ONLINE MONITORING OF THE NEWSPAPER PRINT QUALITY

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1. Introduction

The increasing number of pages and the growing portion of coloured pictures in newspapers together with the rising costs of paper have been the main reasons for the adoption of automation technology into modern newspaper printing. Part of the problems have been solved by automatic remote control, sequence control and presetting control. The online measuring of the main quality parameters, such as print density and colour register, has not yet been solved. On the other hand, also the increasing quality requirements of newspaper pictures call for fast and reliable online methods to measure the print quality.

The measuring of the essential quality parameters is important both during the make-ready period and during the production printing.

At the start the quality of the colour register is guaranteed by means of a reliable pin register system from the paste up to the plate cylinders rather than by a register monitoring device. This is due to the use of page-sized plates (4 ... 8 plates per cylinder) in the larger newspaper presses. It is essential to find the plate opening in the non-image areas of the plate. In newspapers with dozens of pages it takes time to browse through the sample taken from the conveyor and to find possible tinting on some of the pages. Finding can be made easier

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by means of a proper density monitoring system.

The second step is to study the density levels of the coloured pages to maintain the print quality (tone rendering and gray balance). This also requires some kind of density or image quality monitoring system.

During the production printing tinting tendency, tone rendering and gray balance have to be monitored continously for reasons of quality. Also the changes of the colour register, e.g. following the automatic pasting sequences, may cause remarkable quality variations which should be monitored by online measuring. In this case the registers of all the pages of the whole cylinder vary simultaneously. This variation largely depends on the construction of the colour printing units of the press.

At the time of writing this paper no reports are available on the efforts at solving the online quality monitoring of letterpress and offset newspaper presses. This is the case for both letterpress and offset newspaper presses. The online densitometers described in the literature were primarily intended for heat-set printing.

In connection with the studies of presetting systems for newspaper presses we have experimented with a 16-head web-densitometer installed in different offset newspaper presses /1/. Summarizing the results of these experiments we have come to the following conclusion:

The use of density measuring heads was fairly successful during normal production of newspapers with editions ranging from 60,000 to 100,000. The measurements were reliable and corresponded with subsequent manual measurings, no collection of paper dust was found on the glass cover of the optical surface of the measuring head. The measuring of a tabloid newspaper was rather easy thanks to the density measuring strips at the fold of the tabloid page. When printing the broad sheet paper, as usual, the positioning of the test strips was

evidently temporary. It is not possible to position wide enough test strips on the usual broad-sheet newspaper page. There is probably no possibility of applying any kind of test strips to monitor the newspaper quality.

This is the first progress report on the research work carried out at the Technical Research Centre of Finland (VTT) to develop an online quality monitoring device suitable for use with newspaper printing presses. The following paragraph gives the goals of the investigation.

2. Goals

A newspaper printing press requires a special kind of quality monitoring device fulfilling the demands listed above and suitable for the environment in the newspaper printing hall. In this study we aspire to find out about the possibility of using a diode matrix line sensor as a quality monitoring device. For that purpose we need answers to the following questions:

- Are the basic electrical and optical characteristics of the diode matrix sensors and the involved electronics suitable for the purpose?

- What is the image measuring accuracy needed for the quality monitoring of single-colour and four-colour pictures in newspaper printing?.

- What kind of quality parameters can be measured and what is the functional specification of the device based on the above answers.

3. MEASURING AND MONITORING METHODS

The final goal of the study is to develop a measuring device capable of measuring normal newspaper production. Before starting to develop such a device we have simulated the measuring by an image processing system and by a prototype measuring system. The material for the study was collected when making acceptance tests for newspaper printing presses. The samples were taken periodically during the whole printing period. The material thus consists of both good newspapers and of newspapers with various types of printing failures.

Two alternative methods are available to develop systems that make it easier to control the quality of newspaper printing. First we can make the visual inspection of the print quality easier by developing monitoring systems and second we can automate the inspection by developing automatic measuring devices. This study views both alternatives.

3.1 QUALITY MONITORING

A monitoring system consists of a CCD vector camera with the necessary lighting system and of a CRT monitor. The amount of information needed has a significant effect on the complexity and on the price of the monitoring system. The amount of information depends on the number of pixels in the displayed pictures and on the number of bits in a pixel. The amount of information needed is investigated by an image processing system equipped with a video camera, a colour display and a computer.

