



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: III Month of publication: March 2018

DOI: <http://doi.org/10.22214/ijraset.2018.3151>

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Recognition of Area and Orientation of the Pointer from the Dial Type Pressure Gauge Panel Using labview

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Abstract: *Extracting the pointer from the gauge image is the main objective of this project. Image pre-processing steps are carried out to enhance the image for feature information. ROI (Region of interest) and image masking is carried out to eradicate the unwanted pixels in the image. Performing the morphological operations to extract few specific pointer's particle parameter in pixels range. Pointer extracted for different readings shown in pressure gauge and also analysis of some parameters in pointer area is also included.*

Index Terms: *Pointer extraction, ROI, Image processing, Morphological operation, LabVIEW (Laboratory Virtual Instrument Engineering Workbench)*

I. INTRODUCTION

The present scenario is fully vision based automated system is incorporated in industries. For extracting and detecting the shape of the object or to identify the defects presented in different objects they are using vision system. There, feature extraction and recognition plays an important role in vision system. Feature extraction is reducing the amount of unwanted resources from the large set of data [1]. In the field of digital image processing, the input image to an algorithm is too massive to be processed directly. Only relevant data from the input image is sufficient to retrieve the required information. So, that desired function can be performed by using reduced representation instead of taking entire initial data. Some other advantages of feature extraction are it reduces the storage space, increases the efficiency in feature recognition and obviously it consumes less time. Here in this paper, we are going to discuss the new feature extraction algorithm, which helps to extract the pointer's area from the dial type pressure gauge by using LabVIEW and NI vision assistant toolbox [3].

II. MATERIALS AND METHODS

A. Machine Vision

Machine vision is that the technology and strategies used to provide artificial vision based automatic inspection and analysis for several applications in industry [4]. On a technical ground, it is necessary to implement the proposed algorithm to construct a machine vision system for extracting pointer from the pressure gauge.

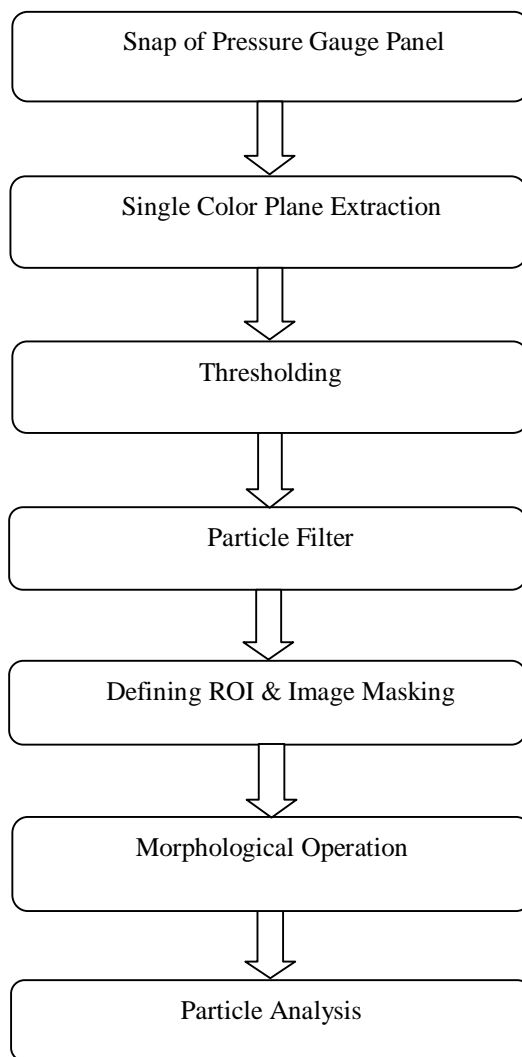


Fig. 1 Pointer Extraction Flow Chart

B. Flow of Pointer Extraction

Capturing the image of pressure gauge and its incorporated with image pre-processing steps as like gray conversion, binary conversion, etc., After completion of pre-processing, defining of ROI and image masking are introduced into this algorithm to remove noise (i.e. Unwanted particles or objects in an image). The pointer is extracted at this step and thereby performing morphological operation of erosion and dilation on the image. Final step is to analysis the particle features of the extracted pointer [5]. The Fig. 1 shows the flow chart of pointer extraction and particle analysis algorithm.

