

# Quantitative Fault Analysis on Pencil Case using Image Processing

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## ABSTRACT

This paper aims at designing an automated system to monitor the production in a pencil industry. The objectives of this work is to count the number of pencils in each pencil case and compare the results to check if desired number of pencils are present. The packets where the number of pencils are not equal to desired is diverted from production line, rest cases which pass the quantity check is counted and further processed. The whole system is carried on with the help of image processing technique utilizing the LabVIEW platform without disturbing the high speed production line. The images of pencil cases are captured using a high frame rate smart camera, then acquired on to the PC through RS232 port and processed using LabVIEW platform. The proposed technique was subjected to test on a real time system and found operating successfully with 98% accuracy.

## General Terms

Image Processing, Automation, Pencil Industry, Counting.

## Keywords

Automation, LabVIEW, Vision.

## 1. INTRODUCTION

Counting objects is a simple task when the number is very small. But when the number increases, it becomes a challenging task for a human and can lead to human errors. Thus to improve the precision of quantitative measurements, automating the process is very much necessary. In most of the applications contact method is used to count which may disturb and delay the process. In this paper an automated and non-contact method for counting the number of pencils in a pencil box moving on a conveyer is proposed. When it comes to marketing of any product, the industry should check the packets for correctness before it is dispatched for the market. In many industries the count is checked in bulk by weighing the batch instead of checking each box. This may lead to decrease in accuracy of count in individual boxes. In this regard the proposed work helps the industry by designing an automated counting system to check the count of the product.

Identification of the individual objects and segmentation of the foreground objects in the cigarette tin packages is reported in [1]. In [2], some of the main tools and techniques used in the field of automatic counting of objects in digital images is discussed. In [3], an automated method of counting feeder fish is discussed by processing the video frames individually and independently using image processing techniques. A method for automatic vehicle detection and counting using image processing is demonstrated in [4-5]. In [6], a work on counting the number of objects in an image using thresholding along with marker controlled watershed segmentation is reported. In [7] an algorithm for verifying the count of frozen semen straws kept in a bunch by using image processing technique is proposed. An algorithm is developed in [8] to

distinguish bicycles from pedestrian using support vector machine to estimate their traffic in a location. In [9] an automated method that measures in-focus suspended flocs and removes out of focus flocs is reported. In [10], a method to count total, filled/unfilled spikelets simultaneously based on automatic discrimination of filled and unfilled spikelets by combining visible light and soft x-ray imaging is reported. A Multi-target tracking method based on adaptive motion models is proposed in [11] to count the number of flowers in a plant.

From the survey of reported work it is clear that many automation techniques are used in the field of counting. But very less work is done in the field of counting the pencils by non-contact method. An attempt was reported in [12], where a simulation model was designed using edge detection algorithm to count the number of pencils, the proposed work is an extension of the reported paper where the image processing algorithm is further improved to have a robust technique using histogram computation and image filtering and application of Hough transform for line detection and particle computation. The technique is further implemented for online processing in real time application. In this paper, a LabVIEW based non-contact algorithm interfacing with NI-1744 is designed to count the number of pencils per box. The results are tested in online.

The paper is organized as follows: After introduction in Section 1, Section 2 discusses the process setup followed by associated problem in Section 3. Section 4 deals with the proposed solution. Results and analysis are given in Section 5. Finally, conclusion is discussed in Section 6

## 2. PROCESS

In any manufacturing industry the process of conversion of raw material into an end product is carried out sequentially, termed as production line. The last stage of production line is usually the packaging. The process of packaging needs to be very efficient since the first impression of customers on any product lies on its packaging. It is very essential that the packaging consists of a desired quantity of materials as mentioned.

Quantities analysis of the packaging at this stage need to be accurate and less interfering with the packed product. The analysis technique should also match with the speed of production line else introduces a delay in production line. A delay in production line also reflects in loss for the manufacturer.

