ADVANCED IMAGE PROCESSING TO SET WELDING HEAD POSITION

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Abstract

The thesis deals with the control of setting the position of the welding head on the line welded tubes with spiral weld. The industrial line is located in the premises of large metallurgical company in Silesian region. It is able to produce tubes in the diameter range from 323.9 mm to 820.0 mm. The tubes are manufactured according to the world standards (ISO, EN, API, DIN, ASTM, NF, BS, GOST, ČSN, etc.). The current low-level solution is expanded by the laser system which consists of three separate lasers, one linear laser and two spotted lasers which get information about material position and future weld position. Information from laser system are processed to setting position of the welding head by image processing, applying color filters to get clear data and in the end applying special algorithms to get the optimal position of welding head. Also information is showed in image of camera output for line worker.

Keywords: Line weld, spiral weld, welding head, laser

1. INTRODUCTION

Worldwide demand for spiral pipelines is increasing mainly due to the continuous development of the petrochemical industry. Therefore, the demands for reliability and speed of production are increased, especially to reduce the loss and error rate of production. Small defects can be tolerated, but must be corrected manually, resulting in time lags and depletion of the worker. Greater defect means losing the whole pipe or at least a large part of it. These mistakes give businesses millions of millions of losses on material, time, and reputation. For these reasons, companies generally try to replace the human factor with an automated system that only man controls and controls. An appropriate solution to the manufacturing process increases reliability and reduces loss. [1,2]

2. CURRENT SOLUTION OF WELDING STATION

The welding station contains a number of automated and regulated technologies, mostly in welding. This means electrode guarding, welding current, temperature and other technological parameters. However, the welding station currently lacks an automatic setting, or at least a welding head position check. This control is currently provided purely manually. The operator of the welding station only controls the settings visually by using a custom view. This is particularly problematic with respect to emitting light radiation during welding. The operator knows the correct setting of the welding head only at the point where the weld is either correctly positioned or badly made. This kind of setup check is inappropriate. Since the error is detected only

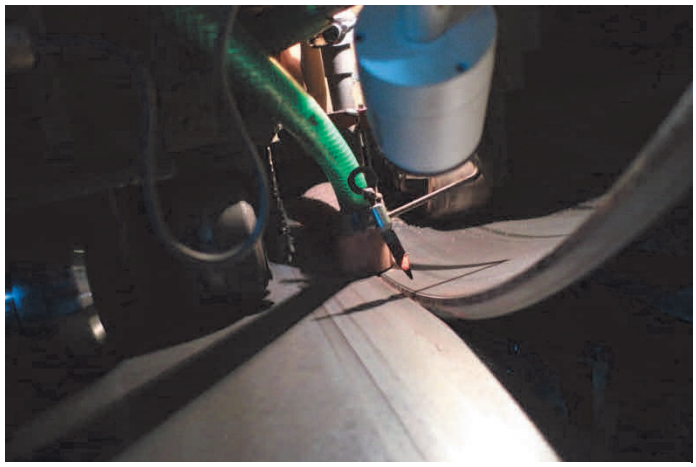

Figure 1 Current solution of welding station [own study]

after welding, this leads to the loss of product. For these reasons, operators have helped with their ingenuity. Before the welding head, they placed an industrial camera in front of which a steel line is placed. This trivial solution is in the **Figure 1**. [3,4]

This line indicates the required position of the gap between the sheets, the so-called **welding point**. After this adjustment, the position of the head was checked prior to welding, which led to a significant reduction in the wrong positioning of the welding head and thus reduced scrap. [5]

However, the solution is not ideal from the point of view of reliability because it requires the operator's constant attention and, in particular, some experience with the line. Only an experienced operator recognizes the correct position of the welding head with the naked eye. The recording from an industrial camera according to which the operator sets the position is shown in **Figure 2**. [6]

Figure 2 Recording from an industrial camera in current solution [own study]

3. EXPANSION OF THE SYSTEM

Implementation requirements were a limiting price. For this reason, it was proposed to change the control system of the existing system, where the optical sensor in the form of an industrial camera was retained. The existing line has been removed from the system, and instead, the optical sensor has been extended by a laser system. The laser system consists of three separate lasers, one laser being linear, and the remaining two lasers are spotted (shown in **Figure 3**).

