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**Image Processing Techniques in Computer Vision: An Important Step for
 Product Visual Inspection**

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ABSTRACT

Human experts have been used for decades as visual inspectors for supervising finished product. This was based on the manufactures guidelines and inspectors level of experience. However, human inspection was prone to different errors. Computer vision has excellently been deployed at various level of industrial productions for visual inspection to enhance the quality of the finished product, such as textile, printed circuit boards, electric components, tablets and blisters, labels, fruits, food items, integrated circuits (IC) and machine tools. This paper review the procedure for image processing as the building blocks for computer vision. The paper describes why image processing is important, the steps in image processing and application of image processing techniques in the computer vision system.

Keywords: Image processing, computer vision, visual inspection, product and computer

1.0 INTRODUCTION

Computer vision is an excellent tool deployed at various level of industrial productions for visual inspection on industrial products quality such as textile, printed circuit boards, electric components, tablets and blisters, labels, fruits, food items, integrated circuits (IC) and machine tools. Visual inspection of products has been a normal practice by several many industries and companies across the globe to ensure the quality of products before it is made ready for consumption. The inspections are carried out traditionally by human experts during the past decades, through the stipulated guidelines provided by the manufacturer subject to inspector's level of experience (Baudet et al., 2013; Mera et al., 2016). The inspection processes were deployed commonly to measure the quality of products, mostly by comparing them with predetermined parameters and comparing such parameters with predetermine values to evaluate the product standard, which in turn determine whether the product should be accepted as a finished product for consumption or be rejected. The involvement of humans was based on their prior knowledge. However, human judgement was found erroneous and can further be influenced by some specific expectation due to human nature (Park et al., 2008). It was also inherently unrealistic, tedious and

costly for human involvement in the visual inspection process (Park et al., 2008).

Lack of other alternatives made the human judgement to be maintained for decades. Until the advent of information technology (IT). Supported by many different application technologies, such as image processing. When manufacturing standard was put as one of the requirements for finished product quality, and to meet up with global marketing standard, visual inspection of product at various level of production becomes the recommended security standard at all level of production (Derganc et al., 2003). This global competitiveness in manufacturing standard for marketing and the need for customer loyalty has necessitated objectivity, consistency and efficiency in the productions. These production quality demands posed a greater challenge to manufacturing industries which eventually derived the needs for the introduction of automated inspection systems (Park et al., 2008). Automated visual inspection systems were reported of have offered a variety of advantages including a high rate of production (quantity), high production standard (quality), minimal error (free from human error) (Mera et al., 2016). Quality inspection of industrial products is an important asset to industry

competitiveness and productivity. The automated inspection system has reduced human involvement and increased system throughput (Park et al., 2008). The process employed the use of various image processing techniques depending on the type of product to be inspected. This is because the techniques used for inspecting items in the food industry may not be appropriate for integrated circuits, expiration dates of pharmaceuticals or textile.

Image processing is a form of signal processing which acquire various forms of images from different image sources, such as motion picture from satellite or still pictures from non-moving objects, photographs or video frames as input and translate the image into digital form as output to provide either an enhance image or other useful features or information from the image (K. Sumithra et al., 2015). The output may be an image or set of parameters related to the image (P & Sunny, 2018). The process follows strictly the signal distribution procedure which takes in an image and applies an efficient algorithm and the output of the processed image may result as an image or characteristics features of the image (Khedaskar et al., 2018). The application of image processing for visual inspection has been promising in keeping track of product quality, reduces workload by human intervention, and the cost of labour while increasing the system throughput (Park et al., 2008)

Image processing for visual inspections takes many forms depending on the type of product particularly being inspected. Visual inspection has been described as a procedure taken to detect product functional anomalies (Baudet et al., 2013). It has been applied to different products for inspecting the quality of the products, such as the investigation of Gelatin capsules by (J. Islam et al., 2012) serves as a typical example. Image processing for visual inspections comprises various factors and application components that linked the objective of the investigation at stake to achieve greater automation feedback. This review focus on visual inspection automation using image processing techniques. The rest of the paper includes section 2, detail literature on the image processing techniques used in visual inspection, section 3 shows the various application in

machine vision systems for visual inspections. Finally, section 4 presents the conclusion.

