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SIS-Stamp: An integrated inspection system for sheet prints in stamp printing application

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Abstract

Postal stamps with print defects are valuable collectables for philatelists. However, stamp printers strive to emit exclusively defect-free stamps. In order to achieve high quality of the production process, each sheet is inspected by especially trained staff. This kind of inspection is very flexible but it is tedious and leads to unstable and irreproducible results. Based on the experience in quality inspection, the ARC Seibersdorf Research Team set the goal to design an automated sheet inspection system (SIS), in which the front and rear side of the sheet are quality-inspected in a fully automatic mode using image processing methods. The print inspection covers each single stamp in the sheet and includes, among others, misalignments of the individual print phases and the perforation, detecting defects like smears, splashes and missing parts of the print. The features to be inspected, as well as the defect sensitivity, can be defined by a special setup program. The patented mechanical sheet transportation system separates the sheets, transports them to the inspection stations, and finally, stacks them in two trays for good and defective sheets. The prototype of the SIS-Stamp is installed in the Austrian State Printing Office (Österreichische Staatsdruckerei, ÖSD) for final inspection of postal stamps and vouchers.

Keywords: Quality inspection; Sheet inspection; Image processing

1. Introduction

Postal stamps are produced in a complex printing process resulting in sheets consisting of over 100 single stamps and more. This paper presents a novel test facility for quality inspection of these sheets, called sheet inspection system (SIS). The SIS-Stamp has been developed in the ARC Seibersdorf Research GmbH. Intended customers are printing houses specialized in stamps, which emphasize high quality in their products.

1.1. Motivation

Postal stamps with print defects are valuable collectables for philatelists. However, stamp printers

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trive to produce and emit exclusively defect-free stamps. For this purpose, they need appropriate quality control systems. Traditionally, each sheet is inspected at the end of the production process visually by specially trained staff. As the postal stamps are usually printed in very large batches and each individual sheet has to be inspected, this process leads to extremely high staff costs. The visual inspection is flexible, can adapt to different layouts very quickly, but the tedious work leads to unstable and irreproducible results. Moreover, the subjective decisions are affected by the actual 'condition' of the individual inspector. In comparison to the visual inspection, the following arguments speak in favor of the development of an automatic inspection system: constant inspection quality, substantially higher number of inspected defect classes, high throughput and the connected huge cost saving potential.

1.2. Aims

Based on the long-term experience in quality inspection, the ARC Seibersdorf Research Team set the goal to design an automated inspection system for this task. The qualitatively unstable visual inspection by humans can, thereby, be replaced. This ensures a stable and objective quality decision for each single printed sheet. The requirements are very high, since due to the ''competition'' with stamp collectors, only the absolutely defect-free stamps have to reach the customer. The aim was to develop a novel machine that would not only be capable of inspecting any potential postal stamp design, but also different stamp designs on one sheet.

1.3. Integration into the stamp production process

At the beginning of the development work, it had to be decided whether the inspection system should be integrated into the existing printing machines, or whether the inspection should be carried out as an independent step in the process of stamp manufacturing.

The option of integration into existing machines seemed attractive for reasons of cost and time saving (printing and inspection in one step). However, it had to be dropped for the following reasons:

- The integration of the inspection unit requires numerous adaptations to the existing machinery resulting in a massive conversion effort.
- Since stamps are usually printed on various machines according to layout and type using different printing technology (offset, intaglio, gravure, application of foils, etc.), it would require refitting a number of different printing presses with inspection systems. Cumulated costs of procurement for all printing machines would be extraordinarily high.

Therefore, the decision was made to develop a stand-alone test facility allowing for inspection of sheets independently of their printing process.

1.4. Requirements

The requirements for the SIS-Stamp were classified into three domains: (i) production-related factors; (ii) requirements given by the nature of the inspected object; (iii) requirements of the inspection process itself.

1.4.1. Production-related factors

- Production must be manageable by a single operator per system.
- The system must be suited for handling by unskilled staff. This includes not only operation (loading and unloading of sheets, calibration, replacement of lamps, etc.), but also preparing the inspection process for a particular layout of stamps.
- The system must be suitable for 24 h operation.
- The time required for setting up and adjusting the system to any new layout must not exceed 3 h.
- Conversion time for an already inspected layout must not exceed 10 min.

1.4.2. Features of inspected objects

- The system has to accept sheets of various sizes (from 160 mm × 116 mm to 550 mm × 350 mm).
- Sheets perforated together by a punching machine in five to seven layers have to be separated by a reliable device. The process of perforation causes the sheets to stick together. Separation and feeding devices used in common printing or photocopying equipment are not appropriate for separation of stamp sheets.