# Laser Machine Vision Enables Automotive Inspection

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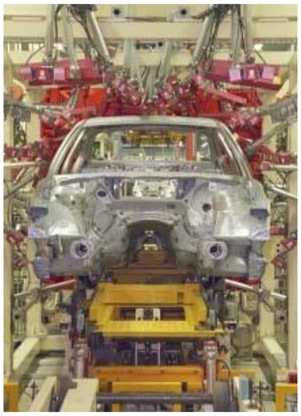

The mass production of automobiles and automotive components is becoming ever more automated, with smart robotic tools performing a wide range of tasks. To ensure consistent quality and specified performance, the robots are usually operated in a closed loop manner in response to some type of spatial information. Here we'll look at a few specific applications and explain the key requirements for the laser module in each case: tire manufacturing (and installation), windscreen installation, side panel installation & alignment, and component-level inspection (clutch plates).

Laser machine vision is now widely used to provide this spatial feedback because it can easily provide unambiguous information on the relative position, spacing, shape and orientation of physical objects.

## Tire manufacturing

Because they are consumables, albeit >30K mile consumables, the tire industry is massive with over 1 billion tires produced worldwide annually. Each tire is built up on a drum from multiple components, starting with the inner liner (made of halobutyl rubber) which provides the air barrier needed to enable long continuous (low-leak) inflation. Various fiber and rubber components are then successively added before the assembled tire is cured by a combination of heat and pressure. A key step is the application of the tread, called the “green tread” at this stage, which is made in a long continuous strip, whose pattern and composition is optimized for long life, or sport handling, etc.

The green tread is made in an extrusion process that is monitored using laser machine vision in a long-established format.  Here the laser module generates a single line that is projected at 90º to the extrusion direction, across the outer (tread side) of the continuously extruded strip.  The line image is then observed by a camera at a non-normal incidence viewing angle. Simple triangulation enables the system controller to compute the thickness of the tread and the detailed profile of the tread – displacements in the xy camera image are converted into z axis depth information. (For a discussion of laser vision trigonometry see "Laser Triangulation Meets

Growing Need for 3D Inspection".)

Key laser projector parameters for this application are line straightness, uniform line thickness, and high pointing stability. Good line brightness uniformity is also desirable but not mission-critical. Red (diode-based) modules have been traditionally preferred for this application because of their lower cost.  But the tire industry is now looking at blue and green alternatives as the cost of laser diodes at these wavelengths continue to decrease. This wavelength change will offer better contrast and possibly better resolution in part because the depth of focus is inversely proportional to wavelength for a given spot diameter or line thickness.

Laser vision is also used to check the alignment of wheel and tire during mounting on to cars on the production line, e.g., relative to the steering mechanism. Here the laser module projects a pattern of parallel lines on to the front wheel(s) and the image is recorded as the steering is moved. This pattern is produced by a standard refractive line generation lens followed by a diffractive optic to produce multiple lines (i.e., multiple orders). The critical parameters here are the grid shape and size, i.e., line linearity, parallelism, line spacing, and high pointing accuracy (microrad/ºC). This latter parameter is particularly important because temperature varies a lot in the typical production environment.

## Windscreen installation

Windscreen installation is another robotic process performed under laser vision feedback. The robot arm picks up the windscreen using vacuum suction. Correct, adhesive-fixed installation requires correct orientation of the glass in several axes and dimensions, e.g., tilt, rotation, XY, etc. The current practice here is to project a small line across the gap between the windscreen and frame in the center of each edge of the windscreen (top, bottom, both sides). Again, non-normal viewing provides full three dimensional information via triangulation.

## Side panel installation and alignment

Side panels, fenders and doors are all installed – and then re-checked after installation – using similar laser vision setups, such as multiple edge sampling. Consistent gaps are required for correct function, e.g., rain sealing, lower wind noise, as well as for cosmetic perceived value considerations. Most typically, three parallel lines (rather than one for the windscreen) are used at each edge to provide 3X faster sampling and 3X lower error. Red is preferred currently although the industry is beginning to look at blue because red is not an optimal wavelength for darker painted cars; the panels are painted and finished before assembly.

## Clutch plate inspection

Another long-established application at the component level is inspection of clutch plates for contour and dimensional accuracy, including height changes and surface irregularities.


In this relatively simple application, a single line projection spans the diameter of the clutch plate as it is rotated. Triangulation of the red line image then provides a high resolution scan of the entire plate.

In summary, the automotive industry is like other manufacturing sectors in its ever increasing use of robotics and automation to lower manpower costs and increase productivity and product consistency. And in many instances it is laser triangulation that is providing the key spatial information to ensure high and consistent product quality through closed loop feedback and control.

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*Photo: The contemporary automotive production line features an extremely high level of automation, including robotic actuators and supporting machine vision systems. The red boxes are laser-based scanning modules supplied by Perceptron.*