III. IMPLEMENTATION METHOD

To implement the image feature extraction from the pressure gauge panel image using some software tools. There are various tools available for implementation. Here NI Vision Assistant [9] is being used as a development tool.

A. NI Vision Assistant 2015

Vision Assistant is a tool for analysing and testing the image. Its major area is used for image processing applications. Various algorithm and also prototype of an image processing application can build with the Vision Assistant scripting functions [9]. The scripting function records every step of the processing algorithm. After completing the algorithm, we can test it on number of images to make sure that it works correctly. The algorithm is recorded in a builder file, that lists the processing functions and relevant parameters for an algorithm that we prototype in NI Vision Assistant tool.

B. Single Color Extraction

The images acquired from the camera are 1280×720 pixels as 32-bit color images. The Fig. 1 shows the acquired image from the input device. Here, processing the RGB image is computationally more complex and still does not produce better result. It can convert the 32-bit color (RGB) images into 8-bit grayscale images by averaging the 32-bit color. Since the background of the images is mostly green, the blue color pixels from RGB the images are extracted. By going for single color extraction, the blue color plane from an image is extracted and only the pixels with a high blue intensity will appear white[7]. This will reduce noise from high intensity greens and reds. Thus the extracted image of pressure gauge is a grayscale image, which consists of only pixels from 0 to 255.

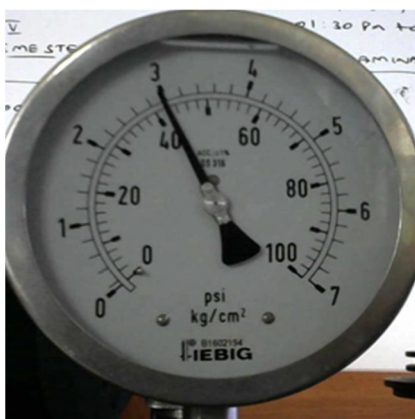


Fig. 2 32-bit Color Image of Pressure Gauge



Fig. 3 8-bit Blue Color Image of Pressure Gauge

C. Thresholding

Thresholding is the major preprocessing method, which is used to differentiate objects from a background. Under non-uniform background lighting, the maximum image intensity and intensity distribution of the image will vary, and it is almost impossible to perform normal thresholding to detect the edges of the object. Therefore, it is needed to analyze the image intensity distribution. Intensity analysis of the gauge image can be performed using NI Vision Assistant tool[9]. The Fig. 4 shows the threshold setup in NI Vision Assistant toolkit, which is used to vary the range for analysis of pointers maximum intensity level. For the taken gauge image, the maximum intensity level of pointer's pixel is determined by analysing, which is in the range between 25 and 30. Therefore, the intensity range is from 25 to 30 is used to extract the pointer in the image.

The Mathematical view of threshold value was described as,

$$g(x,y) = \begin{cases} 1, & \text{if } f(x,y) \geq T \\ 0, & \text{if } f(x,y) < T \end{cases} \quad (1)$$

Where, $f(x,y)$ is the input image, $g(x,y)$ is the threshold output image, T is the threshold value. The threshold value of 25 in thresholding technique will obtain a binary image by calculating using (1), which is shown in the Fig. 4

