PRECISION PLACEMENT OF THE TOUCHPAD

3D LASER TRIANGULATION FOR KEYBOARD AND TOUCHPAD

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The installation of the keyboard and touchpad in a notebook housing requires maximum precision. The precise alignment and height of the keys, as well as a seamless connection of the touchpad, are critical factors for the perception of quality and comfort of the user. To meet these requirements, a modular measuring station has been developed that uses 3D laser triangulation to measure the precise position of the keys and the depth of the touchpad slot.

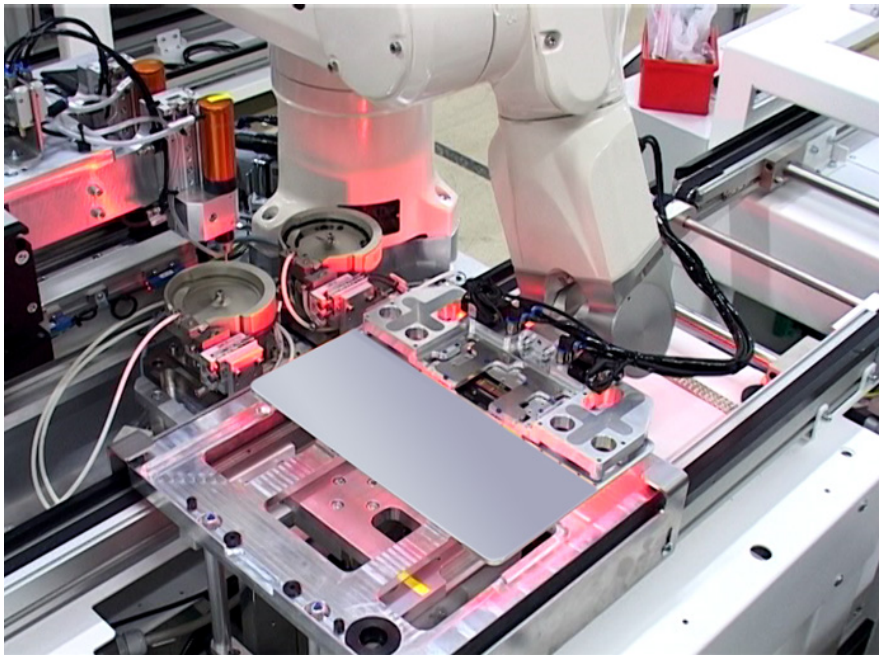

Image 1: Two laser triangulation sensors measure the depth of the touchpad slot in a notebook housing.

Just a few micrometers can make the difference between a notebook being perceived as high quality or cheap. When keys have the exact same height and the gap dimensions between the touchpad and the slot of the housing are imperceptibly small, the design has a higher quality appearance. For this reason premium manufacturers place great value on such cosmetic details. The alignment procedure previously used for precision keyboard and touchpad placement, which

involved multiple manual steps, can now be replaced with a high-precision, automated production solution from Manz. Using laser triangulation, a proven procedure in optical metrology, the measuring machine measures the alignment and height of each individual key and the height of the touchpad in the housing.

Example with touchpad

Before the part is inserted in the recess of the housing – the so-called touchpad slot – a laser sensor measures the depth of the slot and its topography. The thickness and topography of the touchpad are also determined before installation. Both dimensions will vary as a result of production-related fluctuations. But if both dimensions are known before installation, these values can be used to calculate the required height compensation using a 3D matching process and to automatically insert the correct washers – eliminating the need for manual adjustment. Four washers are used for this purpose, which can vary in thickness. The touchpad can thus be set to the correct height on each side. The washers range between 25 – 400 μm at 25 μm increments. The touchpad can thus be used with great precision.

Manz has many years of experience with 3D laser triangulation. The company has used the method previously, for example for measuring the evenness and thicknesses of solar cells. In the new measuring machine there is a sensor head whose laser casts a fine line of blue light on the object. A camera positioned inside the angle measures the reflected light. The known triangulation angle can thus be used to measure a contour of the object. Height differences, e.g. between touchpad and housing, appear in the image as steps in the line of the reflected light. By passing over the entire notebook housing with the sensor head, a three-dimensional height image can be created from the individual line images. The required measurements can then be made inside of this height image. The measurement uncertainty, correlated to a tactile coordinate measuring machine, was a maximum of 20 micrometers. This did not even take into account a comparable temperature, which when measuring aluminum parts has a not insignificant influence. Therefore there is even more room for improvement.

The challenge of measuring speed

To meet the requirements of the market, the engineers at Manz had to venture into unknown territory. One challenge was measuring speed: Because of the high rate of speed used for the assembly of notebooks, there are only eleven seconds available for the measurement. The sensor travels across the housing at a rate of 400 millimeters per second, which is enough for five passes. The frequency of the sensor ranges up to eight kilohertz. Although this is fast, it is not fast enough for the entire surface of the laptop. A second sensor was therefore required. It is installed at a distance of about one half of the width of the notebook housing. The

two sensors share the work by each covering half of the housing. The two images overlap in part at the center, which requires a precise calibration. Otherwise the data would return conflicting results in the overlap zone.

Because of the high speed of the two sensors, the data volume doubles to 200 megabytes per housing. This large data quantity must be processed within five seconds after measurement because the next notebook will already be moving into the work station. An industrial PC is used for this purpose which runs an image processing software suite developed by Manz. For this task, a new software interface had to be programmed for the laser triangulation sensor. An evaluation algorithm was also developed which using new calibration techniques combines the sensor traces into a topographic image and performs the required measurement in it. In addition to compensating for sensor inaccuracies, the calibration procedures compensate for any errors in the axis systems (skewing or crests and troughs) that are present "naturally" because of their guide systems. With a second measuring machine from Manz, though only using a two-dimensional measurement to determine gap dimensions in the notebook housing – but with greater lateral resolution – data volume even reaches a gigabyte.

The Manz measuring station has been in use in serial production since March 2015, for four customers in all now – with very good results. Currently Manz is developing a measuring machine for a new product with a sensor that features a better lens and higher resolution. It is specifically designed for even more precise depth determination of the touchpad slot. The keyboard is not included in the measurement here.

The 3D laser triangulation measurement is part of a novel modular assembly system for electronics products such as smartphones, tablet computers or notebooks. It consists of various compact and freely combinable modules – including for such functions as material handling, screwing, laser marking or for final inspection – which can be used to put together a suitable assembly line for production.

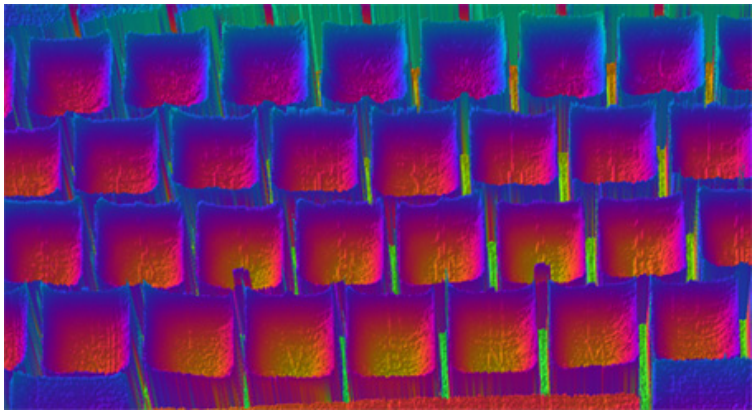

Image 2: Topography of a notebook keyboard, measured using 3D laser triangulation