OPTICAL METHODS OF MEASURING IN TEXTILE INDUSTRIES

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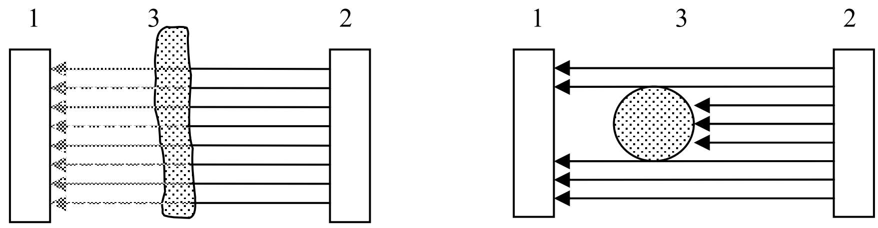
ABSTRACT

The project which is submitted present methods and application of optical sensors such as cameras with line scan modules (CCD or CMOS sensors). It hint scope how to use optical sensors for yarn or web measurement system. Methods will be discussed and compared with other types of sensors based on different principles. The main goal of this project is to develop an inexpensive measurement system for moving linear textile formation. We are working on system for measuring homogeneity of textile formation.

1 INTRODUCTION

Prediction of the appearance and other quality attributes of fabrics using the on-line measurements are most useful for fabric development and textile process control. Automatic optical inspection systems are suitable for use in variety of applications where webs, yarns, etc. are being produced. We are developing a control system for electronically imaging the quality attributes (basis weight, appearance uniformity, physical properties, etc.) of woven and knitted fabrics directly from an on-line measurement system. We are doing this without having to knit or weave the real fabrics. Such a system, if perfected, is expected to economize and improve the efficiencies of product development and quality control.

The basic principles of photoelectric sensors for measuring are well known [3]. In the first idea called „transmitted method"(shown on Fig. 1a) we measure reduction of luminous flux passing through textile formation. It is suitable for products with smaller optical thickness when filling whole optical path from light to sensor. Or we can measure collected luminous flux on detector – „shadow method"(fig. 1b). This method is typically used for construction of optical sensors for measuring width or diameter of yarn.



1 – Photo element, 2 – light source, 3 – textile formation

Fig. 1: *Inspection by transmitted light and shadow method in fabric inspection*

The main disadvantages of these sensors are elimination of exterior affect on their characteristics (temperature and humidity of environment, lights from others sources etc.) For this precision application of sensitive sensors the light sources and electronics must be very stable for disturbance. Electronic must be powered by voltage regulators with higher precision. At present, three possible types of sensor are used in practice:

- Laser scanner
- CCD camera systems.
- Photodiode application

1.1 OPTICAL DENSITY

The optical density is defined (1) as relation between luminous flux that overpasses through measured object (named P_t) to total emission P_o. The result value is logarithm of this division.

$$D = \log_{10}\left(\frac{P_t}{P_0}\right) \qquad (1)$$

2 APPLICATION OF LINE SCAN CAMERAS

Typical camera application for inspection of moving object is shown on fig 2. The light source excites material which is measured and camera with attached optical-lens periodically captures line of web. We are developing systems based on CCD or CMOS sensors from Taos or Photon-Visions systems [1] These line scan camera can capture sequence of rows with custom selectable pixel resolution.

In any line scan application we must consider both desired resolution perpendicular to the object’s movement (horizontal resolution) and the resolution along the path of the object’s movement (vertical resolution. The solution is well described in application notes [2]. Transport encoder is recommended for all line scan applications to ensure synchronization of the camera scan rate with the transport velocity.

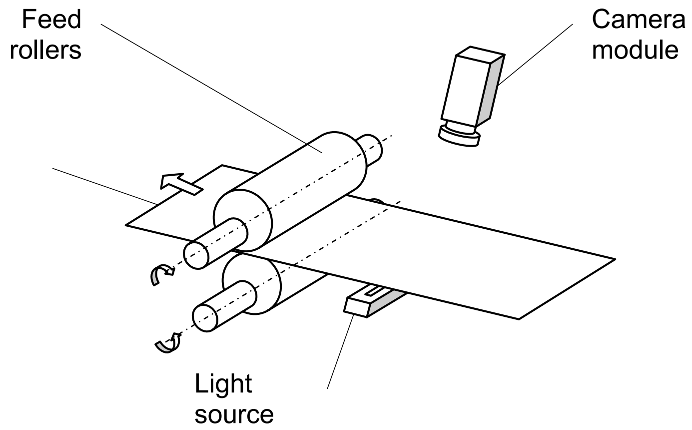


Fig. 2: *Camera module for web inspection application*

2.1 OVERVIEW OF SYSTEM

The main part of image inspection system (shown on fig. 3) is optosensor TAOS, which contain sensing pixels with integrated fast digital to analog converter (DAC) and serial interface (SPI). With integrated 8bit digital to analog converter (DAC) it is capable to get 256 levels of gray. The image sensor is controlled by microcontroller (based on 8051 family). This controller contains software for one-shot capturing of image row, instructions for configuration of sensors pixels and also for diagnostics functions.