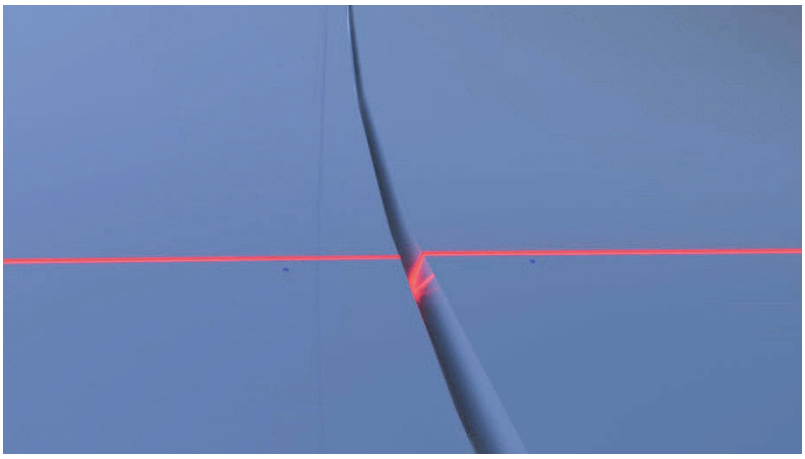

Figure 3 Visualization of the lasers system [own study]

The laser system serves to simplify and refine the positioning of images in the image. Blue point lasers are firmly connected to the positioning mechanism of the welding head. This indicates the position of the welding head. Line red laser is located with an optical sensor or just like point lasers. The Raspberry Pi 3 mini computer is processing the image information. [7]

4. PROCESSING OF IMAGE INFORMATION

When processing the image information, the position of the welding head and the desired welding point is determined. The required welding site is the center of the gap between the angled plates. The gap indicates the interruption of the line laser. The center of the gap then lies at the center of the interruption. Point lasers are set so that the position of the welding head is centered between two-point lasers. The positioning algorithm allows for calibration, which makes the laser installation precision difficult. The centers can be calibrated, i.e. virtually offset.

The image processing algorithm uses the open-source Aforge library to optimize image processing. To identify the center of the gap, only the red channel is first filtered (**Figure 4**). A convolutional mask is designed for this treated image, which is designed not to take into account vertical glare. The result can be seen in **Figure 5**.

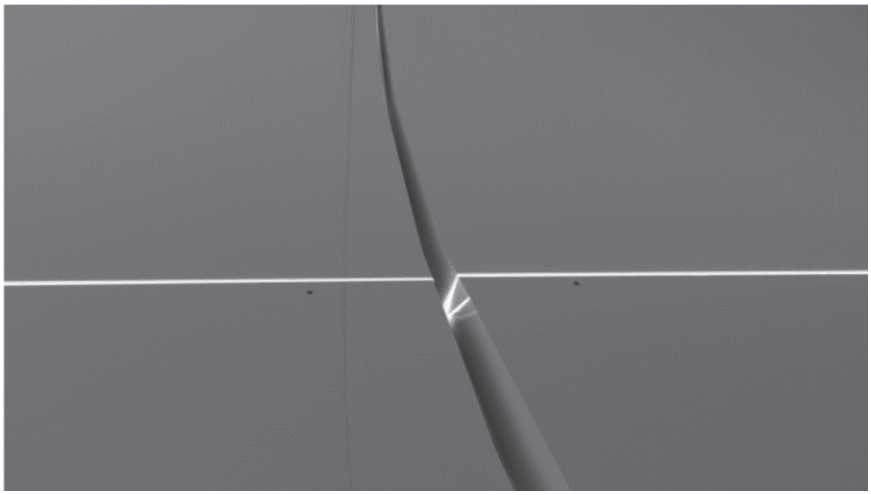

Figure 4 Image of filtered red channel [own study]

