Automatic Fabric Inspection

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By: Vasant Kothari

All textile industries aim to produce competitive fabrics. The competition enhancement depends mainly on productivity and quality of the fabrics produced by each industry. In the textile sector, there have been an enlarge amount of losses due to faulty fabrics. In the least developed countries, most defects arising in the production process of a textile material are still detected by human inspection. The work of inspectors is very tedious and time consuming. They have to detect small details that can be located in a wide area that is moving through their visual field. The identification rate is about 70%. In addition, the effectiveness of visual inspection decreases quickly with fatigue. Digital image processing techniques have been increasingly applied to textured samples analysis over the last ten years.

- Wastage reduction through accurate and early stage detection of defects in fabrics is also an important aspect of quality improvement.
- Summarize the comparison between human visual inspection and automated inspection.
- Price of textile fabric is reduced by 45% to 65% due to defects.

Machine vision automated inspection system for textile defects has been in the research industry for a long time, Recognition of patterns independent of position, size, brightness and orientation in the visual field has been the goal of much recent work. However, there is still a lack of work in machine vision automated system for recognizing textile defects using a neural network pattern recognizer was developed. Fully connected three multilayer percetron network was used to identify different sizable objects. The input of this network is seven standardized invariant moment and the weights are trained using back propagation.

Inspection Type	Visual	Automated
Fabric Types	100%	70%
Defect Detection	70%	80%+
Rate		
Reproducibility	50%	90%+
Objective Defect	50%	100%
Judgment		
Statistics Ability	0%	95%+
Inspection Speed	30m/min	120m/min
Response Type	50%	80%
Information	50%	90%+
Content		
Information Exchange	20%	90%+

Since the network uses standardized moments as input, neural net similar to this requires lots of iteration to train. The research takes directly input as binary images as a result no pre-processing of image is performed.

Today's automated fabric inspection systems are based on adaptive neural networks. So instead of going through complex programming routines, the users are able to simply scan a short length of good quality fabric to show the inspection system what to expect. This coupled with specialized computer processors that have the computing power of several hundred Pentium chips makes these systems viable. State-of the-art fabric inspection systems are - BarcoVision's Cyclops, Shelton Machines' webSPECTOR, Elbit Vision System's I-Tex Zellweger Uster's Fabriscan and MQT.

These systems can be criticized on grounds that they all work under structured environments - a feat that is almost nonexistent in LDC countries. There are some works based on the optical Fourier transform directly obtained from the fabric with optical devices and a laser beam. Digital image processing techniques have been increasingly applied to textured samples analysis over the last ten years. Several authors have considered defect detection on textile materials.

