ON-PRESS CONTROL OF THE NEWSPAPER PRINT QUALITY

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Abstract:
There are several problems in the development of automatic quality monitoring systems for newspaper presses. A press contains several wide, quick-moving printed webs to be monitored on both sides, the webbing-up routes vary from job to job, the printed paper web is curly and fluttering, and the monitoring environment is contaminated by ink and paper dust, to mention some of the main difficulties. This paper describes the progress in the development of a quality monitoring system based on a video-matrix sensor. Some test trials have already been carried out with the experimental systems on the laboratory's test bench as well as in a full-scale newspaper printing press. The results are discussed in this paper.

INTRODUCTION

The offset printing method is a good tool for producing a high print quality, even in four-colour printed newspapers. Problems with the control of the very complicated lithographic printing process make cost effective printing difficult, mainly due to the high amount of waste before the required quality level is reached and to disturbances during the production.

Readers and advertisers demand **more colour and more full-colour pages**, especially in the form of four-colour pictures. By responding quickly and efficiently to this demand, newspapers have been able to increase their share of the market for printed publicity.

Besides being more colourful, the newspaper are now of **a better print quality** than before. Four-colour printing as such requires a better printing quality. Consequently, better printing presses and more accurate control of printing are needed to produce the new, more colourful newspaper.

The high requirements of production are not satisfied at the expense of **productivity**, e.g. by spending more time in printing or producing more waste to achieve the higher quality of the printed pages.

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All the above-mentioned circumstances require a better control of the printing variables. New, efficient **press automation and computerized control systems** are the tools used for this purpose.

The automatic control of the print quality by means of a **closed-loop control** is, however, difficult in newspaper printing. The main tasks of the control in this case are the control of the print density and the control of the colour registers. The use of several paper webs with varying web leads through the press, having four plates across the web, and complicated web leads between the printing units and the folder make the application of quality measuring sensors difficult and expensive.

The problems in the colour production of newspapers were discussed in our TAGA paper two years ago /1/.

METHODS FOR THE QUALITY CONTROL OF NEWSPAPER PRINTING

The most advanced quality control methods for newspaper printing available commercially today are *feed-forward control methods.* **Presetting systems** using film or plate scanners to give the right setting values for the zonal ink-feed mechanisms of conventional inkers are already widely accepted and their benefits have been recognized. Because of the complexity of the process, control tools, especially *automatic closed-loop control* methods, are also needed during the production to maintain the stable and high quality of the printed newspaper. Automated closed-loop systems are now commercially available only for the control of the colour register. As the control targets have to be printed on the pages of the newspaper, they have to be unnoticeable and small in size. There are several systems on the market for this purpose (Celogic, Harland Crosfield, Eltromat, Grafikontrol, Quad/Tech, Web Printing Controls).

Lately, video monitoring systems are offered for the visual control of the printed quality on the paper web (BST Servo-Technik, CCI, Drello, Eltromat, Harland Crosfield, Mitsubishi Heavy Industries, TecScan). These systems are control aids for the printer rather than components of integrated control systems. The system includes colour video cameras to monitor four-colour webs, picture grabbing electronics to store the image captured by a strobe light, and a picture storing and processing unit to show the printed images on the video monitors of the control console of the printing press.

In result, only the colour register has been taken care of by an automatic closed-loop control system. The other significant print quality characteristics, such as the macro-quality disturbances at the beginning of the printing, like tinting or water marks, the density levels of the various colours, dot gain and the grey balance of the four-colour pictures are outside the automatic control at present. With a separate control system for each quality parameter, it is very difficult to solve the total control economically, because several wide paper webs are printed in four colours. The quality control of newspaper printing should be done with *an integrated system* taking care of all the important control variables.

Integrated systems applying modern DSP and image analysing technology to *measure and analyse the print quality on-line* in a newspaper offset printing press have not been reported as yet. This paper is a progress report on the developments made at VTT's Graphic Arts Laboratory in Finland in the automatic quality control of newspaper printing by on-line measuring and analysing of the printed images.

VTT'S QUALITY CONTROL CONCEPT

To get the quality of a newspaper printed in colour under control with minimal waste in a conventional web-offset printing press, at least the following quality variables should be controlled properly:

- Colour register at the start and during the production
- Macroquality at the start and during the production
  - Opening of the plates
  - Correct inking and dampening for each page
  - Correct cut-off register
- Density and grey balance in 4-colour production
- Dot gain in 4-colour production.

The measurements have to be carried out with as few sensors as possible. But simply monitoring the printed image and visualising it on video monitors is not enough for a good automation system. An automatic analysis of the quality characteristics is needed. This is absolutely necessary for a closed-loop control system. All larger presses have several webs with 4-colour images, possibly on both sides of the webs. Therefore the cost of the equipment per web has to be reasonable.

