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Evaluation of Weld Bead Mechanical Properties Using Image Processing during Destructive Testing by Multivision Technique

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Abstract

Pulsed Gas metal arc welding (P-GMAW) is usually used fabrication course in industries. By melting constantly fed current-carrying wire P-GMAW achieves combination of metals. P-GMAW needs consistent, high- quality welding procedures, to obtain good quality of weld and productivity. This need is due to continuous control metal transfer that is necessary in P-GMAW for thin metal work pieces. This paper explores how image processing could be useful in evaluation of mechanical properties by destructive testing of MS ASTM A 106 B grade material weld bead. Image features like height and area of weld bead have been extracted for different loading conditions using image processing by multivision technique. The vision technique plays a substantial role in quality inspection and process monitoring in the industries. This technology enhances the edge recognition, pixel processing in a reliable manner. The quality and productivity of the weld bead are consistently accomplished during fabrication process in the industries. The weld bead images taken during tensile testing on MS ASTM A 106 material are analysed by considering region of interest in the weld bead. From the study it is found that multivision is capable to quantify the parameters associated with soundness and performance of welded joints and the established trend using image processing features is correlating well with traditional measurement. Considering the results gained the fabrication process can be used in advanced processing industries.

Keywords; *P-GMAW, MS ASTM A 106, Multivision, Destructive test.*

I. INTRODUCTION

In advanced manufacturing industries, P-GMAW is one of the leading welding processes, which makes conventional welding process a significantly controllable process. In pulse current gas metal arc welding (P-GMAW) process, the current is periodically modulated between a relatively low base current and high peak current. Pulsed Current Metal Inert Gas Welding is commonly used for root pass welding of tubes and pipe welding. The main setting parameters which influence weld quality or wire melting are background current (Ib), peak current (Ip), background time (Tb) and peak time (Tp) which is depicted in Fig. 1. To increase the productivity and lower the cost in today's welding inspection image processing by multivision technique is widely used. Weld beads are usually subjected to destructive tests such as tensile, toughness and bend for assessing the suitability of weld joint for a particular application. The researchers introduce machine vision and image processing techniques, in the welding processes for proper assessing of weld beads. The most commonly used industrial vision sensor is the monochrome camera, which acquires visible light intensities from black to white in various shades of grey. Monochrome cameras are used in industrial applications not requiring colour information to perform the required task.

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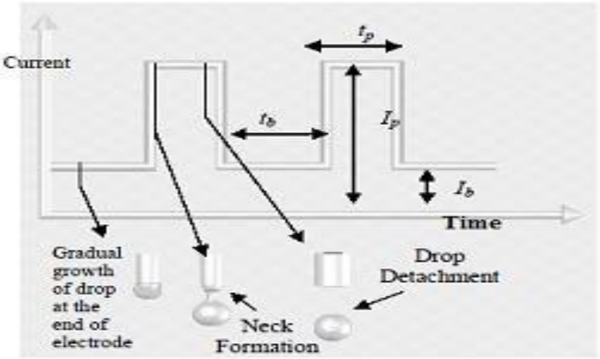

