WATCH THE WELD

by Molly McCormack Moody, editorial assistant

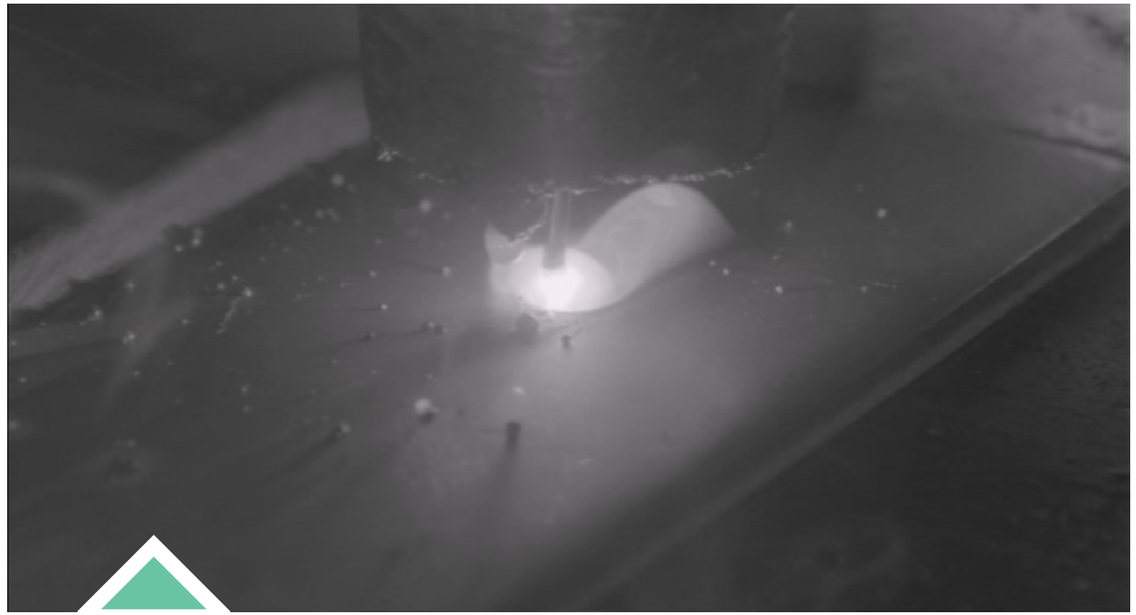
Weld inspection cameras – understanding the options to make the right choice

Since the introduction of robotic welding in the 1980s, operators have needed to monitor the automated welding process to ensure that it was running appropriately. Monitoring the welding process meant operators needed to be directly in view, relying on welding helmets and protective screens to hide them from the harmful radiation coming from the weld arc. Understanding the many downsides to monitoring in close proximity, welding shops started to explore alternative solutions, utilizing the latest camera technology to create weld inspection cameras.

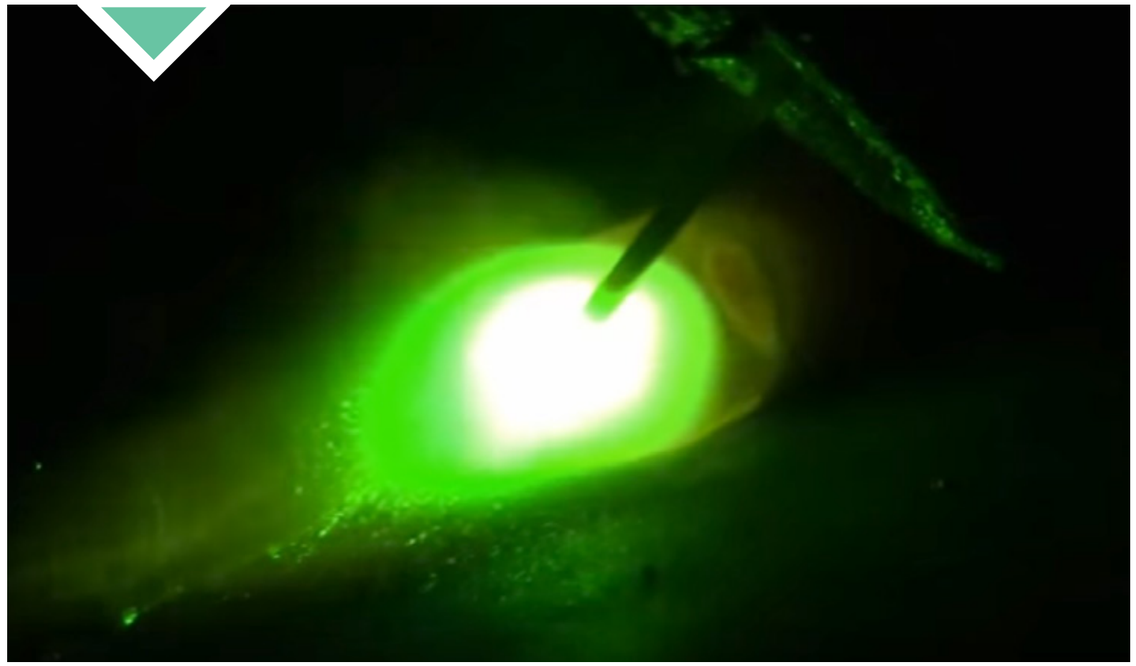
Xiris Automation Inc., developers of optical systems for quality control, explains various methods and technologies available for weld inspection cameras currently on the market. The company discusses cameras with optical filters, rapid imaging with various exposures, photochromic imaging and specialized sensors, outlining the pros and cons of each solution.

