Willkommen, Oliver Sidla (Das sind nicht Sie?)

Taking Dimensional Tolerance Measurements of High-End Steel Plates with NI LabVIEW, IMAQ Vision

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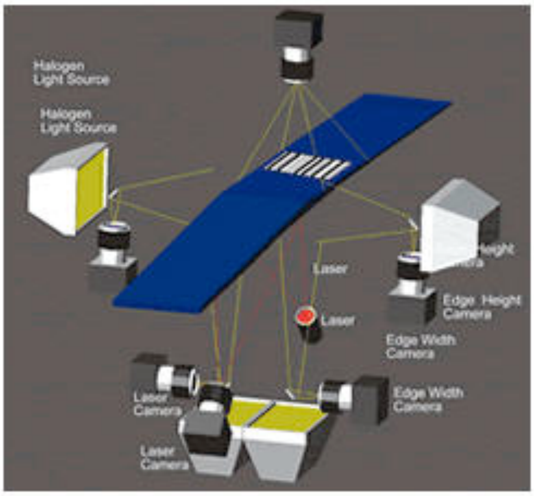
Branche:
Maschinenbau/Mechanik

Produkte:
LabVIEW

Die Aufgabe:
Developing a system that automatically takes dimensional tolerance measurements for high-end steel plates.

Die Lösung:
Measuring the steel plate edge dimensions and flatness of six IEEE 1394 (FireWire) cameras using NI LabVIEW and IMAQ Vision.



Vergrößern

Camera Arrangement

> "LabVIEW relieved the development team of tiresome and time-consuming code writing, leaving a lot more manpower to solve optics and mechanics problems and to concentrate on overall project success. "

Using LabVIEW for Quick, Accurate Measurements
To measure dimensional tolerance for steel plates, the customer presented the following system requirements:

- 0.05 mm accuracy for both edge width and height values
- 0.03 mm accuracy for flatness measurement
- Intuitive, 3D-measured flatness value display
- Individual plate measured value documentation
- Four-month turnaround time from system order to delivery and test

When we analyzed these requirements in detail, we found the need for a large system optical and mechanical traditional design effort to ensure required accuracies. However, our prior experience with the LabVIEW programming environment had shown that software for such a project could easily be developed in three to five man-weeks. We could therefore allocate more manpower for solving hardware problems, a few of which this solution outlines in detail.

Designing the System around Geometry
One difficulty in meeting the above specs was the objects' geometry. The plates are curved, vary in shape, and usually are much narrower in the middle than at the ends. Their geometry and the fact that they are transported by simply lying on a conveyor belt means that the distance from the cameras to the plate edge surface changes considerably, and hardly controllably. Thus, we met a major design hurdle in trying to achieve a very high depth of field and to precisely triangulate the actual plate edge position for every measurement taken. The cameras' axes are oriented at right angles so that, for instance, one lower camera supplies edge distance information for the upper camera, and vice versa. This distance information numerically compensates for the change in scale factor as the plate moves closer to or further away from the camera lens.

To reliably illuminate and detect the steel edges, we required direct, bright field illumination coaxial with the camera via a tiny mirror to bend the cameras' paths of light at a right angle. We implemented a high-power illumination scheme to achieve the required depth of field (high f-number on the camera lens), combined with a relatively short exposure time in the order of 0.6 ms. In the end, we installed a total of 2500 W of lamp power in the system.

We chose a set of four CCIR resolution cameras for edge measurements. Given the plate position uncertainty, the cameras must cover a field of view of 30 mm and 70 mm, respectively. Simple calculation shows that, to achieve the required spatial resolution, the system would have needed expensive nonstandard, megapixel-range cameras. Fortunately, Joanneum Research has a comprehensive library of image processing VIs, including a sophisticated subpixel resolution edge detection algorithm that can reliably fulfill the accuracy requirements without requiring expensive cameras.

To document and store measured data, the system must read every single unique plate bar code . However, the great variety in plate surface finish and design poses a problem. Furthermore, the field containing the bar code is always in a different position for each type of plate, so reliably finding it posed a certain challenge. Ultimately, a brute force solution proved most successful – the NI-IMAQ Vision built-in bar code-reading VI is highly reliable and fast enough to simply search for the barcode rectangle by scanning the image line-by-line, column-by-column, until it finds and reads a valid code. Naturally, this simplistic approach consumes some computing power, but, given the Pentium 4 GHz processor performance, some optimizations, and the additional power made available through LabVIEW built-in hyperthreading support, there was still plenty of safety margin left in terms of processor load.

In-process profile gauging (for example, for steel rail manufacturers) has been a standard Joanneum Research service for many years. Therefore, we readily integrated the flatness measurement algorithms into the LabVIEW environment using existing code originally written in C++. The hardware consists of a 5 mW diode laser with line projection optics and a CCIR resolution CCD camera with a 760 nm narrow-pass filter. The laser diode and camera are oriented towards the base of the sheeting at an approximate 45 degree angle.

LabVIEW Indispensable in Parallel, Independent Tasking
LabVIEW relieved the development team of tiresome and time-consuming code writing, leaving a lot more manpower to solve optics and mechanics problems and to concentrate on overall project success. LabVIEW built-in multithreading is indispensable in situations where a great number of independent tasks need to run in parallel. Hyperthreading support delivers even more efficient exploitation of today’s high-end processors for computationally intensive tasks.