

Computer Vision Based Recognition of Nut and Bolt System

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Abstract - This paper focuses on Moving Nuts or Bolts is Sensed by Proximity Sensor and image is acquired by a Web Camera and image is processed through MATLAB to sort bolts and nuts. Develop the image processing algorithm using stationary wavelet transform to get the normalized cropping images which would be suitable inputs processing and detection. Testing is done using a real-time visual recognition system. The MATLAB software version 7.8 2009 is used to integrate all algorithms. The implementation also consists of a prototype that emulates the sorting of nuts and bolts. It also activates the motor differently to sort the different parts. The result shows that the system can detect moving object accurately on the belt conveyor and sort them accordingly as required for the application of Computer vision based automated approach is useful in automobile industry.

Keywords: Computer Vision, Recognition, Nuts and Bolts.

I. INTRODUCTION

In nut and bolt manufacturing industry, size of object is of prime concern. An authentic determination of size quality for each nut and bolt under production is a challenging task. Employing human personnel for this task, is one approach to achieve the target. However, the adherence to certain quality standards varies from machine to machine employed for the same task. The machine is made by integration of many parts to extract information from an image in order to solve some task. Computer vision based automated approach is useful in automobile industry. It is related to the determination of whether or not the image data contains some specific object, feature, or activity. This task can normally be solved robustly and without effort by a human, but is still not satisfactorily solved in computer vision for the general case.

The bolt and nut is a sample of a fastener which is a hardware device that mechanically joins or affixes two or more objects together. Fasteners can also be used to close a container such as a bag, a box, or an envelope; or they may involve keeping together the sides of an opening of flexible material, attaching

a lid to a container, etc. Stationary wavelet transform is a technique that will be suitably used for the application purpose for sorting of nuts and bolts on a conveyor belt in an industry. We use the MATLAB and implement the stationary wavelet transform for image processing and detection. The optimization algorithm has less iteration than implementation with Artificial Neural Network process for the same task and other improved algorithms while the convergence rate is faster and the precision is higher. This method is more suitable for real time recognition systems.

THE PROPOSED INSPECTION METHODOLOGY

The image processing-based inspection methodology include image acquisition, image pre-processing, feature extraction and inspection procedures.

2.1 Image acquisition: VP-EYE Image software is used to acquire the product image then the images are stored in the computer.

2.2 Image pre-processing: after the acquired images have been stored, the image pre-processing algorithm is executed through Matlab software, which includes three steps:

1) Convert the image from RGB image to grey-level image using Matlab function "Reg2gray".

2) Thresholding process is used to convert the grey image into a binary image. The grey scale value under specified threshold is assigned to '0' and others are assigned to '1'. The binary value can be expressed as by Jain (Anil K. Jain, 1989) as follows:

$$B'(x,y) = \begin{cases} 1 & \text{if } f(x,y) > k \\ 0 & \text{Other wise} \end{cases}$$

In this research, the thresholding value is calculated automatically through Matlab and is equal to 0.46.

3. Filtering: the filtering is done using morphological operations; the number of pixels added or removed from the objects in an image depends on the size and shape of the

structuring element (SE) used to process the image (Rafael C. Gonzalez and Richard E. Woods, 2002). In the morphological operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The morphological operations are used to remove the noise, which called the morphological filter. The filtration is done by removing all connected components (noise) that have fewer than 30 pixels using the Matlab function (bwareaopen). Afterwards another morphological operation closing is implemented using (imclose) function to perform morphological closing on the image.

1) Image inversion: It means the change binary of image value '0' and '1' into '1' and '0'. It is a necessary step, because the image of the character is wanted not to be the image of background. The image inversion can be expressed as

$$B'(x,y) = \begin{cases} 1 & \text{if } B(x,y) = 0 \\ 0 & \text{if } B(x,y) = 1 \end{cases} \quad (2)$$

Where $B(x, y)$ is the binary value and $B'(x, y)$ is the inverted binary value.

2) Segmentation: The segmentation of an image into various objects from the background is implemented. Two segmentations are done; first segmentation is executed by separating each character out from the product image. Figure (1) shows

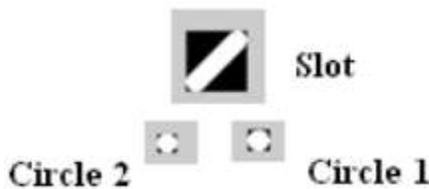


Fig. 1: characters segmentation

The result of the first segmentation of each character is shown using Matlab software.

Each quality characteristic is centered in a box that is dominant to its size. The boxes of the master product image (image with nominal sizes) are similar to their relevant in each inspected product image.

