Application Note: Surface matching
INTRODUCTION

Many times there are applications in which an object has to be compared from an initial state with a successive state. For comparison the object has to be scanned twice which requires re-positioning on the scan table. However, it is almost impossible to place an object both times exactly in the same location with the same alignment. Automatic Surface matching helps to adjust and compare the acquired measurement data sets.

TECHNOLOGY OVERVIEW

Traditionally, surface topography used to be measured with contacting stylus profilometers. However, due to the sensitivity of the surfaces, contacting methods no longer meet the requirements of the industry. On the other hand, AFM technology, although it offers outstanding resolution, is often not feasible due to limited measurement area, range and scan speed.

This leads to the development of advanced optical surface metrology systems, which can roughly be broken into two groups: Microscope based systems, with relatively high resolution but limited measurement areas and scanning systems, where a point source is moved relatively to the sample surface and the surface variation is detected.

The advantage of scanning systems lies within their capability to measure over large areas without impact on measurement resolution. They also provide much larger dynamic measurement ranges at high resolutions than microscope based systems.

MEASUREMENT OBJECTIVE

The cyberTECHNOLOGIES® CT SERIES is designed to measure the height of different surfaces. The CT 300 can handle one or multiple objects up to 315 mm x 315 mm (12” x 12”). The heart of the system is a fast chromatic white light sensor that takes advantage of chromatic aberration.
MEASUREMENT TECHNOLOGY

A very bright white light source focuses a small spot onto the sample surface with the different wavelengths focusing on slightly different focal planes. The reflected light is collected and a spectrometer analyzes the light intensity vs. wavelength. A height reading is generated from the maximum intensity of a certain wavelength on the spectrometer. The sensor achieves a resolution of 0.01 µm (10 nm).

SCAN SPEED

The chromatic white light sensors are available with different controller models, a LED based controller with 2 kHz data rate, a controller using a halogen light source with 4 kHz and a 14 kHz controller based on a very bright arc lamp. With fast magnetic linear motors and 50 nm encoder resolution, the CT SERIES can scan bidirectional.
MEASUREMENT RESULTS

The application of automatic surface matching will be described in the following example of a manipulated tooth:

A user-configurable screen layout shows all the pertinent information at a glance:

- Measurement parameters selected, such as scan dimensions and lateral resolution
- 3D raster screen, with false color controls
- Selected 3D surface parameters
- 2D line profile of user selected cross-section
- 2D surface profile parameters
- Abbott-Firestone curve and parametric results
- Surface histogram with results and user defined thresholds
Original Object

The initial scan of the original object - a color-coded raster of the scanned area on the right and a 3D rendering of the surface below.

The blue line indicates where the 2D line profile is extracted. The user can easily move the line up and down, or even change the angle of the virtual cut, the line profile is updated dynamically.
**Manipulated Object**

The second scan of the object after the object was manipulated - a color-coded raster of the scanned area on right and a 3D rendering of the surface below.
COMPARISON

The following two images show the difference of the original to the modified state of the tooth. The second image shows the modified tooth in which the manipulated areas are marked.
Comparison in SCAN SUITE

The comparison in SCAN SUITE is really simple. After scanning the two different 3D scans the result is visible with just 3 clicks.

The grey line in the left window (profile window) represents the profile along the straight blue line / “Index” in the raster image of the original scan to the right. The blue profile line underneath is the extracted profile from the modified scan. The red line in the profile window shows the difference between the scan of the original and the modified sample. The grey and blue lines are on different height levels because of different set-ups of the z-axis while scanning, representing a typical use case where multiple users measure a wide variety of different samples.

The difference of the two scans is shown in the red profile in the image below. Almost the entire differential profile is around the “0” level, in other words the two samples are equal, except for the edge on the right side. Here as well as in the raster window the difference of both samples is clearly visible and measurable as one can see in the following image. The 3D raster image shows the deviation across the entire sample in sub-micron resolution. The color scale to the right indicates the level of difference between both scans.