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Proceeding Paper

Improving Quality Inspection of Textiles by an Augmented RGB-IR-HS-AI Approach †

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Abstract: The aim of this research topic and paper is to investigate the application possibilities of vision technology in the textile industry. These include RGB, active thermography and hyperspectral imaging techniques. In the future, this approach will be supplemented by a machine learning algorithm (e.g., in Matlab or Python) to enable the detection of defects in textiles and to correctly categorize these defects. In the first place, the various options for building such a convolutional neural network are discussed. The focus was on the models used in the literature. Based on the effectiveness of these ML models and the feasibility to build them, choices can be made to determine the most suitable models. Sufficient samples are an important link to properly train a model. Because there is a shortage of open data, it is also discussed how samples obtained from the textile industry, were measured in the lab. At first, we will limit ourselves to the five most common defects. In a later phase of research, the results with this dataset and the open datasets are benchmarked against the results from the literature.

Keywords: active thermography; NDT inspection; textile inspection; multi-modal imaging

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1. Introduction

In the textile weaving industry, quality inspection is traditionally carried out by human inspection of the fabrics over a lighting screen. This leaves a number of possibilities for human errors and creates difficulty in collecting and tracking data. On the other hand, in the textile coating industry (coated fabrics, carpets), thickness/weight quality inspection still frequently makes use of radioactive sources. Several of these sources will be prohibited in Europe in the near future because of environmental and health issues.

The aim of the Inspect 4.0 research project is to combine machine leaning and machine vision to achieve a flexible and accurate quality inspection system that can be deployed in a range of textile manufacturing setups. In Inspect 4.0, machine vision is seen as a combination of camera systems that use the wavelength spectrum of electromagnetic waves between the UV and long-wave infrared spectrum (250 nm–14 µm) complemented with extensive data analysis. The combination of different camera systems can be used to replace and/or enhance the existing quality inspection systems. The data analysis will be used for a machine learning system, allowing for the detection and prediction of errors from the moment the processing parameters start deviating from the parameter window set for the specific application. This can then be embedded within a broader predictive maintenance framework.

2. Methodology and Measurement Setup

In order to optimize the automated fault detection by trained neural networks, images are gathered from textiles with common defects. These initial samples are measured by using 3 imaging techniques: RGB imaging, infrared imaging by active thermography and hyperspectral imaging. All these images will be stored in a data hypercube to be used for the training of the neural networks. For these initial feasibility study, there are 68 samples gathered with a total of 92 defects. The most common mistake is a "thread too many" which is present 27 times in the dataset. It quickly became clear throughout the course of the research that the amount of data is an important factor aspect. An insufficient amount of open data (RGB measurements) is available with textile defects to set up a network and achieve decent accuracy. There are out of 3 sources of open data. A first dataset consists of 106 grayscale images [1]. Finally, there are two other sources with RGB images [2,3].

2.1. Hyperspectral Measurements

Measurements were performed with a Specim FX17e NIR camera by means of the setup in Figure 1. Below the sample are some papers blades to provide a neutral surface.

Specifications:

- 1130 frames;
- 640 pixels per frame;
- 900–1700 nm divided into 224 bands [4].

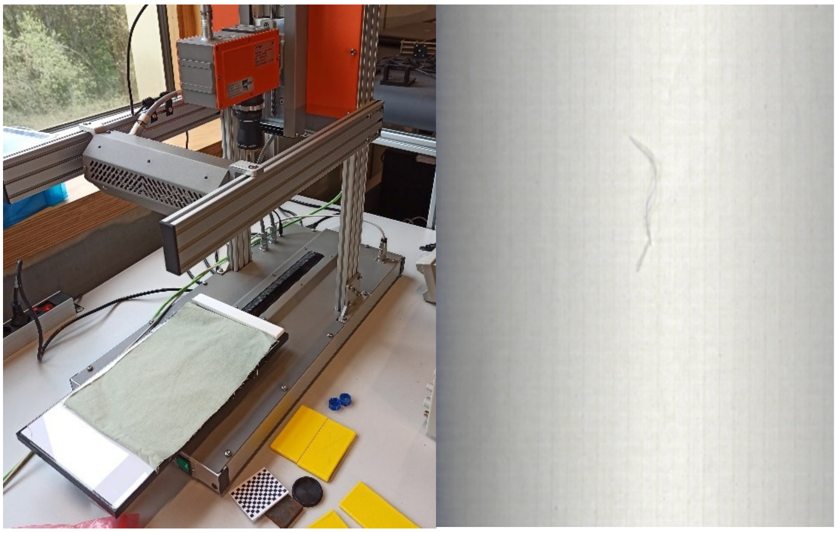

Figure 1. Left: Measurement setup for hyperspectral images at InViLab. **Right:** output image showing a "thread to many" defect.

