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Assessing print quality by machine in offset colour printing

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ABSTRACT

Information processing steps in printing industry are highly automated, except the last one—print quality assessment, which usually is a manual, tedious, and subjective procedure. This article presents a random forests-based technique for automatic print quality assessment based on objective values of several print quality attributes. Values of the attributes are obtained from soft sensors through data mining and colour image analysis. Experimental investigations have shown good correspondence between print quality evaluations obtained by the technique proposed and the average observer.

1. Introduction

Offset printing is the most widely used commercial printing process in production of newspapers and magazines [1]. Multicolour pictures in offset printing are created by printing cyan (*C*), magenta (*M*), yellow (*Y*), and black (*K*) dots of varying sizes upon each other having different raster angles. An image comprised of such dots of one colour is usually called a halftone image. Since four colours are used in the printing process, four halftone images are created, see Fig. 1 illustrating the flowchart of the graphical process. Halftone images are transferred onto printing plates, thin aluminium plates, in the computer-to-plate (CTP) process. There is a separate plate for each printing colour, see Fig. 1. The image, labelled original in Fig. 1, is usually recorded in the RGB colour space, by using a colour camera, for example. Since *C*, *M*, *Y*, and *K* colours are used to print colour pictures, the so-called colour separation process, converting images from the RGB to the *CMYK* colour space, is applied.

Various factors affect print quality: paper (ink demand and ink pigment penetration increase with increasing surface roughness, for example [2]), ink, printing press, digital proofing system used in colour management [3], ink–water balance [4], operator actions, and the quality of printing plates. A large variety of deficiencies and problems may appear during printing: misregistration of printing plates, paper wrinkle formation [5], poorly formed paper surface [6], too high linting due to poorly formed paper surface [7], piling, mottling, web breaks, etc. Even if all the aforementioned deficiencies are absent, the quality of print can be low.

A printed picture may deviate from the expected result, due to various reasons. The larger the deviation the poorer is the print quality. To make visual and instrumental assessment of some print quality attributes possible, test areas, the so-called double grey bars, illustrated in Fig. 2, are often printed at the edges of a newspaper page. Values of the print quality attributes are used for timely adjustment of the printing process aiming to improve print quality.

Print quality attributes can also be used for studying relations between print quality and various parameters characterising paper, printing press, ink, and the papermaking as well as printing processes. Such relations can be very helpful aiming to maintain print quality in a predetermined range when the aforementioned parameters vary.

Print quality can be assessed by a collection of values of various print quality attributes as well as by subjective visual evaluation. Since a subjective observer is an ultimate evaluator of print quality, instrumental, print quality attributes-based evaluation, should correlate with human judgements. This article is concerned with a random forests-based technique for automatic print quality assessment in offset colour printing using objective values of several print quality attributes estimated automatically on images of double grey bars.

In the next section we briefly survey recent developments in automated print quality assessment. In Section 3, we motivate the choice of print quality attributes. In Sections 4 and 5 the relevant theory and practical setup are explained. Results of experimental

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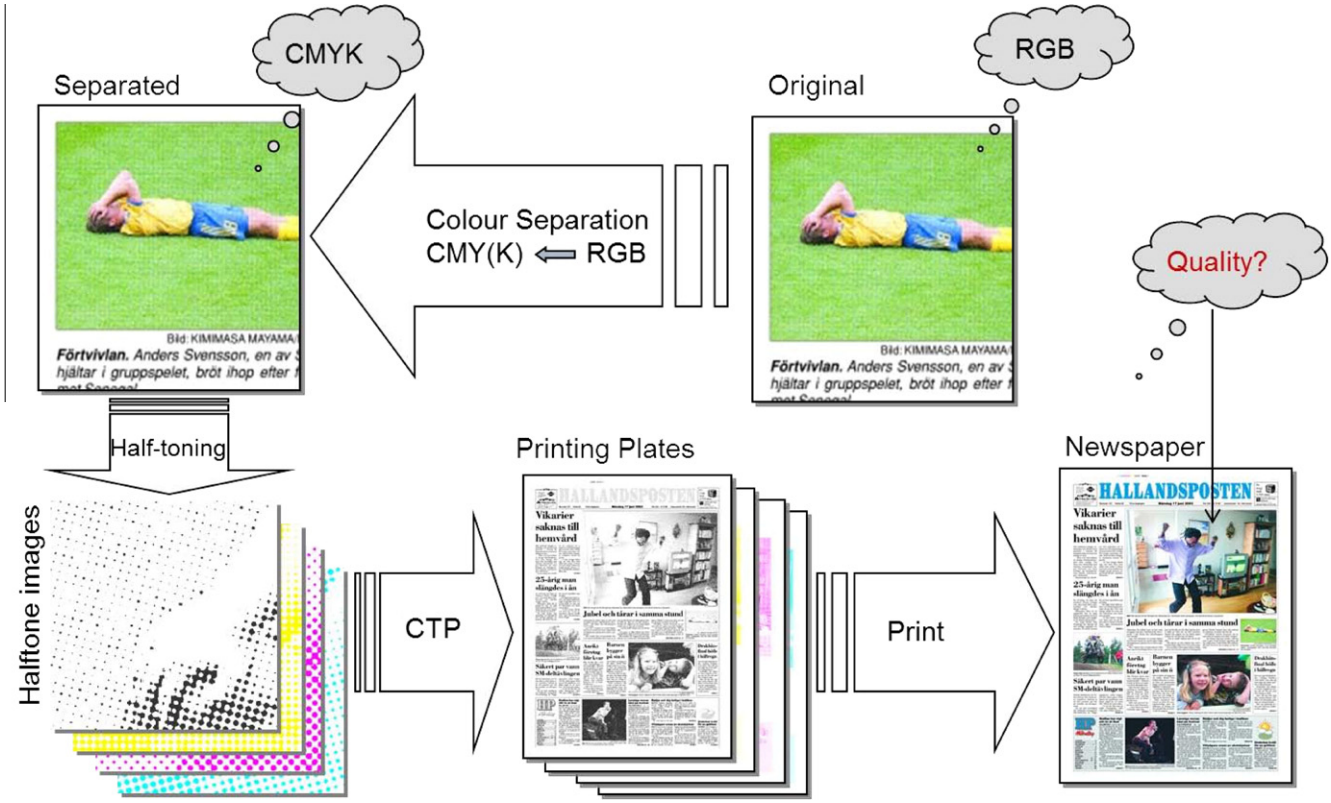