Figure 5 Image of finding the linear laser [own study]

Instead, a blue channel is used to identify point lasers (**Figure 6**). The filter threshold is used for filtering. It only takes pixel values that have a higher value than the one set in the filter. The result can be seen in **Figure 7**. [8]

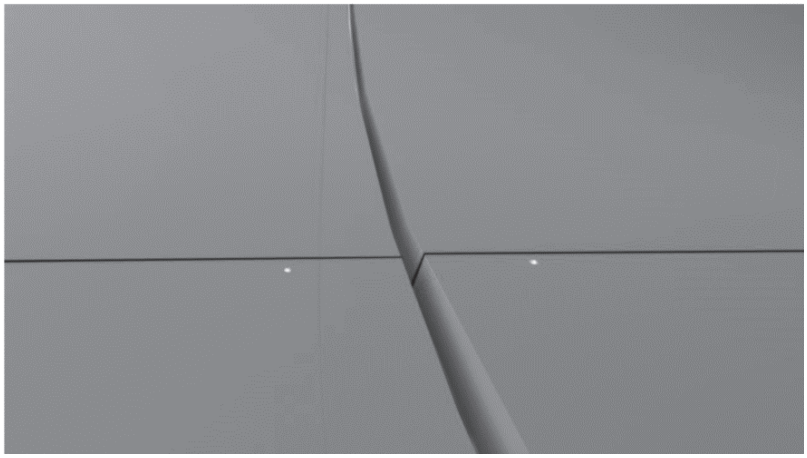

Figure 6 Image of filtered blue channel [own study]

Figure 7 Finding two-**point** lasers [own study]

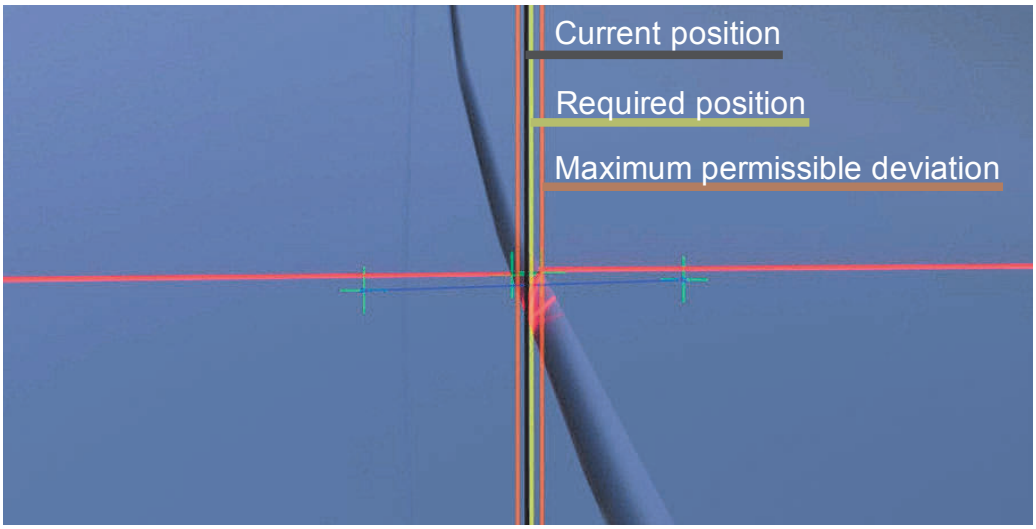

Figure 8 The resulting view for the operator [own study]

Once the positions are determined, the image is expanded by the information that has been detected. The current position of the welding head, the position of the welding head and the deviation from the desired position are displayed. The operator is also presented with recommendations for position compensation, and the operator is warned when the deviation is disproportionate. The output image for the operator is shown in **Figure 8**.

CONCLUSION

Replacing an existing solution will lower the operator's attention. Provides the operator with clear information about the position of the welding head and its deviations from this position. It will then provide a correction recommendation. In the event of an ever-increasing or unacceptable deviation, the operator alerts, thus increasing the overall quality of the operation, reducing the scrap and thus the production costs.

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