As the characters of the product are extracted and each character has appeared in a box (the features extracted for statistical approach), a second segmentation is executed by dividing each character to eight-equally regions.

These regions are performed by determining the character centroid, starting with a horizontal line then drawing other equi-angles (45o) seven lines. These lines are the boundary of 8- regions. Figure (1), for example, shows a circle centered in a box and its divisions including portion number 1, 2, 3, 4, 5, 6, 7, and 8.

The steps for extracting these characters are image inversion and segmentation.

II. SOFTWARE FRAMEWORK DEVELOPMENT

In A software framework for image processing in defect detection of real-time visual inspection system has been developed using stationary wavelet transform technique and is the Real-Time Intelligent Visual Inspection. The framework will start at image acquisition and will go through a series of processes before the results can be output. Fig 1 showthe developed PCA software.

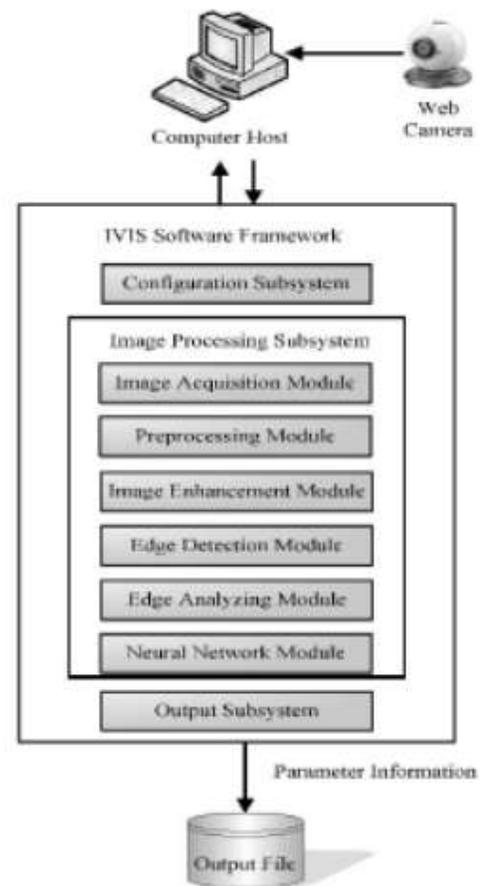


Fig.2: Software Framework

PCA covariance of image $c_x = 1/n(xx^t)$. The process start with image acquisition where image will be capture, follow by pre-

processing of the images captured to reduce noises in the image. Images are then enhanced to ease the analyzing process. After the images have been enhanced, the edge inside the images was then determined. Lastly according to the parameter of edges, the status of a bottle in the bottling process can be determined by using neural network and action.

3.1 Configuration subsystem

Video configuration module used for configure the information e.g. to choose proper webcam device, image brightness, image colour, etc. This module also use for configure the information such as image size and image resolution. In this case, image size is fixed i.e. 352 x 280 pixels, and the image input format is in gray scale.

3.2 Image processing subsystem

Image processing sub-system consists of some modules as shown in figure 2.

3.2.1 Image acquisition module

When come into development of a vision system, image acquisition is the first and most important step to be taking care of. Any deficiency of the initial image can cause a major problem while processing and analyzing the image. Hardware equipment carries a very important role to acquire image with sufficient contrast and sharp focusing. However in this paper, we will stress on the software framework in this section, and an ordinary low-end webcam have been used as an image acquisition device. In the software point of view, MATLAB (fig 3) has been chosen as the development tools. Using the tools mentioned, there are several ways to acquire a video stream from a webcam. The most common ways are DirectX, QuickCAM or VFW (Video For Windows). A real-time series of image can be acquired using the tools mentioned. Each individual image was stored and further analyzing can be carried on thereafter.



