Enhancement Machine Vision for Object Counter

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***Abstract*—Machine vision is recently used for automatic counting objects system which exploits the image processing to achieve the target. This article presents an intraframe analysis technique for object counter. It uses to solve the counting objects system which objects are located in different focus. It uses only one image can count it all. The canny technique is used to detect and recognize the object. Then the intraframe relation is used to calculate and count the small components in each object. The results show that it provides counting accuracy at least 98%.**

***Index Terms*—intraframe, counting objects, machine vision**

I. Introduction

In recent years, Machine vision [1]-[10] for automatic counting has a large number of applications which uses in the industrial area. It has been an increased scope for the automatic analysis of object counting. It uses the additional numbers of cameras and other sensors, enhanced infrastructure, and consequent accessibility of data. In addition, the advancement of analytical techniques for processing the video (and other) data, together with increased computing power, has enabled new applications. However, this article is exploited the intraframe relation in image processing part to achieve the object counting.

There are many researches that develop in the machine vision for object counting. In [11] introduces a review of computer vision techniques for the analysis of urban traffic. It focuses on recent approaches for monocular road-side cameras in urban environments used by human operators to provide automated solutions to the aforementioned monitoring problems. In [12] introduces the people counting and human detection in a challenging situation. It aims to develop an effective method for estimating the number of people in a complicated outdoor scene. The application of methods based on segmenting the foreground has been extended to detection of people who are moving only slightly. In [13] introduces a robust crowd counting using detection flow. Crowd counting which aims at obtaining the number of people within a scene is an important computer vision task. It uses the detection flow which is defined as a set of object detection responses along the temporal video sequence. It is robust to temporal object occlusions and noises. Also it is more competent to give specific descriptions of the crowd. In [14] presents an image-based system for measuring objects on oblique plane and its applications in 2-D localization. It presents an image-based framework for measuring target objects on an oblique plane by using a single charge-coupled device camera and two laser projectors mounted in parallel beside the camera. Experimental results have demonstrated the effectiveness of the proposed approach in distance measurement, as well as localization of objects on an oblique plane. In [15] presents a classification and counting of composite objects in traffic scenes using global and local image analysis. It proposed a multimodal multiscale appearance-based blob classification approach. It addresses the problem of classifying and counting composite objects such as bicyclists among simpler objects such as pedestrians. It is also compared our approach with a blob morphology and velocity classifier. The results indicate the importance of appearance based methods and the significance of both global and local image analysis. In [16] presents a counting vehicles from semantic regions. Automatically counting vehicles in complex traffic scenes from videos is challenging. It proposes a new approach of counting vehicles through exploiting contextual regularities from scene structures. It is based on tracking and clustering feature points and can be summarized in threefold. First, an algorithm is proposed to automatically learn the models of scene structures. A traffic scene is segmented into local semantic regions by exploiting the temporal co-occurrence of local motions. Local semantic regions are connected into global complete paths using the proposed fast marching algorithm. Second, an algorithm is proposed to cluster trajectories of feature points into objects and to estimate average vehicle sizes at different locations from initial clustering results. Third, trajectories of features points are often fragmented due to occlusions. Experimental results on a complex traffic scene show the effectiveness of our approach. In [17] presents a counting vehicles from semantic regions. It proposes an algorithm to estimate the average vehicle sizes at different locations along each path that helps to cluster feature points into objects in turn. The Hungarian algorithm is used to associate fragmented trajectories considering the contextual information added by the models of semantic regions, sources, and sinks. Experimental results show that it has some limitations and can be improved in several aspects.

This article investigates the intraframe analysis technique to count the objects for machine vision system.

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Those objects are located in difference distance from reference point.

II. Preprocessing

A. Grayscale

Image processing [18]-[22] can be divided into four categories: Binary, Grayscale, Color and Indexed. In grayscale, each pixel is a shade of gray, normally from 0 (black) to 255 (white). This range means that each pixel can be represented by 8 bits. This is a very natural range for image file handing.

B. Convolution

In image processing, many operators are based on applying some function to the pixels within a local window. That is, when finding the value of an output pixel, a window is centered at that location, and only the pixels falling within this window are used when calculating the value of that output pixel. If the f is the image that does want to filter, g the corresponding output image, and let h be the convolution kernel (the "flipped" weight matrix):

$$g(x, y)=\sum_{i=-w}^{w}\sum_{j=-w}^{w} h(i, j)f(x-i, y-j) \qquad (1)$$

where the size of the kernel is $(2w+1)\times(2w+1)$.

The convolution [23]-[29] operator is linear, that is, it provides the same result if it performs the convolution on two separate images and sum their results as if it was to sum the two images before we apply the convolution.

