11]. Most of the time pixels with similar gray scales belong to the same object. Therefore, classifying the image by gray-scale pixels may reduce and simplify some image processing operations such as pattern recognition, and classification [9]. There are a number of methods for thresholding :-

1) Mean gray-level method
2) Single threshold method
3) P-tile method
4) Edge pixel method
5) Iterative method

Video Analysis

Human interfaces for computer graphics systems are now evolving towards multi-modal approach. Information gathered using visual, audio and motion capture systems are now becoming increasingly important within user controlled virtual environments. Intelligent video analysis is a problem of great importance for applications such as surveillance and automatic annotation [4]. The method of video analysis is summarized as follows:

First, moving regions are extracted using an active contour technique. Second, visual descriptions of the moving regions are extracted and are compared with references.

Motion Capture for Computer Animation

In a general sense, motion capture is the process of recording a motion event and translating it into usable mathematical terms by tracking a number of key points or regions segments in space over time and combining them to obtain a three dimensional representation of the performance.

The captured object could be anything that exists in the real world and makes some motion [5]. The study of motion in image sequences is a typical topic research area in computer vision. Motion is a powerful feature of image sequence, revealing the dynamics of scenes by relating spatial image features to temporal changes. The task of motion analysis remains a challenging and fundamental problem of computer vision.

Monitoring of Moving Object System

Monitoring of objects throughout a video is possible under the assumptions that object motion is smooth and objects do not disappear or change direction suddenly. Video output is a series of 2D, time sequential images. The size, frame rate, view volume, and other factors, they are all dependent on the type of video used, any filters applied, and the analysis techniques employed. Moving object detection is an important problem in image sequence analysis. Currently there are very few integrated video monitoring products available for virtual environment work. This is partially because video output is much more complex than other monitoring technologies' output, requiring substantially more processing power for analysis. The number of possible combinations of technical factors in video monitoring systems is vast, and typically each system must be customized to fit the intended application [15].

Problems in Objects Monitoring

Typical problems in scene analysis algorithms are [7]:

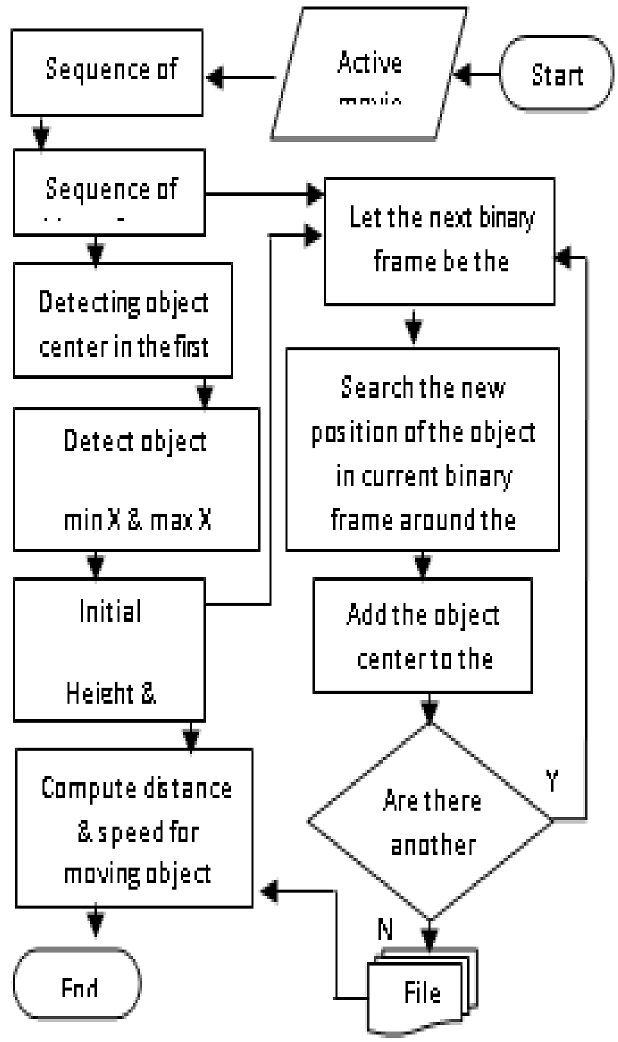
1) Image changes, such as noise, shadows, light changes, reflection, and clutter that can obscure object features to mislead monitoring.
2) The presence of multiple moving objects, especially when objects have similar features, when their paths cross, or when they occlude each other.
3) The presence of non-rigid and articulated objects and their non uniform features.
4) Inaccurate of preceded object segmentation.
5) Changing object features, e.g., due to object deformation or scale change. Objects that look as background or noise. This might happen when an object.
6) Enters a shadowed region or a cloud of fog.
7) When only part of a single object can be detected.

