

## Review on Vision System in Welding Applications

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### Abstract:

In industries, due to rising demand in mass production and the difficulty in measuring, counting of components, condition monitoring of the real time process need the use of vision system. For example to identify the defects during the welding process and also to check the uniformity in the welding processes online inspection system is required. Similarly the shortage of skilled welders and a need for welds of a consistently high quality requires the help of automated welding systems supported by vision system. These systems will provide consistency and quality and also protect the operator from the hazardous welding environment, satisfying increasingly stringent health and safety regulations.

The objective of this review paper is to study the types of Vision System used in various industries and also identify the opportunity for implementation of vision system in automation of welding process

**Keywords:** Automation, Robotics, Welding, Vision System, Online Method, Offline Method

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## **1.INTRODUCTION**

The visual inspection system is integrated with automated plants having inline process manufacturing and assembling units for the purpose of inspection and monitoring. The inclusion of correct parts, finding defects in product and real time sorting of the parts were carried out with the help of vision system. All the vision system works on non destructive and non-invasive techniques.

The inspection in the sense of product analysis may be defined as the process of determining degree of deviation from a given set of specification it involves measurement and detection of part features from the specimen or image data, this was studied by **Zainul abdin jaffery (2016)**.

**Kamal Pal et al (2010)** recommended the usage of vision system as the present trend in manufacturing demands the joining or welding of materials that are capable of withstanding ever increasing stress and temperature. Unfortunately problems arise due to poor joint strength thus the process is monitored by vision system process.

**Anna et al (2008)** suggested that the high quality of automatic welding processes is usually achieved through constant control of process parameters. The quality weld is achieved by employing vision control. This approach can be based on observation in infrared and also in visible electromagnetic band.

**Jerzy Sladek et al (2012)** recommended that assessing the accuracy of optical based measurement systems is an important task because vision system has recently gained increasing popularity. They are easy to use, accurate, low cost, and a universal tool which used .

## **2.TYPES OF VISION SYSTEM**

The vision system is classified into 4 different types to identify the defects in various applications. They may be classified as,

- Automated optical inspection
- Automated X-ray inspection
- Automated vision system
- Remote visual inspection

## 2.1. AUTOMATED OPTICAL INSPECTION

Automatic or automated optical inspection (AOI) is a key technique used in the manufacture and test of welding component. Automatic optical inspection AOI enables fast and accurate inspection of welding and in particular area to ensure that the quality of welded component is leaving the production line is high and to find out the defects in welding.

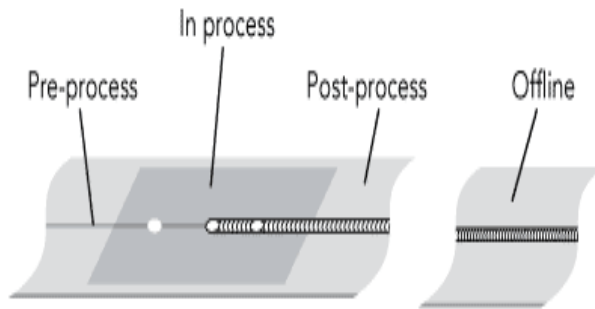


Fig:1 Types of vision system

### Need for Automatic Optical Inspection (AOI)

Despite the major improvement that have been made in modern welding . The introduction of surface mount technology and the subsequent further reductions in size mean that boards held to be in compact size& shape and easily fitted in the required place

## 2.2. AUTOMATED X\_RAY INSPECTION

Automated X-ray inspection is a technology based on the same principle as automated optical inspection (AIO). It uses x-ray as its source instead of visible light, to automatically inspected features which are typically hidden from view.

## 2.3. AUTOMATED VISION SYSTEM

Automated vision system is employed process welding and for quality inspection. It helps to improve the line as well as the quality of the process. Vision system manufacture agrees that the big driver for these automated vision system is the automotive industry as car makers push their suppliers to tighten controls on their process and quality.

## 2.4. REMOTE VISUAL INSPECTION OR REMOTE DIGITAL VIDEO INSPECTION:

It also known as RVI or RDVI, is a form of visual inspection which uses visual aids including video technology to allow an inspector to look at objects and materials from a distance because the objects are inaccessible or it is in dangerous environments.

### **3. APPLICATION OF MACHINE VISION SYSTEM IN WELDING:**

Machine vision is the technology and method used to provide imaging based automatic inspection and analysis for applications such as automatic inspection, process control and robot guidance in the industry

**Melton G et al (2009)** came to a conclusion that vision is capable of producing good image of TIG & MIG welding. For the good result of images light source about 100-250 mm from the torch at angle of 10-20 degree to the horizontal. The camera was positioned at 250-500mm from the torch at an angle of 20-30degree and higher power diodes were required.

**Hangbo Zhao et al (2016)** suggested to use the full laser penetration welding process vision system to detect the keyhole in the work piece ,effective monitoring and control methods to improve the quality of welding.

**C.B.Jiaet al (2016)** carried out study in Underwater environment, which was very complex for the welding process. In underwater welding process bubbles, molten droplet, welding arc were continuously interacts with each other so the visual sensing system was used to capture by developed sensing system.