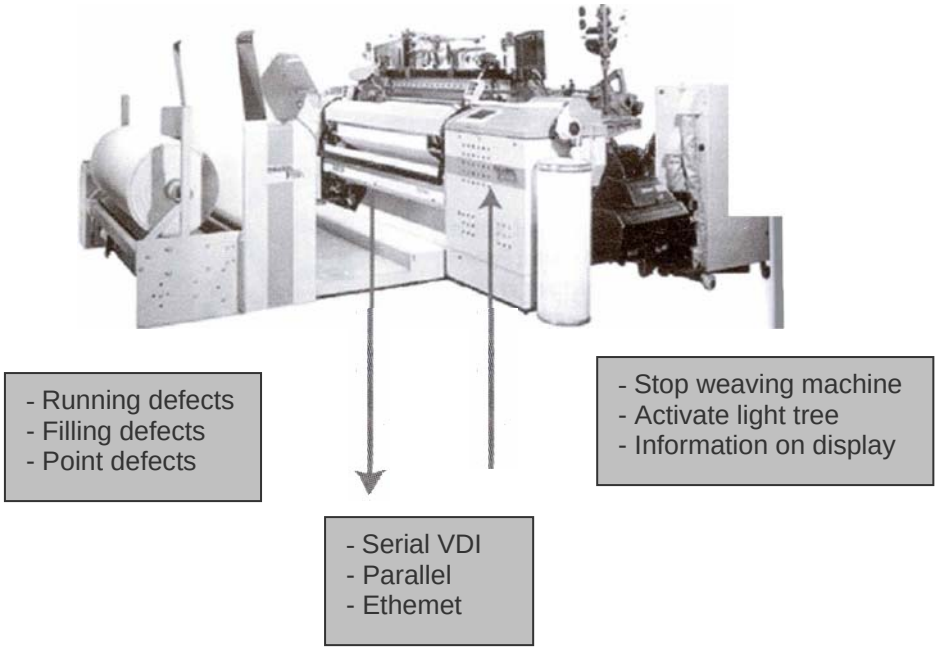
Barco Vision's Cyclops

Barco has launched a brand new generation of "Cyclops" on-loom inspection system. The new system is targeted towards the growing market for technical textiles, where 100% coverage in inspection is often required. The "High Speed Cyclops" system scans for defects at a 3 times higher speed than today's single camera system, which allows for 100'i, inspection coverage for all fabric up to a width of 280 cm. On the "Cyclops" automatic, camera-based on-loom fabric inspection system, the camera moves from left to right and back, taking pictures of the fabric. By means of an image processor and related software algorithms, these images are analyzed to detect defects in the fabric.

Until now, the scanning speed of the camera in "Cyclops" was 18 cm/sec but the new "High-Speed Cyclops" scans three times faster at 54 cm/sec. Where the existing "Cyclops" system inspected about 80% of the fabric, the new version has coverage of 100% for all fabrics and loom speeds. As a result, detection of small local defects, such as stains, kinky weft or filling, etc. can now also be guaranteed, along with the detection of running defects and full width weft or filling defects. Barco "Cyclops" on-loom inspection system for fabric widths up to 500 cm, there is a "Cyclops" version available with 2 cameras. The scanning speed of the dual camera version has been increased from 18 to 27 cm/sec, allowing for improved inspection coverage for wide fabrics.

Barco's automatic on-loom inspection system detects warp, filling and point defects by means of a moving camera system installed on the off-loom take up. In case of a warp defect or a concentration of filling or point defects, the system stops the loom, lights a warning lamp in the loom's light tree and informs the defect nature and location on the loom's microprocessor display.

The system holds the loom in the stopped position till the weaver has made the "defect corrected" declaration. Connected to Barco's QUALIMASTER system, all defect information, pick and time stamped, is sent to a fabric quality data base. This allows producing defect maps and various types of quality reports.



Benefits and advantages

- Real time defect detection allowing stopping the loom and preventing the production of defective fabric.
- Independent of human perception.
- Higher fabric quality, less second choice.
- Automatic fabric grading based on customer defined rules.
- Lower work load in greige inspection department.
- No investment needed in automatic inspection of loom state fabric.
- Integration with QUALIMASTER and WEAVEMASTER loom monitoring system.
- Easy to install.
- No maintenance required.

Webspector

Webspector is a machine vision system developed by Shelton Vision System developed for the inspection of textiles and other web materials.

The Shelton webSPECTOR® family of machine vision products can tackle a wide range of automated inspection tasks that until now have required bespoke engineering. The webSPECTOR® range breaks inspection tasks or requirements into three groupings:

- Tasks such as gauging, location and measurement where the objects being studied have a pattern or profile to match against are covered by the webSPECTOR® Lite system.
- Fault detection tasks involving unknown data are covered by the webSPECTOR® Standard system.
- Tasks requiring increased functionality such as database management, defect libraries and self training are included in the webSPECTOR® Plus system.

Each of the above systems form the basis for a custom engineered solution, which is scaled to suit the mechanical size and resolution of the task being undertaken. Training an automated inspection system to find a fault depends very much, on what is being produced and for what market. An inconsistency that is a fault for one manufacturer may not be a fault for another. Indeed, the same inconsistency in the same textile produced by the same manufacturer mayor may not be a fault depending on the customer to which it is going to be dispatched. Just as a human inspector can tailor his criteria then so can automated vision systems based on the webSPECTOR® family of products.

