Research Paper

Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 - 8179

Engineering

KEYWORDS : acquisition; segmentation; aperture; gradient; noise

Image Acquisition and Gradient Method for Main Subject Detection

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ABSTRACT

Image acquisition is the process of obtaining a digital image from a real world basis. Each step in the acquisition process may initiate casual changes into the values of pixels. These changes are called noise. The proposed algorithms do not depend on prior knowledge of the indoor/outdoor setting or scene, and are willing to software implementation on fixed-point programmable digital signal processors available in digital still cameras. In this paper, we join optical and digital image processing to execute the segmentation of the main subject without prior knowledge of the scene. In particular, we propose to get a picture in which the main subject is in center of attention, and the shutter aperture is fully open. The lens optics will blur any entity not in the plane of focus. For the acquired picture, this paper expands a computationally simple one-pass algorithm to segment the main subject. The Gradient information may be more consistent feature for segmentation.

I. Introduction

When taking pictures photographers employ a variety of composition rules. For automation of these rules, it is necessary to detect and segment the mail subject and blurring the background [1]. I propose a detection and segmentation algorithm that leverages the optics in a digital camera. Based on where the user points the camera, an auto-focus filter primarily puts the main subject matter in focus[2,3] and takes a picture. The major challenge associated with image segmentation in any application is the ill posed property of the problem itself. The Gradient information may be more reliable feature for segmentation in certain applications. The use of gradient information also removes the ambiguity that is prevalent in the region based approaches. Another advantage of the gradient-based segmentation is that it does not depend on any' a priori knowledge'.

III. IMAGE ACQUISITION

Image acquisition in processing of images can be defined as the action of retrieving an image from some resource, typically a hardware-based source, so it can be go through whatever processes required to occur. Performing acquisition in image processing is the first step because, without an image, no processing is possible. The image that is acquired is totally untreated and is the result of whatever hardware was used to produce it, which can be awfully important in some fields to have a regular baseline from which to work. One of the crucial goals of image acquisition in image processing is to have a source of input that operates within such controlled and precise guidelines that the same image can, if required, be almost completely reproduced under the same situation so abnormal factors are easier to trace and eliminate. Figure 1 is showing the formation of an image by camera.

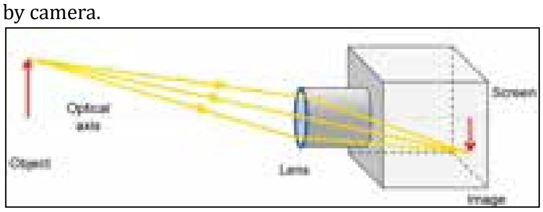

Figure 1: Image formation by camera

Example of a Camera: Image Formation
Digital Signal Lens Reflex (DSLR) camera's component:

1. Matte focusing screen: A screen on which the light passes throughout the lens will project.
2. Condensing lens: A lens that is used to focus the arriving light.
3. Pentaprism: To make a properly oriented and right side up image and project it to the viewfinder eyepiece.
4. AF sensor: It's full name is autofocus sensor, which is used to achieve correct auto focus.
5. Viewfinder eyepiece: To permit us to see what will be recorded on the image sensor.
6. LCD screen: It's full name is liquid crystal display, which is used to show the photos stored in its memory card settings and also what will be recorded on the image sensor in the live view form.
7. Image sensor: A device that contains a large number of pixels for converting an optical image into electrical signals. The commonly used types are charge- coupled device (CCD) and Complementary Metal-oxide semiconductor (CMOS).
8. AE sensor: Its full name is auto exposure sensor, which is used to give exposure information and regulate the exposure settings after calculations under different conditions.
9. Sub mirror: To reflect the light passes through the semi-transparent area on the main mirror to the autofocus (AF) sensor.
10. Main mirror: To reflect incoming light into the viewfinder compartment. It must be in an angle of just 45 degrees. There is a small semi-transparent area on it to make possible auto focus.

Having an in general idea about the internal arrangement of a DSLR camera and the functions of dissimilar components, I will use the following figure to illustrate its working principle.

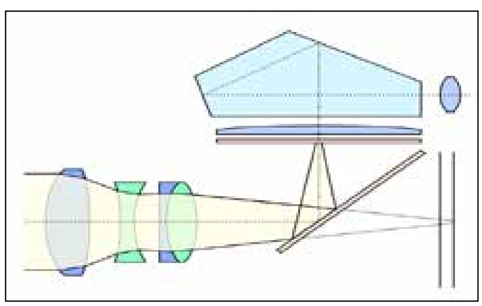

Figure 2: The basic working principle of a DSLR camera

B. In the above figure, we can see that light from the external world first passes throughout the lens. After this, the light is projected on the matte focus screen through reflection by the main mirror. The image shaped on the matte focus screen is then schemed by the condensing lens and the pentaprism to the viewfinder eyepiece by internal reflection. This explains is why we can distinguish the image that will be taken by the camera through the view finder.

When we require to take a photo using autofocus, we can first push the shutter button half-way down to activate the process. During this procedure, the light is directed to the AF sensor by the sub-mirror. The AF sensor then performs a sequence of calculations to achieve acceptable focus. After focusing, the core mirror will flip up (towards the matte focus plane). As a consequence, the light coming from the lens can arrive at the image sensor. A digital image is shaped after the light has been converted to electronic signals by the image sensor.