2.2. Infrared Measurements

The infrared camera used to measure the samples in the lab is a FLIR X6540sc. Two 2 kW halogen lamps were used to heat up the textiles (Figure 2). The heat from the lamps warms up the camera, which affects the measurements. Therefore, we have shielded the lens to ensure the heating of the camera significantly reduced.

Specifications of the *FLIR X6540sc* infrared camera:

- Resolution of 640 $\times$ 512 pixels;
- Sample rate of 1000 frames;
- 3 s warm-up time by means of 2 $\times$ 2 kW halogen lamps;
- 8 s cool down time.

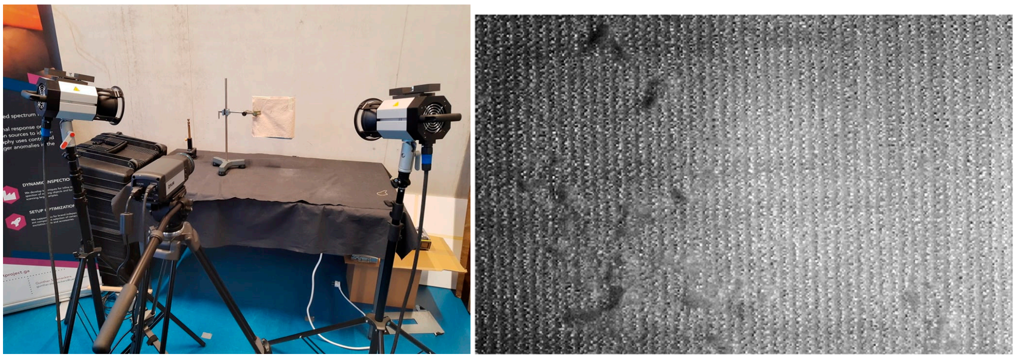

Figure 2. Measurement setup for IR images at InViLab.

2.3. RGB and Grayscale Measurements

In the literature, RGB measurements are often used to detect defects in textiles (Figure 3). One option is to only use RGB data. Another possibility is to use the RGB data as a basis for the first part of a classification network, supplemented with other sources of data, such as IR, UV or HS images. In the lab, the measurements were performed with the available RGB camera from *Allied Vision*. The lamp was added to reduce the influence of the incoming light through the window.

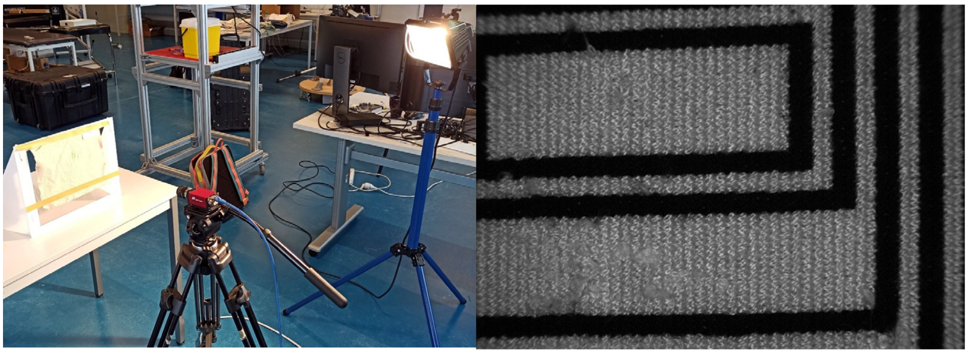

Figure 3. Measurement setup for RGB and grayscale images at InViLab.

3. Results and Discussion

There is a literature review conducted on the use of vision technology in the textile industry. Research has also been carried out into the possibilities of use of hyperspectral, infrared and RGB images. The field of application for such images in textiles was also outlined. A division has been made into four categories based on their approach strategy. the learning approach on which we have focused was clarified. The methods of use for pre-trained networks and the most commonly used pre-trained models are already defined and listed. During the initial tests, it became clear that there is a shortage of open data (RGB) available with textile defects. Finally, a quick switch was made to collect samples by contacting textile companies and measure them in the lab with the various measuring equipment present. A dataset consisting of 68 samples with a total of 92 defects was created for further investigation. The most common production error in textiles is present 27 times, which is a large enough number to justify deploying a pre-trained network and training it properly. In the future, the InViLab research group will identify the different types of measurements to set up a highly reliable network that can be used in the textile industry.

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Conflicts of Interest: The authors declare no conflict of interest.

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