Benefits of “True” Laser Spot Scanner vs Laser Striper

There are two main approaches to laser based triangulation for weld seam tracking and other 3D measurement applications: one uses a laser stripe and a 2-d imager; the other uses a laser spot and a 1-d imager.

Meta makes both types and there are applications for which one or the other type is clearly superior. However, the scanning spot principle has some definite benefits in terms of raw signal quality.

Striper

The simpler and more common approach to laser triangulation is to project a laser stripe on to the target and image the stripe on a 2d imaging device such as a CCD or CMOS camera. This method is illustrated conceptually in figure 1.

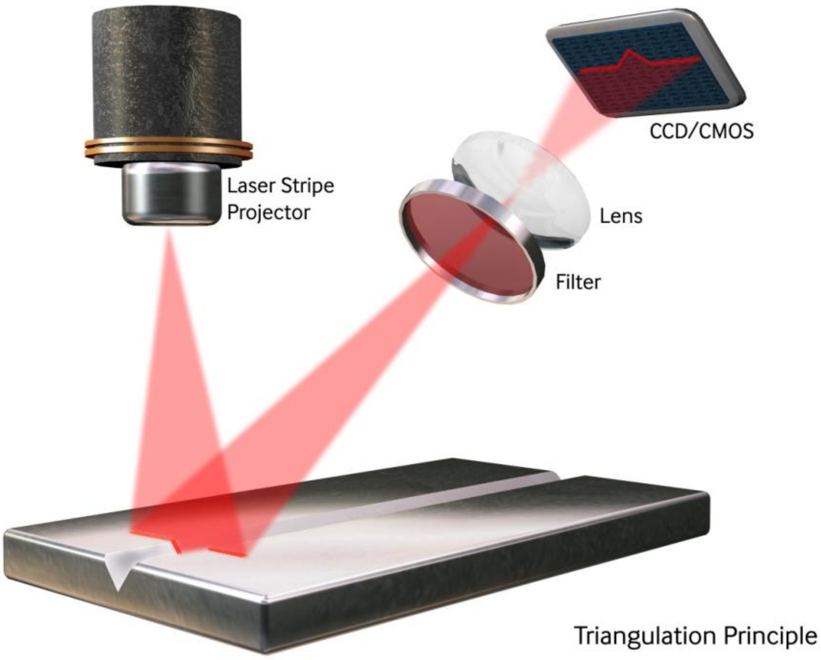

Figure 1 - Triangulation Using Laser Stripe

There are four potential image quality problems with this approach, namely:

1. Since the entire laser stripe is on all of the time and since the entire image is illuminated all of the time, dark parts of the scene may not return much light to the image sensor, while bright parts may return a very large amount of light. In other words, the dynamic range of the image falling onto the sensor may be very large. This range from very dark to very bright may be larger than the dynamic range of the CCD/CMOS camera itself. The net result is that it may be difficult to find a setting of laser power and camera integration time which results in enough laser light from the dark areas of the scene but doesn’t oversaturate the image sensor with too much laser light from the brighter areas of the scene.

2. A second major problem associated with this type of laser sensor is also related to the complete laser stripe and camera image being “on” all of the time. With shiny surfaces in certain configurations (which are common in welding) secondary reflections may return more light to the camera than the primary surface of interest. This results in a more complex image which then has to be analysed in software to try and identify which laser stripe components in the image are “real” and which are reflections.

3. The third problem is that the geometry of the laser sensor is largely fixed by the triangulation angle (angle between the plane of the laser and the camera axis) and the camera lens. As a result, the vertical resolution is related in a fixed way to the horizontal resolution and the vertical field of view is related in a fixed way to the horizontal field of view. The outcome of these is that the vertical resolution is usually much worse than the horizontal resolution while at the same time, the vertical depth of field is usually much larger than the horizontal width of field. While this may be desirable in some special applications, it is not generally preferred.

4. A fourth problem, specifically for welding, is that the 2-d imager in integrating the entire image. This means that, in conventional camera terms, the shutter is open for the complete acquisition over the whole image. If there is arc light or weld spatter from the welding process present, then it will also be integrated for the complete acquisition period.

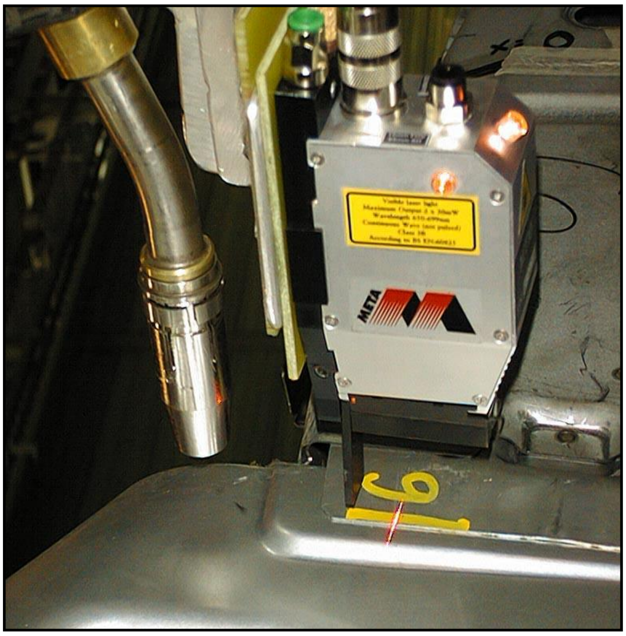

Figure 2 - Laser Stripe Sensor

Laser Spot Scanner

The laser spot scanner is based on the same principle of triangulation as the striper. However, it uses a laser spot instead of a laser stripe and a 1-d linear CCD/CMOS detector as opposed to the 2-d device in the striper. The spot scanner makes only a single point measurement at any one time and thereby requires a scanning mechanism to sweep the spot/linear detector across the scene being imaged (and hence the claim that this is a "true" scanning device). This principle is illustrated conceptually in figure 3 below.