The proposed technique involves a non-contact technique using image processing algorithms for quantitative analysis of packed cases of pencils. For implementation of the proposed technique a pilot model of production line is mimicked on a conveyer belt as shown in Fig. 1. The production line consist of a conveyer belt moving with predesigned speed, a smart camera is placed facing a conveyer as shown in Fig.1. The

camera captures images of packed case, and transfer's the data to PC through a RS232 port for processing. On processing the image if it is found that the case doesn't contain requisite number of pencils an error signal is indicated along with the trigger of solenoid which will push the defective case out of production line.



Fig 1: Experimental setup

### 3. ASSOCIATED PROBLEMS

Manufacturing of products on the production line is a fast moving process, which makes it very difficult to employ any manual technique. Automation in the production line becomes very essential activity of a process industry. The proposed technique involves the following steps:

- Quantitative measurement in this proposed work involves the capture of image of the packets filled with pencils
- To measure the number of pencils in the packet and compare with desired number using image processing algorithms.
- If defect detected initiate a control signal to displace the case from production line.
- The whole system is designed using a hard real time application.

### 4. PROPOSED SOLUTIONS

To achieve the objectives mentioned in the previous section a technique is proposed using image processing algorithms. The image is acquired on the LabVIEW platform once the image is acquired it is processed and counting of pencils is done. If the number of pencil is not equal to the desired number, the defective product is pushed from the production line.

The production line is designed using a conveyer, operated by a stepper motor programmed using the motion control function. The speed of the conveyor is very important for the design of quantitative analysis of pencil case, since the packet needs to be pushed from conveyer, with the solenoid, which is a time based parameter, depending on the speed of the conveyer.

The operations to be performed on acquired image to achieve the desired objectives are:-

1. Selection of Region of Interest (ROI)
2. Image filtering and computation of pixel histogram
3. Using Hough transform to detect the edge line of the pencil
4. Counting of closed edge lines.

The front panel of LabVIEW [13]–[15] programmed is as shown in Fig. 2. The front panel consist of image window which shows the image on which quantitative analysis is to be

applied. Three numerical indicators indicating number of pencils in the case, date of production, and total number of cases which has passed the quality check on the prescribed date. Logical indicator display's result of quantitative analysis. A push button switch for manually stopping entire process.

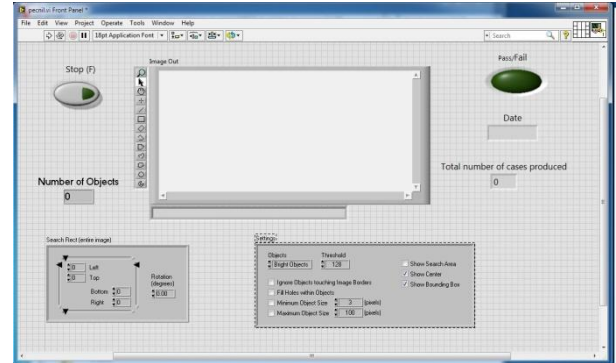


Fig.2. Front panel of proposed technique.

The proposed technique for counting of pencils inside a pencil box using image processing technique is programmed on the block diagram of LabVIEW using image processing pallets. The complete process is divided as

#### Selection of ROI:

Rectangular type of ROI with coordinate values for left, top, right, bottom is created from the entire image. Also we can use different types of ROI like point, line, oval, annulus etc. The inspection will automatically pass if measurements necessary to determine the ROI are available and the coordinates of the ROI are valid.

Methods for creating an ROI:

- Draw the region on top of an image and using the operation ImageGenerateROIMask.
- Define the region mathematically using a command line. e.g. Make/N=(rows,cols) roiWave=255  
RoiWave[startRow,endRow][startCol,endCol]=0

Provide a pair of waves that define a closed contour and use ImageBoundaryToMask operation.

- Use ImageSeedFill together with a seed and a selection rule.
- Use ImageAnalyzeParticles operation with the mark keyword.

#### Image filtering and computation of pixel histogram:

Histogram equalization is a method for stretching the contrast of such images by uniformly redistributing the grey values. This step may make threshold selection approaches more effective. In general, histogram modification enhances the subjective quality of an image and is useful when the image is intended for viewing by a human observer [16], [17].

