SOLUTION DESCRIPTION

INNOVATIVE LIGHT EMITTING DIODE SYSTEM SIMPLIFIES HI-SPEED QUALITY IMAGING

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HISLED: DEVELOPED FOR A CHALLENGING MILITARY APPLICATION

Ask any imaging professional, high-speed imaging is not easy. While the stated goal, to capture an object in motion, may be simple, managing variables such as lens aperture setting, camera shutter speed, trigger coordination and lighting intensity and duration can be a daunting task, often requiring several attempts. Adding a requirement for precise measurement makes the challenge formidable. Recently, engineers at Metaphase Technologies, Inc. accepted such a challenge, precise imaging of a projectile travelling at 3000 feet per second, with remarkable results.

To understand the approach taken by Metaphase engineers, it is useful to review two common methods of high-speed imaging: shuttering the camera or strobing the light. The former method uses the (electronic) camera shutter. The amount of time the shutter is open determines the exposure. A short shutter time “freezes” the motion of the object. The advantage of this method is that object illumination level can be constant; the disadvantage is that the camera shutter speed may not be fast enough, resulting in blurring of the image. The strobe method uses a high-intensity, low-duration flash of light while the camera shutter is open. The “freeze” principal is the same as above, except that the lighting pulse duration and intensity determine the exposure. The advantage of this method is that high lighting intensity and short pulse duration greatly simplify other factors associated with the image acquisition. However, there are several challenges to this method. First, a significant hardware problem must be solved in order to achieve very high intensity illumination with extremely short pulse duration. Second, the (longer) exposure time of the camera shutter may introduce noise in the form of ambient light. Third, trigger-to-flash time is critical if the part geometry is such that repeatable illumination would be problematic.

The challenge presented to Metaphase was to develop an illumination platform for a Bullet Yaw Measurement System (BYMS) for the US military. Understanding the behavior of bullets during their flight is useful to designers of both munitions and armaments. Munitions designers want to know flight characteristics for speed, distance and accuracy. Armaments designers are particularly interested in projectile angle of attack. From the time it leaves the barrel to the time it hits its target, a bullet has a variety of pitch and yaw deviations relative to its flight path. BYMS provides accurate pitch and yaw measurements at points along a bullet’s flight path with the use of high-speed image capture. Bullets

travel along their flight path at approximately 3000 feet a second. Measurements are taken along the flight path at a series of locations, and this data is then collected and stored.

Metaphase engineers were asked to provide an illumination solution that would permit acquisition of quality images with off-the-shelf cameras. The Metaphase solution, dubbed "HiSLED" for "High Speed Light Emitting Diode", combines high-intensity/ short pulse width illumination in a package with a highly uniform light distribution. LED technology is developing at break-neck speed, but it alone is not currently sufficient to overcome the technical hurdles associated with this application. Metaphase developed proprietary optics and a thermal management technique that enhances the effective performance of state-of-the-art LEDs. This patent-pending technology provides a semi-collimated light source with extremely high (> 10^6 lux) illumination and a very short (10^{-9} seconds) duration. The key to this innovative approach is an advanced, intelligent controller with adjustable parameters for variables such as pulse-width, intensity, duty cycle, and trigger delay.

With HiSLED application requirements were not just addressed, but exceeded. The lighting was so intense as to drive the camera sensors into saturation. HiSLED's *100 nanosecond* minimum pulse width is faster than the specified 300 nanoseconds. Proprietary optics collimated the light so as to exceed the requirement for a +/- 15% max deviation across a panel measuring approximately 8 inches by 6 inches. Astonishingly, all of this was accomplished with only a minimal cost premium over existing light sources. End results were: high-quality images at extremely high velocity; the use of standard camera products; application simplicity and flexibility; reduced overall system cost and a very happy customer.

GAME-CHANGER FOR THE INDUSTRY

With the knowledge obtained from the successful deployment of HiSLED for the BYMS, engineers at Metaphase realized that there are also a variety of other high-speed inspection applications that could benefit from HiSLED. What are the industry implications for a high-intensity, short duration LED illumination source?

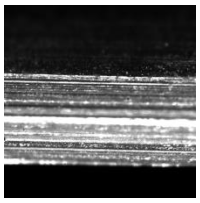
Until now high-speed image applications were the purview of line-scan cameras. As its name implies, a line scan camera has a "line" 1 pixel wide by any number of pixels long; a common length is 2000 (2K) pixels. These cameras are able to achieve high speed, high resolution images by building a 2D image with repeating scans of 1 pixel x 2000 pixels. One axis is provided by the pixels in the camera; the other axis is provided by the number of scans, typically triggered with an encoder. Thus, 2000 scans of a 2000 x 1 pixel line would result in a 2K x 2K image.

Line scan solutions for all their popularity, however, have some issues. First, they are not very intuitive- a 1 pixel x 2000 pixel "image" is difficult to visualize. Second, setup requires that the object be moving so as to acquire an image. Third, line scan technology is more expansive than 2D camera technology. Finally, deployment costs are typically higher. It is for these reasons that a significant market can be now obtained with an off-the-shelf digital camera and HiSLED.

APPLICATIONS FOR HISLED

Virtually any application involving high-speed capture is fair-game for HiSLED. Even those requiring high-speed processing and image throughput could be achieved through the use of multiple vision sensors. Applications falling into this category include web inspection, liquid container inspection, packaging and machine diagnostics.

Web Application: Metal Trim Quality



A major manufacturer of rolled sheet metal needs to detect tool wear and breakage on trimmed sheets. Sheet velocity is 2500 feet/ minute; Field Of View 0.100 (Vertical).

Periodic image acquisition is acceptable for this application. High-speed processing/ throughput is not required. Therefore, HiSLED's intensity and pulse width allow the use of a low-cost smart camera instead of a higher-priced line scan camera.

Liquid Container Inspection: Bottle

In bottling lines, speeds of 300 bottles per minute (bpm) are common, with some lines approaching 1200 bpm. In applications such as this, brightness uniformity is a significant advantage when combined with the requisites of high intensity/ low pulse width.

At speeds of 20 per second, two or more low-cost imaging sensors could be applied with a HiSLED to achieve low-cost, high-speed inspection.

High-speed packaging inspection

This market is so vast as to be served by dozens of system vendors. From pharmaceuticals to consumer products, vendors have developed unique, typically proprietary, high-speed package inspection solution. To be fair, many of these solutions involve part presentation and reject as well as the actual inspection. This does not negate, however, HiSLED's advantage of enabling the designer to incorporate standardized, lower-technology vision sensors with a high-technology lighting solution.

Machine Diagnostics

Perhaps nowhere can there be a greater advantage to HiSLED than in machine diagnostics. No longer is it necessary to employ a bulky, high-speed video camera to examine critical machine functions at high speed. Instead, one of a number of small, off-the-shelf digital cameras, some with external trigger capabilities, can be strategically placed in locations heretofore inaccessible.

CONCLUSION

Metaphase is no stranger to solving complex illumination problems, having received the 2014 Buck's County "Innovative Technology Award" and the 2015 Pennsylvania "Governor's Achievement Award".

This submission for the Vision System Design 2015 Innovators Award, is in the same vein. Although HiSLED was developed for a military application, its effects have potentially far-reaching industry implications.

Pete Kepf is an Automated Imaging Association Certified Vision Professional- Advanced. Pete has over 25 years of factory automation experience specializing in automated inspection with a variety of hardware/ software platforms. Additional info may be found at Pete's web site: www.kepf.me