A selection of printed newspaper pictures are taken by the video camera. The pictures are displayed on the CRT monitor with various amounts of information. We shall study the amount of information needed to distinguish between good and poor print quality.

The requirements for the pixel size and the gray level were defined with the Graphic Arts Laboratory s realtime image workstation (COMTAL VISION ONE/20 called COMTAL in this paper).

3.2 DENSITY MEASURING

We have assembled a prototype to study the possibility of developing a device that measures density values from a running web without any special measuring spots. Our purpose was to gain experience in using a measuring system and to study the capabilities of a device that can be obtained at a reasonable cost.

The amount of information obtained, i.e. the measuring accuracy and the pixel size of the prototype system, is computed and compared with the amount of information needed for visual inspection.

Another important goal was to test how small measuring spots can be used and whether it is possible to make the measurements in the image area of newspaper printing. As with the image processing system we test whether the amount of information is sufficient to distinguish between good and poor print quality.

3.3 TESTING SYSTEM

Since our prototype is not a specialized picture measuring system we cannot reach great speeds in measuring.

The system consists only of the density measuring mode with a graphic bar graph display of specified parts of the page measured. An overview of the system is in Figure 1.

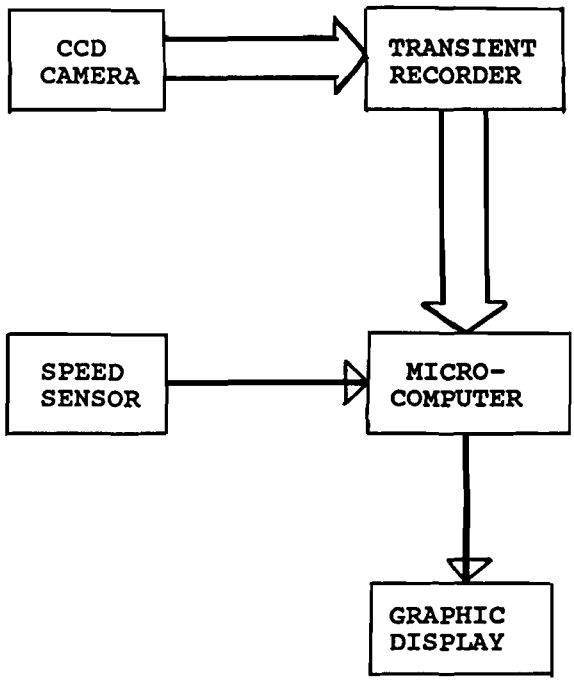

Figure 1. Overview of the system.

Our CCD camera is a 1024-pixel vector camera, Fairchild Model 1310 Line Scan Camera with a Model 1320 Camera Control Unit.

To make the analog-to-digital conversion a transient recorder Datalab DL901 (1024 memory locations, 8 bits, 200 kHz), was

used. The transient recorder has an eight-bit parallel interface for data readout.

The experimental microcomputer is a Motorola Microsystems EXORSET 100, mainly used as a program development tool. The microcomputer is connected with the other system components by using a parallel interface and a programmable timer circuit. The parallel connection is programmed to receive parallel eight-bit measured picture element intensity data from the transient recorder and to control the data transfer sequence. The timer circuit is programmed to synchronize the measuring with the speed of the paper.

To measure the position of the paper a tachometer giving one pulse every 0.1 mm and a revolution counter were used as inputs to the timer circuit.

3.4 TESTING PROGRAMS

The measuring cordinates e.g. the line number and the pixel number from the top of the sheet, can be specified by the user.

To speed up the system only the pixels specified by the user in advance are stored.

Because of the speed of the paper the reading of one row is done with an assembly language subprogram which automatical cancels the measurements not needed and saves only those needed.

The measuring principle is illustrated in Figure 2.