If the desired grey value distribution is known a priori, the following method may be used. Suppose that  $P_i$  is the number of pixels at level  $Z_i$  in the original histogram and  $q_i$  is the number of pixels at level  $Z_i$  in the desired histogram. Begin at the left end of the original histogram and find the value  $k_1$  such that

$$\sum_{i=1}^{k_1-1} P_i \leq q_i < \sum_{i=1}^{k_1} P_i \quad (1)$$

The pixels at levels  $Z_1, Z_2, \dots, Z_{k_1-1}$  map to level  $Z_j$  in the new image. Next, find the value  $k_2$  such that

$$\sum_{i=1}^{k_2-1} P_i \leq q_i + q_2 < \sum_{i=1}^{k_2} P_i \quad (2)$$

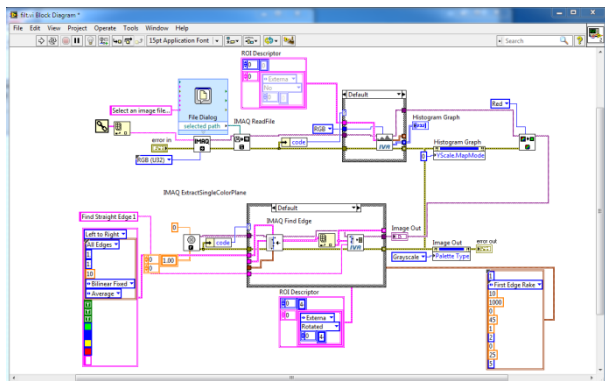
A linear filter is implemented using the weighted sum of the pixels in successive windows. Typically, the same pattern of weights is used in each window, which means that the linear filter is spatially invariant and can be implemented using a convolution mask. If different filter weights are used for different parts of the image, but the filter is still implemented as a weighted sum, then the linear filter is spatially varying. Any filter that is not a weighted sum of pixels is a nonlinear filter. Nonlinear filters can be spatially invariant, meaning that the same calculation is performed regardless of the position in the image, or spatially varying.

**Mean filter:**

One of the simplest linear filters is implemented by a local averaging operation where the value of each pixel is replaced by the average of all the values in the local neighbourhood:

$$h[i, j] = \frac{1}{M} \sum_{(k,l) \in N} f[k, l] \quad (3)$$

The image filtering and histogram computation performed using LabVIEW is as shown with the block diagram representation as in Fig. 3.



**Fig. 3: Block diagram fort the image filtering and histogram technique**

**Hough transforms to detect the edge line of the pencil:**

The Hough Transform technique works by transforming complex patterns of pixels in the image domain into compact features in a chosen parameter space. The transformation operates such that many points in the image space map to single points in the parameter space. This means that searching for complex patterns of pixels is simplified by working in the parameter space and that the technique is robust to some loss of data due to occlusion and other sources of noise [18] – [22].

**Line detection in the image:**

Any line in an image can be described by the slope-intercept equation and appears as a single point in (m; c) space:

$$y = mx + c \quad (4)$$

By transforming from image space to (m; c) space the problem of line detection is simplified to a problem of point detection. In practise the transformation has to be applied to each individual point in the image which transforms into lines in the parameter space, however, collinear points in the image map to intersecting lines in the parameter space. If votes are accumulated for points plotted in the parameter space then the intersection will be seen as a point of local maxima. It follows that lines in the image are found by searching for points of local maxima in the parameter space.

For the application of Hough transform and detection of line on the image, the MATHSCRIPT is made use of and MATLAB code is computed for processing using Hough Transform.