Fig.1: Pulse metal transfer phenomenon

Some researchers have proposed a dual vision and spectroscopic sensing approach to trace narrow gap butt joints during laser welding. An image processing algorithm of the camera recordings have been developed in order to estimate the laser spot position relative to the joint position. The individual performances of these two systems have been experimentally investigated and evaluated offline by data from several welding experiments. Results indicate that a combination of the information provided by the vision and spectroscopic systems is beneficial for development of a hybrid sensing system for joint tracing [1]. Few researchers have proposed a machine vision method for weld defect segmentation using the Least Probability Weighted Background Group (LPWBG), an improved version of Otsu's method. The results reveal that the proposed method provides satisfactory segmentation results over the others [2]. Some researchers have worked on a vision-based weld pool boundary extraction and width measurement during key hole fiber laser welding. A complete weld pool boundary extraction algorithm was developed based on the local maximum gradient of greyness searching and linear interpolation, which efficiently resisted the potential imaging noises. The validations with the experimentally measured weld pool widths and predictions by the three-dimensional multi-phases model proved effectiveness with monitoring method [3]. Some have discussed the application of computer vision technology for real-time seam tracking in robotic Gas Tungsten Arc Welding (GTAW) and Gas Metal Arc Welding (GMAW). By analysing the features of weld images, a new and improved edge detection algorithm was proposed to detect the edges in weld images for more accurately extract the seam and pool characteristic parameters. Results showed that the precision of this vision- based tracking technology can be controlled to be within ±0.17 mm and ±0.3 mm in robotic GTAW and GMAW respectively [4]. Some researchers have studied the fatigue analysis of marine welded joints by means of Digital Image Correlation (DIC) and Infrared Thermography (IR) images during static and fatigue tests. Static tensile and fatigue tests were carried out on butt welded specimens, made of0SS 355 steel. The value of the fatigue limit obtained by the traditional procedure was compared with the values predicted by means of the thermographic method during stepwise succession fatigue tests and by means of the infrared thermography technique during static tensile tests. The predicted values are in good agreement with the experimental values of fatigue life [5].

EXPERIMENTAL SETUP

Pulsed Current Lorch welding machine is used to conduct a trail having 400 amperes maximum current with air type cooling and automated welding set up. Automated Metal Inert Gas torches as well as automatic wire feeding units have provided in this welding machine. Based on Taguchi L27 orthogonal array, experiments were conducted. The specifications for the test specimens are having dimension of 22 mm inner diameter, 25 mm outer diameter with 3 mm wall thickness. Each test specimens are cut in to 150 mm each length and tack welded before welding. Edge preparation was done with 45o angle. Welding process was carried out by using CO2 (15%) and Argon (85%) gas mixture for shielding. The working ranges for the process parameters were selected based on expert's advice, literature review and with the American Welding Society (AWS) hand book. Single pass welding was performed on SS 316L pipes material by varying the process parameters as shown in Table 1.

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Welding and destruction (tensile test) experiments are shown in Fig. 2 and Fig. 3 respectively.

Table.3. Control factors and their level

Sl no	Input parameters	Units	Levels		
			1	2	3
1	Current	amp	60	65	70
2	Gas Flow Rate (GFR)	Ltrs/min	14	15	16
3	Wire Feed Rate (WFR)	mm/min	90	100	110

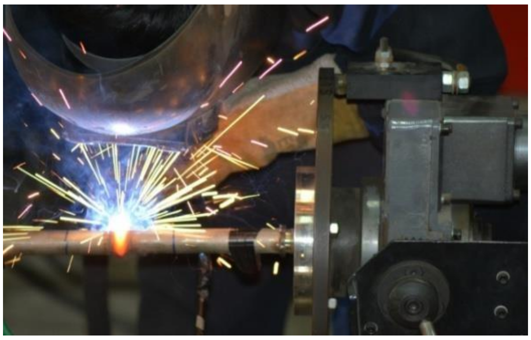

Fig. 2. Experimental setup

Fig. 3. Experimental setup for destructive testing

Fig. 2 and Fig. 3 show welding and destructive (tensile) experimental set up. Ultimate Tensile Strength and weld bead strength of the weld bead is the objectives. For the calculation of the responses i.e., tensile test was performed using Advanced Universal Testing Machine as shown in Fig.3 having model number; AI UTS-1000 KN and make Akash Industries. At the time of destructive testing images were captured under different loading conditions from initial weld bead to final fractured weld bead using machine vision system. Captured images will be processed through image processing software. Then trends will be established.

PROCESSING OF WELD BEAD IMAGES USING MACHINE VISION (MV)

The use of machine vision in the visualization of tool status is fairly wide spread in the manufacturing literature. Several researchers have examined the usage of machine vision for the measurement of tool wear as well as surface roughness [5, 6]. In the present study an attempt is made to utilize vision system to monitor weld bead status during destructive testing. Blob analysis is a branch of image analysis that allows identifying groups of pixels (known as blobs) within a grayscale image.

The steps for performing a blob analysis are:

- Capture weld bead image.
- Use enhancement operations on the image to prepare it for blob Analysis.
- Make the blobs clearly identifiable (use a segmentation procedure).
- Select the features to calculate.
- Calculate the features and analyse the results.

