Illuminating the Design Process

Product-centric Simulation Enables Virtual Defect Detection

Up until now the processes of product development, from design to inspection, had been rather "sequential." First the design of the product had to be finished using CAD software. Then by using CAM software the manufacturing had to be planned and evaluated. Finally product developers had to ensure quality by designing a testing station. Now, a newly developed software tool makes it possible to design in the end-of-line control already during the product development process.

The new CAD-integrated machine vision simulation solution to optimize the choice, configuration and positioning of cameras, sensors and lighting early in the product development process was introduced by France-based company Optis, leading supplier of physics-based simulation of vision and light-matter interaction. This innovative solution offers the machine vision designer the advantage of incorporating the virtual product with its different potential defects in order to optimize all the parameters before the product even exists. He can choose off-the-shelf cameras and lighting from built-in libraries. This is the first time that product inspection can be planned for right from the start of the product development process. Until now, machine vision tended to be an afterthought, with all the constraints that go with it.

For the purposes of machine vision simulation, Optis replaces the complex human eye with the comparatively simple characteristics of digital sensors. The simulation result will be the „raw image" on the sensor, so exactly what the camera sees taking into account the lighting conditions.

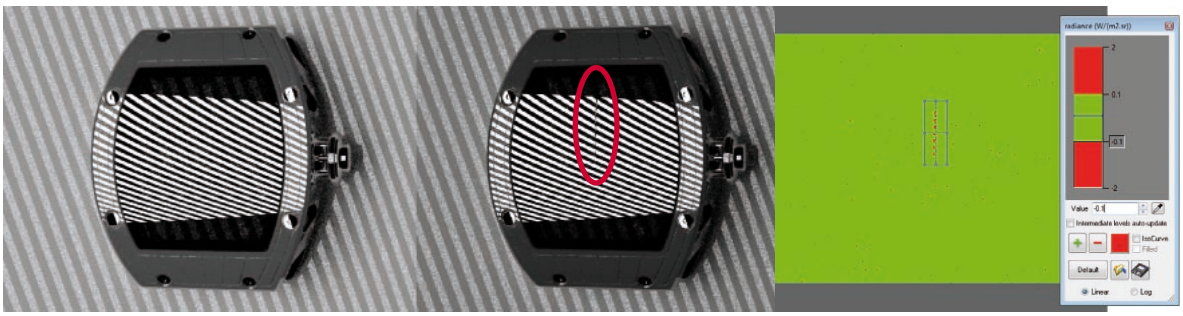
Vision Simulation: How It Works

First we need to have a CAD description of the sample to be inspected. We can start by using the optimal shape of the sample as it has been designed by the engineers – a sample with 'zero defects.' Then we can also introduce the environment, conveyor belt, laboratory walls, baffles etc. Thanks to the software's 100% integration in three of the most widely used CAD systems, it is possible to select the material and surface characteristics of the object and to include this information simply by drag and drop.