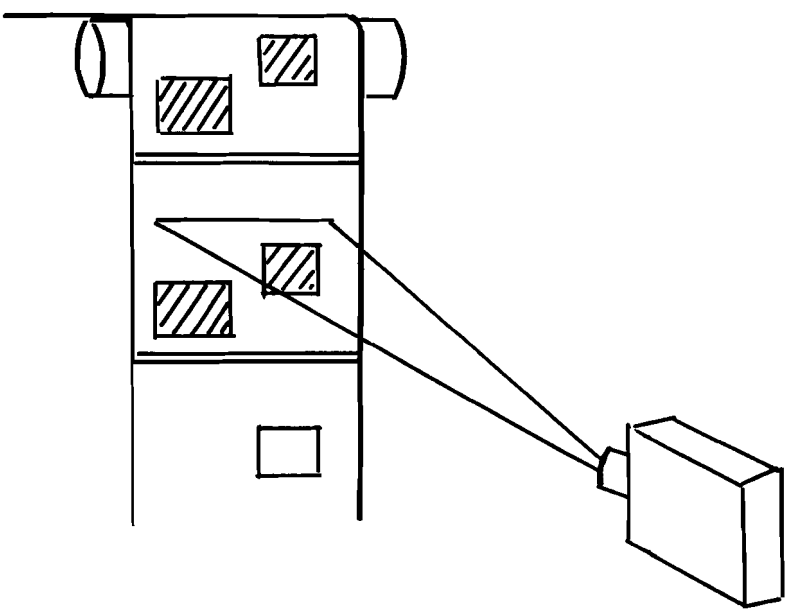

Figure 2. Measuring principle.

The intensity-to-density conversion is also made quickly by a machine language program reading the results from a conversion table, which is calculated in the beginning.

The system can be tested only in laboratory conditions at a low printing speed.

The block diagram of the program is in Figure 3.

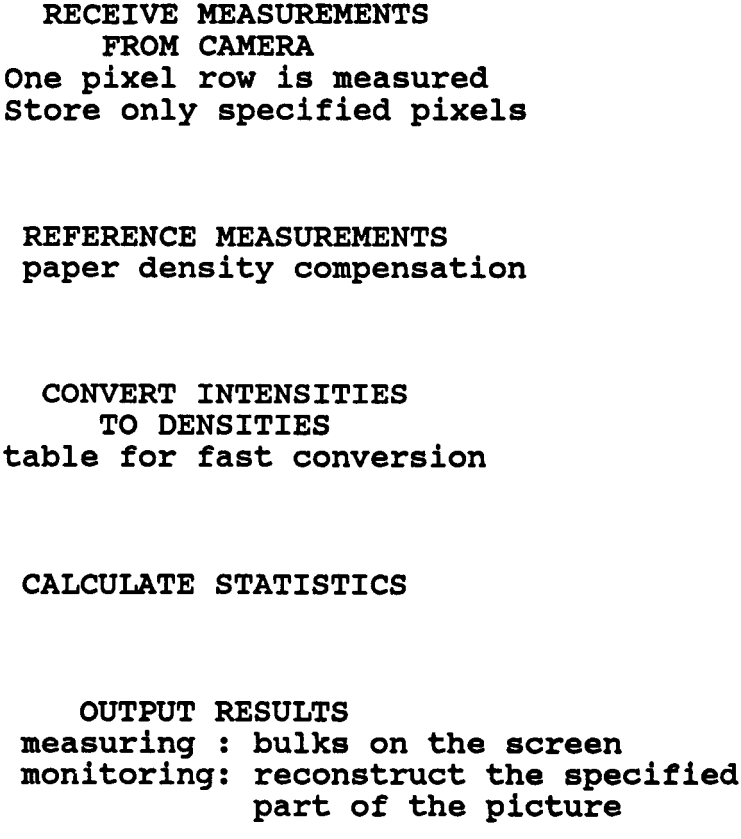

Figure 3. Block diagram of the measuring program.

4. RESULTS

The system has been assembled and programmed and some tests have been made with it. The final results of the experiments are not yet available but we are able to give some preliminary findings.

4.1 RESOLUTION

First some colour slides are read into the memory of the COMTAL. With the COMTAL we could easily manipulate the resolution, e.g. the number of horizontal and vertical picture elements and the amount of gray levels of each colour.

From the studies made with the COMTAL we conclude that the requirement for the pixel size and for the gray level amount is rather low.

If the pixel were too big the reconstructed picture on the screen would be difficult to understand. That is why the pixel size is a rather critical factor.