Fig3: Principal component analysis

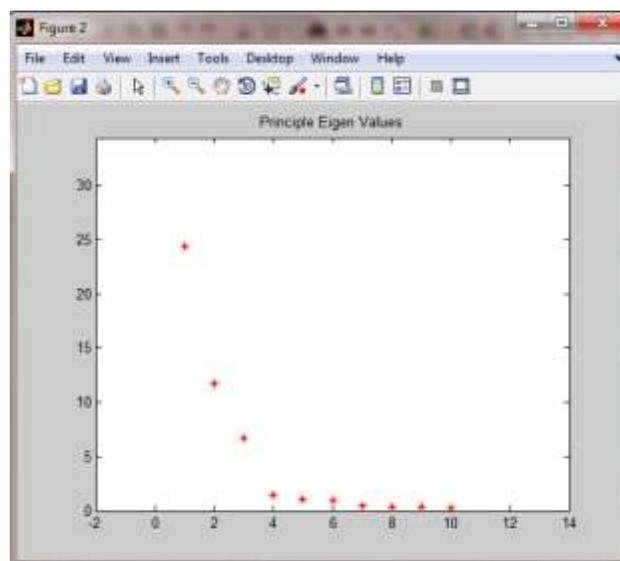


Fig4. Principal component analysis

1.1.1 Image Pre-processing module

After the image has been captured from the first stage, each image will go through the pre-processing stage to eliminate noise inside the image, to enhance the result of the output. Imaging sensor including camera-like devices, rarely have evenly illuminated image. Even in the absence of vignetting (this causes off-axis rays to be lost by collision with the lens mount at large apertures - typically $f/2$ or greater) image brightness falls off rapidly away from the axis of the imaging lens.

III. RESULT & DISCUSSION

In After the image processing sequences, we have a final result for each bolt and nut as shown in Fig. 8 and Fig. 9. The results of stationary wavelet transform of testing can be seen in the Fig. 11. By using the heuristic method for three types of bolt and nut, we can decide that for an output value of less than 0.2 to almost zero is defined as a nut, whereas the output value of greater or equal to 0.2 to almost one is defined as a bolt.

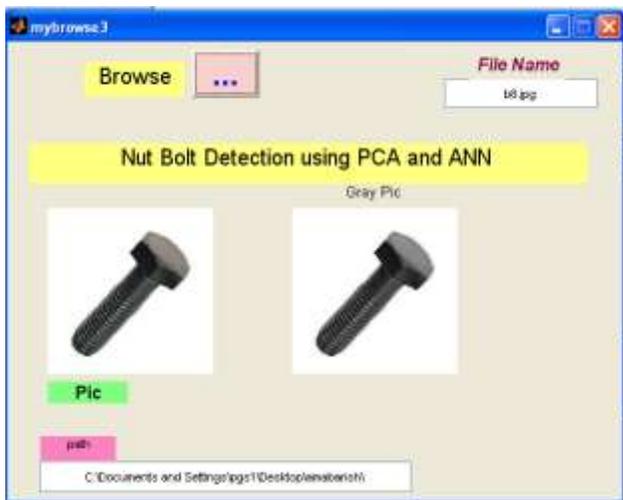


Fig 5: experimental setup for bolt model

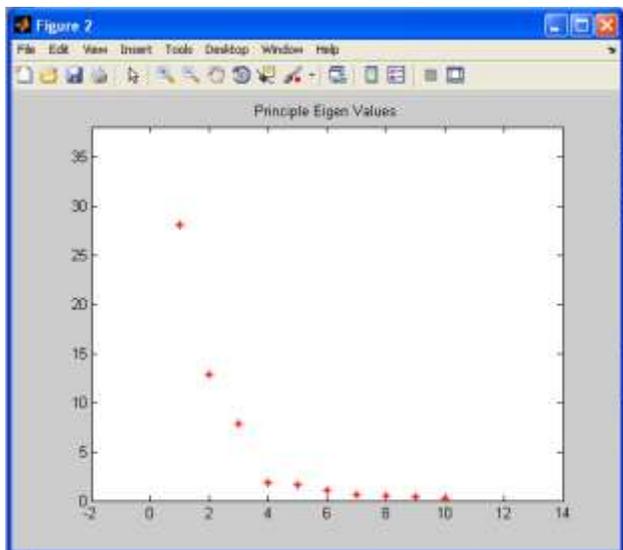


Fig 6: graph for bolt.