An automatic closed-loop control of the total print quality is best realized with an integrated and computerized control system which passes the information received from the presetting and prepress systems.

The main parts of VTT's experimental system are

a) picture grabbing and synchronization
b) image analysis
c) user interface

The system has four CCD video cameras, i.e. two colour cameras (3-output RGB and 1-output NTSC) and two black-and-white cameras. The cameras are connected to a colour frame grabbing board (Matrox MVP-AT) by a multiplexer board. A high-performance digital signal processor board (TAGIPS-DSP-board made by the Finnish company TAMIPS /2/ is used for speedy computations and image analysis. The synchronization is supervised by a microprocessor-based subsystem that takes care of the traverse positioning of cameras, and by a multipurpose timer board that steers the high-speed stroboscope flashes to freeze the picture at the right moment.

The main computer (PC, 80386, 25 MHz) masters the whole system.

- It controls the DSP board (TAGIPS) (communications, transmission of messages etc.),
- selects the right camera by control signals to the multiplexer board,
- sends commands to the traverse positioning system of the cameras,
- computes the exact timing for the stroboscopic flashes,
- takes care of the user interface,
- saves the measurements and results in the database of the mass storage
- commands the frame grabber (MVP-AT) and its video speed data transfer with the DSP board (TAGIPS).

The TAGIPS-DSP board is based on a 32-bit digital signal processor (Texas Instruments TMS320C30) which is one of the fastest signal processor available. The board also contains an image digitizer and memory units, eight 16-bit convolution processors (Inmos-A100), and run-time reconfigurable logic cell array (RRLCA) devices which give hardware solutions to calculation-intensive tasks.

The graphic user interface is through a VGA display with a 1024 x 780 resolution and 256 simultaneous colours, a standard AT keyboard and MS mouse. Fig. 2. shows the display for the programming of the measuring sequences.

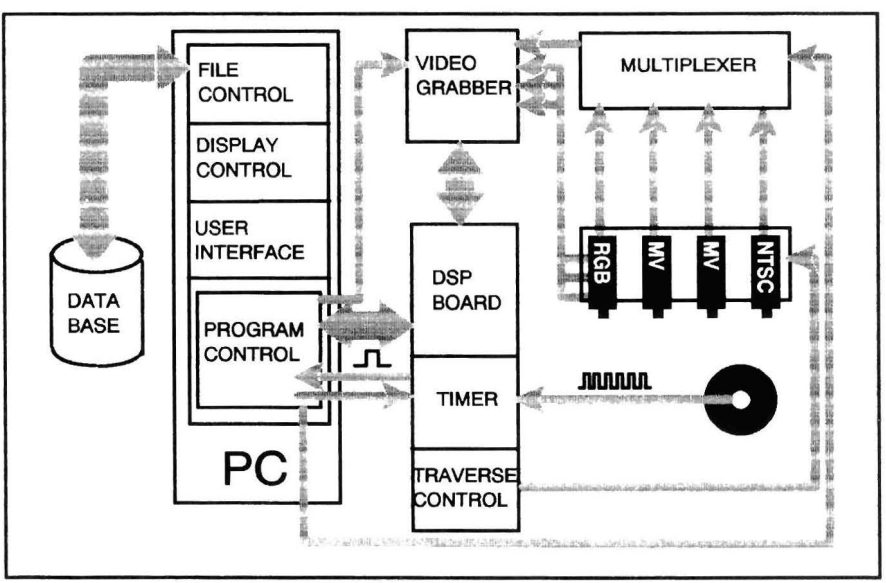

Figure 1. Block diagram of the experimental measuring system.

The user interface makes it possible to **set up new measuring sequences** with arbitrarily selected measurements and measuring positions on the web, or to **recall earlier made measuring sequences from the memory**. The measuring sequences **can be altered by the editing mode** of the user interface. **Different measuring sequences** can be created **for the start of the printing and for the production period**. All the programming functions are available by mouse.

During the printing, the measuring results of selected quality parameters are shown on the display as average momentary values, or as trends showing the direction and magnitude of the changes in the quality parameters. Fig. 3 gives schematic example of a display.