Weld bead features: Blob features considered for the present study are area and height. In blob analysis it is assumed that a un calibrated image contains pixels that are 1 unit by 1 unit in size. Therefore, the area of any pixel is 1 unit squared and the height is 4 units. In this case, the area of0a blob is the sum of the pixels in the blob. The height is the total number of pixel sides in the blob, as shown in Fig.4.

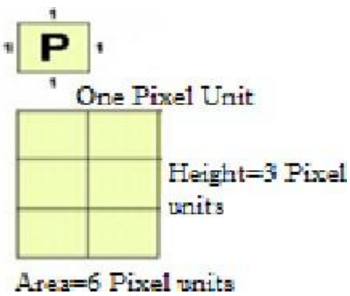

Fig. 4 Area and Height

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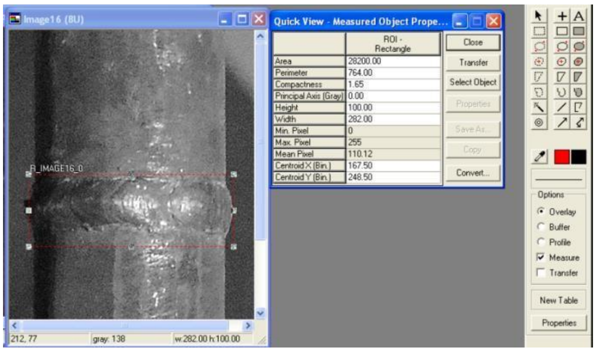
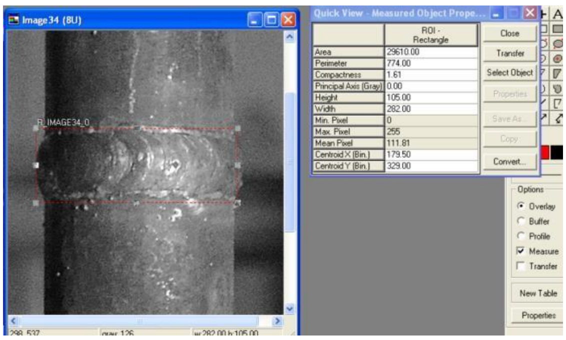
The processing of the weld bead images will be done using view flex image processing software and feature extraction from the images are carried out to obtain features like area, height etc. Due to the increase in area and height of0the weld bead region for corresponding increase in the elongation of actual weld bead for non- optimized welding condition as depicted in Fig.5 (a) to 5 (d)

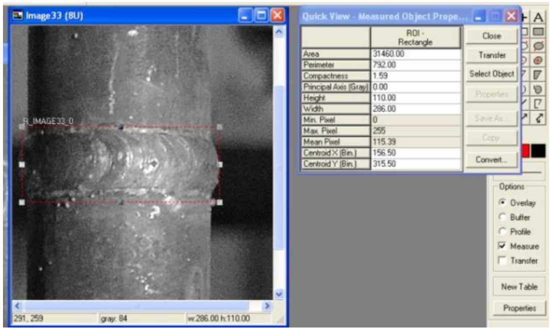
(a)



(b)



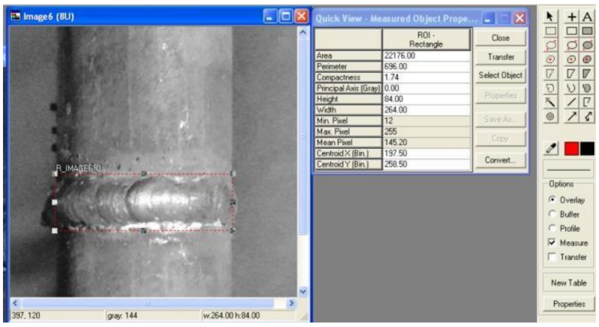
(c)



(d)

Fig. 5: Weld bead images acquired under different loading conditions for non-optimized parameters

The same loading is applied over the weld bead for optimized welding condition. Due to the increase in area and height of the weld bead region for corresponding increase in the elongation of actual weld bead for optimized welding condition as depicted in Fig.6 (a) to 6 (e)



