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A note on neurofractal-based defect recognition and classification in nonwoven web images

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This paper introduces the off-line neurofractal method developed for defect detection and classification in thermal-bond nonwoven web images using box counting dimension as feature extractor and backpropagation neural network algorithm as defect classifier. The results of applying the proposed methodology on nonwoven web images show that defects are recognized and classified with high accuracy.

Keywords: nonwoven; defect; recognition; classification; fractal box counting; neural network; image analysis

Introduction

Visual inspection constitutes an important part of quality control in industry. This fact comes into consideration in textile and nonwoven industries. Quality of nonwoven is deteriorated by inhomogeneities such as thick and thin area and neps. Because of the importance of nonwoven appearances and also the undesirable influences of nonuniformity in nonwoven webs, which are followed by economical detriment, online quality control and monitoring become very important. Development of fast and professional equipment, however, has facilitated the application of image-processing algorithms to real-world industrial inspection problems. Industrial vision systems must operate in real time, produce a low false alarm rate, and be flexible to accommodate variations in inspection sites.

Many attempts have been made to perform these tasks for woven fabrics (Mak & Peng, in press; Ngan, Pang, Yung, & Ng, 2005). Knitted fabrics are practically experienced in the previous works (Ghazi-Saeidi, Latifi, Shaikhzadeh-Najar, & Ghazi-Saeidi, 2005; Latifi, Kim, & Pourdeyhimi, 2001; Semnani, Latifi, Amani-Tehran, Pourdeyhimi, & Merati, 2005). Automated visual inspection of web materials is a very complex task and the research in this field is widely open (Brzakovic & Vujovic, 1996). Northon, Bradshaw, and Jewell (1992) describe a simple system based on adaptive threshold and binary filtering. An optical system for real-time defect detection is introduced in the paper of Olsson and Gruber (1993). It is based on light scattering and using electro-optical equipment for defect detection. Dar, Mahmood, and Vachtsevanos (1997) present a system for detecting one type of defect (pilling) at five grades. Radon transform is used for feature extraction and fuzzy logic method is implemented for rating. Escofet, Navarro, Millan, and Pladellorens (1996) analyze a variety of defects in different fabrics and in each case flaws are finally segmented in the background, while Gabor functions are used for feature extraction. Mueller and Nicolay (1994) apply morphological image processing for gray-level inspections. The system developed by Huart and Postaire (1994) using multicameras with associated hardware. A team of researches (1997) implement wavelets transform and fuzzy logic method to do this task. Stojanovic and Mitropulos (1999) describe a simple system based on fast binary algorithm to determine possible defect regions and use neural network to classify defects. Campbell, Fraley, and Murtagh (1997) present two-dimensional discrete Fourier transform to extract defect features and feed-forward neural network to classify them. Pakkanen, Iivarinen, and Oja (2006) use the MPEG-7 standard feature descriptor and evolving tree self-organizing map for defect image classification. Amet, Ertüzün, and Erçil (2000) use co-occurrence matrix for feature extraction and defect inspection. Serdaroglu, Ertüzün, and Ercil (2006) apply wavelet packet transform for feature extraction of images and Euclidean distance for defect detection. Karras, Karkanis, and Mertzios (1998) present the feature extraction method, which is based on wavelets transform, singular value decomposition (SVD) analysis, and co-occurrence matrix. Sezer, Ertüzün, and Ercil (2003) implement independent component analysis for feature extraction.

Shakeri, Amani Tehran, and Latifi (2006) apply a simple dual thresholding method for fault detection, and Yang and Li (2006) apply fractal geometry to evaluate morphological structure of nonwovens. Hwan Sul, Hwa Hong, Shim, and Jin Kang (2006) use 3-D imaging technique and fractal dimension method to evaluate nonwoven surface roughness.

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