**Guokai Zhang et al(2015)** suggested the Vision system to monitor the weld pool and the keyhole image during the plasma arc welding. Their automation ignored the inspection costing the industry which is being studied.

**Morten Kristiansen et al (2014)** recommended that vision system was very much useful in the robot welding system. The parameters of the welding process were adjusted automatically. Closed loop fuzzy logic system is improving the welding quality.

**RemigiuszLabudzkiet et al** proposed that machine vision system was mainly used in the manufacturing of semi-conductors, where this system is used for inspection of silicon wafers, microchips, resistor, capacitors and lead frame.

**Sadek C. Absi Alfaro et al (2015)** said that the TIG welding processes is used in application that required high quality and good weld bead surface.

### **4. APPLICATION OF MACHINE VISION SYSTEM IN INSPECTION TASKS:**

**Mohd shah et al (2016)** suggested that the advance technology needed in the automation of production processes and quality control inspection to solve welding quality problem has not yet been completely resolved. The weld defects are inspected by human is a hard and difficult task for many weld. So an identification and classification system of weld defects using X-ray film and CCD camera include an acquisition feature extraction identification of welds and technique is applied. The application that will be studied and researched entries using classifiers and feature will be extracted as a value of geometric parameter of the gray and linguistic description segmented radiographs region.

Normally an automatic welding defect has five level namely image acquisition, pre-processing, weld extraction segmentation and classification of defects image acquisition can be selected from a CCD camera ,CCD scanner X-ray or X-ray film it is often damaged by uneven lighting noise and low contract in the defect area .

**Masiyang et al (2015)** explained that in key hole welding the laser beam is focused on a small spot to obtain a high power density at the surface of work piece. While keyhole welding has been paid much attention and studied extensively, the instability of keyhole and the weld pool still generates some defects during welding process.

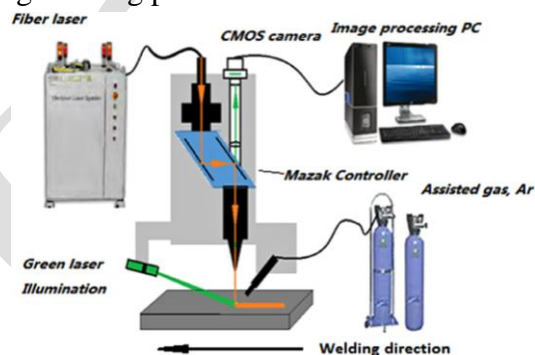


Fig 2.experimental setup for monitoring

To identify the weld defects we are implementing an experimental setup to detect the defect through an CMOS camera, in the keyhole welding the irradiation object is not only the light emission of weld pool but also ionized metal plasma. The wave length is identified from camera and by using that of plotting graph for intensity and wave length .The wave length from 550nm - 650nm is the strongest portion.

According to the collected data the characteristic of the weld pool images are classified, in the head part the existence of keyhole increases the overall brightness nearby so that the region inside the head part of weld pool is much brighter than the other area through that defects are identified.

**Bin Wu et al** suggested to tested by an experiment it consist of monocular vision sensor and CCD camera, through that the pose relationship between monocular vision and the stud is the welded specimen, it is adjusted to make image of the camera parallel to the weld top and bottom surface plane collecting image of weld stud and set the pose as standard reference pose, from the

reference the welded stud are inspected by using an vision sensor to measure the position and attitude of an welded stud and are corrected by changing an attitude of specimen to make an accuracy of online quality inspection.

**Yanling Xu et al(2015)** recommended to design the vision system according to an our feasibility, using vision sensor in robotic welding a dimmer filter system is the key component . It often needs to be removed from CCD camera during welding environment identification and initial seam position guiding, while it must be put under CCD camera during welding.

To perform the real time seam tracking effectively during the robotic welding process whether for robotics GTAW or GMAW the real time welding seam image must be captured clearly and determine the parameter that affect the image capturing. The method is developed based on the Al alloy GTAW and low carbon steel GMAW.

**Zhifen Zhang et al (2015)** suggested by an experiment were performed on an automatic experimental system. It consist of an welding system ,the control and motion system and multisensory signal acquisition system .During the dynamic welding process the light of welding arc is transferred into spectrometer the final data transferred and stored in pc for real time processing through USB with sample period of 35ms which gives detection accuracy of 0.1 mm for welded seam.

The voltage signal was collected by means of a hall sensor used to convert welding current to voltage signal and a protection circuit to isolate the high frequency interference addition the real time vision of welding pool was captured and displayed as an assistant tool based on a CCD camera and a filter-mirror system.

The pre-processing of the signals mainly for voltage and sound signal include three part in peak level bundling of suitable number of sample data and removing DC component. The signal of arc voltage and audible sound acquired would periodically change from peak level to base level due to character of heat input in pulsed GTAW to make an good weld quality.

