

New Prototype Architecture for Vision Automated Inspection

Codrin Donciu, Marinel Temneanu, Alina Samoilă

*Department of Electrical Measurements, Faculty of Electrical Engineering
Bd. D. Mangeron 53, Iași, 6600, Romania
Phone (40) 32278680 Fax (40) 32237627 e-mail:asamoila@ee.tuiasi.ro*

Abstract- *the project proposes to accomplish a new system architecture of real-time video inspection of textile materials, which should ensure a fault tracking-down, rate of over 99%, in the presence of disturbing elements from the industrial environment. The inspection procedure stipulates that the system should learn the correct model of the textile material, so that it is able to notice the deviations that might appear during its inspection. The model changes are analyzed with the help of many detection algorithms to separate real flaws from normal variations, accepted in the material. After the detection, follows the localization of the flaw, settling the coordinates, its size and recording it in the flaw library. This is a work-in-progress that has to be finished in august 2008.*

I. Introduction

The video inspection in textile industry may be realized with human operator or by flaw detection automated system. A few examples of textile inspection grades are: the Konsan inspection grade, MR-OWB-15 grade, Linhai Shengtian inspection grade, CIW-100 and these are only a part of the existing textile inspection grades.

The textile industry is one of the most ancient economical societies and respecting the products quality, the users' claims are more and more bigger.

The human inspection has lots of disadvantages (especially the operator's fatigue) which lead to a very low quality production. The solution is represented by the automated video inspection systems. A few examples are: the Cyclops system - developed by Barco Vision, the Fabriscan system – developed by Zellweger Uster, the Georgia Tech system – developed by the Georgia Technological Institute, I-TEX 1000 system, Loom-TEX system. Using these systems, the products' quality will be superior and that leads to a decreased cost production with 2-3%, productivity growth with 3-5%, quick improvement of technological processes.

The video inspection systems architectures developed until this moment are confronted with the following problems: conceptual differences between algorithms developed for material flaw detection and the ones used for verifying painting treatment quality, severe dependence between the flaw detecting rate and the establishment of parameters for the lighting systems (intensity, radiation spectrum), the existence of high frequency noise produced by the action engine, the appearance of impurities on the surface of the video camera lens. The proposed integrated system for video-intelligent inspection of textile materials confronts no more with this type of problems. The project is distinguished by five new aspects.

First, it is foreseen the use of new detection algorithms of material flaws and flaws resulted after painting treatment, the accomplished system being a flexible one, with a high degree of adaptability to the beneficiaries' requests. We consider this characteristic as an essential one to reduce the effort of economical profile agents towards automating their production lines. Algorithms used normally for material flaw detection are typical for high resolution systems that process the information as in verifying the existence of abnormal discontinuity areas. A satisfying resolution can only be obtained by positioning optical sensors very close to the analyzed material. For increasing the processing speed of the video information, this is classified on grey levels. Algorithms used to detect textile material painting flaws process the information concerning relatively large material areas for detecting eventual gradients due to lack of uniformity of the applied treatment. The solution thought of to accomplish a combined detection system of the two flaw types is the use of a color linear camera-sensor, product newly appeared on the market. Specific algorithms for quick data processing to insure checking at high textile material circulation speed will be designed and implemented.

Secondly, it realizes a transfer of solutions for some complex disturbing problems, false flaws generators, from the hardware domain to the software one. This way, the traditional electronic devices used to remove the disturbing effects, will be replaced with virtual information processing interfaces, located in the pre-process block. Light intensity fluctuations can produce variations of grey shades of the entry data matrix, leading to false errors. Classic solutions stipulate introduction of stabilization and electronic regulation circuits that reduce the fluctuations to 2%. The project proposes a software solution of this problem by introducing the pre-processing PP block in which, with the help of two adaptive parting walls, the global variation of the illumination variation is removed.

Third, it is stipulated a controlled scission of the data flow inside the inspection procedure, to assure the pre-processing block with the necessary autonomy to work in real-time.

Fourth, the system can be used without structural modifications in the interface control, due to the versatility offered by the inspection soft procedure.

