Laser Precision Quality Control

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Tire and rubber manufacturers today are requiring inspection systems to detect small geometric defects wherever they occur on the rubber surface in both final and in-process inspection operations. To increase quality and improve product safety, these smaller areas of dimensional variation or defects must be detected with very high reliability.

To meet these expanding requirements, sensor manufacturers have developed new and very high speed laser line sensors, such as LMI Technologies' Selcom EyeCon product line, to acquire high density data to insure detection of the smallest defects. These high-speed laser line sensors generate masses of data, requiring a reliable communications network easily implemented by machine builders, without the cost and risk of developing custom communications links. Simplicity of implementation benefits end users with high reliability, low cost and minimum maintenance.

In tire manufacturing, multiple sensors are often implemented in a single station to cover the full surface of the product with high resolution. This adds further complexity requiring tight synchronization of data from all sensors and encoders.

The synchronization issue has been resolved by development of a unique platform, providing microsecond synchronization between sensors, and assembling data from all sensors into a single 3D profile map, output to the host over a single Gigabit Ethernet cable.

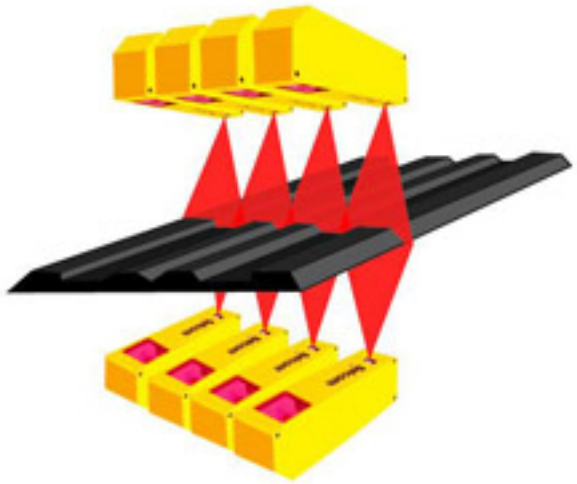

Figure 1

Communications Issues

A typical inspection application may use multiple laser sensors inspecting different zones of the product, such as calendered rubber, conveyor belts or tread extrusions. An in-process profiling application may use 8 or more sensors (half above and half below the conveyor) to provide high data density across the full width of the extrusion (**Figure 1**). The massive amount of data generated in these applications must be sent to the inspection station's host computer for analysis. For convenient layout of inspection stations, and to simplify the task of the system integrator, it is desirable for the host computer to be remotely located, often at a significant distance from the sensors.

Gigabit Ethernet (GigE), broadly used and easy to apply and implement, provides the optimal communications standard. It provides data rates up to 1000 Mbps, with inexpensive cables running up to 100 meters without repeaters, and Power Over Ethernet (PoE) providing power over the same cable as data transmission, resulting in only one cable from the host to the sensors.

Integrating Multi-Sensor Data Challenge

Implementing multiple laser line sensors to cover the full surface of the object creates challenges of synchronizing data from all sensors, and stitching multi-sensor data streams into a single file, without requiring the integrator to carry out these complex operations in the host computer.

Synchronization insures that data from each sensor is obtained at essentially the same point in time. Otherwise, each sensors data will come from a different position along the length of the surface. Stitching involves combining the synchronized profiles from each sensor into a single 3D surface map, transmitted as a single data file to the host.

To simplify the tasks of synchronization and stitching for the system integrator, LMI has developed the FireSync platform. This platform is designed to accept and integrate data from multiple vision sensors, as well as other local inputs such as encoders and photocells.

This approach simplifies data analysis in the host computer, because profiles output by all sensors are tightly synchronized within the sensor system itself. Each "slice" of data from all sensors is combined into a single complete 3D data file, sent from the platform over a single GigE output cable to the host computer. This total integration architecture simplifies installation.

The platform also provides tools for multi-sensor position calibration using an appropriate artifact of known dimensions that is placed in the system measuring area. This process locates each sensors position with respect to a global coordinate system defined relative to the target. Transformation parameters for each sensor in the system are acquired during the system calibration process and are used to transform profile data from the multiple sensors into a single coordinate system.

Figure 2

Application Example – Tire Final Inspection

Typical tire final inspection systems use three high-speed laser line sensors, one inspecting each sidewall and the third inspecting the tread (**Figure 2**). Each sensor measures hundreds of points along the laser line, at frame rates of 4 kHz or faster. The FireSync platform provides synchronization and stitching functions for the 3 sensors.

The application is complicated further by the need for analysis software to remove or filter out all points that relate to raised lettering, bar codes and other acceptable variations in the surface. These sensors employ “dual triangulation” with two cameras viewing the laser line, one on either side of the laser projector. This design eliminated data dropouts caused by shadowing of the laser beam at the edges of raised material on the sidewall surface.

Conclusion

Today’s high-speed laser line sensors provide high-density data to detect and quantify defects and dimensional variations in both in-process and final inspection applications in high volume tire manufacturing. Synchronization and communications issues are simplified by the FireSync™ platform, with communications to the host computer on a single Gigabit Ethernet cable. The platform is designed to simplify the tasks of system integration, and maximizes reliability for the end user.

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