Focal length:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

Where

f = focal length
u = distance from subject to lens
v = distance from image to lens
IV. Main subject detection

It is very essential to detect the main subject [4,5] for images to be processed further. Images are classified into following:

1. Main Subject
2. Background.

This paper proposes to vary the optical settings in the camera to take a supplementary picture, before or after the amateur photographer acquires a picture.

Concept Design
In the supplementry picture, the properties of the local edges are different between the main subject and the background.
The main subject region (in focus) has crisp gradients whereas the background (blurred) has low-intensity gradients.

Thus this property can then be used for unsupervised segmentation of the main subject.

For example:

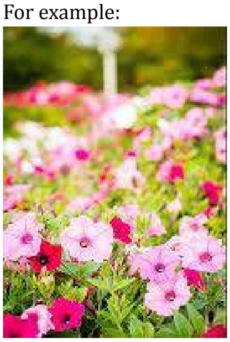

Figure 2.a

Figure 3.b

Given two images image 3.a and image 3.b

Image 3.a shows a picture taken in which the main subject and the background are equally focused.

Image 3.b is the same picture with a wider shutter aperture. Here the main subject is seen to have distinguishable image edge features compared to the background.

The auto-focus filter puts the main subject in focus [6] whenever the camera is pointing to the main object; now to blur background the shutter aperture is widened. The blurring occurs because the light from out-of-focus objects does not converge as sharply as from the main object in focus.

By utilizing the significant difference in frequency content of the in-focus [7] and background region, the proposed algorithm detects the main subject using filtering, edge detection & contour smoothing.

A. GRADIENT METHOD OF SEGMENTATION FOR MAIN SUBJECT DETECTION
The segmentation [10] of the object from the background is accomplished based on gradient features.

This algorithm stats that detecting regions with higher gradient values in contrast to the regions having more low frequency components provided a salient classification of pixels in either the main object class or the background class.

To sense regions with high gradient [8] in contrast to the blurred background as the main subject is the main motivation of the proposed algorithm.

Algorithm:
a.
For the 2-D case, the following conditions are met with an image sharpening filter as modeled in the figure 4.

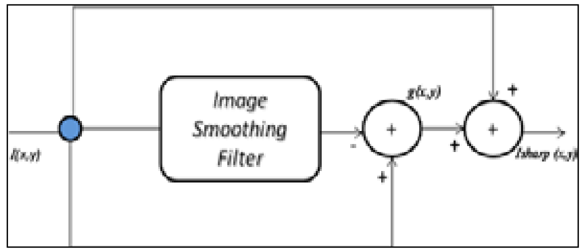

Figure 4

Let Ismooth(x,y) define the image comprising of the intensity function derived from low frequency components; i.e., the smoothed image derived from the original image I(x; y).

To reduce the effect of the blurred components in the image I(x, y), Ismooth(,x, y) is subtracted from I(x, y). Let the resultant image be denoted as

g(x,y) = I(x,y)-Ismooth(x,y ......(1)

and A sharpened image can be generated by adding g(x, y) with the original image I(x, y), as follows:

Isharp(x,y) = I(x,y)+k g(x,y) ....(2)

;where F is the image domain, i =intensity value (i Є F)

k = constant. Here the factor k, gives the proportion of high

gradient image into the resultant Isharp(x, y)

I(x, y) is composed of a weighted combination of Isharp(x, y) and Ismooth(x, y):

$$\frac{1}{k+1} Isharp(x,y) + \frac{k}{k+1} Ismooth\,(x,y)$$

As the value of the non-negative real parameter k increases, the contribution of the smoothed image into the original image increases, thus blurring the image. The effect of this on the final output will be evident from the following step. The original image I(x, y) needs to be subtracted from

Isharp(x, y). Thus,
Isharp(x,y) – I(x,y) = (Isharp(x,y) – Ismooth(x,y)) .....(4)

Subtracting a smoothed version of the user-intended image from the sharpened image generates an edge map in which the edges around the main subject are sharper than the background edges. Hence, the problem of segmenting the main subject reduces to separating the regions with the sharper edges from the regions with smeared edges. For the above tasks, it is proposed to design a linear time invariant filter for both lowpass and highpass filtering.

An image having relatively weak edge feature could be processed by a filter having a lower cut-off and greater span in the spatial domain.

The resulting image obtained by using eq. (4) is passed through an edge detector. The Canny edge detector [9] first smoothes

Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 - 8179

the difference image g(x, y) in figure 4 then computes the gradient, and finally thresholds the gradient to preserve the strong edges and suppress the weak edges. The Canny edge detector preserves the directions of the edges, which is vital information for closing the boundary of the main subject by using gradient vector flow.

c. Contour Detection: To close the boundary of the detected strong edges and to generate the main
Subject mask, this paper chooses to feed the edge detection output into a contour detection framework. This paper prefers to use this approach over by using morphological operators or snake algorithms to close the boundary of the detected strong edges.

V. Conclusion

This paper proposes a method for detecting and segmenting the main subject during image acquisition.

First, the user takes a picture in which an autofocus filter has put the main subject into focus. Immediately thereafter, the shutter aperture is widened to blur the background, and a second picture is taken. Finally, the background-blurred image is processed by the proposed algorithm to compute the main subject mask. In the case that the subject or camera moves during the acquisition of the two pictures, image registration may be needed before the main subject mask can be applied to the user-intended image.

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