Fifth, by adding the function of the electrostatic F filter, by introducing an additional algorithm for removing errors introduced by the deposition of textile impurities on the video camera lens, it increases the tracking-down rate of real flaws.

II. The algorithm typology used in video inspection

The video system block architecture consists in image acquisition system and estimation system. The specialized software algorithm may be decomposed in a few modules, not necessarily very well separated and not always together.

Image acquisition – the most important element of the image acquisition system is the CCD sensor. It captures the light in little photocells inclined in a matrix. First, the charges from the first line are transferred into a reading register. The signals are amplified and then taken over by an analogous-numerical converter. After a line was read, its charges are deleted from the reading register. The next line will be transferred in the reading register and all the lines will be transferred in a lower line.

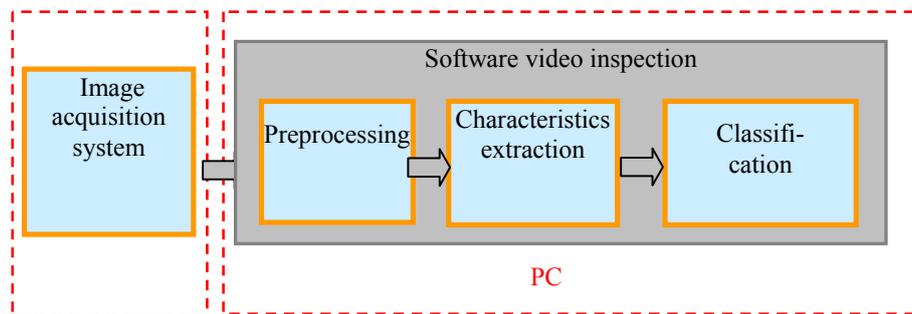


Figure 1. The block scheme of a video inspection system

The charges from each line are coupled in such way that at each transfer from the current line to the next line it is realized in the same time another transfer from the previously line to the current line. This way we may read a whole line at one time.

Preprocessing – the preprocessing operations have the role to eliminate the noise or the unnecessary informations from the image. These operations are necessary to improve the execution time and the results of different algorithms.

The filtering operation is used to eliminate the noises and to distinguish the edges. Generally, they are used three types of filters: low-pass filters - to eliminate the filters, band-pass filters - usually used to process the images acquired from the plain or satellites, high-pass filters - used to distinguish the edges.

The restoration operation – as a result of acquisition, the image can be twisted. The optical system represents the main cause for these distortions. A sampling operation can fix these errors. This way, the mathematic relations necessary for image correction are determined by calculating each sample's (pixel's) value from the new image on the basis of a number of samples from the twisted image.

Segmentation – it's a digital image partitioning process in more classes by attributing them individual pixels. This way will result distinct objects from the image. The segmentation result is a string of pixels'

intensities which represents either the profile of the interest region or the entire region. The segmentation is one of the most difficult stages in the image digital processing. On the one hand, the sophisticated segmentation algorithms require complicate calculus and a very long period of time. On the other hand, the insufficient elaborated algorithms can't be applied successfully. The segmentation's result is usually a string of pixels' intensities and it represents either the edge of the interest zone or the entire zone.

Characteristics extraction and classification – this consists of selecting the characteristics and has as a result quantitative information or characteristic that differences a class of objects from others. The classification represents the process of establishing an object's affiliation to a specific category on the basis of the information as a result of the description of the segmental image.

The storage of digital images – a digital image on 8 bits, 1024x1024 pixels, needs a very large memory space and that's why the image storage is very important in developing image processing systems. The digital storage can be classified in three categories: short-time storage, for the proper processing needs, on-line storage for quick access of the images and the storage used to record the images. The most used method of short-time storage consists of using the computer's memory. A second method uses specialized memory cards (frame buffers) and allows the storage of one or more frames; the access is very fast, usually in real time, which means 25 complete frames per second.

Image digital transmission – the communication problem in image digital processing implies on the one hand the local communication between the processing systems and remote communications on the other hand. The hardware and the software for the local communications is usually offered by the computers network facilities.

