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Research Article

Pedestrian and Object Detection Using a Spatial Filter in the Dark Environment

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Abstract: This study dedicates a new approach for detecting the pedestrians and the objects in the dark environment using a spatial filter. Detecting an actual position of an object and a person in the dark region is an atomic challenge for many researchers. To detect the objects and the persons, a spatial filter is utilized. The basic idea of the spatial filter is adapted by varying its radii of the dark region. Based on the radii's variation, the persons and the objects are detected. Finally, the actual position of detecting objects and persons are segmented using object compensation. Extensive experiments have been carried out on an object equipped with an infrared/digital camera and preliminarily tested in different situations. This proposed method is achieved 90.7% accuracy in detecting an actual position of the human and the object in the dark area.

Keywords: Dark regions, IR/digital image, segmentation, spatial filter

INTRODUCTION

Computer vision approaches have been spaciously exploited in peculiar deliberations. A principal target of early computer vision tasks is to qualify digital images for efficient image segmentation. The enhancements of the advanced driver assistance systems are conspicuous and active research area. Advanced Driver Assistance Systems, or ADAS, are schemes to help the driver in its training process. Especially the occurrence of the systems that are capable of reducing the number or the sternness of traffic incidents involving the pedestrians are of major interest. Pedestrian accidents represent the second largest source of the traffic-related injuries.

The use of the video sensors and image processing methods are enthusiastic to detect and allotting the pedestrians and the objects provide a promising approach for the improvement of such driver assistance systems.

Detection of a human in video frames can provide various useful appliances such as light pole switching and security surveillance purposes. We contemplate a dark scenario, with a fixed camera position, while keeping the scene as respectively simple like a street area of the suburban residential area. In normal light conditions, the video frame contains a limited image noise and the foreground object segmentation can be adequately a pursuit by a basic background model. However, in a dark region due to the natural of the sensors used in the modern digital cameras, it exposure time is sententious upgraded. This will result in an indulgent noise in the video frames, while the stereotyped background model will be incapable to precisely segment the object and hence type cast the object.

Unlike carrying out a pedestrian detection at night time with the infrared devices which usually generate a more cost, we believe that in the darkness, a normal cheap camera is adequate for a pedestrian detection. The main challenge remains the image noises caused by the dark effect and also low edge contrasts between a foreground and a background.

Video surveillance systems in most appliances must activate on an around the clock basis. Normal cameras that direct visible spectrum images are not very emphatic without the presence of the external illumination. In a day time, this illumination can come from the sun but at night, artificial illumination is required. Important regions of interest could be radiated bright lights, obnoxious activity is more likely to occur in darker areas. Infrared cameras are ideally suited to image under these conditions, as they sense emanated radiation from the object of interest such as human. They used an image in the day time as well though in the day time, one may also want to increment the data with VS images. The aspect of IR images has been enhancing, prices have been dwindling rapidly. While they still remain rather expensive for deployment on a large scale, the prices are reasonable enough to start venturing with them to evolve techniques that work with an IR data. Images in the infrared domain deliver a type of information from images in the visible spectrum. Some IR images are captured from a cam which is depicted in Fig. 1.

A spatial filter is an optical device which uses the principles of Fourier's optics to diversify the configuration of a beam of coherent light or

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Fig. 1: Sample infrared images

other electromagnetic radiation. Spatial filtering is commonly used to crack down the output of the lasers, removing eccentricity in the transverse due to immature, grimy, or contaminated optics, or due to fluctuations in the laser gain mediocre itself. This can be used to generate a laser beam incorporating only a single oblique mode of the laser's optical resonator. It is essentially a beam converging device coupled with a filter. The filter, or pinhole is used to remove interference patterns in a laser beam caused by diffraction from dust, lint, lens imperfections, etc., that is part of any laser optical system. Diffraction interference degrades the laser beam by generating phase and amplitude variations, or modulation, on the otherwise uniphase laser output, leading to Fresnel zone patterns in the beam. The interference is removed from the beam in the following manner the laser output appears as a point a source at infinity; however, the interference producing sources appear as Huygens generators a finite distance from the filter, due to the contrast in the point of origin, focusing the beam will produce an image of the "source" with all the noise, or interference, defocused in and denies around the focused beam at the pinhole; therefore, the focused beam will pass through the pinhole and the interference will be severely attenuated. The purpose of the spatial filter is to filter out the unwanted intensity variation across a light beam.