This training can be performed manually by an operator for each product code or with the webSPECTOR® plus it can be performed automatically using the automatic training function. Automatic training is facilitated by passing fabric through the system and allowing it to automatically set sensitivity levels relative to the material, it is training.

The trainer uses a pre-determined criterion that takes into account customer wishes and manual inspection knowledge. Whether the training is done manually or automatically the parameter settings are recorded against the fabric type reference and can then be used for all subsequent occurrences of that fabric. The result is that each instance of that fabric type is inspected to the same standard reference.

A great deal of information can be gleaned over the long term from data obtained by these types of system. webSPECTOR® systems can store the information, including the images of the faults for later trend analysis.

The faults and inconsistencies that may be encountered are many and varied. They will depend on the manufacturer and product type, ranging from small defects in the fabrics through to colour variations and on to the geometric structure of fabrics used in technical applications such as car air bags.

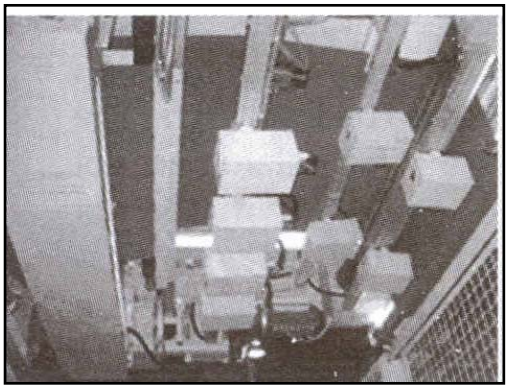
Fabric defects such as holes, stains, slubs and knots tend to be created at the knitting and weaving stage. They can be as small as a few tenths of a millimetre running past the inspection system at up to 200 metres plus per minute. The contrast between a fault and the cloth may be relatively constant, as in white fibreglass, or may vary as in a textile mill producing cloth from black through to white.

Any fault information, which required alterations to the process, could be sever<fl hours out of date. As a result, huge quantities of sub standard product could be produced. Depending on "file type of fault, the end result could be selling at a greatly reduced price with little margin or at worst see the material being sent to landfill sites with the associated costs.

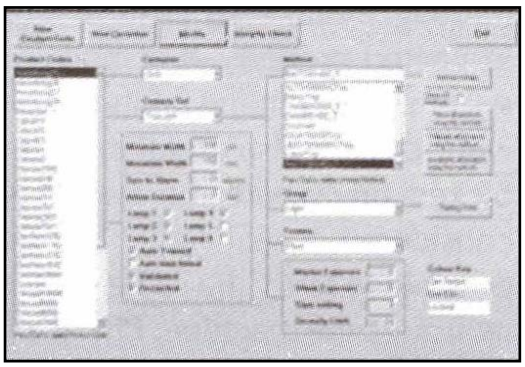
The webSPECTOR® system employs several automation related technologies, to overcome this problem. The first is the web Trainer module which trains the system sensitivity settings on all products in an unsupervised fashion. It does this by assuming most of the material it sees is good product and then trains itself to expect that texture. During inspection, deviations from the normal appearance are then sent for further analysis by a classification module. This decides whether the anomalies are defects or features to be ignored. It is possible to input current manual inspection knowledge into the auto training and classification modules, so that they can be more or less sensitive depending on customer wishes.

The second technology is the webCorder module. This is part of a concept designed to ensure the inspection system is operating as expected and is especially useful where quality is critical and there is little tolerance on faults. The entire web can be recorded at production speeds to disk. It can then be replayed as though the material were being run through the system again. During validation of the system's abilities for each application, the webCorder is used to compare manual and automatic inspection results. If the manual inspectors see a fault not seen by the system, the webCorder can be moved to this position, the inspection

systems settings adjusted to ensure the fault is detected. These settings can then be incorporated into the auto-training module to ensure subsequent products are also inspected properly. It is more common that the inspection system sees genuine faults not picked up by inspectors. The webCorder is also useful in ensuring that false alarms are not picked up, where the system sees something that is not considered a real fault. By recording the material, it is possible to re-try the same product without having to re-run it through the machine. Physically re-running material often imparts more faults and can cause material to be scrapped unnecessarily.