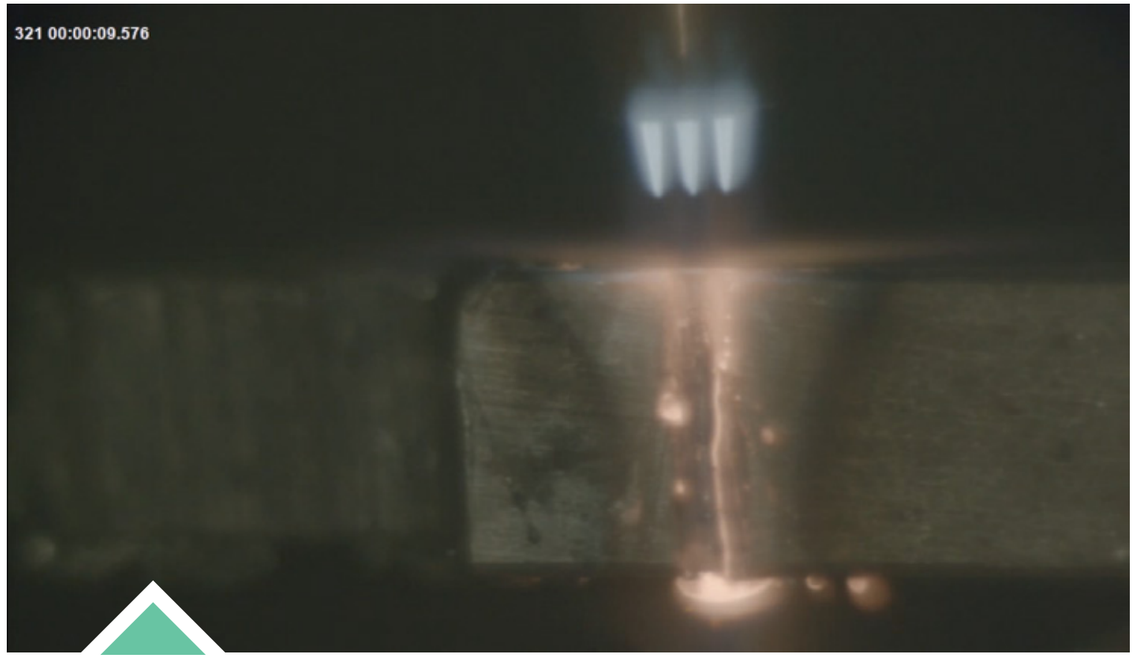
GOOD, BETTER, BEST

While the market provides a range of options for weld inspection cameras, Xiris notes that most of them are unable to truly provide clear images due to overexposure or underexposure. Most standard cameras are only able to capture a range of brightness of about 1,000:1 in an image. A serious issue considering the range of brightness near an open arc weld exceeds 10,000,000:1.



On the top, an image of a weld taken by a Xiris weld inspection camera. On the bottom, an image of a weld taken by a standard camera with darkening filters. Note the large difference in the amount of detail visible in both the background and at the weld arc.





