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WELDING DEFECT DETECTIONS USING VISION BASED SYSTEM IN QUALITY CONTROL

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ABSTRACT

The main aim of our project is to identify the defects present in the materials during the welding process particularly steel which is used in manufacturing of sheet metal components like brackets in automotive applications, in order to effectively identify and classify weld defects of thin-walled sheet metal components, a weld defect detection and it is based on machine vision is proposed in this project. With the weld defects categorized and are proposed to extract the feature areas of the weld defects by using the weld images sampled by the constructed weld defect detection system on a real-world production line, the parameters of the weld defect classifiers are determined empirically. Experimental results show that the proposed methods can identify and classify the weld defects with more than 96% accuracy rate.
Keywords: Weld defects, Detection system, Machine vision system.

1. INTRODUCTION

1.1 WELDING DEFECT

Welding Defects can be defined as the irregularities formed in the given weld metal due to wrong welding process or incorrect welding patterns, etc. The defect may differ from the desired weld bead shape, size, and intended quality. Welding defects may occur either outside or inside the weld metal. Some of the defects may be allowed if the defects are under permissible limits but other defects such as cracks are never accepted Types Welding defects can be classified into two types as external and internal defects.

1.2 SPUTTERING

Sputtering is a physical process in which atoms in a solid state are released and pass into the gas phase by bombardment with energetic ions (mainly noble gas ions). Sputtering is usually understood as the sputter deposition, a high vacuum-based coating technique. Furthermore, Sputtering in surface physics is used as a cleaning method for the preparation of high purity surfaces and as a method for analyzing the chemical composition of surfaces.

1.2.1 PROCESS OF SPUTTERING

The principle of Sputtering is to use the energy of a plasma (partially ionized gas) on the surface of a target (cathode), to pull the atoms of the material one by one and deposit them on the substrate. To do this, a plasma is created by ionization of a pure gas (usually Argon) by means of a potential difference (pulsed DC), or electromagnetic excitation (MF, RF); this plasma is composed of Ar+ ions which are accelerated and confined around the target due to the presence of a magnetic field. Each ionized atom, by striking the target, transfers its energy and rips an atom, having enough energy to be projected to the substrate. The plasma is created at relatively high pressures (10-1 - 10-3 Pa.), but it is necessary to start from a lower pressure before the introduction of Argon, to avoid contamination due to the residual gases. The diversity of sputtering target shapes (circular, rectangular, Delta, tubular...) and the materials used allows creating all types of thin layers, including alloys during a single run.

2. LITERATURE REVIEW

Wei Huang &Radovan Kovacevic et al. "Development of a real-time laserbased machine vision system to monitor and control welding processes" Measurement of weld joint geometrical features, seam tracking, and 3D profiling thorough ANN algorithm to predict the defects of various welding process.
G. Senthil Kumar et al. "Vision inspection system for the identification and classification of defects in MIG welding joints" In thorough ANN algorithm to improve the efficiency upto 95% accuracy of defects prediction.
Waldemar Alfredo Monteiro et al. "Nitriding Process Characterization of Cold Worked AISI 304 and 316 Austenitic Stainless Steels" In the studied materials, two distinguished layers are observed in the microstructure, one formed by the austenite due to the presence of N atoms followed by another layer formed by the austenite due to the presence of C atoms.
Seong-min Kim et al. "Vision Based Automatic Inspection System for Nuts Welded on the Support" In thorough image processing and lab view algorithm to improve the efficiency and accuracy of defects prediction in laser welding process.
R Hartl et al. "Prediction of the surface quality of friction stir welds by the analysis of process data using Artificial Neural Networks" In thorough image processing and artificial neural network algorithm to improve the efficiency and accuracy of defects prediction in friction stir welding process. accuracy could be improved slightly to 88.0%.
Wael Khalifa et al. "Classification of Welding Defects Using Gray Level Histogram Techniques via Neural Network" In thorough the image processing and artificial neural network algorithm to improve the efficiency and accuracy of defects prediction in MIG welding process. Accuracy could be improved slightly to 94.5%.
Seong-min et al. "Automatic inspection system of Welding Defects Using Radiography Techniques via Artificial Neural Network in MIG Welding process" thorough the image processing and artificial neural network algorithm to improve the efficiency and accuracy of defects prediction in MIG welding process. Accuracy could be improved to 80%.

3. VISION PROCESSING

Processing is the mechanism for extracting information from a digital image and may take place externally in a PC-based system, or internally in a standalone vision system. Processing is performed by software and consists of several steps. First, an image is acquired from the sensor. In some cases, pre-processing may be required to optimize the image and ensure that all the necessary features stand out. Next, the software locates the specific features, runs measurements, and compares these to the specification. Finally, a decision is made and the results are communicated.

