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Design of Automated Screw Blade Welding Defect Detection System for Image Processing-based Zero-defect Mass-production

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***Abstract*—As the real-time welding defect detection vision system intended to suggest in this article must detect the welding defect monitoring the screw blade welding process, differently from the existing vision system at the same time, it detects the welding defect by real-time monitoring, image data storing and pattern matching by using the PC-based IP camera. The suggested system is deemed to be helpful in improving the productivity and the quality by reducing the defects in the welding process and the welding time**

Keywords-image processsing; Welding defect detection; welding automation; edge detection; vision system

I. INTRODUCTION

Recently, the interests and the importance of the foundation work is being increased as the buildings are constructed in high-rise building, the remodeling and the vertical extension of existing building are permitted. Therefore, the diverse engineering techniques are being used in the construction site for better foundation work, SAP (Screw Anchor Pile) is one of them.

SAP is the technique that the execution is possible simultaneously with the perforation as the screw is attached to high strength steel pipe and the welding is the most important process to determine the quality of SAP in the manufacturing process. However, as the existing technique is difficult as the workers must weld manually along the spiral rotating the product and depending on the skill of the worker, not only the quality of the product but also the working hours and the production are determined.

In addition, since the worker must detect the welding defect visually one by one, the working hours are getting longer and the quality of the product is determined by the subjective judgment of worker, for which the productivity is lowered and the defect ratio is increased.

In this article, to distinguish the defective product quickly by detecting the defect in the welding process, the system, which detects the defect by analyzing the image using the image processing algorithm after acquiring the image using high speed IP camera, was developed.

II. RELATED RESEACH

A. Machine Vision System

As a technology to realize the human vision system through the camera and the computer, the machine vision is the technology that the system performs the functions of recognition and judgment for the inspection and measurement required in the industrial site instead of human. Currently, the machine vision is being used for inspection of products such as machine, semiconductor, automotive, foods, medicine and medical supplies, etc. and is useful in increasing the accuracy, efficiency and productivity [1-2]. In addition, it is being utilized for welding inspection and the researches to detect the internal defect mainly by penetrating the radioactive ray or using ultrasonic wave are actively under progress [3].

In this study, the welding defect detection through the image analysis by photographing the image in real-time using PC-based IP camera is suggested.

B. Image Processing Algorithm

Image processing refers to all the area related to image such as generating, processing, interpreting and recognizing the images. Therefore, to detect the defect in the welding process, the image processing to recognize and process the image photographed by camera is required. Existing researches measure the size of welding zone or use the detection algorithm various time utilizing the lighting to detect the welding defect, or simply detect the omission of component [4].

In this article, the image is acquired by equipping the high speed camera and detect the defect using the precise algorithm by splitting the zone after analyzing the image

III. DESIGN OF WELDING DEFECT DETECTION SYSTEM

The real-time welding defect detection system suggested in this article photographs the welding process in real-time using the CCD camera and determines the welding defect using detection algorism.

A. System Diagram

Below Figure 1 is the system diagram of the real-time welding defect detection system.

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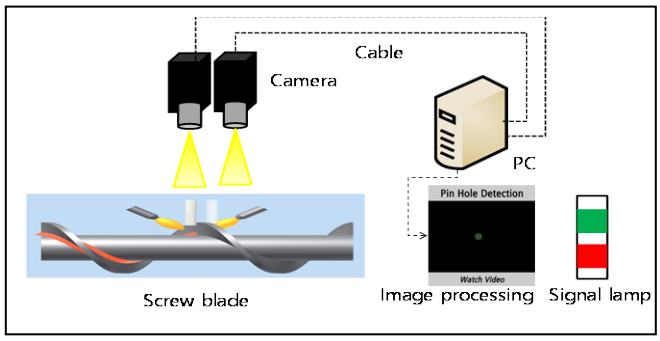

Figure 1. Real-time Welding Defect Detection System Diagram

B. *Design and Analysus of Defect Detection System*

In this article, to develop the welding defect detection system, following processing processes are suggested.

1) Identify the types of defects occurred in SAP welding process.

a) 5 types of welding defects: Acquire theimage data for welding bead, undercut, overlap, pinhole, crack, and browhole.

2) Extract the characteristics of the image for 5 types of defects and build the database by defining them as defect pattern.

3) Extract the characteristics from the welding image, compare them with the defect pattern in the database and evaluate it as welding defect if they are matched with the defect pattern.

C. *Welding Defect Detection Algorithm*

Below Figure 2 is the diagram of the welding defect detection algorism.

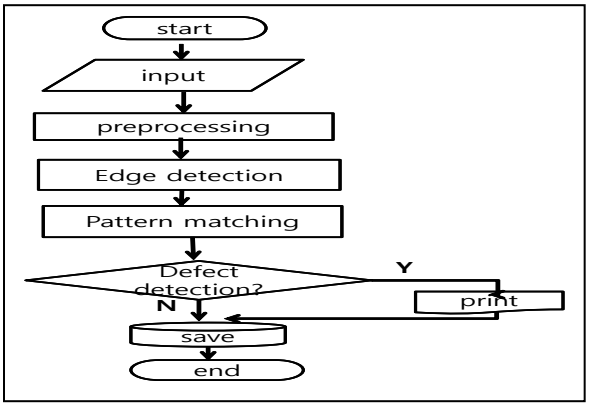

Figure 2. Welding Defect Detection Algorithm Diagram

In this article, to detect the welding defect in real-time, the image processing algorithm is used. To analyze the image from the camera, the image segmentation is performed and to simplify the image by removing the unnecessary information, the image is made as binary code by performing preprocessing process. In making the binary code, all the pixels brighter than the given threshold are changed to white and other pixels are change to black. In this moment, finding the threshold in the brightness distribution of the actual input image is important and in this article, the optimal threshold is found using Otsu's method.

Otsu's binarization method is the method to find the threshold that minimizes the intra-class variance between two classes or maximizes the inter-class variance between two classes when the image pixels are classified into two classes based on the threshold.

In addition, as a method to detect the welding defect, the edge is detected to detect the clear brightness changes in the area and to remove the noise. The edge can be detected by using first derivative or second derivative.

In this article, the unnecessary noise is removed from the image using canny edge algorithm, which is the gradient-based edge detection method, and is smoothed out using Gaussian filter. In this moment, the shaded area by the defect represents relatively darker and the defect can be verified easily by extracting the outline around the defect using the methods such as binarization or the edge detection, etc.

Through the binary image extracted, the welding defect is determined by extracting the characteristics of the object and comparing them with the images of 5 types of defect pattern.

IV. CCONCLUSION

Since this system can detect the welding defect more quickly and accurately by analyzing and processing the image in the process of SAP using the computer and CCD camera than the existing inspection that has been depending on the skill of the worker, it is expected that it will help in improving the quality and mass-production.

More precise defect inspection will be performed by building the products detected by welding defect detection system with database.

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