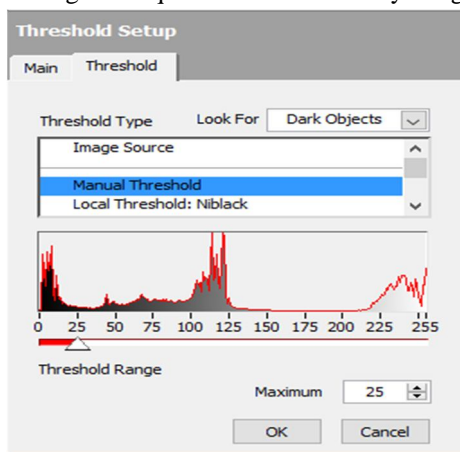


Fig. 4 Intensity Analysis

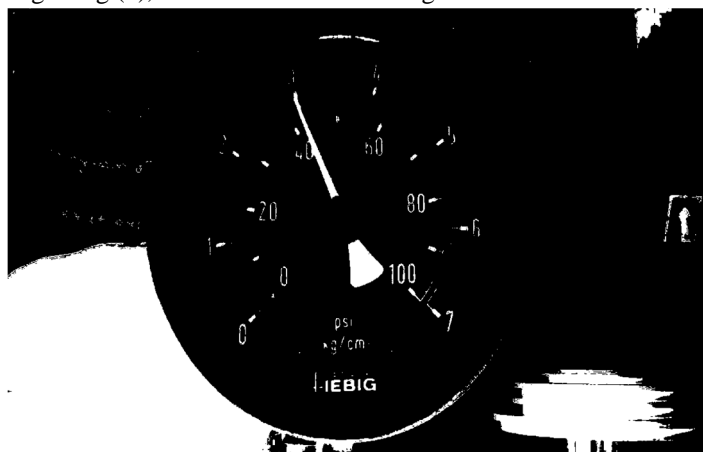


Fig. 5 Threshold Value is fixed to 25

D. Particle Filter

Particle filter acts as a filter option in Vision toolkit. It will remove or keep particle in an image as specified by filter criteria. They represent the particles in the image by a set of weighted pixels together. This filter tool is accompanied with LabVIEW[9].

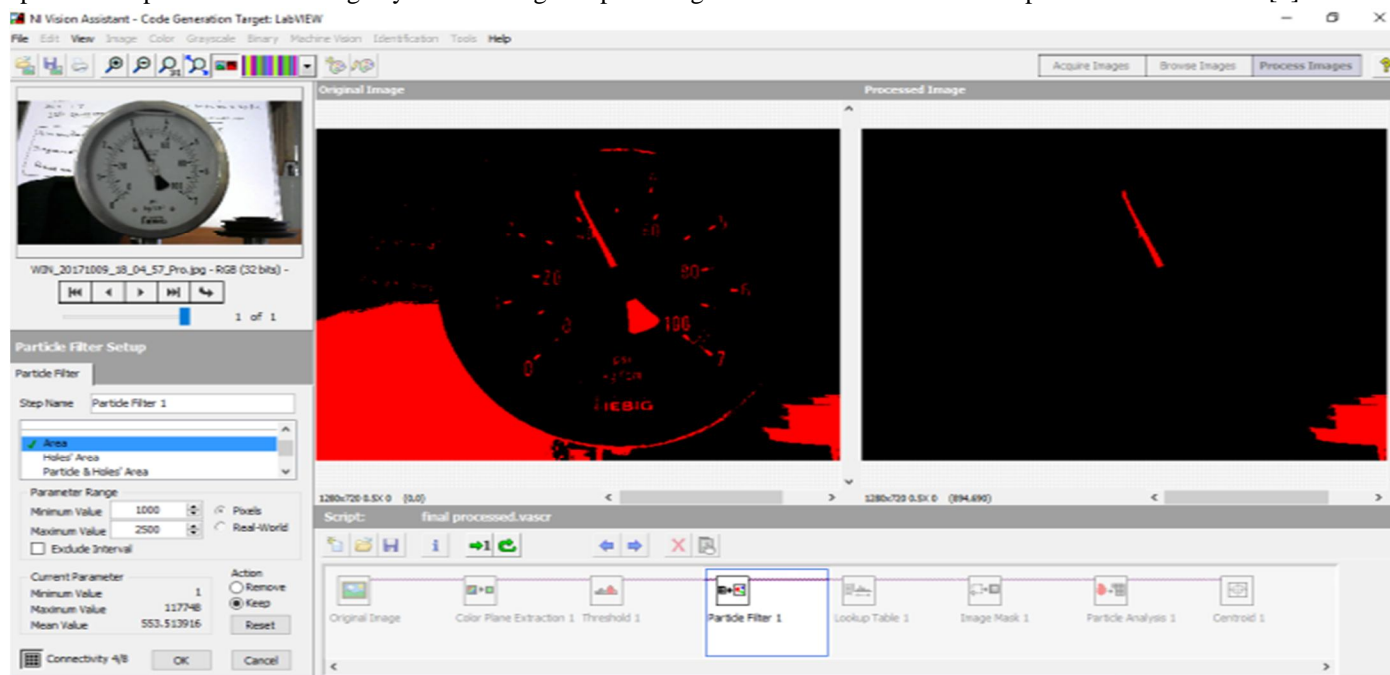


Fig. 6 Vision Assistant Express VI Configuration Window

Fig. 6 shows NI vision assistant window used for analysing of particle filter area, in particle filter setup area option is selected and in that the minimum range and maximum range of particle's area pixels to be present is fixed.

