Defect Detection on an Edge

What’s covered ain’t hidden.

Mi Grandmother

When an edge has been detected, a scan for existing defects can be carried out. It shall be understood that the test edge and the required defects are explicitly defined. This task is not as trivial as it might seem at the first glance. Sometimes, it is difficult to define the difference between a defect and regular deviation of an edge. In other cases, the form of the required edge is unknown and it cannot be definitively defined by any mathematical curve. Then, one would have to use adaptive methods of edge inspection which can ensure a dynamic edge detection as well as a dynamic defect detection. To illustrate this, a defect detection on a rather simple edge is presented.

For edge detection, a light-and-shadow image can be used, which is discussed in this book, but many other methods can also be applied, such as the triangulation technique [28]. For example, this can be done on a manufactured edge of a plate-shaped or disk-shaped test part that is being conveyed by or rotating in front of the capturing device during production process. The detection technique has to correspond to the production process, as well as to the test edge. The most important thing is that this method has to ensure a complete capture and a seamless inspection of an edge quickly running by as a continuous surface edge.

Such an edge usually shows a very sharp transition. This makes the edge detection easier, but requires the detection of the smallest edge or contour defects. Those enclose faults, edge chipping, burrs, geometric irregularities, and roughness that occurs due to the continuously increasing wear of the manufacturing tools. The test edge has a known and even mathematically definable form. Therefore it can be easily inspected.
3.1 Defect Recognition on a Regular Contour

As soon as a test edge can be described by a mathematically definable curve, e.g., a straight line, a circle, or an ellipse, it is analysed using shape tolerances [2]. The detected curve course of the edge is approximated using a mathematically describable curve and compared to it for precise defect evaluation and in order to be able to geometrically inspect the edge. It can also be compared with a standard object. In order to do so, standard parameters of a straight line (standard ascent and standard shifting), a circle (standard radius), or an ellipse (standard semi-axis) are required. The centre for the circle and the orientation angle for the ellipse can be obtained from the stereometry of the standard part.

In both cases, the test contour is transformed to a so-called neutral line so that the tolerance tube for the noise is built around it (Fig. 3.1). The outer width limits the upper values of the difference contour curve and the inner width limits the lower values of difference contour curve. By indicating two different values, an asymmetrical tube is created around the neutral line. Adjacent positions of the difference curve that are outside of this tolerance tube and pass over the defined minimal width can, depending on their number, lead to possible defects.

A defect candidate is recognized as a defect if the number of adjacent points outside the tolerance tube exceeds a defined minimum defect length. If the tolerance line is crossed several times due to noise, all sub-areas have to be separately checked for the required minimum defect length. A defect candidate is not recognized as a defect if the defect width is large enough and if it passes the tolerance line, but the minimum defect width is not achieved.

Fig. 3.1. Recognition of a contour defect on a circle (red framing)