VIDEO INSPECTION WITH PROVEN STROBOSCOPIC LIGHTS PROVIDE MORE EYES AND REDUCED COST[1]

Proven Strobe Lights Help Mills Utilize Latest Image Capture Technology

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Abstract

Advances in industrial machine vision and PC technology are finding their way into a new generation of video inspection systems for steel mills. New image capture hardware, including digital video cameras and digital storage systems, combined with more powerful drivers and software, are upgrading current camera and inspection stations to allow inspectors to see more. Stroboscopic Lights, proven to effectively and economically reduce scrap and rejection rates, are now being teamed with new video technology. The results allow inspectors to more efficiently see various points in the rolling process from one location. The new upgrades have created systems capable of recording detailed images with fewer cameras and providing more detailed playback expanding the advantages already established. The new equipment continues to rely on ever-present strobe light systems whose capabilities keep pace with today's technological advances. The marriage of proven stroboscopic visual inspection to state of the art mega-pixel image acquisition and viewing hardware now enables mill personnel make even greater use of their experience to find defects as small as 1 to 2mm from a distance of 2 to 2.5 meters.

1 *Paper presented at 42th Rolling Processes, Rolled and Coated Products Seminar of ABM; Santos, SP, October 25 to 26, 2005.*
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The advancements in technology have increased the advantages of older video inspection systems by creating a clearer picture for steel mill operators and inspectors. They now have access to improved upgrades to their remote video inspection systems and enabling them to view more of their value-added production lines in more locations without additional manpower. While remote video capability is nothing new in the world of surface inspection, improved camera technology has provided much better resolution and a wider field of view than previous generations of cameras. In addition, the open architecture of a PC-driven image acquisition system allows for viewing and/or post processing software to be installed on the Windows-based computers now commonly found in many steel mill production environments.

The new image capture and editing technologies continue to rely on the ever-present industrial strobe lights found in steel mills worldwide for surface quality inspection. By upgrading older systems with the latest electronics, inspectors can see smaller defects more readily, eliminate mechanical panning units (which have been a sorce of maintenance problems) and be able to view entire strip widths with clearer images to correct problems faster and make necessary changes to their production specifications. These systems have made it possible for mills to reduce rejectable defects to below 1% over the years and have still proven to be a valuable tool even on lines where automatic inspection systems have been installed.

Major steel producers such as Corus, Simar and various JFE facilities use remote video systems on hot mills in conjunction with automatic inspection systems. Unlike automatic inspection systems that show only pictures of the limited number of defect types programmed into the system, the remote video inspection system lets operators and inspectors see any defect that may occur. This allows them to double check the strip without the operator having to physically go down to the line, confirming proof positives and eliminating confusion of proof negatives. In certain cases, were surface color variations mask subtle defects, such as bruises, these customers are reporting that they catch these and other subtle defects sooner with the vision systems. They also report that when a new anomaly occurs in the process, a remote video system enables mill engineers to qualify them and to program the defect into the automatic system's library if needed.

The older systems allowed a random sampling of the strip surface. When upgraded, the system with just a two-camera system, allows each operator to view 100% of the strip. Each camera, an 8-bit black-and-white unit with a video resolution of 1392 x 1040 pixels, can see a 1mm defect on a 1600mm-wide strip moving at full production speeds of 1350m/min. Each camera has its own display, a fast pixel response, 20" flat-panel screen with 1600 x 2000 native resolution and 500:1 contrast ratio, which can help inspectors spot even the slightest defects.

Strategic Locations

Stroboscopic inspection stations have been strategically set at stations near the end of processing lines. Cutbacks in personnel have reduced the ability to man

some of these areas all the time and rely on operator going over to do random checks. The light and camera arrays can be placed strategically in mills to meet a number of critical needs. With their ability to provide images from present inspection stations, it also allows viewing in locations that are inaccessible or dangerous for mill personnel, such as those presently on hot mills. Remote video systems enable inspectors now to monitor one or more places along the line that they had not been able to see because of inaccessibility or because there has not been enough manpower to staff an inspection site. Remote video lets an inspector monitor several inspection systems from a control room or a pulpit. Conversely, mills can place several monitors throughout the facility to display acquired images wherever personnel need to view them.

Giving inspectors access to more inspection points maximizes the benefits of instant knowledge of defects gained by visual inspection. Typically located before the recoiler or at critical inspection points along the process, operators at control consoles can now see the strip without leaving their workstations. This is essential on coating lines, where any one of hundreds of rolls on multiple platform levels could be the source of a problem. Tactically locating inspection cameras in cooling towers or after accumulators quickly provides the location of problems in the process.

On galvanizing lines, where towers can hold 1 to 3km of steel, operators can use the images to narrow down the location of a defect's cause and use a portable stroboscopic inspection light, such as a Unilux Miti-Lite, to view the strip at strategic points of the processing line to resolve problems quickly before 15 to 20 coils with anomalies start to accumulate.

In remote video inspection operation, positioning the cameras for the maximum width of 1.6m, each frame will capture an image an area of approximately 1000 x 750cm. This set-up will have some overlapping of each camera's field of vision to ensure complete coverage of the strip. If the video system captures images at the rate of 30 frames/sec, the strip can travel at 22.5m/sec or 1350m/min, and the system will provide 100% coverage.