(a)

(b)

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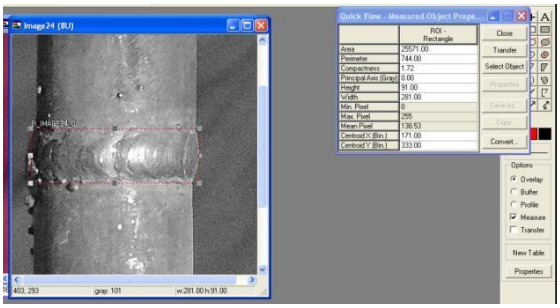

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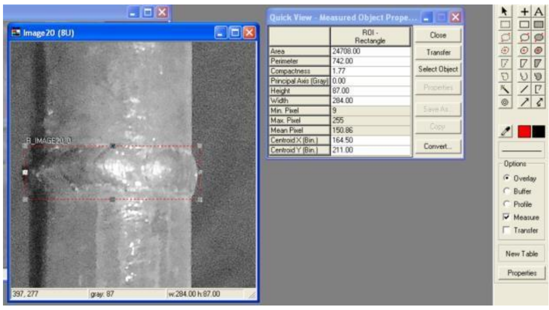
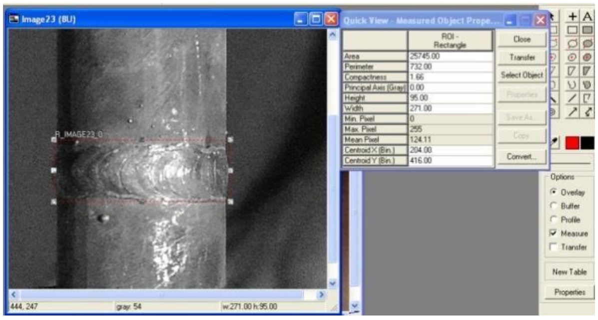


(d)



(e)

Fig. 6: Weld bead images acquired under different loading conditions for optimized parameters

RESULTS AND DISCUSSIONS

The tensile test is carried out on universal testing machine by fixing two extreme ends in between two laws and by pulling specimens to failure. Then dividing the maximum load required during testing by the cross-sectional area. Tensile properties of the weld bead namely Ultimate Tensile Strength (UTS), Yield Strength (YS) and % age of0elongation in weld bead area can be obtained by directly method. The result is plotted against load V/s displacement by direct method is as shown in Fig.7. Tensile tests were carried out to ascertain the UTS on the weld section that is heterogeneous in nature, containing base metal, weld metal and the welded joint using machine vision system. During the test, the tensile load and the elongation of a weld bead was monitored by acquiring series of weld bead images for different loading condition. After processing these images features which characterize the brittle property of specimens. As the load increases weld bead area increases and follows the trend obtained by traditional method is as shown in Fig.8. Similar trends were obtained for other features such as height as shown in Fig.9. From Fig.9 it is inferred that, due to fracture at higher loading condition height values may have gone up, hence machine vision is capable of monitoring the weld bead status during destructive testing efficiently.