C. Edge Detection

Edge contains some of the most useful information in an image. It may use edge to measure the size of objects in an image, to isolate particular objects from their back ground. Many edge-finding operators are based on differentiation [30]-[36]: to apply continuous derivative to a discrete image, first recall the definition of the derivative:

$$\frac{df}{dx} = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \qquad (2)$$

Since in an image, the smallest possible value of h is 1, being the difference between the index values of two adjacent pixels, a discrete version of the

$$f(x+1)-f(x) \qquad (3)$$

Other expressions for the derivative are

$$\lim_{h\to 0}\frac{f(x)-f(x-h)}{h},\ \lim_{h\to 0}\frac{f(x+h)-f(x-h)}{2h} \qquad (4)$$

With discrete counterparts

$$f(x)-f(x-1),\ \frac{(f(x+1)-f(x\mp 1))}{2} \qquad (5)$$

D. Canny

Canny [37]-[40] showed that the best filter to use for beginning his algorithm was a Gaussian (for smoothing, followed by the derivative of the Gaussian, which

$$\left(-\frac{x}{\sigma^2}\right)e^{-\frac{x^2}{2\sigma}} \qquad (6)$$

These filters have the effect of the both smoothing noise and finding possible candidate pixels for edges. The canny provides the three criteria for edge detection:

1) Low error rate of detection. It should find all edges and nothing but edges.
2) Localization of edges. The distance between actual edges in the image and edges found by this algorithm should be minimized.
3) Single response. The algorithm should not return multiple edge pixels when only a single exists.

E. Intraframe Analysis

In the condition of the different focus point of objects, it always makes the counting object error in machine vision system. Fig. 1 shows two objects which located in difference position of focusing.

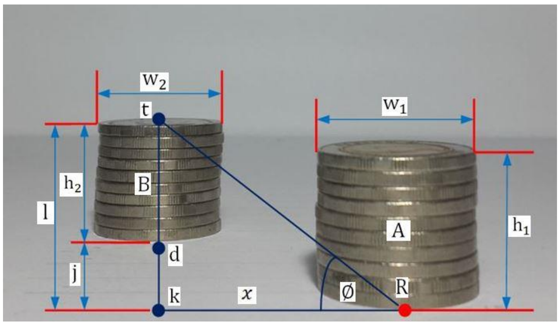


Figure 1. The intraframe correlation

There are two objects (Fig. 1); A and B, which locates in difference focus. Each object contains of 10 coins equally. But this image shows that the size of each coin (w_1 and w_2) and height of each object (h_1 and h_2) is not equal. w_2 is always less than w_1. At this point, how the machine vision can count the coin inside each object in the same time. This article presents the intraframe analysis technique to solve above problem.

Firstly, the height (c) of each coin in object A can be find as (7).

$$c = \frac{h_1}{10} \qquad (7)$$

The amount (n) of object A can be find as (8)

$$n = \frac{h_1}{c} \qquad (8)$$

Therefore,

$$n_1 = \frac{h_1}{c_1} \qquad (9)$$

And

$$n_2 = \frac{h_2}{c_2} \qquad (10)$$

If the point R in the object A is the reference point, the j distance is the distance of the object B in the condition of comparing with the level of R in object A. At the top of object B (t) occurs from the tan of $\emptyset$ angle to the reference point (R).

$$l = tan\emptyset \cdot x \qquad (11)$$

Therefore the high of object B relates to the $\emptyset$. Moreover, the ration of the width and the height of both objects $\left(\frac{w_1}{h_1}\text{ and }\frac{w_2}{h_2}\right)$ are related in each other.

Refer to Fig. 1, it can notice that the length of object B (l) to the reference point (R) can be found as Equation 12.

$$l = h_2 + j \tag{12}$$

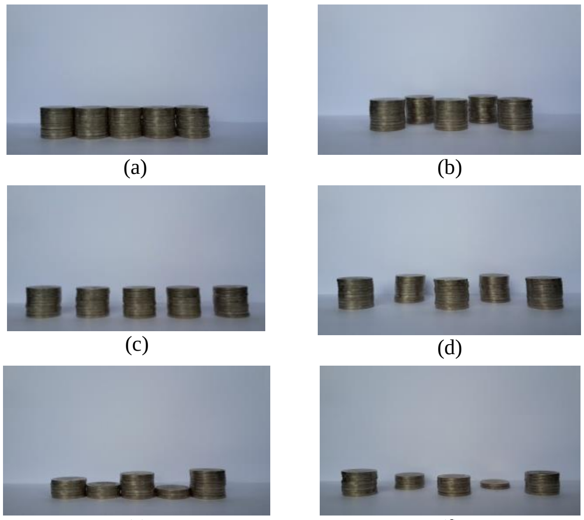
where l is the length of object B (l) to the reference point (R)

j is the distance from the base of object B (d) and the level of to the reference point (k)

$$j \infty w \tag{13}$$

III. Experiment and Results

There are 10 coins in each object which locates in the difference focus to use as input image as show in Fig. 2.