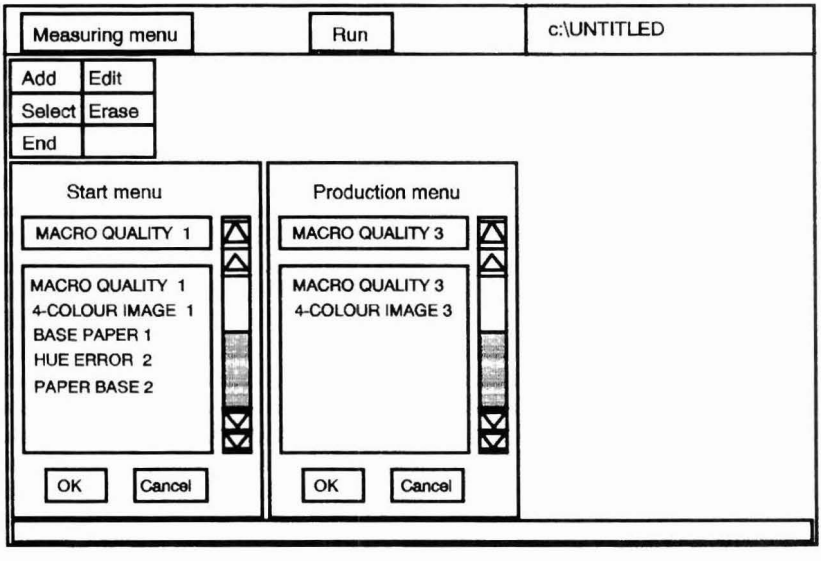

Figure 2. Display for setting up the measuring sequences.

The above described quality measuring system is an experimental measuring system for research and development purposes. For the actual production control in a newspaper printing house, the number of cameras has to be minimised and more efficient circuit boards, e.g. a multi-channel video multiplexer and a fast multichannel A/D converter have to be included. A commercially produced measuring system may be too expensive at the present prices of hard-ware but

considering the rapid development in the price/efficiency ratio, a reasonable price level will be reached rather soon.

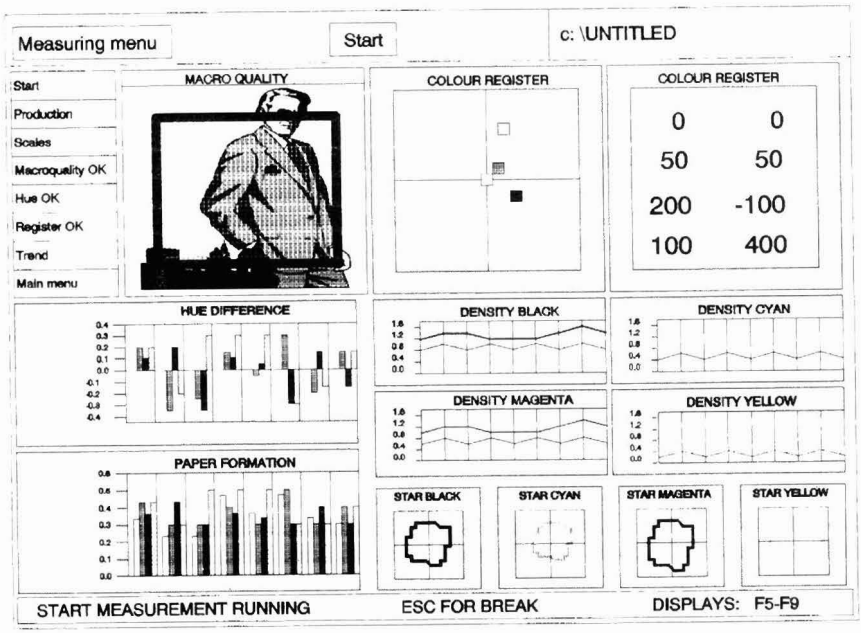

Figure 3. An example of a display showing the measured quality parameters.

REPORT ON THE OBSERVATIONS

A large number of **bench tests** were carried out using the laboratory's PC-controlled instrument bench tester. The purpose of testing was to verify the reliability and repeatability of the measurements made by standard B/W and 3-colour video cameras. It turned out that in newspaper printing, where the density readings in production are rarely above 1.0 D-units, the accuracy of the density measurement can be maintained at a satisfactory level. The total accuracy, which includes the errors of on-line measuring and the errors of a desktop densitometer, was better than +/- 0.05 D-units. The accuracy of the colour register measurement was above +/- 0.05 mm.

Some **tests in production conditions** have also been carried out. The experiments were made at the second printing plant of theFinnish newspaper Helsingin Sanomat in Varkaus, Finland. The measurements were carried out on test targets printed on the back fold of the tabloid paper Ilta-Sanomat. The sensor bar with the PC-controlled traversing and synchronizing mechanisms was installed in the position in which the paper web was printed in the 4-colour satellite printing unit of the Wifag OF8 press. The measuring bars of the targets contained of test fields of solid and 50% tones of separate process colours and 3-colour overprints, plus the test target for the measurement of the colour register. The macroquality was measured from the printed picture and in its non-printed surroundings.