Limitations

Design of Monitoring System for Detection of Over Speed Object

The proposal Monitoring system works to monitoring one moving object with speed using a sequence of video frames input from single camera, which can be applied to the monitoring of object speed for various application such as radars, airbus, space and other.

Figure(3) illustrate the general steps of Monitoring System.



Figure(3): General Monitoring System Operation

The general steps of the proposed Monitoring System are:

Step 1: The system is design to convert movie into sequence of frames.

Step 2: The image is passing through a set of filters to convert this sequence of true color frames to a sequence of binary frames.

Step 3: Object detection is used to first binary frame and extract the height, width and center coordinate.

Step 4: Perform object tracking operation that searches at each other frames for the new location of this object to detect the path of moving object.

Step5: Compute the distance and speed for the object.

Estimation of the Speed of Object

In practical computer vision, motion analysis requires the storage and manipulation of image sequences rather than single images. Image sequences can be stored in memory as lists of arrays with sequential numbering. Each image in a sequence is often called a frame, the time, which elapses between each frame, is according to the frame rate.

This time is constant, then the total time for the film can be computed by multiplying number of frames by frame rate (Frame rate: is the number of frames per second).

Each frame is an image that represents the required scene but at different time, then the moving objects may appear at each frame with a different place and/or different size.

A special case of motion analysis is when the camera is actually static with respect to its environment, but some other objects are moving. The proposed Video Monitoring System is manipulated sequence of frames rather than a movie file, then the file must converted to a sequence of frames. The system receives any movie file (AVI file) and converts it into a sequence of frames (BMP files).

A common method for segmentation of moving objects in image sequences involves background subtraction or thresholding the error between two image frames $f(x, y, t_i)$ and $f(x, y, t_j)$ taken at times t_i and t_j respectively, is to compare the two images pixel by pixel. A difference image between two images at times t; and ti may be defined as:

$$d_{ij}(x,y)=\begin{cases} 1 & if \quad f(x,y,t_i)-f(x,y,t_j)>T \\ 0 & otherwise \end{cases} \tag{1}$$

where T is a specified threshold, and $d_{i,j}(x, y)$ has a value of 1 at spatial coordinates (x, y) only if the gray-level difference between two images is appreciably different at those coordinates, as determined by the specified threshold.

Convert the Movie File to a Sequence of Binary BMP Files

Using the of the project software to detect required part of the movie file by set the first scene and last scene then capturing the selected part of movie file to a setting of color frames (each one is a BMP file) separated by a constant period of time called "frame rate". Number of frames in the selected part of movie file is F and the order of the first and last frames are S_f and L_f. In this system, the suggestion frame rate equals 40 (i.e. 40 frame per second).

In the proposed system, there are many steps to be followed in order to improve the quality of the images (frames), a preprocessing step, which contains the following stages, has been carried out:

1- Converting each frame from true color image to 256 gray scale images.
2- Smoothing each 256 gray scale frame by Mean filter.
3- Using Sobel filters for edge detection for all the smoothing frames.
4- After the above three stages, each frame is converted to binary frames using one value of threshold.

Converting image from True Color to 256 Grayscale

This sequence of frames is bitmaps; it is an array of RGB structures. When reading the pixel values of such a bitmap, each pixel value will be an index into this array indicating the color that value…represents.

The value of $f(x, y)$ is a vector with three components, corresponding to Red, Green and Blue. Since each of the three components is normally quantized using 8-bit, an image made up of these components is commonly described as 24-bit color images [14]. In 256 gray-scale, each pixel in the frame is $gr(x, y)$. The value of $gr(x, y)$ is an 8-bit (256 gray level). The following equation is used to convert image from true color (24 bit) to grayscale (8 bit) [16]:

$$gr(x,y)=\frac{f(x,y)\cdot red+f(x,y)\cdot green+f(x,y)\cdot blue}{3} \qquad (2)$$

Converting Image from 256 Gray-Scale to Binary Image

After the operation of edge detection the frames become ready to be segmented. The edges will be highlighted and the segmentation operation will be easier by scanning the image pixel by pixel and labeling each pixel as object or background, depending on whether the gray-level of that pixel is greater or less than the value of threshold (T). Image thresholding enjoys a central position in applications of image segmentation. Corresponding to frames result from edge detection stage, one obvious way to extract the objects from the background is to select a threshold (T) that separates these modes [13]:

$$b(x,y)=\begin{cases}1 & if \quad s(x,y)>T\\ 0 & if \quad s(x,y)\le T\end{cases} \qquad (3)$$

for x=0 to weight , y=0 to height

where $s(x, y)$ is the value of pixel at coordinate x, y in the images after using Sobel filters, and $b(x, y)$ is the binary value at the same location in binary frames. In this monitoring System there are two methods to. Set the value of threshold (T) automatically by using the following steps:

If $s(x, y) \neq 0$ Background Color then

$$S=\sum f(x, y) \qquad (4)$$

Where $x = 0$ to width, and $y= 0$ to height

$$T=S / (width * height) \qquad (5)$$

Detecting Objects in First Binary Frame

The objective of segmentation is to partition an image into regions. In this stage all the frames are arrays of 2D each element in these arrays is either 0 or 1. This operation is called Object Detection done after converting all the frames from color images to binary mages.

The coordinates of center (X_{cen},Y_{cen})and the coordinates of minimum and maximum X and Y (X_{min}, Y_{min}, X_{max} and Y_{max}) for each detected object will be computed. There are two methods to find the object's center; first one is by using the following equations:

$$X_{cen}(C)=\frac{X_{\max}(C)-X_{\min}(C)}{2} \qquad (6)$$

$$Y_{cen}(C)=\frac{Y_{\max}(C)-Y_{\min}(C)}{2} \qquad (7)$$

Finding the Distances between Any Sequential Motion for the Selected Moving Object at the Sequence of Frames

The following equations are to find the distances between any sequential motions for the selected moving object at the sequence of frames, starting from the second frame:

$$\Delta X = X_{move}(i+1) - X_{move}(i) \quad (8)$$

$$\Delta Y = Y_{move}(i+1) - Y_{move}(i) \quad (9)$$

$$Shift(i) = \sqrt{(\Delta X)^2 + (\Delta Y)^2} \quad (10)$$

where (i) means the order of the frame, $i = S_f + 1$ to Lf.

S_f is start frame order and L_f is last frame order $Shift(i)$ is the distance in real world between the two sequential locations of the selected moving object.

At each loop the distance $Shift(i)$ is added to the whole distance Total Distance by the following equation:

$$\text{Total distance} = \sum_{i=S_f+1}^{L_f} Shift(i) \quad (11)$$

Compute the Final Shift

Find the distances between location of moving object in firs frame and last frame, by the following equations:

$$\Delta FX = X_{move}(S_f) - X_{move}(L_f) \quad (12)$$

$$\Delta FY = Y_{move}(S_f) - Y_{move}(L_f) \quad (13)$$

Compute the Total Time

$$\text{TotalTime} = \text{Time}(L_f) - \text{Time}(S_f) \quad (14)$$

where F is the number of frames that the selected objects to be tracked from the selected start frame to the selected last frame.

Compute the Average of Speed

Then find the speed for moving object when it appears on the screen. The Drawing Scale must be knows to compute the final real speed of the object by using the following equation:

$$\text{Total DistanceSpeed} = \frac{\text{Total distance}}{\text{Total time}} \times Scale \quad (15)$$

Discussion and Conclusions

This system is applied on various input video file, it is need to camera, video splitter into sequence of consecutive bmp images according to Time Interval, and Drawing Scale, then the proposed system can be applied to detect multi moving objects as proved in the execution of the proposed system program.

The proposed Monitoring System use to identify and monitoring moving objects and detect the speed of each mobile object. The system can monitor well when the motion is smooth and there is no more robustness in the background. It is an interactive system, which depends on the experience of the system user. The system may be employed in radars, airbus, space challenges and other applications. The proposed system may be also, applied in real-time application. Some problems remain to be solved, including the effect of shadows and occlusion of the objects.

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نظام مراقبة لكشف سرعة جسم

عبد الرحمن درع خلف **علي مكي صغير**

E.mail: abdulrahman_khalaf@yahoo.com

خلاصة:

هذا البحث يقدم نظام يطبق لمراقبة سرعةِ الأجسام المتحرّكةِ باستعمال آلة تصوير وحيدة. إنّ نظامَ المراقبة المطوّر في هذا البحث يراقب الجسم المتحرّك كلّ مرة بسرعتِه عن طريق إستعمال سلسلة من الصور من الفيديو. ويمكن ان يستخدم لمعالجة البيانات الحقيقية المباشرة وكشف الأجسام المتحرّكة المتعدّدة وكذلك الضوضاء اخذت بنظر الاعتبار.

يَعتمدُ النظامُ المُقترَحُ على تَحديد الموقعِ وتوجيهِ الأجسام المتحرّكةِ في العالم الحقيقي طبقاً لنقطةِ المرجع المناسبةِ على الشاشةِ، الذي يُمْكِنُ أَنْ يَختَارَ مِن قِبل المستخدم.