All of these commands can be entered by communications line from PC. We started with serial interface RS232 but there are limits to speed by 115 kbits per second. So we try to develop USB peripheral. Each command sends echo to host computer or required data block. The whole system contain power supply source for simply connection to =/~ 12V.

For proper activity and maintenance before capturing image data the system must initialize the optical sensor. It contains registers for corrections individual sensing elements. Then it is possible to send command for capture single row of pixels and wait for answer. Sending command also contain parameters which set time for integration in ms units. And microcontroller provides service image sensor, accuracy delay for integration and reads data from image registers. The whole process can be doing in cycle.

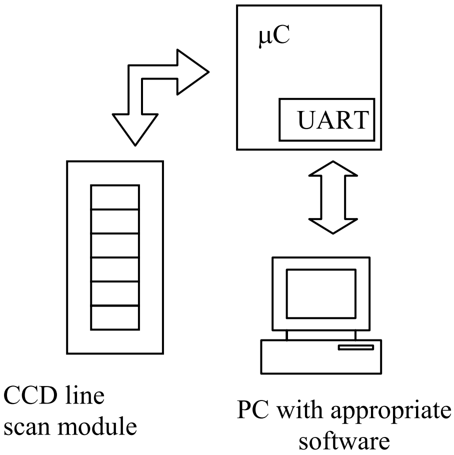


Fig. 3: *Block schema of line-scan camera system*

2.2 SOFTWARE FOR DATA COLLECTION

Main mode of application, shown on fig. 4, is collecting data from microcontroller and graphical representation of measured data. The program is written in Borland Delphi development environment. Software parts are designed for user comfort ability and for simultaneous work in Windows environment. However for best performance in real process measurements it should be written completely to target microcontroller for on-line connection to control system of textile machines.

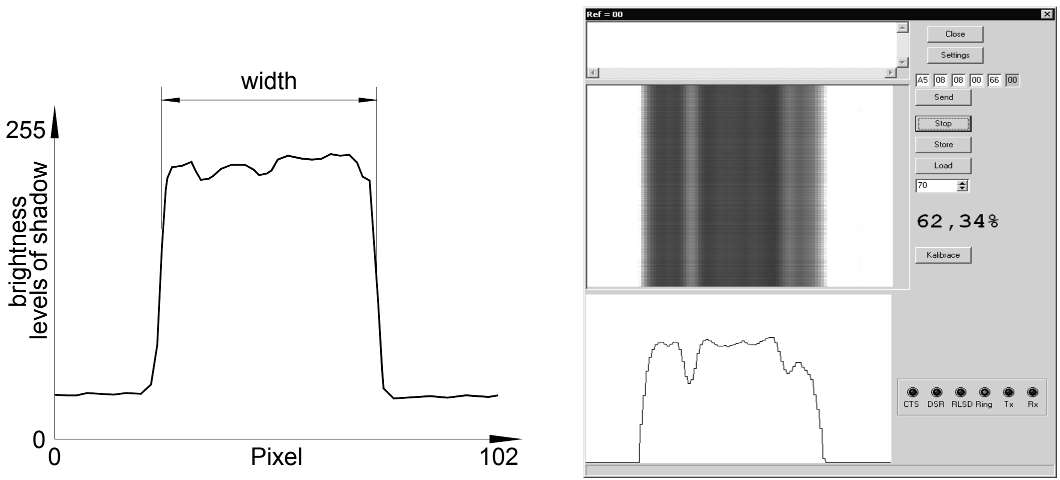


Fig. 4: *Software for graphical representation of brightness function*

2.3 ANALYZING OF MEASURED DATA

In addition to these visual methods, we also developed theory and application for 2-D and 3-D. Visualization of this 2-D matrix was done by MATLAB graphics package. So we can characterize the variation of fabric mass or other physical prosperities in two dimensions. The 3-D image visualization of web measurements is shown on fig. 5. For 3-D images, bigger valued data points in our models correspond to the darker points (and higher z value). Both axes X and Y are physical dimensions of web formation.