By observing the Fig. 6 the particles containing range of 1000 to 2500 pixels will be retained, other particles are eradicated. The pointers pixels and some other component will also come along with pointer. Therefore, along with pointer image, other unwanted area having 1000 to 2500 area pixels are also joined with the image. Next process is to remove the unwanted pixels accompanying in gauge image, even after particle filter completion. The gauge image after applying particle filter is shown in Fig. 7.

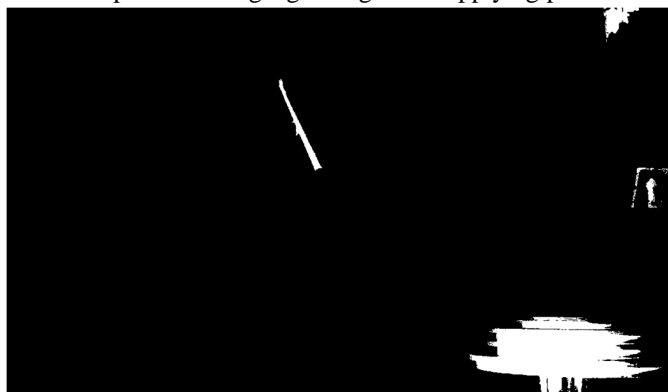


Fig. 7 Processed Image after Applying Particle Filter

E. Defining ROI and Image Mask

The tem region of interest (ROI) is created within a portion of an image. Developing ROI in an image is used for various operations to be performed later in particular portion of an image. Defining an ROI can be done by creating binary mask. The ROI of the image is created by finding the center point in the previous obtained image which is shown in the Fig. 8. By implementing addition and subtraction function from center (X, Y) of the image, a square is developed. Later convert that square box is converted into a ROI and then image mask is created followed by the ROI.

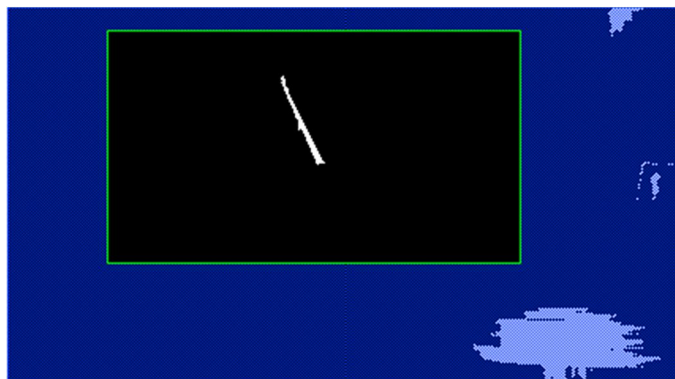


Fig. 8 ROI on Image

The Fig. 9 shows the masked image and it is taken for next processing. In the mask image, the pixels that define the ROI are set to 1 and all other pixels set to 0. That binary mask is a binary image which is in same size as the image needs to process. One can define more than one ROI in a single image. From the Fig. 9, it is observed that the pointer is extracted separately from the image of pressure gauge panel using region splitting and image masking technique in a binary image[10].

