Application NOTES & Technical TIPS

When "Adequate" Lighting is Not *Really* Good Enough

ADVANCED iLLUMINATION

May 12, 2008

Fig. 1a Axial Diffuse : DL2449

Fig. 1b Dark Field Ring : RL1660

Fig. 1c Broad Area Linear Array : AL4424

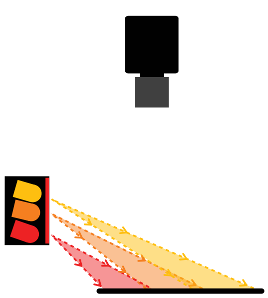

Fig. 1d BALA Function Diagram

In the early days of machine vision, lighting choices were very limited in several ways – source type, style, geometry and color. Many vision inspections failed or succeeded largely on the only available lighting choice - a white incandescent point-source. Those applications that required more structured, task-specific lighting were typically compromised in some fashion, if they were workable at all.

Today there is a wide variety of lighting sources, types, geometries and colors available for vision engineers to apply, often with more than one type or geometry functioning adequately. But with this plethora of potential overlapping choices, how do we determine whether a lighting solution is, or is not, truly "good enough"?

There are three criteria that may be applied when solving a lighting problem - all relating to image contrast:

1) Maximize contrast on those features of interest, and
2) Minimize contrast on those features (background) of no interest, and also
3) Make the solution robust

It is this third criterion that often is overlooked, and is typically the best discriminator for whether the lighting solution is merely "adequate" versus truly robust.

For purposes of this discussion, we will consider several examples illustrating why it is important for the lighting solution to not just be "good enough", but also be robust. In other words, the lighting solution must be effective and consistent over a wide variety of minor part differences, such as shape/size, orientation, color and presentation, to name just a few.

Figs. 1a – 1c illustrate a series of images from an inspection requiring the system to read the barcode beneath a cellophane wrapper. The image in Fig. 1a was generated using a coaxial diffuse light, and clearly is ineffective for reading the bar code because of the specular reflections.

Fig. 2a Coaxial Ring : RL1424

Fig. 2b RL1424 with Polarizers

Fig. 1b illustrates the results of applying a medium angle dark field light; the image is more consistently free of specular wrapper reflections, thus the lighting solution could be considered adequate. There is still potential for the next sample to have a particularly strong fold that might obscure the code, because we have not completely removed the specular reflection potential. The image in Fig. 1c shows the same sample free of specular reflection, and is thus not only "adequate", but is in fact more robust. Fig. 1d shows the light and geometry applied to generate the image in Fig. 1c.

In the following example, the image in Fig. 2a shows a specular image reflection from a bottle inspected with a typical system geometry – coaxial ring light and camera oriented perpendicular to the sample surface. A polarizer set, one on the light and one on the camera lens, was applied in an attempt to block glare, which might be said to be adequate (Fig. 2b), although some glare can still be seen. However, polarization may be ineffective if the bottle shape, size or orientation changes, or the incident light angle is modified. A more robust solution is to change the 3-D geometry among sample, light and lens. In this case (Figs 2c – 2d) the light was moved off-axis, and the image is now completely free of specular reflections.

Fig. 2c Off-Axis Ring : RL1424

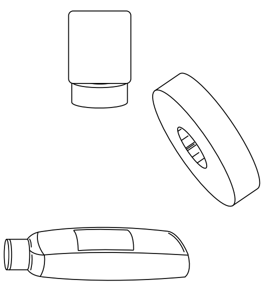

Fig. 2d Ring Light Geometry

The motor oil bottle sample (Figs 3a – 3b) was originally imaged with a white light, effectively imaging the dot-matrix printed lot code on the bottle. However, a UV light fluoresced a covert date and lot code otherwise not obvious, hence a more robust solution, if the covert code was the inspection goal.

Fig. 3a White Ring: RL4260

Fig. 3b UV Ring: RL4260-395

Printed postage stamps for commercial mailer envelopes are typically inspected with red LED light (Fig. 4a). Clearly, the red light is effective on black stamps; however, we generate no contrast when a red printed postage stamp is illuminated with a red light (Fig. 4b), and therefore the system cannot read the stamp. The original red light solution was adequate or good enough, but not robust.

Reading or verifying the purple dot matrix print on the concave bottom of an aluminum soda can is a common inspection. Fig. 5a illustrates an adequate image obtained with an axial diffuse light (See Fig 5b). In this instance the image is acceptable, but only if every print is centered through the middle of the can. Using a diffuse dome technique (Figs 5c – 5d), we obtain a more robust solution, which allows the vision system software to read or verify the print regardless of its location on the can bottom.

Fig. 4a Black Stamp, Red Light

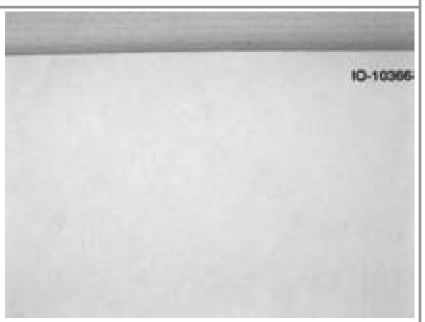

Fig. 4b Red Stamp, Red Light

As we have seen, what might appear to be an "adequate" lighting solution can turn out to be insufficiently robust to account for all the sample differences encountered. The simplest method for avoiding this problem is to test many samples – ones that include any possible sizes, shapes, orientations, colors/textures and presentations before settling on a lighting type. It is also helpful to have good control on ambient lighting problems by using either physical shrouding, or a narrow-band colored light and a matching pass filter.

Fig. 5a Axial Diffuse: DL2449

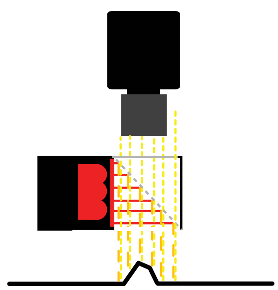

Fig. 5b Axial Function Diagram

Fig. 6d Diffuse Dome: DL2230

About Ai

A lighting solutions company, Advanced illumination is based in Rochester, VT and manufactures a full line of LED-based lighting products and industry-leading control electronics, primarily for industrial vision inspection. Our technologies include Evenlite LED sorting and aiming; Signatech and Signatech 2 LED protection for maximizing both light output and LED life.

Ai sells through a world-wide network of distributors and strategic vision partners. Standard products ship same day; Standard variations offer customized options in two weeks. We also provide Free lab services and evaluation products for on-site testing.

For more information, visit us on line at the address below, or call 802.767.3830

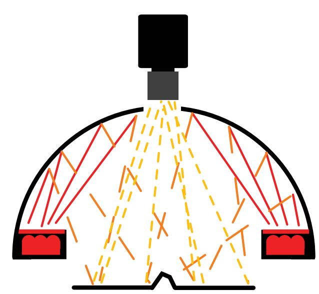

Fig. 6d Diffuse Dome Function