Review on Edge Detection Techniques for Pharmaceutical Drugs

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Abstract— Edge detection is a necessary tool in image processing, machine vision and computer vision and plays a vital role in the field of feature detection and feature extraction. Edge detection has various applications in image processing such as image automation, remote sensing, criminology, security, medicines, military applications etc. Edge detection has a major role in pharmaceutical industries. In Pharmaceutical industries, drugs i.e. Tablets and Capsules are produced in a large scale every day. These tablets and capsules may not be produced precisely i.e. .they are in damaged form when produced. It could also happen that drugs are missing in a blister. So, Proper inspections of these pharmaceutical drugs are required. So edge detection helps in inspection .This paper presents comparative analysis of various edge detection techniques.

Key words: Pharmaceutical drugs, image processing, Edge detection, Canny, Sobel, Prewitt Center of mass

I. INTRODUCTION

Image Processing is a mode of signal processing in which both input and output are images. Sometimes output will be some characteristics or specification or attributes extracted of/from image. Image Processing associate with many techniques that related to Pattern technique, edge detection, feature extraction and template matching to progress digital images. Image processing is a process to alter an image into digital form and perform some operations on it, in order to draw out some useful information or to get an enhanced image from it. Image processing includes operations like image accomplishment, restoration, enhancement, compression, morphological operation, segmentation and recognition etc [8]. it also plays a vital role in pharmaceutical industry. In pharmaceutical industry, high quality zero defect products are required in competitive markets as it effects privilege of any manufacturing industry. To guarantee every capsules and tablets free of defects, each capsule must be inspected individually. Manual inspection is automated using image processing techniques. It has become possible only due to advancement in the field of sensor technology, image and signal processing for the purpose of quality assertion /productivity enhancement in real-time [9].

Fig. 1: Computer Vision Process

In Image processing, both input and output are the images. While in the computer vision, the input is an image and the Output contained the information about the image itself that may be used by another process. Fig. 1, illustrates a block

Diagram of computer vision process. It is quite clear that in computer vision image processing techniques are always the first phase, also several time image processing algorithms are used as feature extraction algorithms in the first level of the image analysis procedures. When input data to an algorithm is too large to be processed then it can be transformed into a reduced set of features. The extracted features are expected to contain the relevant information from the input data so that the desired task can be obtained by using this reduced representation instead of the complete initial data. Finally judgment made by the decision criterion. [1]

A. Edge Detection

Edge detection is one of the important part of image processing that has been studied for decades. In general, edge detection aim is to significantly reduce the amount of data in an image, while retaining the structural properties to be used for further image processing [4]. In many computer vision applications, edge detection is the first step in mechanism, like face recognition, image compression and recognition edge based target etc. Edge detection is a delicate process, particularly for finding image regions with abrupt changes. The accuracy of this process is extremely significant for the overall accomplishment of high level processing systems. Edges are the boundaries between the domains of an image that helps in segmentation and object identification. Edges are the local change in the intensity of an image. Edges of an image are detected by edge detectors also called edge operators. Some edge detectors works intensely i.e. recognize more edges than other. Some takes more time than other [8].

These edge-detectors are very susceptible to noise and edges that contain high frequency contents. So removal of this noise is very important because it cause blurred and distorted edges in the image result. A wide range of edge detectors are applicable that can extract the edges from noisy image. Some edge detectors use gradients with some threshold, if gradients exceed the threshold value it appear one value (i.e. edge detected) otherwise zero (i.e. uniform region).The detection is depending on intensity, illumination, noise, objects etc. [3]

Some edge detectors/operators are explained below:

1) Sobel Edge Detector

The Sobel operator is particularly used for edge detection algorithms. This operator is based on convolving the image with a small, separable, and integer valued filter in both horizontal and vertical direction and is therefore relatively inexpensive in terms of computation .The sobel edge detector estimate the gradient by using the discrete differences between rows and columns of a 3X3 neighborhood.[2][8].

$$\begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \qquad \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

