

Automated evaluation of patterned fabrics for defects detection

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ABSTRACT

On the frames of the pedagogic project developed over last four years by the first author “Learning by research”, on this communication we will make a detailed presentation of one research work undertaken by the students on the classes of Image Processing of the Applied Physics undergraduate course of the Physics Department of the University of Minho.

The research work was developed on request from a textile industry company and consists on the automation of the process of defect detection on different kinds of fabrics. The type of defects ranges from broken or missing threads, over casting threads, color and pattern defects. The evaluation is also made on comparison with reference sample. The settled system acquires the fabric’s images under proper illumination, store and process’ them in order to sort out automatically the desired information. The assessment of the pedagogical benefits of this work made by the students them selves will be presented.

1. INTRODUCTION

The learning process requires always an active critical participation of the students⁽¹⁻⁶⁾. This is especially true for science and technology students. Within the classes of Image Processing of the Applied Physics undergraduate course of the Physics Department of the University of Minho we begun in 1995 pedagogical experiment that we named, first “Teaching by research” renamed to “Learning by research” because the issue here is really about Learning!

This experiment is explained and presented elsewhere^(1,2) we will just summarize it now. We decided to center students’ learning process of the basics of digital image processing on simple applied research programs. A problem is generically presented to the student (or else they find their own theme). Applied, interdisciplinary problems brought from the real word are always chosen. To the students is given almost entire liberty and responsibility. We limited our selves to assess the development of the project orienting them and point out different or pertinent points of view only when strictly necessary.

2. DEFECTS DETECTION ON PATTERNED FABRICS

In the 1988/99 Image Processing⁽³⁾ class one of our students brought from a textile factory a practical problem to be solved. The industry was engaged in the production of different kinds of fabrics to be used in the local clothing industry. The assessment of the fabrics’ quality was made by visual comparison to a reference sample by experienced technicians. The process was rather time consuming and the percentage of faulty evaluations increasingly large. An automated inspection method was to be implemented.

The students begin with a careful definition of the real actual inspection requirements including the tolerances. A set of reference samples and fabric samples with different types of defects was gathered. Both were carefully characterized on view of the work to be carried out.

Soon the students realized the true complexity of the task they had in hands! The all range of image processing and characterization techniques and methods they learn was were tried with different grade of success.

The application of isolated simple operators thus never gives acceptable results. The combination of different basic operations or eventually complex routines (of pattern matching for instance) was proven to give acceptable results for particular types of fabrics' patterns^(1,3, 7-8).

3. A FEW SUCESSFUL EXAMPLES

The system used in this work included an color camera (one CCD, 450x415 pixels, Cohu 2252-1000), an B/W Electrim EDC1000-HR camera (746x488 pixels) with its own image digitalization system, and a Matrox Corona frame grabber, using the Matrox Inspector software.

The physical limitations of the material available precluded the detection of many meaningful features namely those related to subtle color changes on fabrics' pattern. However many situation were detectable and automated detection possible.

One of the most common situations was the existence of isolated broken threads. In figure 1. a typical fabric' pattern is shown.

Figure 1.

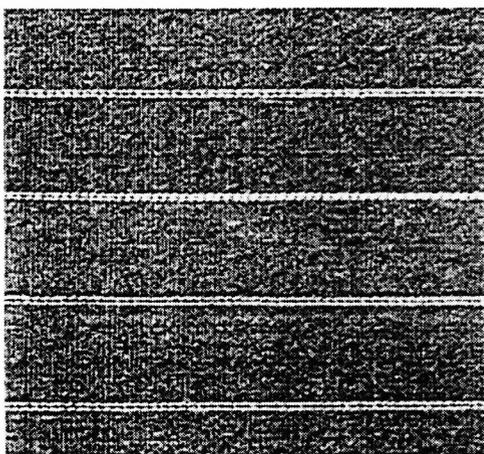


Figure 1. A typical fabric' pattern.

Figure 2.

