A NEUROCHIP FOR DETECTING FIBROUS MATERIALS

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Initial situation

Waste textiles may be of decisive importance in the production of quality products only if separated according to the various materials involved, and if used in innovative textile manufacturing processes as precisely defined components having specific properties. High quality and increased performance in textile recycling may be achieved through the prompt online detection of textile waste. Characteristic spectral lines in the amplitude spectrum of fibrous materials may reveal the chemical composition of materials. Increasingly, neural networks simulating human brain functions are used in science and technology. As a rule, neural networks are not programmed but trained through special learning procedures.

Research target

Neural networks were examined to find out whether they may be used for detecting fibrous textile materials and their blends, using the spectral analysis in the infrared range (NIR).
A fibrous material detection system based upon a hardware-assisted neural network for achieving high detection speeds was implemented.

Research progress

Linking, adapting and developing highly advanced technologies such as NIR spectroscopy, neural networks and microelectronics are important contributions to creating high-speed detection systems for textile fibrous materials. After analysing the amplitude spectra of a number of selected fibrous materials, a near infrared special camera was installed for collecting measured values. The aim was to determine the most important properties of fibrous materials and their blends in the form of spectrograms in order to process the relevant data in a neural network. To choose an optimal neural network structure, a large number of fibrous samples were measured, and the spectra were visually analysed (Figure 1). According to the neural network conditions, data preparation and measuring data consolidation were performed in order to establish an optimal learning process. To solve these issues, several algorithms were developed and implemented in the form of Windows programs. The learning and testing process was carried out on the NNSIM network simulator running under the LINUX operating system. In a great number of variations, strategies for creating learning files were developed and tested, including data modulation, data consolidation, and data standardization. Computer software running under Windows was developed for data preparation, evaluation and assessment. During the testing processes, it was possible to detect the selected fibrous textile materials and their various blends, both quantitatively and qualitatively. The detection error rate for blends is approximately 2 to 5 per cent (Figure 3). The simulated results were practically implemented in a hardware system based upon SIOP2 ASICs developed by the "Modular Neurologic System" working group. The network structure required was established by using a testboard provided with 3 chips. The communication with the testboard was ensured by a program for Windows developed under C++. The program was also used to re-program the neural information of the SIOP2 chips and adapt it to various detection duties (Figure 2). Using this hardware, it was possible to prove the results obtained during simulation.

Application and economic advantages

The results may be applied for a prompt online detection of fibrous materials in sorting installations, or in process control systems and for quality control. Combining this know-how with advanced signal collection and signal processing systems as well as with high-performance computation equipment may allow detection times in the millisecond range (ms). Multiple scanning of the samples to be identified ensures high levels of detection quality. Consequently, there are completely new opportunities for performing real-time analyses. One example for application is a textile waste sorting plant (Figure 4).

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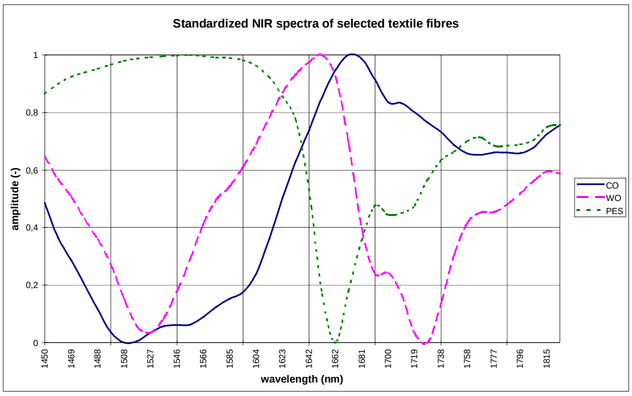

Figure 1:
Typical spectra of selected textile fibres

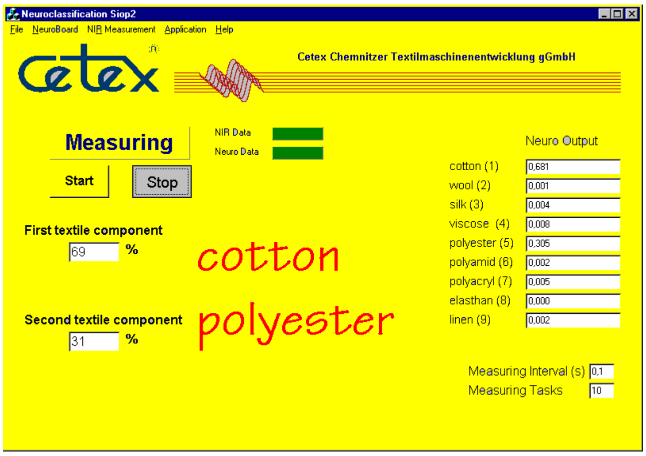

Figure 2:
Operating surface communications programme SIOP2 Board

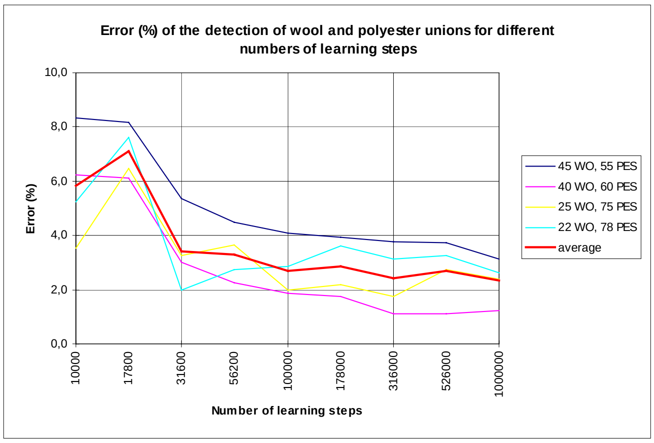

Figure 3:
Error of the detection of wool and polyester unions

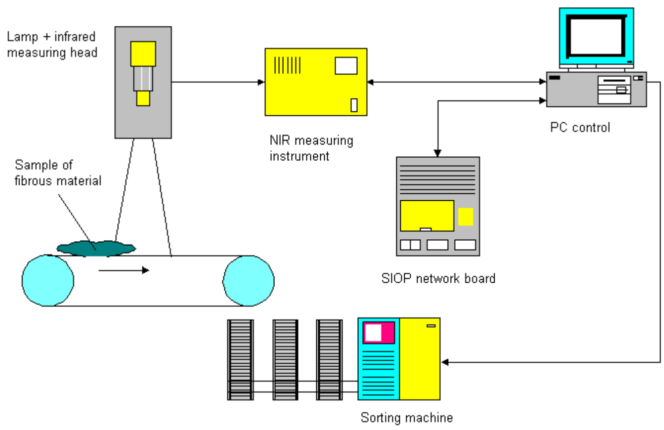

Figure 4:
Structure of a sorting unit for waste textiles