Fig. 2: Convolution mask Gx Convolution mask Gy

2) Prewitt Edge Detector

Prewitt operator edge detection mask are the one of the oldest and best implicit method for detecting edges in images. This operator does not place any pixels which are closer to the center of the mask. The prewitt edge operator is based on convolving the image with a small, different, and integer valued filter in both horizontal and vertical direction and in relation of computations. On the other hand, the gradient operator is relatively immature method for high frequency variations in the image [2]. Prewitt operator is similar to the Sobel operator .The Prewitt edge detector uses the following specified mask to approximate digitally the first derivatives Gx and Gy [8].

$$\begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \qquad \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix}$$

Fig. 3: Convolutimask Gx and Convolution mask Gy

The gradient magnitude of both prewitt and sobel operators is given by: | G |= ((Gx2+Gy2)) 1/2 or | Gx | + | Gy |

The Direction of both prewitt and sobel operators is given by:

θ = arctan (Gy / Gx).

3) Canny Edge Detector

The Canny edge detection operator was developed in 1986 by John F. Canny and uses a multi-stage algorithm to observe large scale of edges in images. An optimal edge detector is depending on the following three criteria: [8][2]

1) Good detection: The algorithm should point as many real edges in the image as possible.
2) Good localization: pointed edges should be close to the edge in the real scene.
3) Minimal response: A given edge in the image should only be marked once, and where possible, false edges should not create by image noise.

This detector finds edges by looking for local maxima of the gradient of f(x, y). The method uses two thresholds to detect strong and weak edges and marked the weak edges only if they are connected to strong edges in the output. The main advantage of this method is elimination of multiple responses to a single edge. To further reduce noise Canny also introduce a hysteresis method. Hysteresis uses the upper threshold to find out the start of an edge. Then edge is traced from the start point, point an edge whenever gradient value is above the lower threshold. The weak edge points are deleted by hysteresis steps that are not connected to a strong edge.

4) Edge Detection By Centre Of Mass

Edges are defined as the abrupt changes in intensity functions of an image. If we calculate a local Center of Mass Of non-edge locations inside a region of certain size, the center of mass will be very close to the center of that region. Fig. shows a 1D case of step edge whose intensity is introduce on the vertical axes. It is found that the center of mass of the region a to b is distant from the region center and Center of mass of region g to f coincides with the region center. The distance between Center of mass and center of region can give the change of intensity function. This allows the possibility of using Center of mass to design a new edge detector [4]

The location of Center of Mass is given by the equation:

$XCOM = mixmi$

This represents a vector equation that give each of the three object dimensions in the physical world.

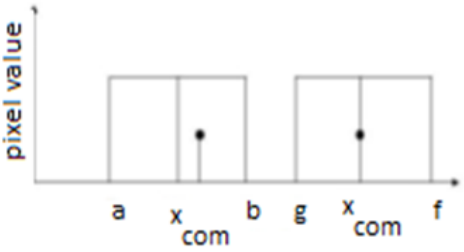

Fig. 2: Center of mass of 1D case

II. Related Study

Dipti et.al, suggested an idea to inspect damaged tablets and missing capsules. A novel method is introduced i.e. detection of damaged and missing pharmaceutical drugs with Centre of Mass (COM) edge detection method. This method introduces the concept of finding edges of tablets by knowing their Centre. The missing capsules in the blister also audited by Centre of Mass edge detection method. [7].

Munish Kumar Dhiman et.al, suggested an approach for automatic analysis of broken pharmaceutical drugs. This approach is used to check for the defects in tablets and based on canny edge detection and RC-algorithm. It gives the percentage of matching different pharmaceutical drug blister. The image of the blister without any damage is taken as template image which undergoes pre-processing step same as input image. input image compared with template image and display the result of two matching different blisters.[8]

YAHIA S. et.al proposed a new two wavelet-based edge detection .The first one named is RC-Algorithm and the second one named is RCD-Algorithm. Both of the techniques have proved better explanation than other old techniques. Edges obtained in final output using RC-Algorithm and RCD-Algorithm, are more sharpen than edges extracted using other techniques. in many cases RCD-Algorithm gave much better results than RC-Algorithm. The RCD-Algorithm can also handle noisier images better than earlier techniques. [1].

S. Jansi , et.al, proposed that edges are recognize according to some previous algorithms such as template-based algorithm and gradient-based algorithm, but they are not so satisfactory for noisy medical image edge detection. To conquer the dispute, adaptive threshold technique using ACO (Ant Colony Optimization) has proposed, Ant colony optimization method which is used for evaluating an optimal threshold value by adaptive threshold for edge detection. [2].