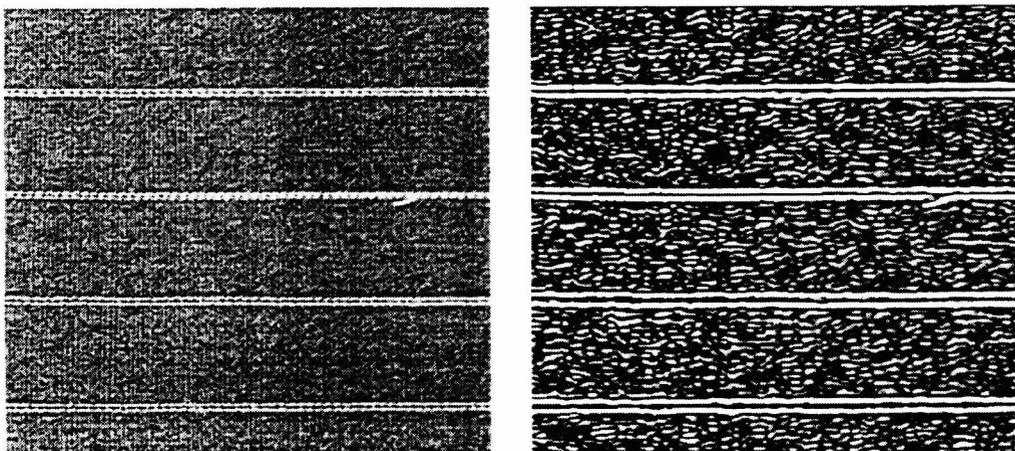


Figure 2. A broken lose thread on a fabric of the type showed in figure 1. Edge detection may be successful if previous smoothing is performed.

On the left side of figure 2, is show one produced fabric of the reference presented on figure 1. A broken thread (on one of the white lines) is noticeable on the middle right side. On this type of stripe patterned images the application of edge detection routines could be immediately suggested. However the fabrics own detailed pattern and the noise added from the detection system makes its use usually unsuccessful. Making previously a smoothing of the left image the application of an edge detection operator (Sobel type in this case) allows a clear visualization of the fault.

The comparison with the reference image is usually necessary. Applying white morphological dilatation of whites to both reference and sample will allow by subtraction the detection of the fault. The application of a blob analysis on that images allows the location and an extensive characterization of the lose thread if needed (see figure 4. below).

Figure 4.

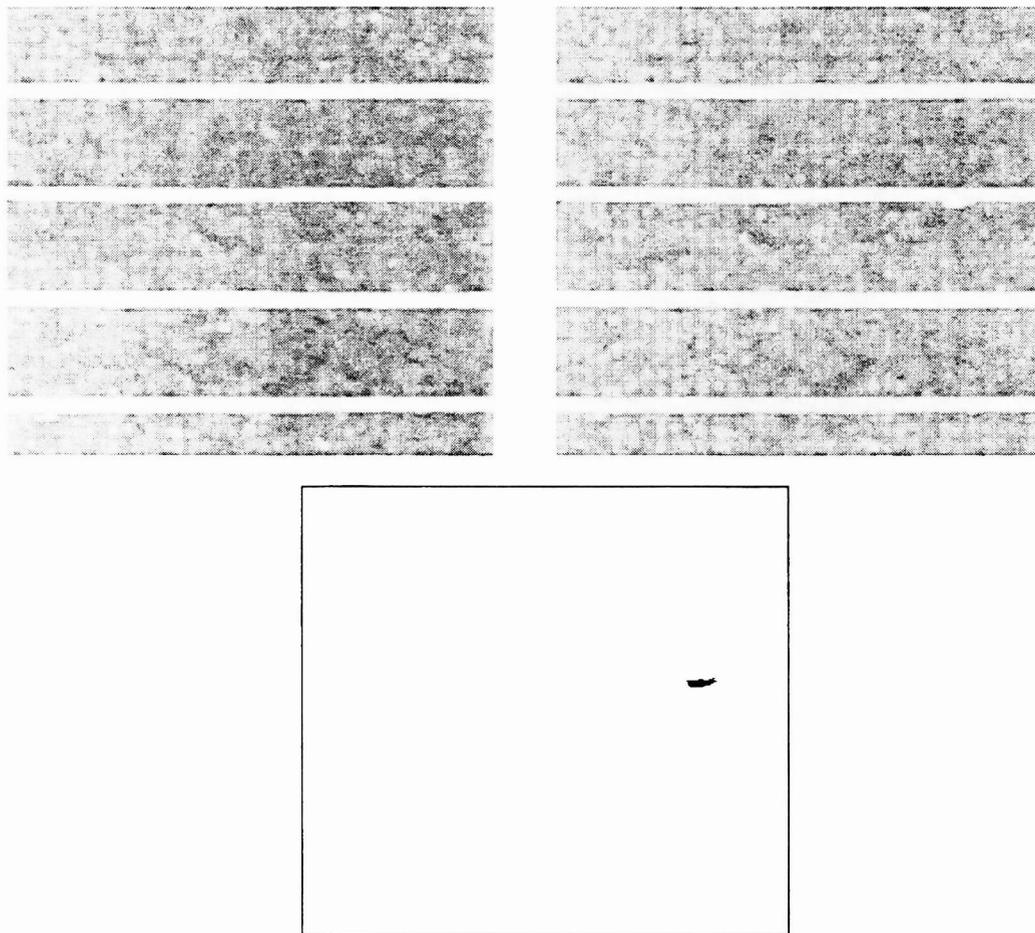


Figure 4. Subtracting the two images after white dilatation gives the identification of the out of place thread tip. Blob analyzes allows evaluation of its size (3 mm long, 1 mm thick).