The Basics of Video for Inspection

The best video inspection results are achieved when the image capture equipment is placed in an array consisting of stroboscopic surface inspection lighting and the high-resolution video cameras. By matching the strobe light's intensity and illumination pattern to the product and line's speed, the system can provide clear, sharp images of a strip moving at up to 1350m per minute. The equipment array is then connected to the Video Inspection Controller unit and then to the ultra high-resolution LCD monitor. The monitor and controller can be located in a control room overlooking the mill floor, a pulpit anywhere on the floor or even a remote location in the mill.

In operation, as the strip passes the array of image capture equipment, the pulse of the strobe lights "freezes" the motion of the strip, and the video camera sends a crisp, clear "snapshot" image to the monitor. In actuality, the images will appear as a continuous stream of snapshots, providing a comprehensive, real-time view of the strip at the inspection point. This will essentially give mill personnel the

same view of a strip that they have been accustomed to seeing with stroboscopic inspection with the added ability to be able to quickly review any segment of the strip.

Looking at the image, an operator can spot defects as small as 1 to 2 mm in size as they do now using just the strobe lights. Based on the type of defect and the operator's knowledge of the product and mill, the image can tell him if the defect is significant enough to downgrade or scrap the coil or if it will still meet the customer's specification. If the defect is severe enough, the operator can halt production until the source of the defect is found and corrected and redirect the coil for another use if possible. If desired the operator can capture and save portions of the strip. Pre-alarm recording allows for a measured time of imaging data to be permanently saved to disk in addition to the images being saved while the "save" button is engaged.

The main defects such as repetitive roll marks, scratches, edge cracks, rust and holes on hot and cold rolled material account for 75% of rejected product. These are easily detected by an image capture system with stroboscopic lighting. In finishing process mills, the coating flaws such as laminations, high dross, voids and scratches are also very visible on the monitors for the operators to see.

Plug-n-Play Leads the Way

The system is ready for use as soon as everything is connected and integrated. There is no software to train for finding and categorizing defects, nor is there a library to build. Mills can best utilize the video system by making better use of each inspector's knowledge of the milling process and the product being run. Better cameras and the possibility of economically placing cameras in a greater variety of strategic locations all contribute to improved product inspection.

The simplicity of integrating the latest image capture systems and strobe lights with a variety of computer systems makes video inspection systems operable in a matter of hours.

The mill provides an inspect signal interface, normally connected to a contact closure. This indicates the presence of steel that needs to be inspected, and it can turn on the video inspection system only for the time inspection is required. The mill can also provide strip identification data to the controller. When the operator saves a portion of the imaging, the mill-supplied strip-identification data and the date and time stamp all become part of the Quality Record

Advanced Viewing and Storage

By combining the video with the strobe now allows operators to train faster in the inspection process. By controlling the frame display on the monitor, operators can get detail information of the strip surface in slow motion. This allows the operator to become familiar with defects that they will see. As with visual inspection with the strobe lights only, they quickly can identify defects at full production speed. The recording capability speeds up the learning curve, because the operator can double check what they viewed for confirmation.

Mill operators can choose from three viewing modes for inspection. Modes are selected from the Video Inspection Controller unit.

- Live Mode displays each video picture generated at the standard video rate of 30 Frames per Second
- Stop Mode provides a still image at the video monitor for close examination of the strip surface image.
- Go Mode provides a stream of still images that are displayed at a rate selected by the operator. The rate can range from one picture every four seconds to 30 pictures or frames per second.

The viewing mode applies only to the pictures displayed on the selected monitor. In addition to monitoring the strip from a control room or pulpit, images from the array can be sent to another monitor in another location, such as an engineering office.

Short-term storage can store up to three hour's worth of high-resolution images, depending upon the type of video compression used and speed of the strip. This is typically sufficient to determine the cause of a specific defect and to correct the problem.

With more than 120 variations of recognizable surface anomalies in the metals industry, each with varying degrees of severity, it is important that each anomaly be spotted at any point in the rolling process as soon as it occurs. The earlier that defects such as bruises, bulges, roll marks, scale, edge cracks, slivers, friction digs, stains, stickers, grind marks, laminations, scratches, pinchers, chatter and shape problems are detected, the faster steps can be taken to determine and eliminate the cause. This will enable a mill to stop further valued added processing, divert unacceptable material to less stringent orders and reschedule the rolling order to meet delivery schedules.

In conclusion, stroboscopic inspection systems for continuous processes have for close over three decades, provided improved efficiency to the inspection process, better and more consistent product quality, increased throughput at increased speeds, energy savings in the production process and an overall improvement in bottom line cost. Combining the latest strobe lighting with the video system enables a mill to have "more eyes" in more places, where personnel can control product quality much more effectively.

A properly specified and installed video inspection system will give workers the tool they need to do a better job by providing clear, consistent visual information on what is going on in the production process. This will help a mill focus on steel quality, where the ability to greatly reduce customer rejections and scrap both save money and build customer confidence.