(a) (b) (c) (d) (e) (f)

Figure 2. The different location of objects

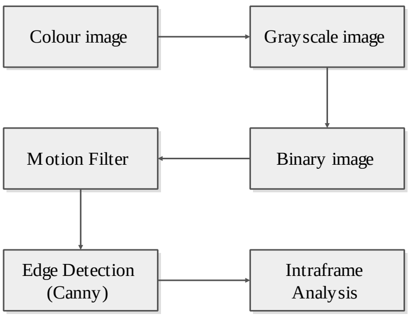
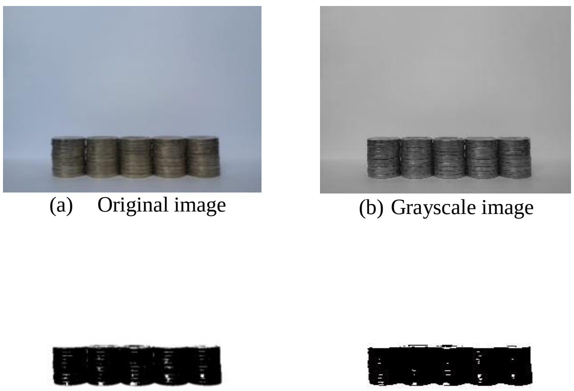
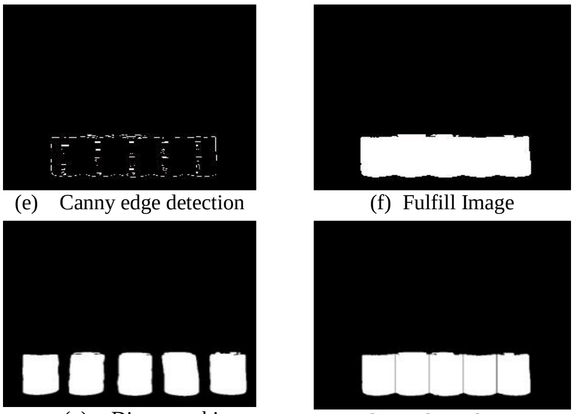


Figure 3. The diagram of process



(a) Original image (b) Grayscale image (c) Binary image (d) Filter



(e) Canny edge detection (f) Fulfill Image (g) Distance object (h) Close object

Figure 4. The process results

The difference number of coins and focus are used as the input as well. The process of this technique is shown in Fig. 3.

The primary results of this technique are shown in Fig. 4.

Secondary experiments with 100 images.

Condition A: Each object locates close in each other and have the same amount of coin.

Condition B: Each object locates in difference distance each other and has the same amount of coin.

Condition C: Each object locates in difference distance each other and has the difference amount of coin.

Condition D: Each object locates in difference distance each other and has the same amount of coin.

TABLE I. Two Objects Locate in Different Position

Distance of object B from reference point (R) (cm.)	Width of the object (w_2) (cm.)	High of the object (h_2) (cm.)	High of each coin (c_2) (cm.)
1	5.25	4.85	0.485
2	5.05	4.55	0.455
3	4.70	4.25	0.425
4	4.45	4.10	0.410
5	4.25	3.90	0.390
6	4.05	3.70	0.370
7	3.85	3.50	0.350
8	3.70	3.30	0.330
9	3.55	3.25	0.325
10	3.40	3.05	0.305

TABLE II. The Accuracy Counting Object

Condition	Condition of focus	Number of correct image	Counting Accuracy (%)
A	same	100	100
A	difference	99	99
B	same	100	100
B	difference	99	99
C	same	100	100
C	difference	98	98
D	same	100	100
D	difference	98	98

From Table I and Table II, the results show that the intraframe technique provides counting accuracy at 100% in the condition of same focus position. However, it provides the minimum counting accuracy at 98% in the condition of difference focus.

IV. SUMMARY

This article presents the intraframe analysis technique for object counter in machine vision. The grayscale and binary technique are used in the pre-process. The motion filter is used to reduce the back ground noise from the image. The canny edge detection technique is used to search and bound the object. Finally the intraframe analysis technique is used to calculate and count the components in each object which each object is located in different position and focus. It used the relation position and ∅ angle to count the components

The system shows that it can be perform at least 98% of counting accuracy in the condition of the objects that located in different position and focus. This technique will be applied to the machine vision system for counting object such the paper production industrial.

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