Chapter 12
Automatic Defect Detection and Classification of Terminals in a Bussed Electrical Center Using Computer Vision

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ABSTRACT

In this chapter, an intelligent Computer Vision (CV) system, for the automatic defect detection and classification of the terminals in a Bussed Electrical Center (BEC) is presented. The system is able to detect and classify three types of defects in a set of the seven lower pairs of terminals of a BEC namely: a) twisted; b) damaged and c) missed. First, an environment to acquire a total of 56 training and test images was created. After that, the image preprocessing is performed by defining a Region Of Interest (ROI) followed by a binarization and a morphological operation to remove small objects. Then, the segmentation stage is computed resulting in a set of 12-14 labeled zones. A vector of 56 features is extracted for each image containing information of area, centroid and diameter of all terminals segmented. Finally, the classification is performed using a K-Nearest Neighbor (KNN) algorithm. Experimental results on 28 BEC images have shown an accuracy of 92.8% of the proposed system, allowing changes in brightness, contrast and salt and pepper noise.

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INTRODUCTION

Nowadays, the modern manufacturing industry is demanding the creation of higher quality products. The quality is becoming a more important instrument of competition. A product with decent quality sells well in the market and enhances the image of the company. Companies need to ensure, that the product manufacturing has been performed based on good quality standards to maintain market competitiveness and increase profitability (Rouhiainen, 2015).

The features that must fulfill a product are defined by an expert who knows the specific client requirements and market necessities. The task of verifying a product is one of the most vital aspects in the manufacturing industry, because it can assure the quality of products and reduce the cost of defective products (Huang & Pan, 2015). The process to inspect if a product complies with a set of quality characteristics, to verify if a part deviates from one or several design specifications, and to detect if the product does not contain defects is frequently performed visually by a human inspector.

Visual inspection is the result of a processing made by a part of the brain of the luminous information that arrives to the eyes, and it is one of the main data sources of the real world (Sannen & Van Brussel, 2012). The information perceived with the sense of sight is processed in distinct ways based on the specific characteristics needed to execute the future tasks. The representation of an object is obtained as a result of an image analysis process, after that, a decision is taken to define what to do with the visual information, which frequently implies the recognition of the object(s) detected inside a scene and a reaction carried out by a body part.

The main problem is, that the human visual inspection it is a fatiguing, time-consuming and boring task. As a consequence, the inspection could be subjective and highly dependent on the inspector experience, which frequently leads to accepting poor quality objects and having less satisfied customers (Daminelli & Alves, 2015). There exist several solutions to solve this problem. One can be increase the number of inspectors, with the aim of rotating the personal and to perform the task only by a short period of time. However, this solution is frequently rejected due to the involved costs. On the other hand, a statistical sampling scheme which estimates the overall quality of a given batch of objects at a certain confidence level can be used. Unfortunately, this scheme cannot assure the required quality standard for each individual product. Other solution could be, to replace human inspectors by automatic systems. This can be carried out by using a computer vision (CV) system which implies the use of optical non-contact sensing to acquire and interpret images automatically to obtain information or control machines or processes (Lin and Fang, 2013).

In this context, the development of automated processes for quality inspection becomes important. The use of CV systems to control the manufacturing process and to enhance the product quality has become increasingly important in several industries. The advantage of automation arises in that automatic processes are usually faster and more efficient than man controlled processes.

It has been proved that CV can be successfully applied to several industrial inspection problems, allowing faster and more accurate quality control. The automotive industry is particularly interesting for this work due to an important inspection problem has been detected. Therefore, in this chapter, a simple intelligent CV system, for automatic defect detection and classification of the terminals in a bussed electrical center (BEC) is presented. The system is able to detect and classify three types of defects in a set of the seven lower pairs of terminals of a BEC namely: a) twisted, that occurs when one of the terminals is outside the cavity guides of the BEC; b) damaged, when one end of the terminal is bended within the assembly, causing it cannot be observed; and c) missed, when one of the terminals is absent.