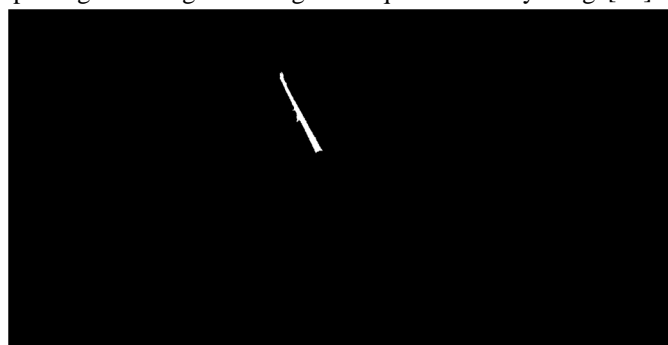


Fig. 9 Binary Masked Image

F. Morphological Operation

Morphological operations are generally neighbourhood based (the new value for the Pixel Under Inspection (PUI) is determined from the values of its neighbouring pixels). The two main types of binary morphological operations are erosion and dilation (other morphological operations exist, but are generally combinations of the two). Morphological operations are very similar to filters [6], except the kernels used are dependent on the original value of the PUI.

1) *Erosion*: Erosion is an operation that ‘shrinks’ or ‘thins’ object in a binary image. Erosion can split apart joined objects and strip away extrusions. It is usually represented by \ominus . The pointer image before applying erosion is shown in Fig. 10.

The mathematical definition of erosion of binary image A by the structuring element B is defined by the following equation (2),

$$(A \ominus B) = \{z \mid (B)_z \subseteq A\} \quad (2)$$

Where, $(B)_z$ denotes the translation of B by the vector z. The above equation indicates that the erosion of A by B is the set of all points z such that B, translated by z, is contained in A.



Fig. 10 Pointer Binary Images before Erosion

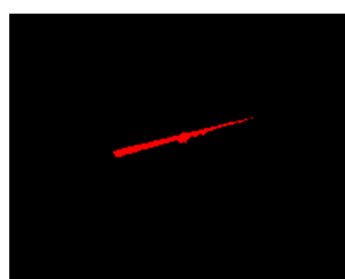


Fig. 11 Pointer Binary Images after Erosion

Additional unwanted pixels present with the pointer line may cause some error while determining edges of the needle. So, those pixels have to be removed by applying erosion. The Fig. 11 represents the pointer image which was eroded.

2) *Dilation*: Dilation is an operation that ‘grows’ or ‘thickens’ object in a binary image. Filling holes and connecting neighbouring objects. Dilation can repair breaks and intrusions. It is usually represented by \oplus . The pointer image before undergoing dilation process is shown in Fig. 12.

The mathematical definition of dilation of A and B, is defined by the following equation (3),

$$(A \oplus B) = \left\{ z \mid (B^S)_z \cap A \right\} \quad (3)$$

Where, B^S denotes the symmetric of B. The equation (3) indicates that the dilation of A by B is the set of all points z.

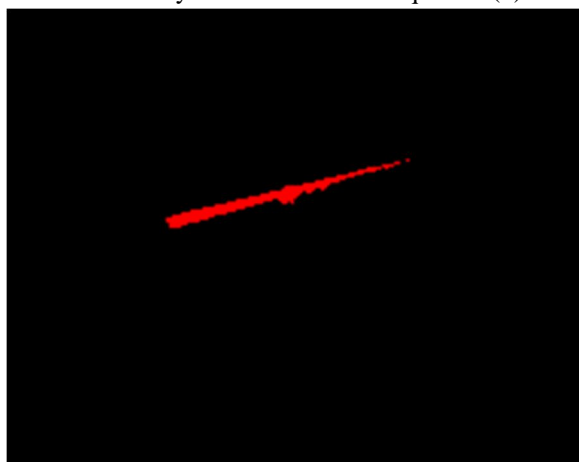


Fig. 12 Pointer Binary Images before Dilation

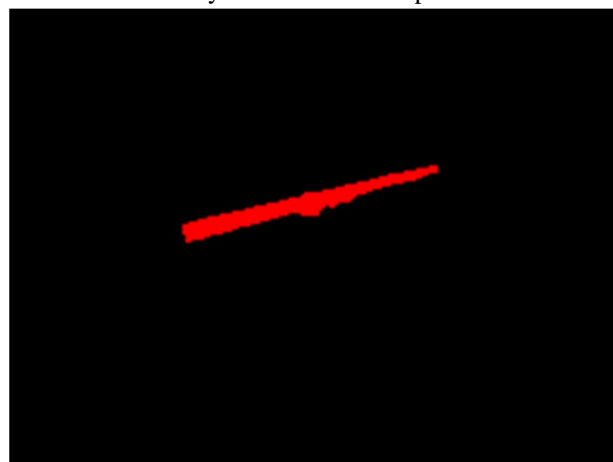


Fig. 13 Pointer Binary Images after Dilation

In erosion process few pixels will be separated from the whole area of the pointer. To organise those pixels together with the pointer area, the dilation process is introduced after erosion process. The dilated pointer image is shown in the Fig. 13. After dilation, the area of the pointer is increased and it is taken for particle analysis process. After completion of proposed algorithm, the pointer in the pressure gauge is extracted at different readings which are shown in Fig. 14.