The end stage of the textile manufacture process, in terms of shipping rolls of textile from the factory door, tends to be dying and finishing (although this depends on the type of textile being manufactured). Eagle eyed customers of the end product inspect rolls arriving at their goods inwards and then apply discounts to the price paid based on defect types, quantities and positions. It is important for the dyer/finisher to minimise faults in dispatched material and anticipate any rejection rates. Traditionally this has lead to a very manpower intensive manual inspection system looking not only for manufacturing faults from weavers and knitters, but also dye faults, finishing faults and material specification. Finishing faults and manufacturing faults are covered by traditional defect detection methods. Colour and material specification require different technique.



Colour is a very subjective effect to judge. A surface will appear as a different shade or even colour under different illumination, angle of view and to differing observers. Even two nominally identical 'white' lights can lead to differing colour interpretations. Colour is measured using a spectrophotometer and many bench top versions exist which give highly reliable colour measurement in lab conditions on small samples. The WebSPECTOR® can offer measurement of colour at three discrete sample positions across the width of the roll and along its entire length.

With the application of machine vision, a manufacture can supply a better product with fewer inherent defects, a standard level of applied inspection and information showing the location of those faults, which are included. The customer now has every thing he needs to buy with confidence.

Elbit Vision System

I-TEX 200 system installed in-line with a sanforizer inspecting bottom weight apparel

The I-TEX system is capable of inspection speeds up to 300 meters per minute and can handle fabric widths up to 5 meters. The system's proprietary software algorithms were designed I-TEX 200 system installed in-line to imitate the human visual with a sanforizer inspecting system. It learns the normal bottom weight apparel fabrics pattern of the fabric and detects changes. These changes in the pattern are then analyzed by multiple detection algorithms to separate real defects from random but normal variations in the fabric. Once a defect is detected, the x and y location, as well as the size of the defect, are recorded in a defect map. In addition, a digital image of the defect is saved for later review of the system operator.

The I-TEX system cost" is dependant on a number of factors such as the fabric application, desired speed and fabric width. The system sells for between $100,000 and $650,00Q. Payback for the system is generally between six months and 2 years, according to EVS.

Zellweger Uster

The Zellweger Uster's current system, Fabriscan, can inspect fabric at speeds up to 120 meters per minute and can detect defects down to a resolution of 0.3 millimeters. It can handle fabric widths from 110 to 440

centimeters. Zellweger Uster has several installations in Europe covering a range greige fabrics including apparel, denim and industrial fabrics.

What makes Fabriscan unique is that it classifies defects in a matrix called Uster Fabriclass, which is similar to the well-known Uster Classimat system for yarns. Fabriclass has two axes. On the y-axis is the contrast of the defect and on the x-axis is the length of the defect. This allows the system to tell the difference between disturbing defects versus non-disturbing defects and makes over-detection virtually nonexistent, according to the company. Data on defects can also be stored in a relational database, allowing users to generate any type of report that they need. Cut optimization software is included to improve first quality fabric yield.

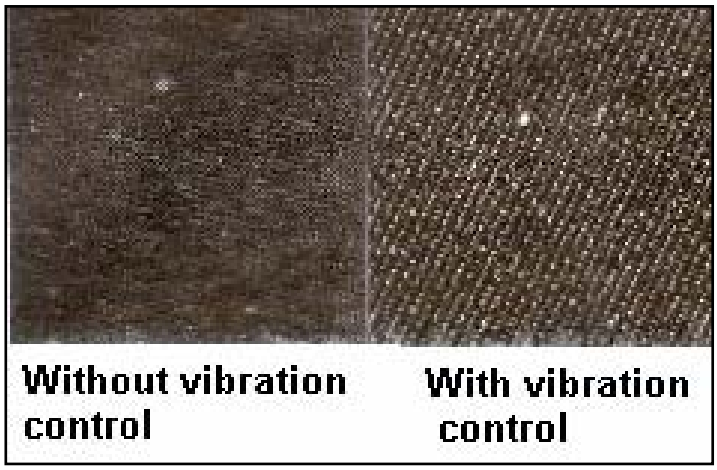
The Zellweger Uster Fabriscan system classifies defects in a matrix called Uster Fabriclass.