Our proposed objective is to energetically segment a human and an object in the dark region using object compensation whereas a detection process can be performed via a spatial filter. In this pre-processing step, the images are usually filtered in order to correct image contrast, extinguish noise or to significant some image/object characteristics. Among frequent tasks is a derivation of dark objects from a scene. Dark region in the image is extracted using DRD filter. Finally, it is passed to the object compensation for segmenting a human and an object.

Then the actual position of the segmented images is evaluated by using statistical parameter such as success Score (S). This proposed method is applied in Advanced Driver Assistance Systems (ADAS) to avoid accidents which happened in the dark area.

INTERIOR METHODOLOGY

Bertozzi *et al*. (2003) have proposed the method for detecting a pedestrian in the dark environment which an end results in the frustration is due to miscalculating the actual position of the human. Carr and Hartley (2009) have proposed a geometric method for detecting a object in the dark region. Chavez (1998) has proposed a subtraction technique in order to improve object detection in the dark region. Fengliang *et al*. (2005) has proposed the method for detecting a pedestrian in the night time. He *et al.* (2010) have proposed a filter method for detecting an object in the dark environment. Kopf *et al*. (2008) and Kratz and Nishino (2009) have proposed a enhanced method for object detection. Tan (2008) and Tarel and Hautiere (2009) have proposed a restoration method for detecting pedestrian in the dark region. Yi (2009) have also proposed the method in order to detect a human in the semi-dark environment which also outcomes the failure is due to underestimating an actual position of the human. Thou-Ho *et al*. (2005, 2007) have proposed an efficient video segmentation algorithm in order to detect a pedestrian and an object in the dark environment. To overcome these problems, object compensation method with DRD filter is used. The main contributions are discussed as follows:

Spatial DRD filter: Bozidar (2006) has introduced a spatial filter for detecting a dark region. A new spatial filter is known as "Dark Region Detection "filter. The purpose of the spatial DRD filter is used to extract the dark regions in the digital/IR images. DRD filter is a Laplacian linear filter. It is otherwise called as sharpening spatial filter or high-pass filter. This filter convolution mask is defined by the sparse matrix with the dimension of (2R+1) X (2R+1) where R = 5. It is defined by the following:

$$h(x, y) = 1, \quad x^2+y^2 = R^2 - 2\Pi R + \pi \qquad x = y = 0 \tag{1}$$

where, x, y are spatial continuous coordinates and R is a filter radius. This filter actually compares the values of the pixels from the circumference with the radius R to the value of the circumference's centroid C.
DRD for pixel (x, y) is, thus, defined as:

$$g(x, y) = f(x, y) * h(x, y) \tag{2}$$

The Eq. (2) can be reformulated as:

Fig. 2: Output-spatial DRD filter

$$D(x, y) = 1 \text{ (dark) } g(x, y) > 0 \quad 0 \text{ (bright) else} \tag{3}$$

where image D (x, y) holds dark if the value is 1 or bright if the value is 0. Consociated pixels with value 1 in an image D form a dark region. The output of the spatial filter is shown in Fig. 2.

Advantages:

- It is more efficient
- It requires fewer processing resources for implementation

Object compensation: After dark regions are detected, the pixels in the dark areas are determined. This results in the detection of the human and the object. Pixels which are detected as ground illumination in these regions can be compensated to the object mask to increase the accuracy of segmentation. To segment, the actual position of the human and the object, a statistical technique is used. Statistical technique is implemented by applying RGB color spaces in Euler equation. The general equation can be expressed as:

$$\frac{\partial \phi}{\partial t} = \delta(\phi) R_{\alpha}\left[\mu div\left(\frac{\nabla \phi}{|\nabla \phi|}\right) - \sum_{i=1}^{4}\left(\xi_{i,c}\left(d^{i} - \overline{d_{1}^{i}}\right)^{2} - \xi_{i,c}\left(d^{i} - \overline{d_{2}^{i}}\right)^{2}\right)\right] \tag{4}$$