**Drago Bracun, Alojzlj Sluga (2015)** tested the quality of critical welds and weld deposits significant welding parameter are monitored on line and recorded the welding desired to an standard. The welding path was as the time sequence of the arc position in 3D space. Arc position in 3D space were measured with system of two cameras that simultaneously acquired image of the arc .the camera were separated for a particular distance and rotate for an angle with respect to each other to ensure triangulation geometry. For each camera 8 internal parameters have to be determined the intersection of optical axis with the image ,focal length lens radial distortion and lens tangential distortion. Camera calibration was used in order to calibrate the system of internal and external parameter of weld.

**Yinshui He et al (2015)** tested to detect the future profile of an weld in an online welding process by an visual attention model. The welding system mainly comprises three parts –a



welding robot system a welding equipment subsystem and an image acquisition system. Through testing the classic models in this field such as GBVS model cannot accurately detect the weld seam profile via saliency maps created.

Additionally after being used the prevalent techniques such as wavelet transform, median filtering threshold segmentation and depositing cannot extract the weld seam profile from background.

Therefore there is need for designing a new algorithm to detect the weld seam profile effectively, the future point extraction for multi pass are calibrated.

**Zuming Liu et al (2015)** studied that during plasma arc welding the energy is transferred to the work-piece surface the material at point of energy deposition can be almost immediately melted and molten pool is created. There are various kinds of method are used to monitor the keyhole condition.

The efflux plasma charge sensor measures the electrical potential of the plasma efflux at the exit of the work piece when the key hole established. It can identified the keyhole image under different level of welding current. The keyhole size expands as the welding current increases .the brightness of the keyhole image is also increased with raising welding current. During the whole welding process from arc plasma ignition to its extinction, the keyhole images are captured continuously from the underside of work-piece. The image sampling frequency is 30 frames per second. Then all the captured images at different instants are processed and the four geometric parameters of the keyhole are determined.

**Mitchell Dinham&GuFang (2013)** stated that the welding is one of the most fundamental process in manufacturing and is used to fabricate products from chairs to space station . By using computer vision robotics welding can be given the flexibility and intelligence to be used more widely. Computer vision can be used to identified and located the position of welding seam which can be used to plan a path to weld the part automatically and the image are captured.

After the operation of seam welding the image used to verify the seam identification and localization. The image contains weldment with both straight line and curved joints which are typical to welding application. As can be seen the weld seams run horizontally across the image as opposed to vertically furthermore it can be seen that lighting and contrast also vary between the left and right views.

**Julio Molleda (2012)** studied that the technician inspected each weld visually and manually. During welding they visually supervised the weld formation as they observed the temperature reached along the lap joint. Then they manually tested that the strips were properly joined by hitting the welded lap joint with a hammer. The manual inspection causes a loss of time in the manufacturing process which increases if the weld is defective due to re welding of the strip. In order to obtain the best values for the parameter for a specific manufacturing line, an

experimental design is required. Two set of assessed by the technicians of the galvanizing line were used to identify the weld defects in online welding process.

**G.Senthil Kumar et al (2012)** suggested vision inspection system is required to identify welding defects in the present manufacturing scenario for overcoming certain limitations such as problem of inaccuracy in the images, the instrument is integrate a multitude of technologies including digital imaging digital imaging, electronics, embedded systems and software. By using this technology the types of weld defects to be inspected include defect free welded joint, excess weld in sufficient weld and no weld. Four zones of LEDs with different illumination are used to capture four types of weld joints and processed using RAPID 1V3.4 machine vision system. The weld region must be isolated from the rest of parent metals. Noise on images usually appears as randomly dispersed pixels having different values of intensity in relation to their nearest pixels. Low pass filters are usually employed to remove the noise and extend the technique of fuzzy k-means clustering followed by the cropping mechanism.

### Results & Discussion:

The vision system is the improved technology in the field of inspection of the welded components. It is been fully automated and it is Online so the problems could be identified then and there and it could be rectified simultaneously by changing the parameters. In the continuous machining process also the offline vision system is used to check the parameters such as the dimensions, etc. In the offline vision system the camera and the sensors record the process and after that the defects are rectified by comparing the component dimension with master dimension stored in the computer.

In the recent years the vision system is also integrated with the welding equipments to identify the defects during and after the welding process. In the underground welding process the online vision system is used to monitor the process, if any process parameters changes abruptly the process will be stopped and corrected simultaneously and the process is carried out with the suitable process parameters. In any type of traditional welding process, the offline vision system is used to check the weld bead size, length of the weld etc

The vision system is the easiest way of monitoring the process while it is done online, since the defects are being rectified simultaneously and welding process is carried out continuously and quickly.

The advantage of Online vision system while implementing in the continuous process is if any process parameter changes occurred in welding, it will be identified in the initial stage itself, and the whole process is rectified immediately to avoid any interruption in welding process. On the other hand, when it comes to offline vision system, the process is being recorded and if there are changes in the parameters required it is identified only at the last stage and the parameter changing can be done only for the next component.

Similarly taking corrective action for the offline process is also difficult but the advantage is system setup is cheap when compared to the online vision system. Due to the



current demands in the industry and also to take corrective action immediately for the welding process, the online vision system is encouragable since the process is monitored and corrected simultaneously.

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