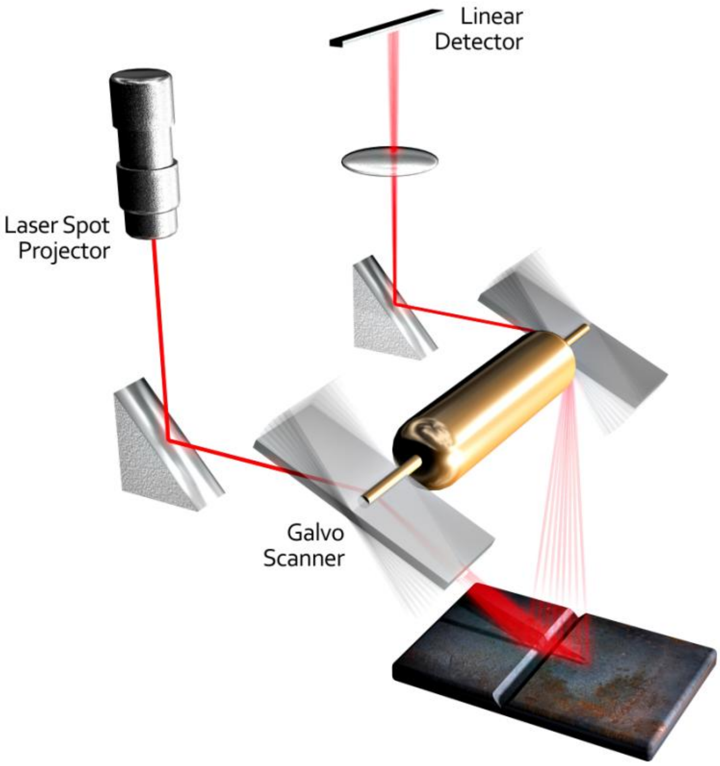

Figure 3 - Triangulation using scanning spot

The laser spot scanner deals directly with all of the main striper problems listed above, as follows:

1. Since only a single point laser measurement is made at any time, the laser power and integration time can be easily (and automatically) controlled to optimise the received signal level. This laser agc eliminates any problems with the received light level being too high or too low, and, as a very useful additional benefit, removes the need for a machine operator to have to set laser power or camera integration levels.

2. Reflections occur with a laser stripe sensor because of light reflecting from one side of the scene to the other and then reflecting back to the imager. This is not a problem with the scanning spot sensor, because the 1-d detector is only looking on a line along the length of the scene and so literally does not see the reflection.

The combination of laser agc and immunity to reflections result is a 3-d profile whose raw quality is much higher than from comparable laser stripe sensors.

3. The depth of field for the scanning spot sensor is defined by the linear detector and its associated optics. The width of field is defined by the scanning mechanism. These two are completely unrelated and so the depth of field and width of field can be designed independently. Furthermore, the scanning mechanism can easily be designed to be programmable, so the width of the scan can easily be changed at any time to suit the application.

4. The linear detector is integrated separately and sequentially for each depth measurement. As the scan progresses across the field of view, it consists of a series of short separate image integration processes. This means that the effective signal to noise ratio in the presence of arc light, weld spatter or other extraneous interfering light sources is reduced relative to the laser signal.

Scanning spot laser sensors are particularly useful in cases where reflections can be an issue, such as welding shiny materials or freshly machined faces. They are also outstanding in situations where there is a requirement for a small width of field but a very large depth of field, such as welding deep grooves.

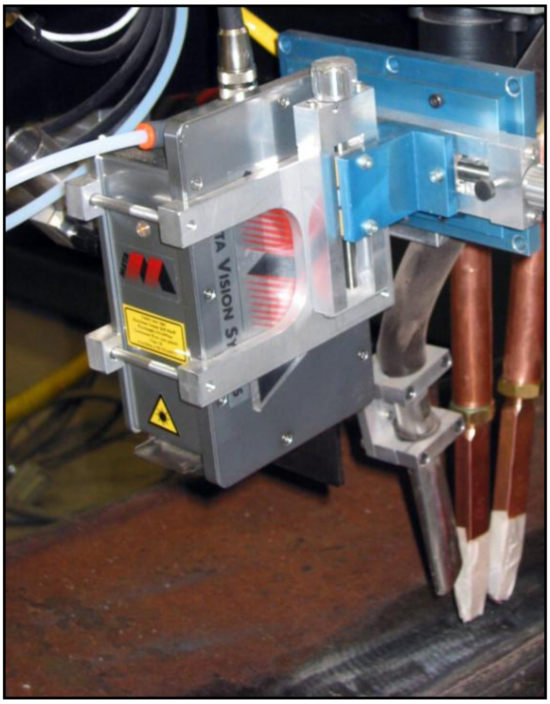

Figure 4 - Meta DLS200 Scanning Spot Laser Sensor