Only matrix-video cameras were used in the experimental measuring system. That is why the measurements had to be made in a position, in which the page is like a plane

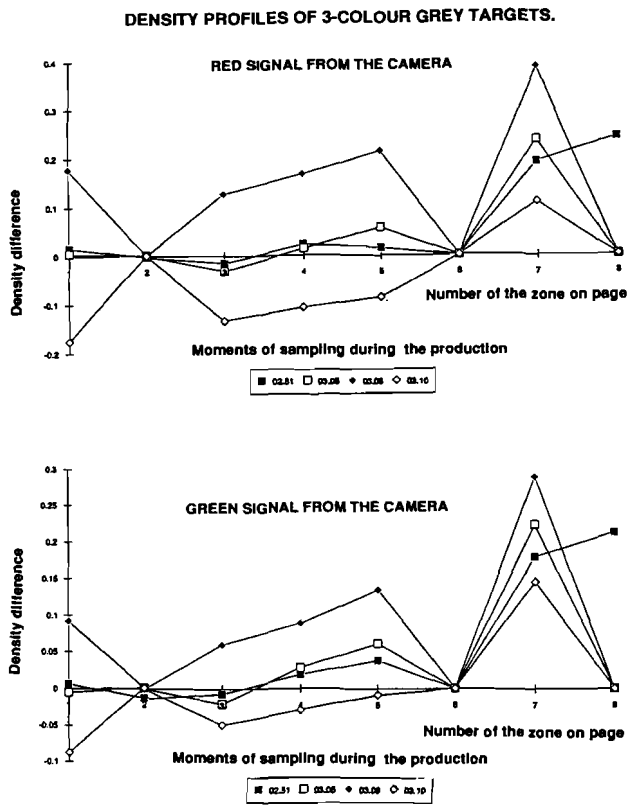

Figure 4. An example of the variations in inking during the production of the tabloid newspaper Ilta-Sanomat.

e.g. before or after a pipe roller. The free running web in the printing press never is like a plane, however. There are always waves or pleats in the web, which substantially disturb the measurements. This means that a matrix camera can be used to measure the macro-quality characteristics but not quality characteristics which require enlarging optics in the camera, and matrix cameras are hardly able to to produce the density measurements in accordance with the measuring standards.

We succeeded in measuring the macroquality characteristics very well in spite of the fact that the observation window of the experimental measuring camera was not large enough for proper production control. Even the changes in inking could be observed with the equipment, as shown for magenta by the graphs in Fig. 4.

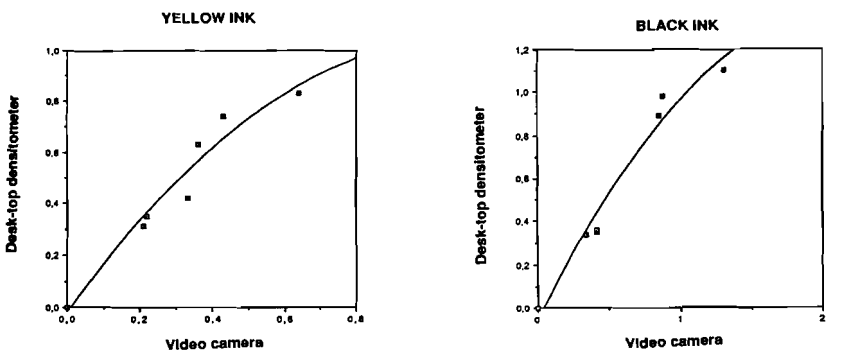

Figure 5. Desk-top vs. camera density for two inks.

The density measurements from the test targets were also carried out satisfactorily. However, if the density rises a lot above 1.0 D-units, the non-standard illumination geometry of the measurement by the matrix camera and the instable flatness of the paper web seriously disturb the accuracy of the measurement.

CONCLUSIONS

The automatic control of print quality in a web offset printing press for newspaper production is not an easy task to solve. The automation problem cannot be solved economically using a separate measuring system for each quality parameter, such as the colour register and the print density. The width and number of printed webs raises the cost of such systems too high for the production of newspapers. The purpose of the study described in this paper was to find a solution to the measuring problem by using matrix CCD cameras in a computerized system for the analysis of various characteristics of the print quality. Major macroquality disturbances, such as tinting, the lack of inking or the overall variations of the density levels of the process colours can easily be detected, analysed and warned about by an automatic control system. Problems arise when the exact measurements of the density or colour register from

small test targets, or - even more - when the screen dot characteristics of an enlarged image are to be measured and analysed. These measurements are possible only on large-diameter pipe rollers on which the web runs smoothly.

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