On figure 5. Another application example is presented illustrating a common situation: a hole or a stain in a colored fabric. This particular problem can be easily solved. However we are going to use it to stress the problems involved in the use, often quite useful of the subtraction of two raw images. For these patterns no good results will be achieved unless we have an excellent alignment of both reference and test fabrics (especially with color images!).

Pattern matching is a complex procedure implemented in different approaches in different commercial image processing software packages. The Matrox Inspector software was used in this application. On the kind of fabric of figure 6. we found that the best approach was to define as pattern' area, to be used as reference, the whole reference sample. The

results of a pattern matching procedure, with the manufactured samples show a matching percentage that allow us to distinguish the existence of the broken thread (bottom right of figure 7. Matching percentage of roughly 22%) or missing thread (bottom left of figure 7. Matching percentage of 16%) from a fabric' rotation for instance.

Figure 5.

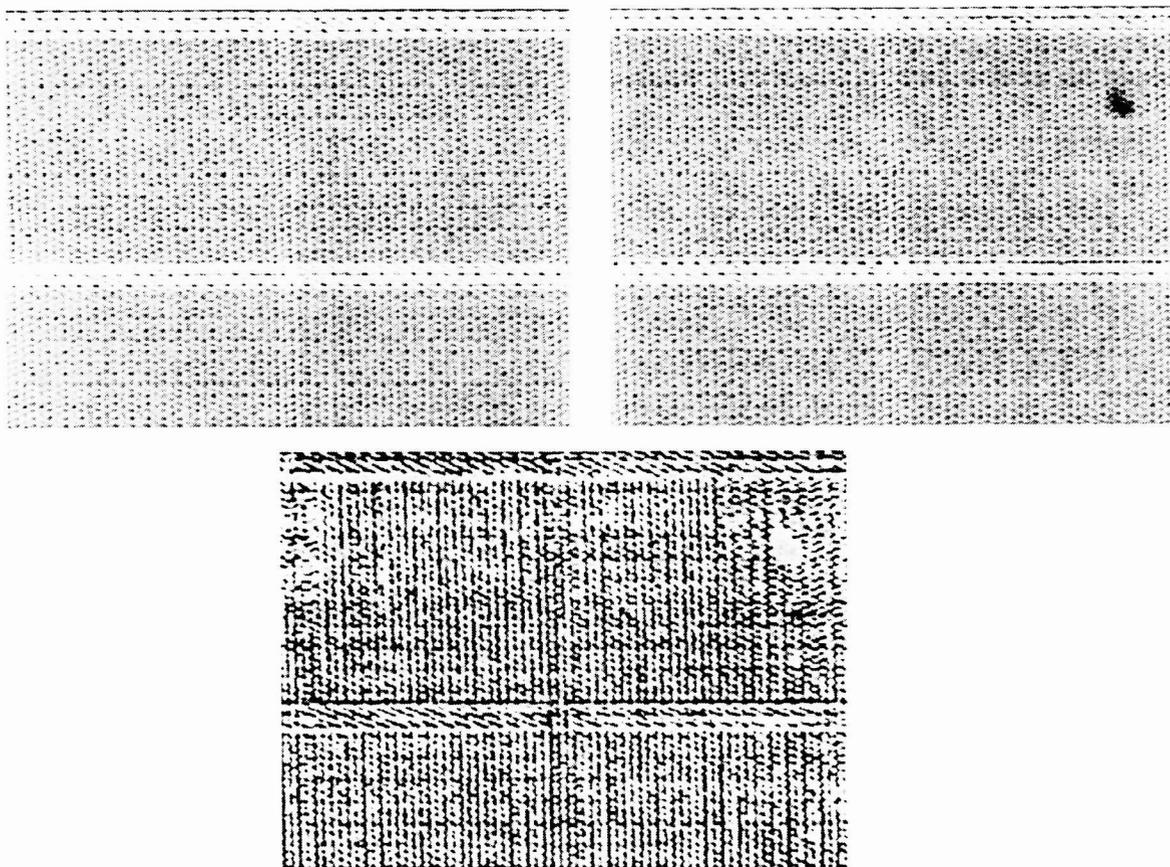


Figure 5. A hole in a colored fabric. Not always the subtraction of two raw images give good results unless we achieve an excellent alignment of both reference and test fabrics (especially with color images!).