Saket Bhardwaja, et.al, found a comparison between various edge detectors to identify which edge detector performs better results. It has been demonstrated that modified declivity operator gives better result as compared to other edge detectors. It takes less computational time as compare to canny. It is self-adaptive due to threshold. It finds thin edges as compare to canny. It detects more true edges from the low contrast images. It also solves the problem of localization. So, by this comparison

analysis we observed that modified declivity operator has much better results than others. [3]

Aleksandar Jevtic, et.al, suggested a method of fast edge detection and computes image gradients Centre of Mass (COM). To access fast computing this method uses integral image .The algorithm runs with a constant number of operations per pixel independently from its scale. As distinguished with the conventional convolutional edge detector such as Sobel edge detector, this new method accomplish faster when region size is larger than 9×9. To achieve fast performance the suggested method can be used as frame of references for multi-scale edge detectors. [4]

K.J.S Lorraine, et.al. Observed that as compared to prewitt, sobel and Robert's algorithms canny algorithm is more extravagant. Cancer is a disease identified by uncontrolled growth of abnormal cells. Hence, it is essential to detect the boundaries of cancer cells so that they can be easily subjected to radiation therapy without disturbing the other blood cells. So, in this paper canny and Sobel algorithms have been used to detect the boundaries of cancer cells. Sobel algorithm has detected the boundaries of cancer cells more clearly compared to canny algorithm. [5]

Prof. Amit Choksi, et.al, examines the two basic methods Prewitt Edge Detector and Gaussian Edge Detector with different structuring elements. These algorithms are resolved and applied to an image set with different text size, text language and font style. Performance is calculated on base of precision rate and recall rate for each method on the same image set. The technique consist of various steps used for text extraction including Pre-processing of image, Edge Detection, morphological operation, character extraction [6].

S.No	Author and year	Edge detection Method used	Features	Finding
1.	Dipti 2015	Center of Mass and color segmentation	- consume less time. - fast computing - Precise result. - Competent with canny edge detector.	Edge of tablets by knowing their center and missing capsule in the blister by Color segmentation
2.	Munish kumar dhiman 2014	Canny edge detection and RC algorithm	- Ease of removal of noise. - Results are efficiently detected.	Inspection of broken pharmaceutical drugs.
3.	K.J.S Lorraine 2014	Sobel operator	- detected the edge more clearly than canny. - Less sensitive to noise. - Smoothes the image to a greater extent.	Detect the boundaries of cancer cells.
4.	Bhadauria HS 2013	Wavelet and canny based	- reduce noise - Edges are accurately located. - Image edges are fined continuous and distinct.	Noise removal on lung CT image (high frequency edge by wavelet and low frequency edge by canny operator).
5.	Prof.Amit Choksi 2013	Prewitt edge	- more robust than Gaussian - remove non text regions from the images. - More efficient than Gaussian.	Compare the two basic methods prewitt and Gaussian with different structuring elements.
6.	S.Jansi 2012	Optimized Adaptive thresholding using ACO	- Good result than other. - ACO had better performance.	Adaptive threshold used for edge detection, ACO used for computing an optimum threshold value.
7.	Saket Bhardwaj 2012	Modified Declivity operator	- Good performance over canny. - Less time consumption. - Self adaptive due to threshold.	Comparison between various edge detectors.
8.	Aleksandar Jevtic 2013	Center of mass	- Faster when region size is larger. - can be used as a framework for multiscale edge detector.	Fast edge detection which computes image gradient using COM.

Table 1. Edge Detection Comparison of various Techniques

III. CONCLUSION

Sobel edge detector gives simple detection of edges and their orientation and computationally more efficient as canny but with more sensitive to noise. Prewitt is fast edge detection method but sensitive to noise and filter coefficient size are fixed and cannot be adapted to the given image so it is only suitable for noiseless images. Robert's operator detects edges only when there is a sharp change in intensity value and doesn't detect edges when small change in gray scale value and detected edges are thin. Canny operator gives better edge detection especially in noise. It is more efficient than other techniques and enables to detect feeble edges. But its time consumption is more. Center of Mass gives fast computing and consume less time. It can be used as a frame work for multiscale edge detectors. It is competent to canny operator.

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