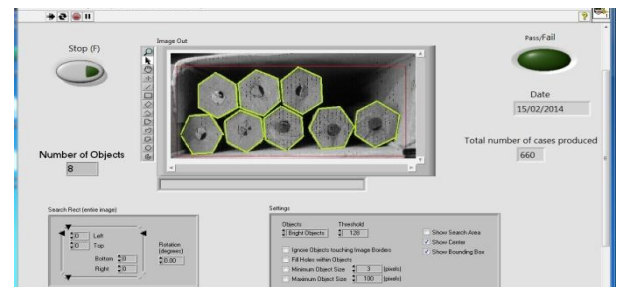
**Particle counting:**

In this section number of pencils in particular image is counted. To achieve the task of counting labeling needs to be performed.

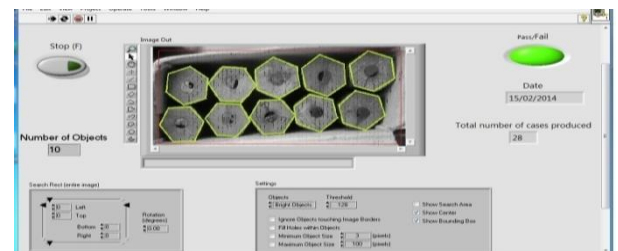
"Connected component labeling" is processing which detects the connected pixels. The number of particles can be counted by counting detected areas. The size of area can be calculated by counting pixels with the same label. The length of circumference can be calculated by counting pixels with the outmost label of the area. Thus, the "connected component labeling" can calculate the number and the feature of particles. When using "connected component labeling", pictures need to be binary images. Raster scan is used for the purpose in the proposed work.

**5. RESULTS AND ANALYSIS**

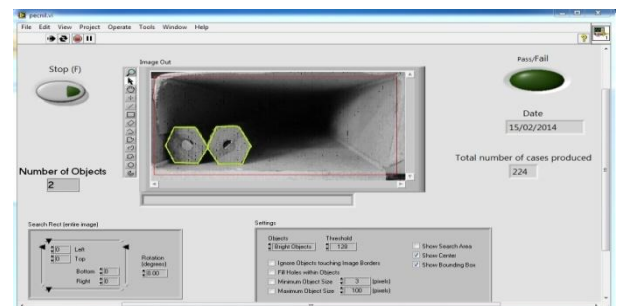
In this paper, an automated fault detection system for quantitative measurement of pencils in pencil packet using image processing technique is designed. The process was subjected to test with 780 test cases. The proposed technique produced correct readings for 765 cases, amounting to an accuracy of 98%. The results obtained from the front panel are shown in Fig.4, Fig. 5, Fig.6 and Fig. 7.



**Fig.4. Result as seen on front panel for a packet with 8 numbers of pencils.**



**Fig.5. Result as seen on front panel for a packet with 10 numbers of pencils**



**Fig.6. Result as seen on front panel for a packet with 2 numbers of pencils**

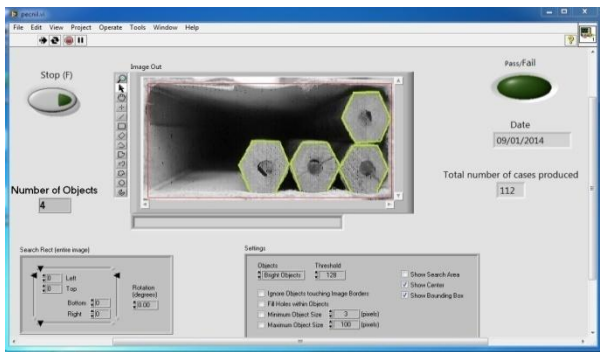


Fig.7. Result as seen on front panel for a packet with 4 numbers of pencils

## 6. CONCLUSION

This paper aimed at designing an automated system to monitor the production in a pencil industry. The work carried out is, counting the number of pencils in each pencil case, diverting the pencil box which does not have the desired number of pencils from production line, and rest cases which pass the quantity check is counted and further processed. Results discussed in the previous section are justifying the satisfaction of the objectives of this work.

The proposed system has achieved the desired objective with an accuracy of 98%, with the time specification as desired for a production line. The remaining 2% error is because of inadequate lighting in the production area when the data was acquired and the timing mismatch of the image frame. The proposed work can be further implemented on any quantitative analysis of any manufacturing process.

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