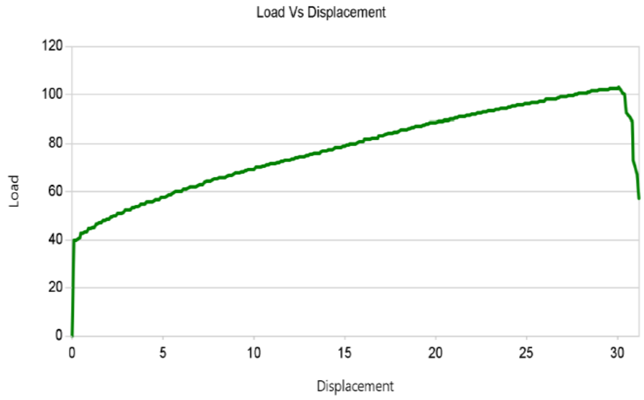


Fig. 7. Trend obtained by UTM machine

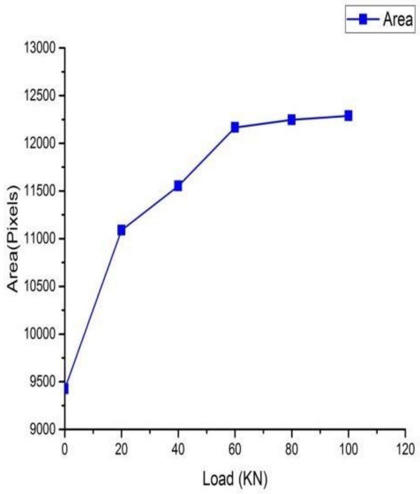


Fig. 8. Weld bead area (Pixels) v/s load (KN)

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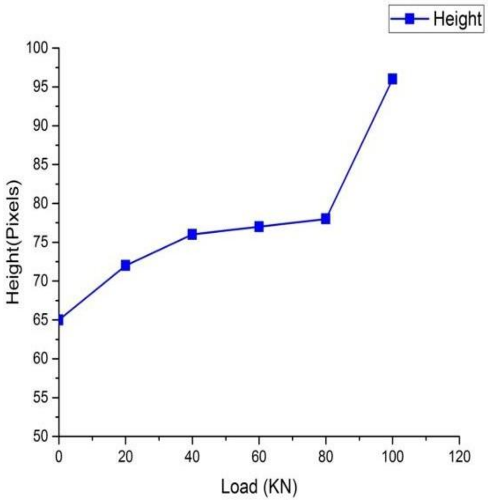

Fig. 9. Weld bead height (Pixels) v/s load (KN)

CONCLUSION

In the present research work, automated testing of weld bead using machine vision is being applied. To determine the tensile strength of the welded joint the samples were prepared as per ASTM standards. As per the trials based on the design of0experiments and to perform tensile testing on Universal Testing Machine, welded specimens were prepared by using the optimized welding parameters. To conduct mechanical testing which includes tensile test, it was observed that there was no fracture in the weldment whereas fractures were originates in the base metals. Tensile test was carried out by gripping the specimen in a universal testing machine (UTM) and applying an increasing pull on to the specimen ends till it fractures. During the test, the tensile load and the elongation of a weld bead were monitored by acquiring series of weld bead images for different loading condition. After processing these images features which characterize the ductile property of specimens. As the load increases weld bead area increases and follows the trend obtained by traditional method. Similar trends were obtained for other features. Hence machine vision is capable of monitoring the weld bead status during destructive testing efficiently.

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REFERENCES

[1] Morgan Nilsen, Fredrik Sikström, Anna-Karin Christiansson, Antonio Ancona, “Vision and spectroscopic sensing for joint tracing in narrow gap laser butt welding”,Optics and Laser Technology, 0030-3992/_ 2017, Elsevier Ltd, Vol. 96, 2017, pp. 107–116.

[2] Muthukumaran Malarvel, Gopalakrishnan Sethumadhavan, Purna Chandra Rao Bhagi, Soumitra Kar, Saravanan Thangavel, “An improved version of Otsu’s method for segmentation of weld defects on X-radiography images”, Optik,0030-4026, Elsevier GmbH, Vol. 142, 2017 pp. 109–118.

[3] MasiyangLuo,YungC.Shin, “Vision-based weld pool boundary extraction and width measurement during keyhole fiber laser welding”, Optics and Lasers in Engineering, 0143-8166, 2014, Elsevier Ltd, Vol. 64, 2015, pp. 59–70.

[4] YanlingXu, GuFang, NaLv, ShanbenChen, JuJiaZou, “Computer vision technology for seam tracking in robotic GTAW and GMAW”, Robotics and Computer-Integrated Manufacturing, 0736-5845, 2014, Elsevier Ltd , Vol. 32, 2015, pp. 25–36.

[5] P. Corigliano, G. Epasto, E. Guglielmino, G. Risitano, “Fatigue analysis of marine welded joints by means of DIC and IR images during static and fatigue tests”, Engineering Fracture Mechanics, 0013-7944, 2017 Elsevier Ltd, V.ol. 183, 2017, pp. 26–38.