III. Detailed description of used procedures

Implementation of the automated video inspection system in the textile industry is of major importance due to the fact that the flaw presence in textile material leads to a price dropping of the final product with 45-65%. A typical reel of textile material has a width between 1-3m and is moved on the inspection table with a speed between 20m/min and 200 m/min.

A video inspection with good results can be obtained if the horizontal and vertical resolution is smaller than 1 mm. In best case, the human operator that realizes the inspection can detect at most 60% of the present flaws and can not inspect materials with a width larger than 2m or moved with a speed higher than 30m/min. In the specialty literature there are 235 types of material flaws. Detecting and correct classification of them represents a complicated problem due to necessity of a high data transfer rate, noise presence in the industrial environment, large number of flaw classes, light intensity fluctuations of the textile material, speed fluctuations of the movement of the textile material.

The ability to recognize flaws and to stop the production as soon as possible after the flaws appearance is very important for the textile producers. This system can be applied to control textile materials in diverse stages of the technological fabrication process: inspection of the wire before weaving or knitting, inspection of the knit or the material during the process or right after knitting, inspection of the material during or after the dyeing, control of the new confectioned product. Everything is developing in real time and that is why the cost of immediate detection of the flaws is a lot reduced. Systems can realize an inspection of a representative set of textile materials, from which they will learn their characteristics, adapting to the demands of the fabrication status.

The inspection procedure consists in detecting and locating de material flaws, followed by the determination of the flaw's coordinates and its size. All these informations will be recorded in a library so that they may be used in a further inspection.

The system's architecture is structured on two main levels: the interface with process level and the software inspection procedure level.

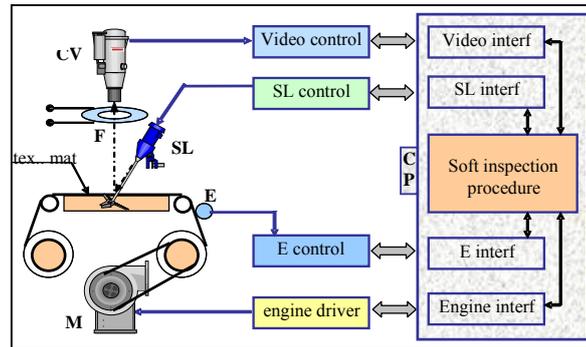


Figure. 2 Video inspection system architecture

Interface with process (figure 1) is composed of video system (video camera CV, video controller and video interface), illumination system (light source SL, controller SL and command interface SL), transducer movement system (encoder E, controller E and command interface E), motor system (engine M, engine driver and motor command interface).

The command interface and software inspection procedure are resident on the process computer. The light source is a fluorescent tube that gives a lighting of 5000 lucs and works at a frequency of 40-50 KHz, to stop the appearance of flickering. The tube is set up at a distance of 10 cm from the material. Using the incremented encoder allows synchronizing between the image read by the video camera and the movement of the material on the inspection table. The M engine assures the entrapment of the movement mechanism of the textile material and can be stopped when a flaw is noticed, by command from the afferent driver. The optical lens of the video camera is protected from impurities settlement by the electrostatic filter F.

Software inspection procedure (figure 2) represents an assembly of routines with a role in noticing a flaw appearance in the material, in classifying the recorded flaws and adapting the automated decisions according to the previous interventions of the human operator, developed by virtual instrumentation methods. First stage, in the inspection procedure, is the calibration. The reference image loading routine $f_r(i,j)$ takes from the material inspected a flawless sample, which will be referred to in other comparisons. The pre-processing block PP has, as a main function, to detect real flaws and uses binary processing algorithms to reduce the data flow. The entry data matrix $f(i,j)$ is rectified with the help of two adaptive parting walls $T_1(i)$ and $T_2(i)$, thus obtaining the binary image $B(i,j)$. This sequence has the role of removing the noise superposed over the entry matrix, low frequency noise coming from non uniform lighting of the investigated material and high frequency noise coming from the movement engine of the cinematic chain. The filtering sequence has the role of removing false flaws, such as waves of the material or the presence of sewing on materials in the interface circuit and it is accomplished with loss of resolution, for decreasing the process data flow. The exit of the pre-process block is represented by the flaw sub image, labeled.