2.0 IMAGE PROCESSING TECHNIQUES

The process of manipulating images using computer algorithms is known as digital image processing. The main objective of digital image processing according to (K. Bhargavi & S. Jyothi, 2014) is to enhance the image or extract useful information from the images. Digital image processing is a subcategory of signal processing that uses a form of signal distribution to translate various images into digital form. Most image processing techniques treated image as a two-dimensional and apply standard signal processing to it (Article, 2013). Image processing techniques undergo specific procedures to process an image. The goal of image processing is to manipulate the pixel values of the image to visualize the statistical distribution of the image intensities, used for extracting vital required features or information from the image. These processing steps were described differently by many researchers depending on the objectives of what is to be viewed in the images. (Bhagavan et al., 2018) described image processing steps to include Image acquisition, image preprocessing, image segmentation, image extraction, image classification and image recognition. In (K. Sumithra et al., 2015), mentioned Image enhancement, Image restoration, Image compression, Image segmentation, Image recognizing as image processing techniques. In (Muaidi, 2014) considers Preprocessing, Image Enhancement, Image Transformation and Image Classification and Analysis as the image processing techniques. In a survey conducted by (Shukla & Agarwal, 2016) to investigate medical image processing tools, he mentioned image registration, segmentation, visualization, reconstruction, simulation and diffusion as the image processing tools used for image processing applications. image pre-processing, image compression, edge detection and segmentation was mention by (Prabhu, 2017) as image processing techniques. Image processing techniques were determined to includes preprocessing, enhancement, segmentation, feature extraction and image classification (Chitradevi & Srimathi, 2014). In an attempt to diagnose breast cancer using image processing techniques, a survey was conducted by (Yasmin et al., 2013), techniques

such as preprocessing, segmentation, feature extraction and image classification were used. (Padmaja & Nirupama, 2012) describe image processing techniques to includes Image representation, Image preprocessing, image enhancement, image restoration, image analysis, image reconstruction, and image data compression. Some real application were also reviewed where (Zaafouri, Sayadi, & Fnaiech, 2015), in their research “Vision approach for expiry date recognition using stretch Gabor features”, employed the use of image preprocessing, expiry date code segmentation,

features extraction and finally numerals classification. In a research conducted by (Hosozawa et al., 2018), to recognize expiration date on food packages uses techniques such as image acquisition, image segmentation and image classification.

It is therefore understood that the nature and intensity of the image data and the outcome required, determine the number of steps to be encountered. Based on the above premise, image preprocessing, enhancement, segmentation, feature extract

Table 1: Image Processing Techniques in computer vision

Authors	year	Acquisition	Preprocessing	Enhancement	Edge detection	Segmentation	Compression	Restoration	Extraction	Transformation	Reconstruction	Analysis	classification	recognition
(Bhagavan et al., 2018)	2018	×	×			×			×				×	×
(K. Sumithra et al., 2015)	2015			×		×	×	×						×
(Muaidi, 2014)	2015		×	×						×		×	×	
(Muthuselvi & Prabhu, 2016)	2016		×		×	×	×							
(Yasmin et al., 2013)	2013		×			×							×	
(Padmaja & Nirupama, 2012)	2012	×	×	×			×	×			×	×		
(Zaafouri, Sayadi, Fnaiech, et al., 2015)	2015		×			×			×				×	
(Hosozawa et al., 2018)	2018					×							×	