The new USTER® FABRISCAN ON-LOOM integrated fabric inspection system not only gives automatic quality control directly at the loom, but it can replace the customary cloth inspection. No system can inspect closer than touching the fabric surface during inspection. No-one can cover more than the entire area of the fabric. The revolutionary USTER® FABRISCAN ON-LOOM inspects every single millimeter of the fabric and checks it for defects. The scanner sensors are in direct contact with the fabric and deliver high-quality images for reliable detection of defects. The USTER® FABRISCAN ON-LOOM prevents faulty production since, through immediate detection of defects, it enables immediate correction. Quality is markedly improved, reliability of inspection is assured and time spent on checking the fabric is minimized, leaving more time for other tasks.

USTER® FABRISCAN ON-LOOM has a patented system for compensating the vibrations of the loom. Having the sensors in direct contact with the fabric improves the image quality. This means that recordings are never shaky or blurred like those from a camera system, but are precise images of the fabric structure, and provide exact identification of the defect.

Random quality checks are not as certain as comprehensive detection. Often, running, swarm and periodic defects are not discovered until it comes to cloth inspection - hours or even days later - too late to prevent the production of second grade fabric.

USTER® FABRISCAN ON-LOOM detects and reports defects immediately as they occur. Early detection enables early intervention - independently of human perception. Automatic inspection is reliable and consistent, and assessment is based on objective criteria. One can purposefully increase the productivity of first grade fabric.



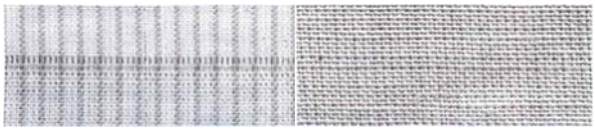
Typical defects/Removal

Running defect/
Repair warp thread

Periodic defect/
check mechanical parts

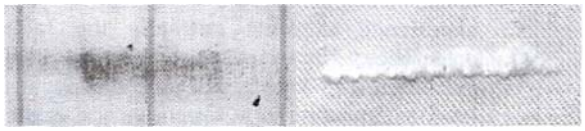
Swarm of defects /
Check weft or insertion