The process block debuts with two sequences of extraction the characteristics of the flaw area. The first sequence is for geometrical characteristics (surface, center coordinates, x projection, y projection, orientation) and it extracts information from the binary image matrix $B_F(p,q)$. The second sequence is for texture characteristics (contrast, medium value, entropy, homogeneity) and it uses application of method for difference between grey levels (GLDM) on matrix $f_k(i,j)$. The exits of the extraction sequences serve as entry for the neuronal flaw classification block. The adaptive control routine allows setting flaw classes that want to be signaled for a certain type of textile material. This adaptation is obtained by processing correction interventions by the human operator on the systems decisions of "real flaw".

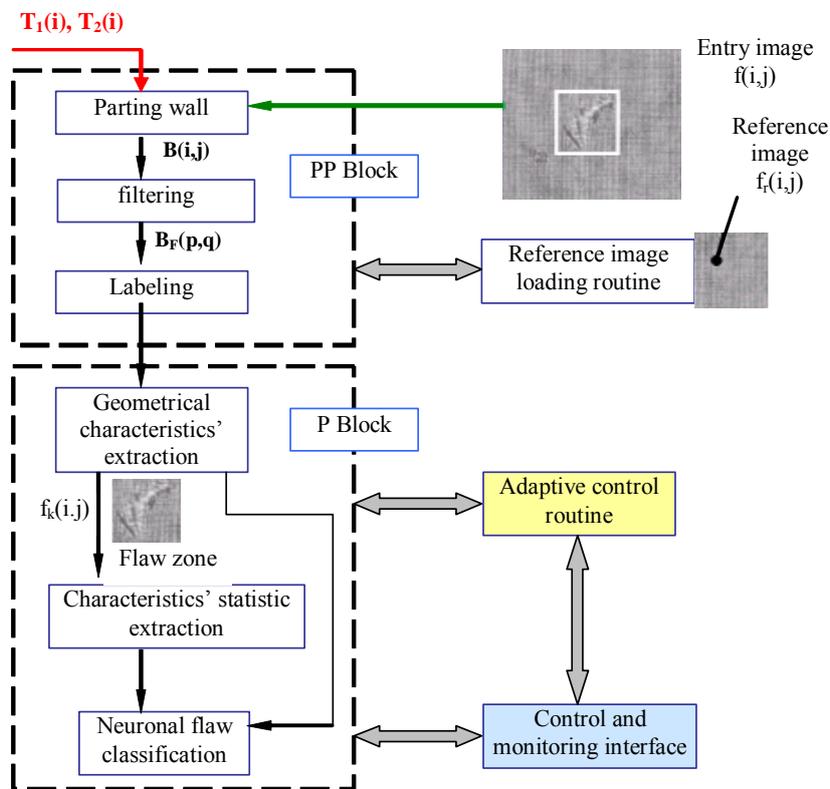


Figure 3. Software inspection procedure diagram

IV. Conclusions

The accomplishment of a new system architecture of real-time video inspection of textile materials, which should ensure a fault tracking-down rate of over 99%, in the presence of disturbing elements from the industrial environment will lead to a growth in units activity quality for textile profile, contributing to the making of competitive CE products.

Using such an automated system to detect flaws leads to:

- Productivity growth with 3 – 5 %;
- Quick and immediate improvement of technological processes and reduced number of errors in production;
- Decreasing cost production with 2 – 3 %.

Besides, the system realizes a flaw track-down rate of over 99%, weaving or knitting, stopping future finishing with bad materials. This leads to reduced energy costs, chemical products and others.

Integrating these modern techniques in the production process can offer important advantages on the textile market due to the high quality products obtained, which determine a better look of the firm and attracting new clients. From the experience of firms that implemented this type of systems, it was seen a growth on the annual income with 10-15%.

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