On the top, an image of oxyacetylene cutting taken by a Xiris weld inspection camera. On the bottom, an image of oxyacetylene cutting taken by a standard camera. With the Xiris camera, users are able to see great detail throughout the cutting flame, whereas the standard camera simply saturates and blooms.

First attempts to capture high dynamic range (HDR) images were performed with cameras equipped with dark, non-removable filters. While the weld arc was visible, operators were unable to monitor the background. To remedy this, a dark spot filter was implemented to obscure the brightest part of the weld arc in order to provide better visibility. Although it was an improvement, the end result relied so heavily on the accuracy of the alignment of the spot filter that the potential for error was greater than the results received.

In recent years, weld inspection cameras have been utilizing a non-optical technique to capture HDR images that combines multiple images taken extremely quickly with different exposures using a tone mapping operator. Formally known as the Wyckoff method, the rapid imaging works well with slow-changing scenes, but it is unfortunately not fast enough for the quick-changing nature of a weld arc. To make it work effectively, there needs to be a smooth frames-per-second video rate to provide enough frames to be mathematically combined, often resulting in high-cost computer and electronics hardware.

Welding inspection cameras with photochromic optics provide an all-optics solution. The lenses work similarly to transition eyeglass lenses, darkening in the sunlight then going clear in the dark. But, much like the eyeglasses, the rate at which the camera lenses can adapt to the changing light is not fast enough. Photochromic optical cameras can be combined with knee point cameras to produce some HDR images, but the possibility for pixel blooming and saturation around bright pixels is incredibly high.

NEW KID ON THE BLOCK

While the options outlined provide some results, it's apparent that the solutions cannot yield consistently clear, full-view, real-time images without some inherent errors. Luckily, in recent years, technology utilizing complementary metal-oxide semiconductor (CMOS) sensors, designed with photo-voltaic pixels, has been introduced into the market place. These sensors offer natural logarithmic responses that do not

In this video, Xiris weld inspection cameras capture manual TIG welding on a rotary pipe in the vertical up position.

saturate and eliminate any blooming effects because there is no excessive accumulation of charge when exposed to high levels of light.

According to Xiris, the pixels deliver a voltage proportional to the logarithm of illumination with exceptional accuracy, providing a dynamic range greater than 160 dB, among the highest ranges of HDR imaging. HDR imaging is perfect for resolving the extremely bright levels of light in a weld arc, while also resolving the surrounding, darker area, in the same image.

Of course, the sensor solution is not without its own small nuance. Background noise can throw the sensors off, but special, advanced background noise compensation can minimize the issue and reduce the overall impact on the image quality. The algorithm makes the sensors able to view a scene at normal, dark and light conditions while simultaneously viewing a bright object without any changes. In other words, the technology allows the operator to view the weld arc and the puddle as well as the background material.

BEST FOR BUSINESS

With an understanding of which product is best for overall performance, it is equally as important to evaluate the true business benefits that result from shops utilizing weld inspection cameras. In conjunction with its discussion of the specifics of the camera technology, Xiris takes a deep dive into the true value of ownership of a camera.

Employing a weld inspection camera to monitor the welding process in real time means an operator does not need to be in the direct weld area, greatly increasing occupational health and safety. By removing the operator from the weld environment, chances for electric shock, welding fume inhalation, welding eye and other work-related issues decrease drastically, resulting in fewer sick days, reduced legal liabilities and a healthier, happier operator.

Along with a happier employee, the weld inspection cameras provide operators with better monitoring of inputs and greatly reduce setup times. A camera also increases the arc-on time by providing less need for the operator to stop during the process to make adjustments. Companies that utilize a weld inspection camera also cite reduced scrap and increase in profits due to the enhanced ability to quickly troubleshoot an issue in real time and identifying what is most likely causing defects as they occur. Through a direct view of the weld arc, operators can make adjustments immediately.

In addition to providing valuable real-time, immediate benefits, weld inspection cameras are capable of recording live video of the welding operation. The recording can provide a review for quality assurance purposes, weld verification and better understanding of what is and isn't working during the process. The video is also ideal for educational purposes, training and analysis. ■

XIRIS AUTOMATION INC.