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Abstract
During the folding process substrates are exposed to high-localized stresses, which in the case of coated papers and boards, can lead to decreased aesthetic features or complete loss of functionality. Production efficiency of the folding process could be improved by an automated, computer vision-based inspection system. For such a task, different existing computer-aided fold-crack evaluation approaches were analyzed. A detailed research was conducted to propose an image processing based fold cracking assessment via finding optimal sample preparation and digitization techniques and developing an algorithm for the digital image analysis and feature extraction. The analysis of the applicability of different sample preparation and digitization parameters, as well as the proposed digital image feature, was done by correlation evaluation, one-way analysis of variance (ANOVA) and corresponding post-hoc tests. The results indicated that the developed algorithm fulfils the set requirements and the proposed feature of digitized samples faithfully describes the analyzed fold-cracks.

Keywords: folding, crack, coated paper, computer vision, image processing, production system

1. Introduction

The continuous development of quality control systems is driven by both reasons, economic and environmental, particularly in production systems with a large number of different processing operations. The graphic industry is one of those production systems with numerous different processing steps and operations. The production process in the graphic industry can be divided into three phases: prepress, press (printing) and post-press (print finishing) [1]. Computer or machine vision-based techniques are often used in modern production systems as a substitute for visual assessments carried out by human observers. They are already present in the graphic industry, mostly in the field of different printing techniques, i.e. web or sheet-fed offset, flexo-gravure, screen or electrophotography printing [2-7]. Some print finishing operations have also computer-vision elements integrated into their quality control (i.e. cutting or collating) or process monitoring system (i.e. handling or conveying) but, the majority of the manufacturing operations is still assessed mainly manually [1]. The folding process, as a basic print finishing technique included in the production process of most graphic products, is one of the manually monitored operations. A high-quality fold has to be at the right position and free of surface damages or material fractures [8]. Its quality control on the spot is usually done by the machine operator, mostly visually. The derived quality measures are highly dependent on the operators` experience, fatigue and other subjective influences, but with an objective folding quality estimation method, based on computer-vision and implemented in the production process, the aforementioned problems could be overcome [9].

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