Fig. 1. The flowchart of the graphical process.

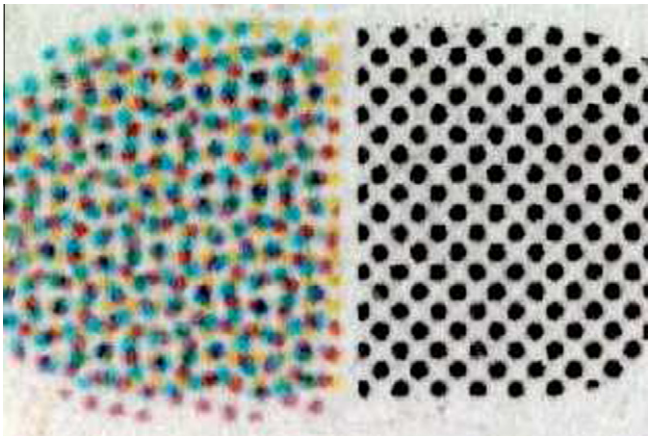

Fig. 2. The double grey bar.

investigations are presented in Section 7. Finally Section 8 presents conclusions and discussion of the results.

2. Recent developments in automated print quality assessment

There are many print quality attributes contributing to the overall print quality. Image analysis and computational intelligence-based techniques are increasingly used for assessing various quality aspects of prints. Since the manual procedures are tedious, time consuming, and the results are subjective as they depend on personal skills and mood, automated printing quality inspection systems are highly appreciated. Developments in this area usually concern simulation of the most common print quality defects [8,9], inspection of one or several print quality attributes, such as the actual size and quality of printed dots [10], mottling [11], CCD camera-based estimation of ink density [12], automatic detection and classification of various printing defects [13].

A recent study used Bayesian networks and genetic algorithms to model the overall print quality assessment by a group of people in electrophotography printing [14]. The trained network structure reflected the relation between instrumental measurements, subjective print quality attributes and the overall quality.

Guan et al. have recently developed a case based reasoning system for offset print quality control [15]. A variety of print quality cases are stored in a knowledge base and exploited for decision-making in the printing process. Perner developed a knowledge-based image inspection system for automatic defect detection, classification, and misprint diagnosis in offset printing [13]. A CCD linear camera is used as an image sensor. The system can recognise defects, categorise them into one of 47 classes, including colour drift, and suggest actions for the operator to eliminate the cause of defect. Another image analysis-based defect detection tool, assisting the press operator in finding defect in the print and taking appropriate adjustments, was tested on a Flexo gravure printing press [16,17]. The system is supposed to be used on offset printing presses. Ductor streaks, hazing, colour splashes, structural defects, and hazing are the types of defects considered. The defect detection is based on a thresholded difference image between the reference print and the sample print. A similar approach of comparing the reference print and the sample print is also utilised in [18].

A print quality inspection system developed by Brown et al. for a rotogravure printing press was tested in the wall-covering printing industry [19,20]. The machine vision-based system uses a spectrophotometer based on holographic grating jointly with a monochrome area scan camera and measures a number of characteristics of the print including colour and the variation of the printed dots. If drift is detected in any of the parameters, the