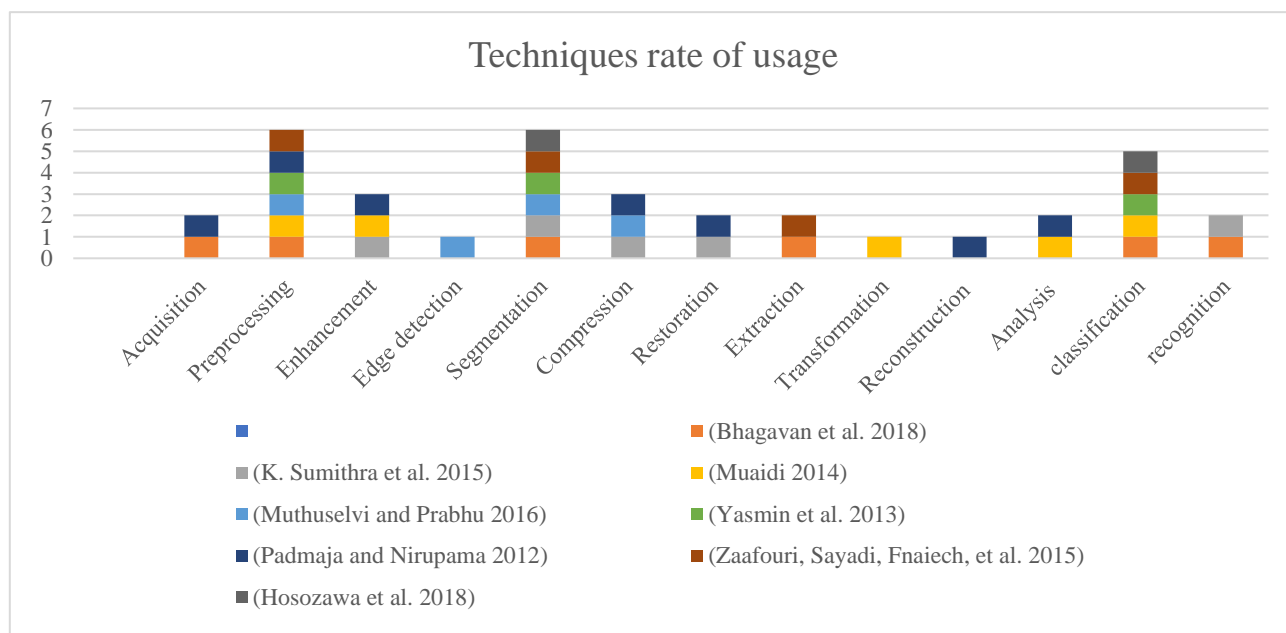


Figure 1: Image Processing Techniques Rate of Usage

According to the above finding, image preprocessing, segmentation and classification has a higher preference in usage during image processing. Functions of some of the above image processing techniques are described below.

2.1 Image acquisition

In every image processing operation, an image must be acquired through some sources such as cameras and scanners. The first and basic image processing step is image acquisition which involves image preprocessing techniques such as scaling

2.2 Image Preprocessing

Images preprocessing is usually the first stage in image processing after image acquisition, it involves removing low-frequency background noise, thereby normalizing the intensity of the individual particles' images (Prabhu, 2017). According to (Hamuda et al., 2016) Pre-processing entails the initial processing activity on the original image as captured from image acquisition sources, such as improving the contrast enhancement or noise removal. This technique was employed in various image processing applications to establish relevant variables (features) for the processing. To explain preprocessing according to (Guyon et al., 2006), we assume \mathbf{x} to be a pattern vector of dimension n , $\mathbf{x} = [x_1, x_2, \dots, x_n]$. The components x_i of this vector are the original features. We call \mathbf{x}' a vector of transformed features of dimension n' . Preprocessing as a primary transformation of data into a pattern of features can undergo standardization, normalization, signal enhancement, extraction of local features, linear and non-linear space embedding methods, non-linear expansion and feature discretization.

2.3 Image Enhancement

One of the important steps in computer vision is image enhancement which involves modifying image components to increase clarity and detail through the visual analysis and interpretation (Muaidi, 2014). It is a process by which an image contrast can be adjusted to address the variability of luminance issues such as sunlight and shadow. It plays a significant role in various application such as industrial inspection of products, medical imaging,

remote sensing and plant disease detection (Hamuda et al., 2016)