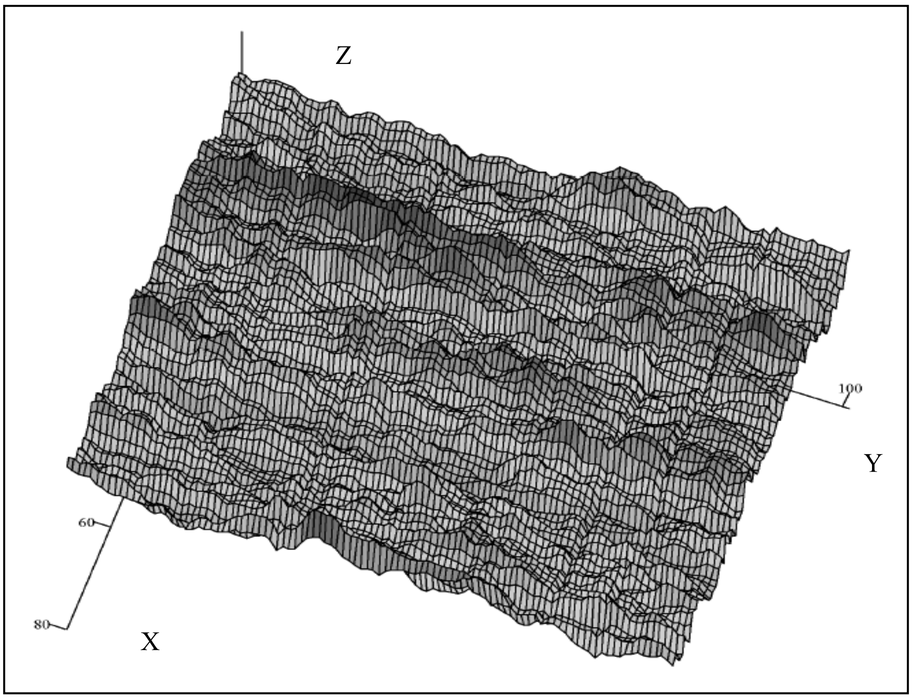


Fig. 5: *3-D Image representation*

3 ARRAY OF PHOTODIODES

This system uses modulated light source and infrared photodetector, so there is no need for special lighting and is non-sensitive to ambient light. The light source in this case is an infra-led transmitter which is driven by pulse modulated signal generated by power source. The receiving diode contains sensitive area witch attached IR filter. The block diagram of this system (fig. 6) consists of separable modules so it is easily reconfigurable for what the customer need for their special application

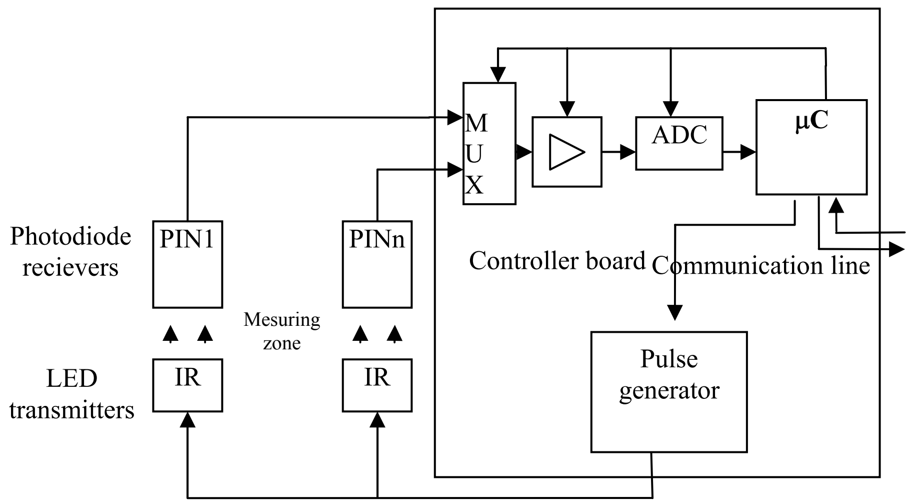


Fig. 6: *Block diagram of array photodiodes*

The Graphical representation of measured data is shown on fig. 7. The trace with number 1 represent value obtained from photodiodes when infra led is on. The bottom trace numbered 3 is opposite condition – when the transmitter led is off. The middle trace (2) corresponds to optical homogeneity of moving textile formation.

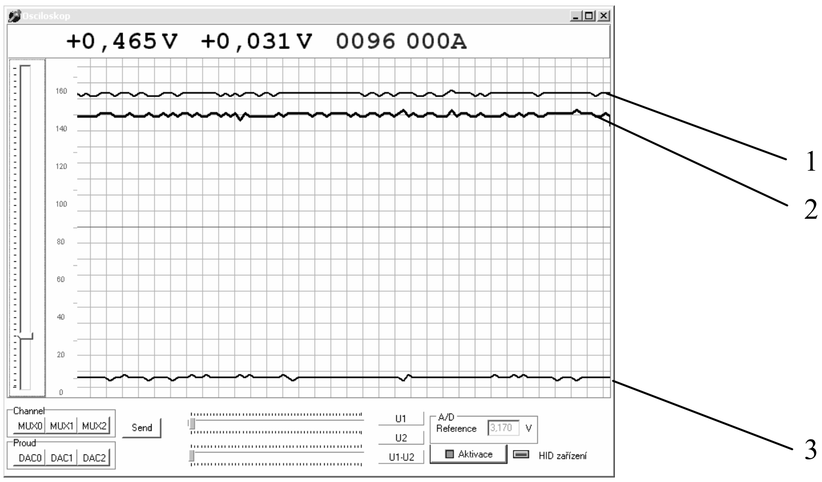


Fig. 7: *Control software*

The system based on complex hardware and software parts is still under intensive development. Further studies shell focus on methods for detecting foreign staples in textile formation.

ACKNOWLEDGEMENTS

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