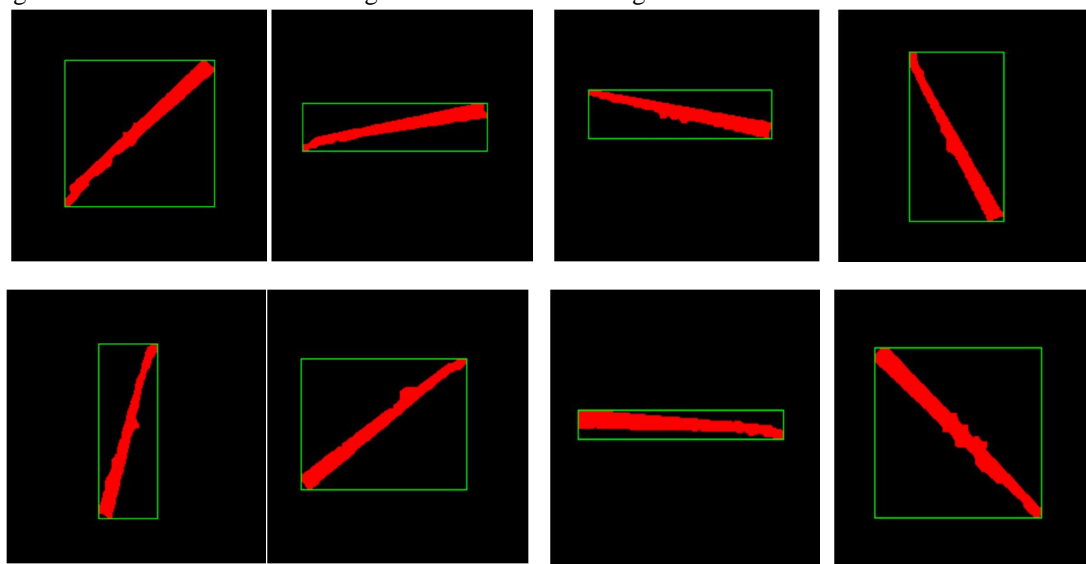


Fig. 14 Pointer extraction at different positions of the pointer

G. Particle Analysis

Analysis of the extracted pointer's particle is done with respect to pixel coverage. The particles analysed here are pixel of rectangular left boundary, rectangular top boundary, rectangular right boundary, rectangular bottom boundary, total area of the extracted pointer and orientation of the pointer line which is shown in Table. 1.

Table. 1 Particle analysis on extracted pointer at different positions

S. No	Pointer Reading (kg/cm ²)	Bottom Boundary	Left Boundary	Top Boundary	Right Boundary	Area	Orientation (degree)
1	0	496	447	354	593	2463	43.1002
2	1	386	342	343	537	2050	19.2398
3	2	335	401	295	577	1835	169.8272
4	3	303	520	135	601	1948	114.329
5	4	302	630	131	662	1746	75.6873
6	5	322	624	212	776	2073	36.1128
7	6	359	623	338	808	1869	177.1481
8	7	498	606	366	755	2550	138.6684

IV. CONCLUSION

The pressure gauge image is analyzed and the area of pointers is extracted using proposed algorithm using LabVIEW and NI Vision Assistant toolkit. Various parameters of pointer are also identified. These parameters can be taken as referential data base for further analysis to digitalize the analog value of pressure gauge and it can assist in making an automated system for inspection. In order to use this method in an industrial application some improvements need to be done. Future work consists of defect identification of pointer's shape and by using angle calculation method, the indicated value of pressure can be determined easily.

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