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Wheel Alignment Goes 3-D

Burke E. Porter Europe joins LMI Technologies Inc. to redefine end-of-line wheel alignment operations

In 2008, wheel-alignment machine builder Burke E. Porter Europe NV (BEP) approached 3-D measurements specialists LMI Technologies Inc. for advice. At the time, BEP was developing plans to improve performance for end-of-line wheel alignment with its series of noncontact-alignment (NCA) machines. These measure toe and camber, displaying the results as guides for operators to make the necessary adjustments to bring vehicle parameters within the customer-specified values.

The issues

BEP realized that noncontact alignment needed higher precision, robustness, and a user-friendly plug-and-play interface. It recognized that the way to achieve these goals would be to start at the beginning with a radically new view on the measurement technology.

Existing sensor technologies based on single-laser line profiling had proven to be a dead end. An ambitious start toward capturing a full 3-D image of the wheel had been carried through to a prototype stage when LMI Technologies was contacted.

The solution

With three decades of experience from servicing a variety of industries, including automotive assembly, with laser-based 3-D measurement solutions, LMI Technologies was able to bring its know-how from essential areas such as optical design, 3-D calibration methods, and temperature compensation, and integrate the BEP prototype into its FireSync sensor networking platform.

The solution to improving system performance was to develop a new 3-D laser sensor, based on multiline technology. Known as the “3-D+,” this sensor projects 15 laser lines on the wheel, creating a high-density, 3-D surface map over a broad field of view. These 3-D data, obtained from every camera frame, significantly improve sensor accuracy.

Now installed in wheel-alignment applications in automotive assembly plants, the multiline sensor has met the goals set by BEP for robust performance higher accuracy, and simplified implementation and integration.

With the multiline sensor’s large field of view, two sensors are mounted per wheel and measure the full spectrum of tire sizes without requiring a moveable sensor. The limited field of view of the sensors on the market at that time made it necessary to reposition the sensors radially for different wheel sizes. The need for mechanical slides to position sensors is eliminated, simplifying sensor mounting and improving system robustness and accuracy.

Another advantage of multiline sensing is that every sensor frame contains 3-D information, including surface angulations. This simplifies system calibration when master artifacts are used for system verification.

Wheel alignment systems must operate on the factory floor, where ambient temperature can vary significantly. Like most measurement technologies, high-precision 3-D sensors, particularly those with large standoff, can have accuracy variations when ambient temperature changes. To eliminate these errors, the 3-D+ sensors are manufactured with automatic temperature compensation. As part of the LMI manufacturing process, each sensor is cycled through a range of ambient temperatures, and compensation coefficients are applied to each sensor.

Another factory-floor condition is uncontrolled ambient light, which has affected performance of traditional single-line sensors applied to wheel alignment systems. LMI has carefully designed the 3-D+ sensor to be insensitive to ambient light; this is achieved without using high laser power. The sensor meets a Laser Safety Class of 2/II, which significantly simplifies safety requirements for the machine builder and the end user.

System configuration and communications

A typical NCA configuration will use eight sensors, two for each vehicle wheel, and data from all sensors are communicated to the NCA host computer. To simplify communications, the LMI FireSync platform with a FireSync Master is used. Each 3-D+ sensor is connected to the FireSync Master with Ethernet cabling, allowing individualized cable lengths to each sensor module and freedom of placement for the FireSync Master. A single Ethernet cable connects the Master to the NCA host. The entire sensor system is powered by a single 48 V supply connected to the FireSync Master, which distributes power to each sensor via the FireSync sensor cables.

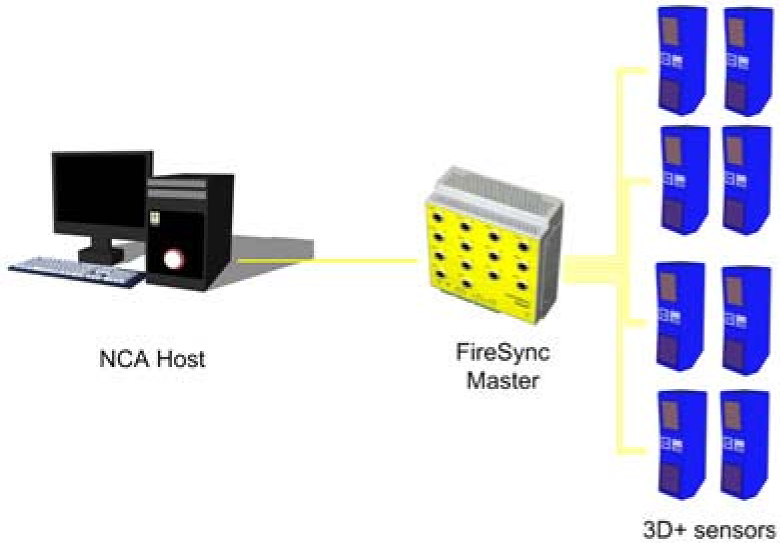
The FireSync platform serves as a scalable connection hub. This flexible architecture is configurable for simple systems with two sensors for single-wheel system, up to a complete 12-sensor systems (eight sensors for all wheels plus four integrated fender height-measurement sensors for ride height-adjustment, one at each wheel).

Because wheels are rotating during the alignment process, it is critical that sensor data are synchronized—i.e., taken at the same instant in time. The FireSync platform includes the ability to synchronize data from all sensors down to the microsecond.

Data analysis and display

Synchronized data from the FireSync Master are sent to the BEP NCA PC, which carries out data analysis and display for the pit operator. The software in the NCA PC performs an automated region of interest (ROI) analysis from the images from each wheel. This ROI defines the segment of data that contains the desired data for alignment analysis, without requiring input data regarding wheel and tire size.

The NCA PC calculates toe and camber measurements, and provides a BEP proprietary graphical display of measured values to the pit operator for alignment with selectable displays for front and rear wheels, operator prompts, and real-time adjustment feedback. In addition, it provides a display of machine and test status, test results, and machine diagnostics.



System performance

Implementing the LMI 3-D+ multiline sensor in the BEP alignment system has improved the precision of toe and camber measurement compared to previous single-laser line sensing. Robustness of operation is improved because much more data are obtained from 15 laser lines. The sensors' larger field of view eliminates the cost, complexity, and maintenance of a sensor tree to adjust measurement positions for different tire sizes. Automated region-of-interest determination eliminates the need to manually teach the ROI for each tire size.

Full 3-D images simplify calibration processes and diagnostics. Ambient light influences are eliminated. Sensor mounting and cabling are simplified by the sensors' plug-and-play design, eliminating the need for precise sensor alignment and critical daisy-chain, connection-order issues.

"Multiline-laser triangulation technology doubles precision and allows for a wide tire size range in a fixed, noncritical mounting scheme," concludes Dannie Van Holm, director of BEP Europe. "It offers us a more robust and user-friendly alignment solution. 3-D+ has taken noncontact alignment to a new dimension."

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