4. CONCLUSION

Not always the results obtained by the students' projects on their "Learning by research" activities are sufficient to cope with their one expectations. However they are always valuable experiences as the students recognized. Positive was also the recognition by the students of the difficulties that a practical application problem in the industrial world poses^(9,10), demanding a rigorous persistent but flexible commitment. Positive as well was the fact they assumed the failure to attain the goals self proposed but, and that's of major importance, the problem will be reanalyzed, the goals and tasks redefined, and different approaches will be tried.

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Figure 6.

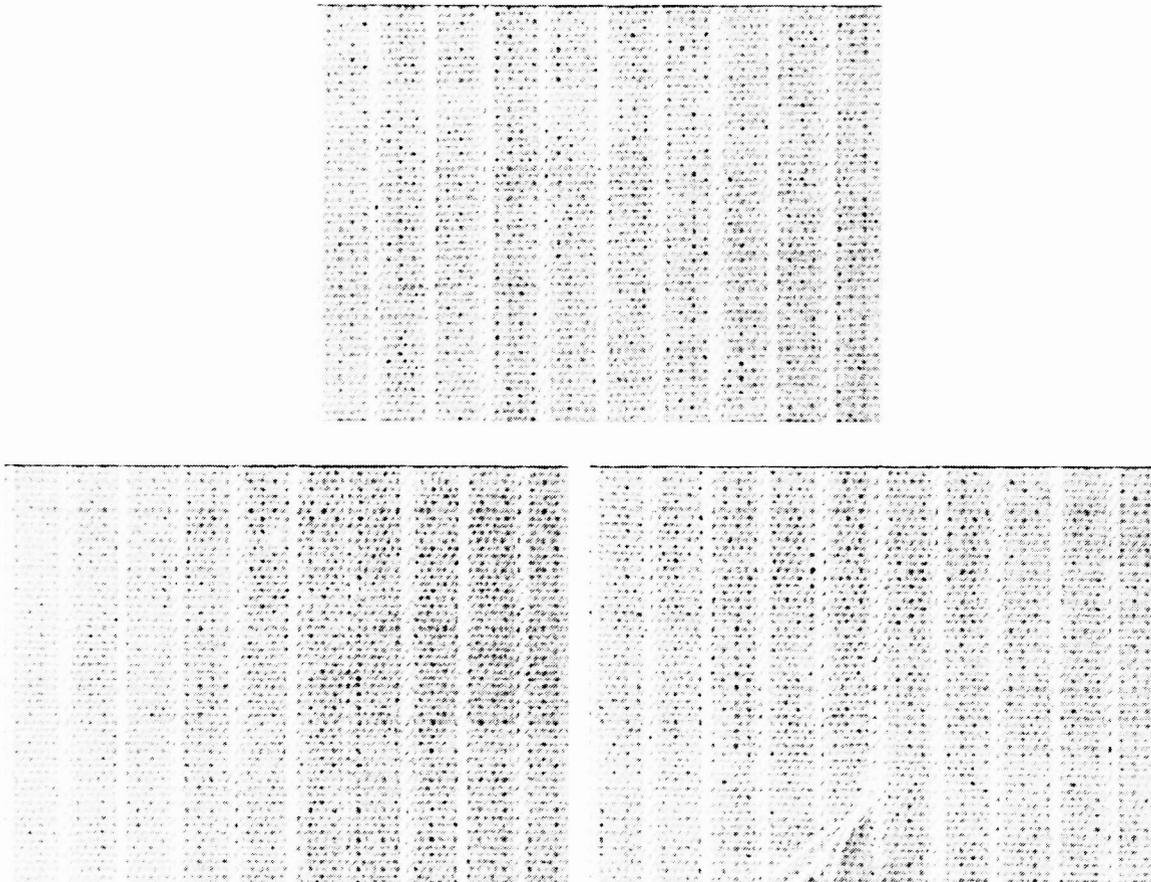


Figure 6. The results of a pattern matching procedure. On top the reference fabric. Left bottom a missing thread and in the right a broken thread.