RGB color spaces can be calculated by the following:

$$R_{Mean} = \frac{\sum_{OM\ (x,y)=0} R_{back}(x, y)}{\sum_{OM\ (x,y)=0} 1} \tag{5}$$

$$G_{Mean} = \frac{\sum_{OM\ (x,y)=0} G_{back}(x, y)}{\sum_{OM\ (x,y)=0} 1} \tag{6}$$

$$B_{Mean} = \frac{\sum_{OM\ (x,y)=0} B_{back}(x, y)}{\sum_{OM\ (x,y)=0} 1} \tag{7}$$

By using Eq. (5), (6) and (7), the background area of the image is extracted. Finally a statistical technique is used by Eq. (4) for segmenting the foreground area.

Architecture illustration: This architecture illustrates about how a spatial filter works for detecting a human and a object in the dark environment. The block diagram is depicted in Fig. 3.
This architecture can be processed with the following procedure:

- Capturing a video in the dark environment through a digital camera/IR camera
- The video can be partitioned in terms of the frames by applying in the pre-processing steps.
- The frame image is passed to the spatial filter for increasing an image contrast and extracting the dark area in the image using DRD spatial filter.
- Finally it is passed to the object compensation for performing these 2 steps:
  - Determine the pixels in the extracting area which belongs to the human or the object.
  - Finally detecting features can be segmented.

DISCUSSION AND CONCLUSION

In this study, we have dedicated a new approach for detecting the pedestrians and the objects in a dark environment using a spatial filter. The architecture which is shown in Fig. 3, completely implemented in

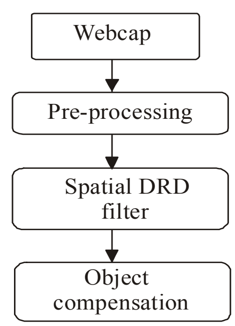

Fig. 3: Block diagram of the proposed architecture

Fig. 4: I1, I2, I3 and I4 output of the proposed architecture-pedestrian and object segmentation

Table 1: The segmentation evaluation

Datas	Values
S1	0.870
S2	0.912
S3	0.997
S4	0.850
OSS	0.907

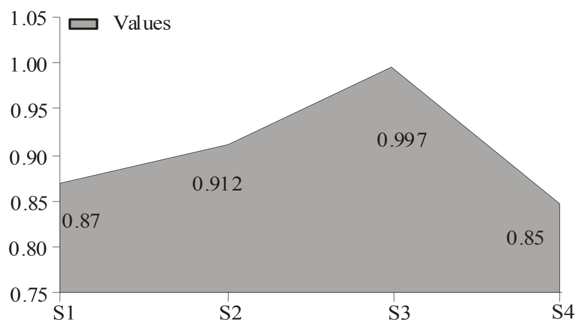

Fig. 5: Segmentation analysis

java respectively. Segmentation is done perfectly whereas a human and object detection plays a vital role. Sample video takes place in this study has duration of 60 s. It consists of 20 frames with the size of 480×320 dimensions. Each frame is applied to a spatial filter for extracting a dark area in the image. Finally, the resultant image is passed to the object compensation to increase the accuracy of segmentation. Ten iterations are used for perfect segmentation. The output of the proposed architecture is shown in Fig. 4. Segmentation is evaluated by using statistical metric such as success Score (S). Success score is determined by difference between the number of pixels in the ground-truth:

S = Image (Input image) and segmented image/
Total number of pixels in ground-truth image

In general S is in the range of $0 \leq S \leq 1$. The estimation of the segmentation is depicted in Table 1.

The success score of the segmented images I1, I2, I3 and I4 are represented as S1, S2, S3 and S4. Finally, the Overall Success Score (OSS) of the segmented images is calculated. The analysis of the segmentation accuracy is shown in Fig. 5. In addition the above discussion illustrated that the proposed approach is well suited for detecting a human and an object in the dark region. This approach is perfectly detected 17 images out of 20 enrolled images in the dark region. This study is achieving a better performance by improving its accuracy in detecting an actual position of the human and the object. The overall success rate of the proposed architecture is 90.7%.

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