Since vision systems often use a variety of off-the-shelf components, these items must coordinate and connect to other machine elements quickly and easily. Typically this is done by either discrete I/O signal or data sent over a serial connection to a device that is logging information or using it. Discrete I/O points may be connected to a programmable logic controller (PLC), which will use that information to control a work cell or an indicator such as a stack light or directly to a solenoid which might be used to trigger a reject mechanism. Data communication by a serial connection can be in the form of a conventional RS- 232 serial output, or Ethernet. Some systems employ a higher-level industrial protocol like Ethernet/IP, which may be connected to a device like a monitor or other operator interface to provide an operator interface specific to the application for convenient process monitoring and control. While many physical components of a machine vision system (such as lighting) offer comparable specifications, the vision system algorithms set them apart and should top the list of key components to evaluate when comparing solutions. Depending on the specific system or application, vision software configures camera parameters, makes the pass-fail decision, communicates with the factory floor, and supports HMI development.

Different types of Machine Vision Systems Broadly classified into, there are 3 categories of machine vision systems: 1D, 2D and 3D. 1D vision system 1D vision analyses a digital signal one line at a time instead of looking at a whole picture at once, such as assessing the variance between the most recent group of ten acquired lines and an earlier group. This technique commonly detects and classifies defects on materials manufactured in a continuous process, such as paper, metals, plastics, and other non-woven sheet or roll goods, as shown in figure 3.1.

Most common inspection cameras perform area scans that involve capturing 2D snapshots in various resolutions, as shown in Figure 11. Another type of 2D machine vision–line scan–builds a 2D image line by line, as shown in Figure 3.2.

3D machine vision systems typically comprise multiple cameras or one or more laser displacement sensors shown in figure 3.3. Multi-camera 3D vision in robotic guidance applications provides the robot with part orientation information. These systems involve multiple cameras mounted at different locations and “triangulation” on an objective position in 3-D space.

In contrast, 3D laser-displacement sensor applications typically include surface inspection and volume measurement, producing 3D results with as few as a single camera. A height map is generated from the displacement of the reflected lasers’ location on an object. The object or camera must be moved to scan the entire product similar to line scanning. With a calibrated offset laser, displacement sensors can measure parameters such as surface height and planarity with accuracy within 20 µm. Figure shows a 3D laser displacement sensor inspecting brake pad surfaces for defects.