2.4 Image Segmentation

One of the major steps in image processing is segmentation, in any image detection problem, or recognition of any part of an image, segmentation form the initial basic technique to identify image intensity values. Segmentation is the process of breaking down a whole image into smaller chunks of objects, it particularly partitions the entire digital image into multiple segments to simplify the image representation into something more meaningful to analyses. The level at which this partitioning is carried out depends on the intensity of the problem-solving. The result of the segmentation is a set of contours that are extracted from the image which are then applied using segmentation algorithm to solve the problems, the segmentation should be over when the object of interest in an application is identified (Chitradevi & Srimathi, 2014). Segmentation algorithm depends on two properties of intensity values, these are discontinuity and similarity (Al-amri et al., 2010). Discontinuity is a property that partitions an image-based in a sudden change of its intensity, while similarity on the other hand partition an image based on the region that is similar by predefined criterion (Al-amri et al., 2010). Image segmentation is, in fact, one of the most important parts of image processing, in segmenting an image so many factors are put into consideration, such as colours, texture, greyscale value etc (Basak et al., 2018). According to (Basak et al., 2018) so many image segmentation techniques exist in the world, but according to the behaviour of image segmentation process they are simply classified into five methods: viz threshold-based, edge-based, region-based, cluster-based and matching-based.

2.5 Feature Extraction

Feature extraction is a dimensionality reduction process by which an initial set of raw data is reduced to more manageable groups for processing. Feature extraction is the name for methods that select and /or combine variables into features, effectively reducing the amount of data that must be processed, while still accurately and completely describing the original data set. Feature extraction is used as a tool to separate new

features from the original set of images to be used for various image processing application to retrieve some vital information as could be expected (Homma & Takenaka, 1985). Features are synonymous to input or variables depending on the nature of the task at hand, in medical diagnosing features may be symptoms which may include glucose level, fever, temperature, blood pressure, weight, height etc. which are key indicators that categories the patient health condition. These features that are used during image processing are usually being constructed from the original data (raw), usually through an integrated modelling process. In the Artificial Neural Network (ANN) approach, the hidden unit form an internal representation analogous to constructed features. Other approaches consider preprocessing as the way towards feature construction (Guyon et al., 2006). Feature extraction can simply be achieved by considering two important steps: feature construction and feature selection. Feature construction is an integral part of the modelling process in constructing features from the original image. It is a very important key in any image analysis process in machine learning. Feature selection occur purposely to select relevant and informative features for image processing and analysis (Guyon et al., 2006; Mark S. Nixon & Alberto S. Aguado, 2012)

2.6 Image Classification

In computer vision, image classification is the process of classifying an image according to its visual content. The purpose of the classification is to categories all pixels in a digital image. It uses the quantitative spectral information in the image which contain the required information of the targeted portion of analysis on the image. That information's can be used to perform both multispectral and hyperspectral imaging.

Digital image classification uses the quantitative spectral information contained in an image, which is related to the composition or condition of the target surface. Image analysis can be performed on multispectral as well as hyperspectral imagery. It requires an understanding of the way materials and objects of interest on the earth's surface absorb, reflect, and emit radiation in the visible, near-infrared, and thermal portions of the electromagnetic spectrum. To make use of image analysis results in a

GIS environment, source image should be orthorectified so that the final image analysis product, whatever format it may be, can be overlaid with other imagery, terrain data, and other geographic data layers. Classification results are initially in raster format, but they may be generalized to polygons with further processing.

3.0 APPLICATION OF IMAGE PROCESSING FOR VISUAL INSPECTIONS

Automatic inspection systems in computer vision have been efficiently used and perform automatic visual inspections with applications applied to a variety of manufacturing challenges, all with the sole aim of improving product quality as well as reduce time constraint in the manufacturing process (Derganc et al., 2003). (Možina et al., 2013) inspected visual appearance of imprint quality of pharmaceutical tablets, alongside, defect detections. The author used appearance-based methods, with images been preprocessed and segmented, the output was generated were eigenspace and the parametric functions describing the correlation of the tablet appearance and rotation parameter, which are used as input for the feature extraction and classification. A real-time segmentation was carried by (Možina et al., 2011) for visual inspection of pharmaceutical tablets, following the regulation code 21CFR206, issued by the Food and Drug Administration, that pharmaceutical companies should ever produce tablets with unambiguous substance and dosage determined by tablet's shape, size, texture, imprint and characteristics that define a good tablet quality. The segmentation method used in this process was based on fast iterative object border tracking and robust border contour verification. A vision approach was used for the recognition of expiry date numerals in 2015 by (Zaafouri, Sayadi, & Fnaiech, 2015). The process follows the basic image processing steps of preprocessing, segmentation, feature extraction and then numeral recognition using Stretched Gabor Filters. The morphological operator was used for image binarization, the vertical projection for image segmentation, and then finally extracted features from S-Gabor filters such as Fourier Magnitude (FM), Local Energy (LE) and complex moment with statistical features. The expiry date numerals were later classified by Multilayer Neural Network