The computer can easily measure and display over 200 gray levels. But because of the logarithmic response the human eye cannot see significant differences between a picture with 20 gray levels and another with 50 gray levels. That is why there is no need for a very high gray level amount in monitoring but density measuring the requirements for gray levels is rather high.

After inspecting the pictures on the COMTAL screen we took some photos of the screen with different pixel sizes and gray level amounts.

Viewed at a normal reading distance (30-50 cm) a postcard photo with a pixel size of 1*1 mm and with as low as sixteen gray levels seems to be almost equal to a picture that has 200 gray levels.

4.2 AMOUNT OF INFORMATION

A CCD camera can have about 5,000 pixels a row. If a sheet is measured within 1 mm and the length of the plate is 500 mm, we have 2,500,000 (2.5 Mbyte) pixels of information, which means that a lot of high-speed memory is needed. The price of such a memory is rather high today but less expensive and faster memory products are coming on the market soon.

4.3 TIMING

The printing press speed may exceed 10 m/s that is 10 mm/ms. Having a 1-mm-wide picture line with for example 1,000 pixels the computer has only 100 microseconds to read and store the whole line. This means that one pixel should be stored in 0.1 microseconds.

Such high speeds cannot be reached by a general-purpose computer.

By assembling a special system with a video speed analog to digital converter and a high-speed memory it is possible to speed up the storing procedure.

4.4 EXPOSURE

Equipped with large aperature lenses today s CCD cameras are already rather light sensitive and the tendency is to develop higher resolution, better sensitivity and greater reliability.

Lighting may be a problem with sensitive cameras needing some extra light. For example if light intensity coming from the general ligthing of the building is high compared to the light intensity coming from the spotlights directed to the paper under investigation, the system may see the intensity of the measurement fluttering with the main current frequence of 50 Hz (60Hz USA) or double.

5. FUTURE PLANS

Our plan for the future is to develop systems for quality monitoring and for density measuring.

The system will have two different modes.

In the monitoring mode the user will see on the monitor a reconstructed image and a graphic picture showing the part of the sheet.

In the measuring mode there is a graphic bar graph display of the densities and also a graphic picture showing the measured spots.

An imagined measuring mode display in figure 4. Using a monitoring device of the future the user may easily select the display mode for monitoring or for measuring and the part of the sheet, e.g. the part of the newspaper page, he wants to see on the screen. He may use a mouse or select the display by pointing with his fingertip.

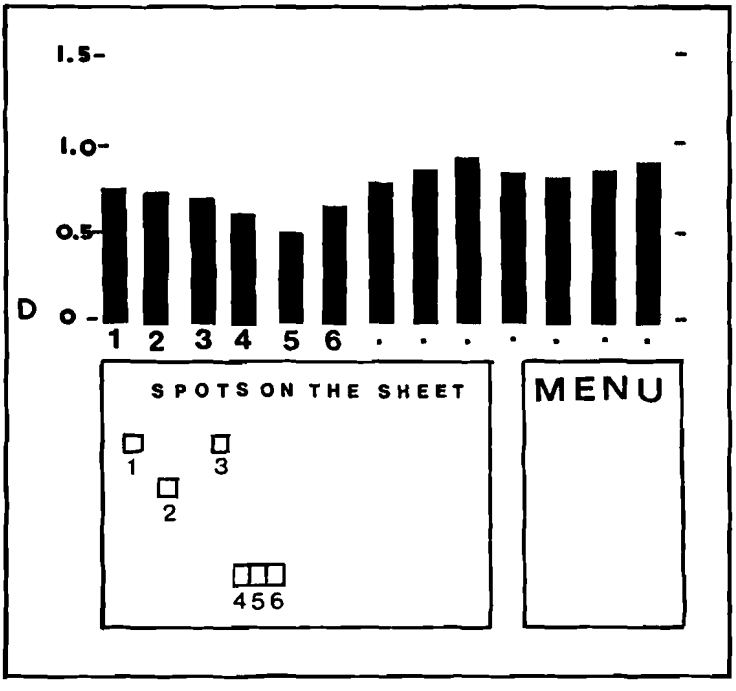

Figure 4. Future display in the measuring mode .

6. REFERENCES

Lehtonen T., Juhola H., Simomaa K., Presetting Systems of Newspaper Presses. Graphic Arts in Finland No. 1, 1982, pp. 18