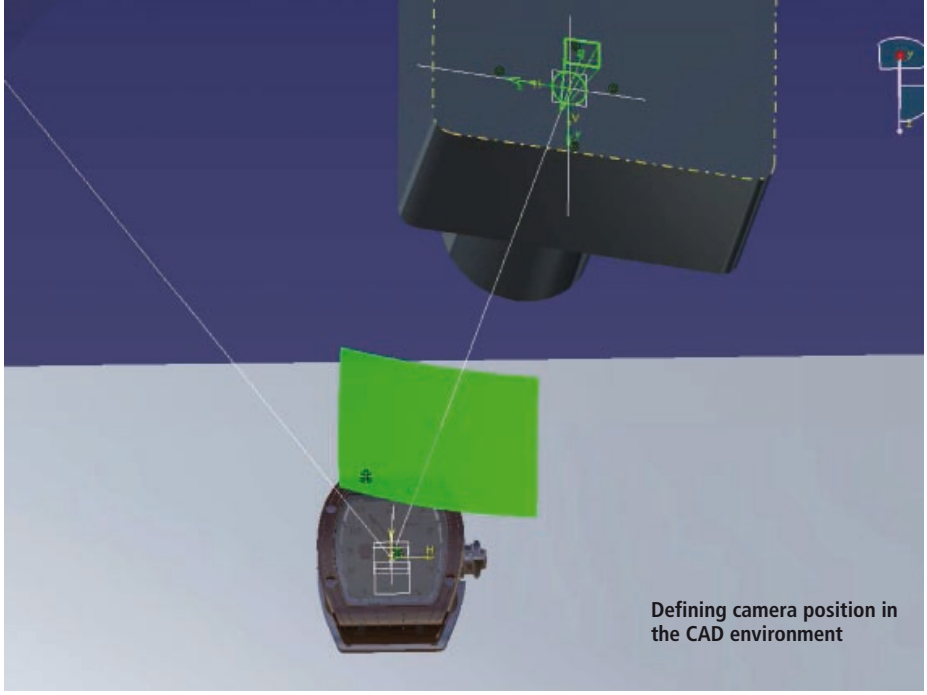
The next step is to define the light sources. We can select different sources from the library: different colored LEDs, incandescent lamps, fluorescent sources etc. The non visible spectral domain, the UV and IR can be taken into account as well. The sources are positioned around the sample whereby different lighting configurations can be set up: frontlight, backlight, diffuse or collimated light. Finally, and perhaps most importantly, the ambient light around where the machine vision system will be working can be included in the simulation e.g. by using an HDRI. This very powerful advantage enables designers to reduce the straylight coming from the environment, which might reduce the contrast and thus the accuracy of the results.

Application Example: Raw image result of the glass window of a watch as seen by a vision system

Digital sensors can be either taken from the library or can be defined using a simple interface based on the manufacturer's descriptions. Thus a multitude of different lens/sensor combinations can



Virtual defect detection in the result simulation of the subtraction of two camera images



Defining camera position in the CAD environment

be tested during the simulation in order to find out the optimal system. The simulation result will give the raw image on the sensor – exactly the image that later on will be physically present on the sensor, taking into account the camera parameters.

Virtual Defect Detection

A first interactive simulation, the pixel grid projection helps to find out the field of vision of the sensor and to evaluate whether the resolution of the sensor is enough to see the details of the object. An interactive simulation means that it is possible to easily change the sensor position; automatically the pixel grid projection in the CAD view is updated.

The last step includes the post-processing of the raw images. The images can be post-treated to analyse if the contrast in the image is sufficient to see the sample. Sometimes it will be necessary to combine several images into one, for example in order to evaluate the front and the back of the sample. By simulating defects and subtracting the defect results from the optimal results, we can ensure that defect samples will be correctly identified and rejected from the production line.

Design over Trial

An application example shall highlight the significant benefit of the new technology: A glass object poses difficulties for production control systems because of its transparency and reflectivity. For example we can use a stripe projector source to project lines on the top surface, but it is hard to detect them as the amount of reflection on the surface is only 4%. However, the contrast of the lines can be improved, for example by using a red grid on a green glass. Like this the transmitted part of the light will be absorbed by the material and the reflection can be detected with a higher contrast. The right choice of lighting is made much faster in simulation than in the real-world trial-and-error.

Product Lifecycle Management

Instead of the sequential design of product, production, and quality management processes, in modern product development the Product Lifecycle Management (PLM) process has been introduced. Now using these tools, it is possible to control the complete production process from initial design up until the recycling of the product using a single software. This enables the processes to run in parallel. Already during the design phase of the product we can think about manufacturing and testing. This is not only an advantage in time and cost; if we imagine that we need to implement a product change late in the development process, just before starting serial production the costs of these changes can be so high that the project becomes unfeasible. Using Optis' simulation technologies to test the product changes very early in the design helps optimizing not only the manufacturing and testing process but the actual product to be inspected.

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