(Zaafouri, Sayadi, & Fnaiech, 2015). Image processing techniques are therefore important techniques for visual inspection of the finished product before final approval for public consumption.

4.0 CONCLUSION

This review paper discussed image processing techniques in computer vision. It identifies various techniques or steps determined as the image processing procedure, which are selected and applied based on the required investigation. The review also compared the rate of usage of these processing steps in various applications. It also verifies the most applicable techniques which may be deemed as the most important in image processing. The review also revealed that image processing techniques are fundamental in the visual inspection process.

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REFERENCES

- Al-amri, S. S., Kalyankar, N. V., & Khamitkar, S. D. (2010). *Image Segmentation by Using Thershod Techniques*. 2(5), 83–86.
- Article, R. (2013). Available Online at www.jgrcs.info A SURVEY OF TECHNIQUES AND APPLICATIONS FOR REAL TIME IMAGE. 4(8), 30–39.
- Basak, R., Chakraborty, S., Mondal, A. K., & Biswas, S. B. (2018). Image Segmentation Techniques : A Survey.
- Baudet, N., Maire, J. L., & Pillet, M. (2013). The visual inspection of product surfaces. *Food Quality and Preference*, 27(2), 153–160. <https://doi.org/10.1016/j.foodqual.2012.08.006>
- Bhagavan, K., S. Sagar Imambi, D., & Shahana Bano, D. (2018). A compressive survey on different image processing techniques to identify the brain tumor. *International Journal of Engineering & Technology*, 7(2.7), 1081. <https://doi.org/10.14419/ijet.v7i2.7.12232>
- Chitradevi, B., & Srimathi, P. (2014). An Overview on Image Processing Techniques. *International Journal of Innovative Research in Computer and Communication Engineering*, 2(11 Nov 2014), 6466–6472. <https://doi.org/10.1155/2013/496701>
- Derganc, J., Likar, B., Bernard, R., Tomažević, D., & Pernuš, F. (2003). Real-time automated visual inspection of color tablets in pharmaceutical blisters. *Real-Time Imaging*, 9(2), 113–124. [https://doi.org/10.1016/S1077-2014\(03\)00018-4](https://doi.org/10.1016/S1077-2014(03)00018-4)
- Guyon, I., Gunn, S., Nikravesh, M., & Eds, L. A. Z. (2006). *Feature Extraction: Studies in Fuzziness and Soft Computing*, Volume 207. Springer Berlin Heidelberg New York This.
- Hamuda, E., Glavin, M., & Jones, E. (2016). A survey of image processing techniques for plant extraction and segmentation in the field. *Computers and Electronics in Agriculture*, 125, 184–199. <https://doi.org/10.1016/j.compag.2016.04.024>
- Homma, K., & Takenaka, E. (1985). An Image Processing Method for Feature Extraction of Space-Occupying Lesions. 1472–1478.
- Hosozawa, K., Wijaya, R. H., Linh, T. D., Seya, H., Arai, M., Maekawa, T., & Mizutani, K. (2018). Recognition of Expiration Dates Written on Food Packages with Open Source OCR. *International Journal of Computer Theory and Engineering*, 10(5), 170–174. <https://doi.org/10.7763/ijcte.2018.v10.1220>
- J. Islam, M., M. Basalamah, S., Ahmadi, M., & A. Sid-Ahmed, M. (2012). Computer Vision-Based Quality Inspection System of Transparent Gelatin Capsules in Pharmaceutical Applications. *American Journal of Intelligent Systems*, 2(1), 14–22. <https://doi.org/10.5923/j.ajis.20120201.03>
- K. Bhargavi, & S. Jyothi. (2014). A Survey on Threshold Based Segmentation Technique in Image Processing. *International Journal of Innovative Research & Development*, 3(12), 234–239. https://www.researchgate.net/profile/Singaraju_Jyothi2/publication/309209325_A_Survey_on_Threshold_Based_Segmentation_Technique_in_Image_Processing/links/5805bb6f08ace314f68e2879/A-Survey-on-Threshold-Based-Segmentation-Technique-in-Image-Processing.pdf