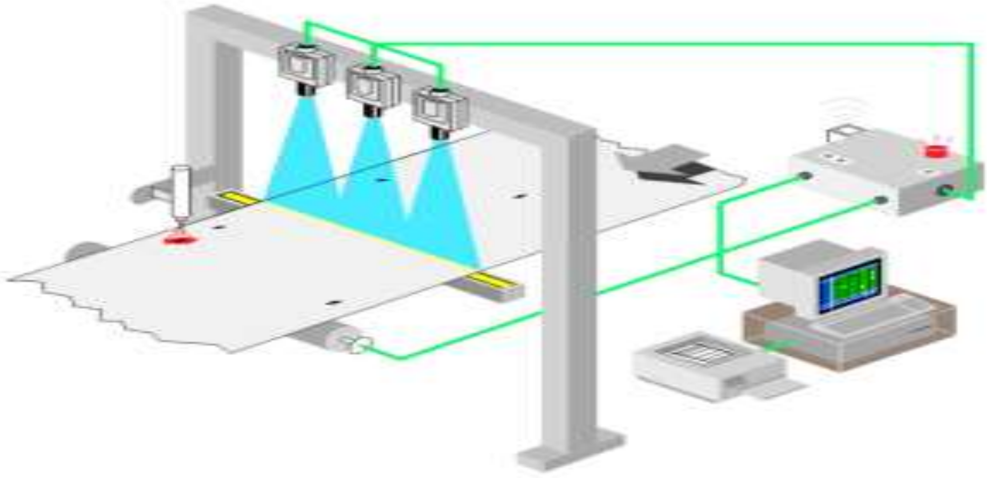

Fig 3.1. 1D Vision System

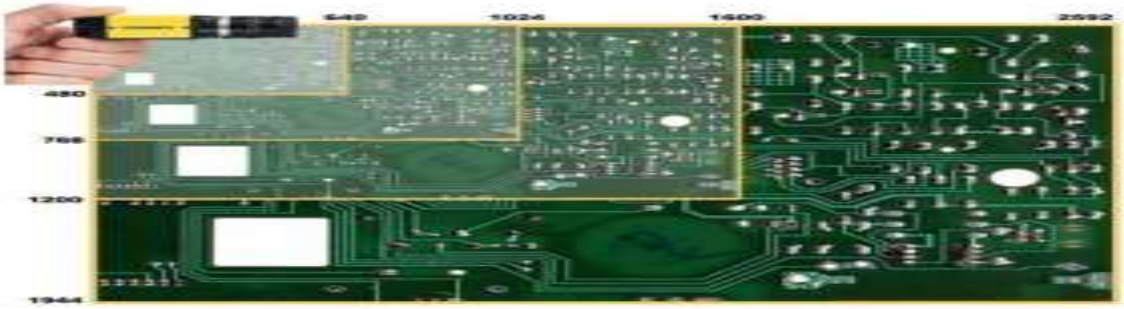

Fig 3.2. 2D Vision System

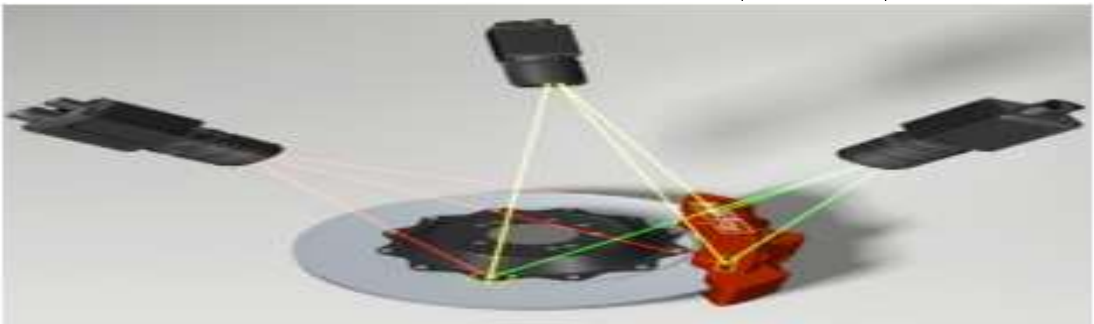

Fig 3.3. 3D Vision System

Fig 3.4 3D Laser Displacement Sensor

3.1 CONVENTIONAL TESTING METHODS - NON DESTRUCTIVE TESTING (NDT)

Non-destructive testing (NDT) is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system for characteristic differences or welding defects and discontinuities without causing damage to the original part.

Types of Non-Destructive Tests for Weld testing and inspection

Visual inspection (VT) Radiographic testing (RT) Ultrasonic testing (UT) Magnetic particle testing (MT) Liquid penetrant testing (PT) Eddy-current testing (ET) Phased Array (PA) Time of flight diffraction (ToFD)

Principle Of Liquid Penetrant Testing

The principle of liquid penetrant testing is that the liquid penetrant is drawn into the surface-breaking crack by capillary action and excess surface penetrant is then removed; a developer (typically a dry powder) is then applied to the surface, to draw out the penetrant in the crack and produce a surface indication.

Surface defect	Application of penetrant	Removal of penetrant and application of developer	Crack indication

4. CONCLUSION

Test procedures were employed with the welding and Machine vision, Image Processing Analysis tests at ASTM standards. Vision measurement result compare with the NDT Technique like LPT. So we decide to predict the welding defect by vision system model, for producing high accuracy result compared to the conventional Inspection Testing Methods.

The accuracy of this method will achieve the more than 96%, it may acceptable in industries point of view. So, we can inspect the surface defects of the welding specimen in very fast manner and also short period especially in mass production industries can inspect their entire welding specimen using our proposed method.

REFERENCES

A. Karnik, "Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP," M. Eng. thesis, Indian Institute ofScience, Bangalore, India, Jan. 1999.

FLEXChip Signal Processor (MC68175/D), Motorola, 1996.

Hartl, R., Praehofer, B. and Zaeh, M.F., 2020. Prediction of the surface quality of friction stir welds by the analysis of process data using Artificial Neural Networks. Proceedings of the Institution of Mechanical Engineers, Part L: Journal of Materials: Design and Applications, 234(5), pp.732-751.

Huang, W. and Kovacevic, R., 2012. Development of a real-time laser-based machine vision system to monitor and control welding processes. The International Journal of Advanced Manufacturing Technology, 63(1-4), pp.235-248.

J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Renocongestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.

Khalifa, W., Abouelatta, O., Gadelmawla, E. and Elewa, I., 2020. Classification of Welding Defects Using Gray Level Histogram Techniques via Neural Network. (Dept. M.(Production)). Bulletin of the Faculty of Engineering. Mansoura University, 39(4), pp.1-13.

Kumar, G.S., Natarajan, U. and Ananthan, S.S., 2012. Vision inspection system for the identification and classification of defects in MIG welding joints. The International Journal of Advanced Manufacturing Technology, 61(9-12), pp.923-933.

Li, Y., Yu, B., Wang, B., Lee, T.H. and Banu, M., 2020. Online quality inspection of ultrasonic composite welding by combining artificial intelligence technologies with welding process signatures. Materials & Design, 194, p.108912.

"PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.

WaldemarAlfredoMonteiro et al. 'Nitriding Process Characterization of Cold Worked AISI 304 and 316 Austenitic Stainless.

Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, IEEE Std. 802.11, 1997.

Zapata, J., Vilar, R. and Ruiz, R., 2012. Automatic inspection system of welding radiographic images based on ANN under a regularisation process. Journal of Nondestructive Evaluation, 31(1), pp.34-45.