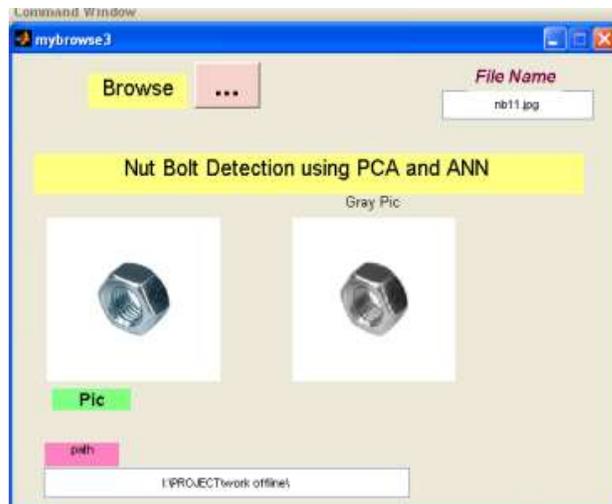


Fig 6: experimental setup for nut model

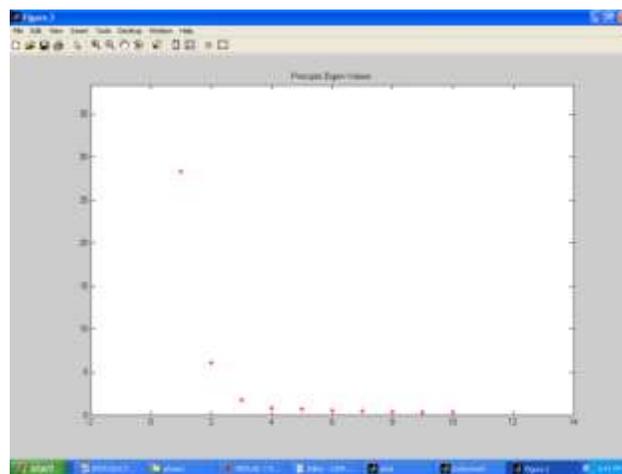


Fig7: graph for bolt

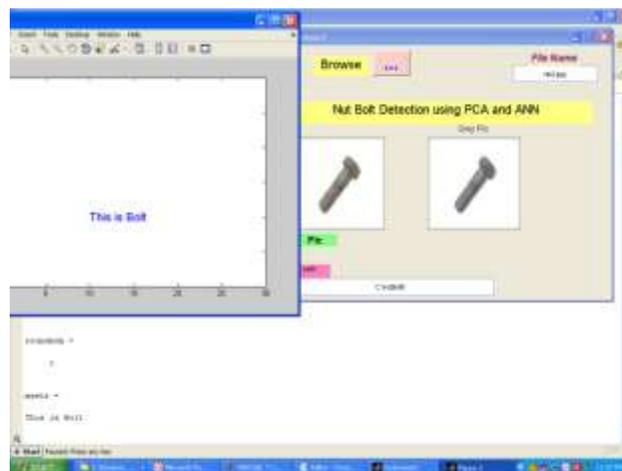


Fig 9: result for bolt detection

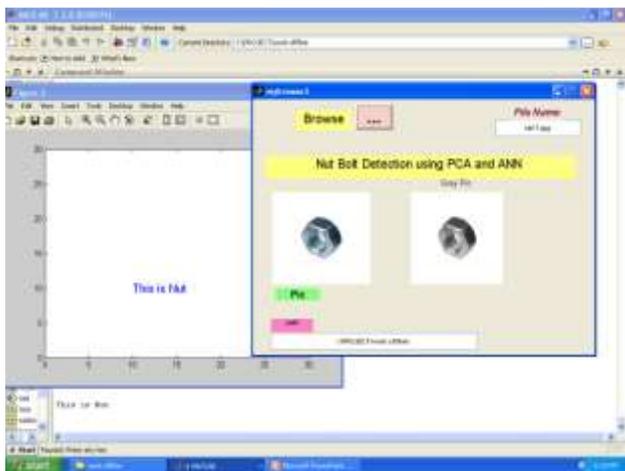


Fig10: Result for nut detection

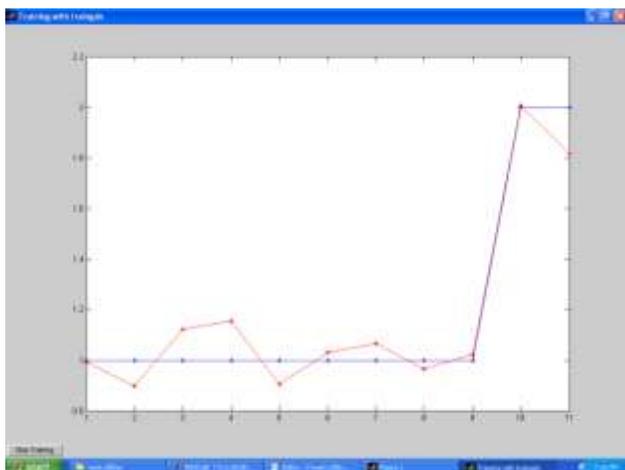


Fig11: Comparison graph of bolt and nut

IV. CONCLUSIONS

This experiment shows satisfactory results as compared to the standard Artificial Neural Network technique while maintaining same threshold error and a good processing speed-up in terms of success rate, speed of belt conveyor, and types of bolt and nut. The success rate is more than 65%, for fixed speed of conveyor belt, and involving bolt and nut. The success rate can be improved up to 74% if we had used an additional spotlight on the object instead of the room fluorescent lighting, with a better belt conveyor (without any black spot). The speed can also be increased if we had used a laser pointer which has a better response time, instead of metal sensor as the sensor for the object.

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