- K. Sumithra, S. Buvana, & R. Somasundaram. (2015). A Survey on Various Types of Image Processing Technique. *International Journal of Engineering Research And*, V4(03). <https://doi.org/10.17577/ijertv4is030552>
- Khedaskar, S. V, Rokade, M. A., Patil, B. R., & Tatwadarshi, P. N. (2018). A Survey of Image Processing and Identification Techniques. 1(1), 1–10.
- Mark S. Nixon, & Alberto S. Aguado. (2012). *Feature Extraction & Image Processing for Computer Vision*. Elsevier.
- Mera, C., Orozco-Alzate, M., Branch, J., & Mery, D. (2016). Automatic visual inspection: An approach with multi-instance learning. *Computers in Industry*, 83, 46–54. <https://doi.org/10.1016/j.compind.2016.09.002>
- Možina, M., Tomaževič, D., Pernuš, F., & Likar, B. (2011). Real-time image segmentation for visual inspection of pharmaceutical tablets. *Machine Vision and Applications*, 22(1), 145–156. <https://doi.org/10.1007/s00138-009-0218-7>
- Možina, M., Tomaževič, D., Pernuš, F., & Likar, B. (2013). Automated visual inspection of imprint quality of pharmaceutical tablets. *Machine Vision and Applications*, 24(1), 63–73. <https://doi.org/10.1007/s00138-011-0366-4>
- Muaidi, H. (2014). A Survey of Digital Image Processing Techniques in Character Recognition. *IJCSNS International Journal of Computer Science and Network Security*, 14(3), 65.
- Muthuselvi, S., & Prabhu, P. (2016). Digital Image Processing Techniques- A Survey. *International Level Multidisciplinary Research Journal*, 5(11), 1–7.
- P, S. B., & Sunny, L. E. (2018). Survey on Feature Extraction Techniques in Image Processing. *International Journal for Research in Applied Science and Engineering Technology*, 6(3), 217–222. <https://doi.org/10.22214/ijraset.2018.3035>
- Padmaja, G. ., & Nirupama, P. (2012). Analysis of Various Image Compression Techniques. *ARNP Journal of Science and Technology*2011, 2(4), 371–376.
- Park, M., Jin, J. S., Au, S. L., & Luo, S. (2008). Pattern recognition from segmented images in automated inspection systems. *Proceedings - 2008 International Symposium on Ubiquitous Multimedia Computing, UMC 2008*, 87–92. <https://doi.org/10.1109/UMC.2008.26>
- Prabhu, S. M. and P. (2017). Digital Image Processing Techniques – A Survey. *International Multidisciplinary Research Journal*, May 2016.
- Shukla, R., & Agarwal, S. (2016). Implementation of Various Image Processing Techniques. 5(5).
- Yasmin, M., Sharif, M., & Mohsin, S. (2013). Survey Paper on Diagnosis of Breast Cancer Using Image Processing Techniques. January.
- Zaafouri, A., Sayadi, M., & Fnaiech, F. (2015). A vision approach for expiry date recognition using stretched gabor features. *International Arab Journal of Information Technology*, 12(5), 448–455.
- Zaafouri, A., Sayadi, M., Fnaiech, F., Al-Jarrah, O., & Wei, W. (2015). A new method for expiration code detection and recognition gabor features based collaborative using representation. *Advanced Engineering Informatics*, 29(4), 1072–1082. <https://doi.org/10.1016/j.aei.2015.07.009>