Swarm of defects /
Depends on defect type



Starting defect/
Check setting of machines

Yarn defect /
Replace cone

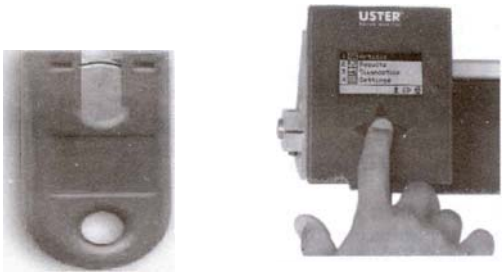


Oil stains/
Check loom for oil leaks

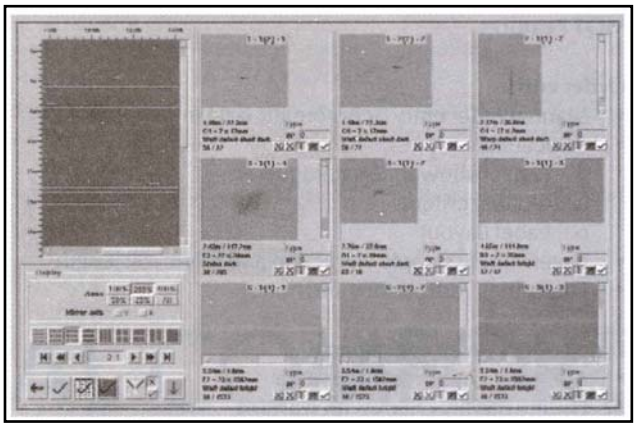
Fly, dust/
Blow-out the loom

USTER® FABRISCAN ON-LOOM is a perfect warning system - when accompanied by the On-Loom Expert system, it replaces the cloth inspection. Quality reports, images and graphic maps of defect distribution are produced online. Reports for monitoring productivity and statistical analyses of efficiency are also available. There is access to all this information at any time via the network. Data and images can be edited and re-archived - and are useful for verifying any customer complaints that may arise.

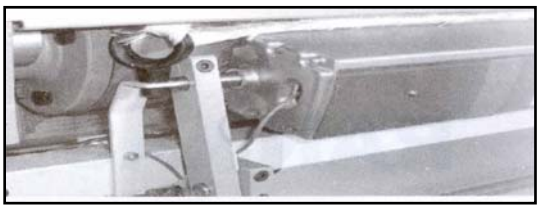
Operation is quick and easy - new articles can be read in with no great effort. Data on type and position of defect is output on an easy to understand display. USTER®



Simple operation, easily understood display



Operator Interface



FABRISCAN ON-LOOM is mounted on the front of the loom. Positioning it there saves space and keeps it out of the weaver's way. This is also the ideal place to successfully compensate for the vibrations of the loom.

MQT

Most Innovative Data Recording System in Fabric Inspection

MQT Features

Order entry

- Manual order entry or Automatic data import from ERP
- Allocating:
- Defect allowance catalogue
- Quality criteria
- Label Layout
- Determining sample extraction and fabric roll length
- Depositing instructions and notes

Data collection on touch panel

- Automatic import of order data
- Online quality check with warning
- Automatic quality classification
- Edit function of protocol
- Automatic machine stop at fabric roll end
- Defect-in-defect entry

Order monitoring

- Order status including degree of completion
- Partial delivery
- Management of rejects
- Order chart
- Fabric roll chart
- complete record of order data
- Supervision of deliveries
- Display of order queue

Reporting

- Data export in MS - EXCEL
- Performance of machines and personnel
- Performance of department
- Statistic of defects
- Evaluation of production chart
- Cut optimisation (optional)

Universal mounting possibilities

A wide range of applications on any inspection machine are available. Mounted units can be placed into ergonomic position to suit any operator.

High reliability

MQT are equipped with top industrial electronic components which guarantee proper functioning over a period of many years. Interference of the software by incorrect use or computer virus is impossible.

User friendly

Data input direct by touch screen, easy to operate, avoiding errors of manual notes and transfers. No computer knowledge of operator required. Surface can be adapted to suit any individual working scheme of a textile factory.

Online Quality checking

Quality criteria are constantly being checked and adapted to customer's instructions or fabric specific matters, giving the possibility to optimise the fabric roll classification.

Saving of costs and time

Abolish the manual paperwork with MQT and obtain the information direct. This allows faster shipping, invoicing and analysis.

Conclusion

In most of the textile garment factories the defects of the fabrics are detected manually. The manual textile quality control usually goes over the human eye inspection. Notoriously, human visual inspection is tedious, tiring and fatiguing task, involving observation, attention and experience to detect correctly the fault occurrence. The accuracy of human visual inspection declines with dull jobs and endless routines. Sometimes slow, expensive and erratic inspection is the result. Therefore, the automatic visual inspection protects both: the man and the quality. Here, it has been demonstrated that Textile Defect Recognition System is capable of detecting fabrics' defects with more accuracy and efficiency. In the research arena, our system tried to use the local threshold technique without the decision tree process. Since our recognizer deals with different types of faults and fabrics, therefore the recognition system cannot access a general approach for local thresholding technique. The system works very well except the quality of the web camera. Because of which sometimes the perfect fabric is also found as faulty part. But this problem will be easily defeated if a good quality camera is used. '

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