A NEURAL NETWORK BASED SYSTEM FOR WOOLLEN CLOTHES COLOR CLASSIFICATION

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In the textile industry recycling can be applied to a wide range of products, since the final product is often obtained using only one bulk material. Wool industry is a clear example of such a condition: pullovers, sweaters and many other clothes are made almost exclusively by treated and colored wool. In this case recycling is a straightforward approach to the supply of a bulk material very similar to the original one.
The common practice for companies performing wool recycling consists of providing the customer with a list of the available colors; according to the customer's choice, the companies start to seek its depot for properly colored clothes. The clothes are selected on the basis not only of the similarity of their color to the desired one, but also of the knowledge of the recycling process. This implies that the company operators demanded to classify the clothes, called "pickers", are aware of the way the different colors combine into a new one. Accordingly, differently colored clothes can be grouped together in color classes, while apparently similar ones can be separated. As a result highly specialized and well-trained operators must perform the selection process.

The final goal of this work is to provide a tool for classifying colored woolen clothes, with the aim of recycle them in a reusable bulk material.
The tool is required to:
- Be capable of respecting the selection criteria given by the human know-how
- Be highly automated;
- Be capable of performing real-time classification;
- Provide repeatable selections;
- Exhibit a low classification error;

The work presented in this paper was carried out in two basic steps:
1. Data Assembly.
2. Color classification tool development.

The purpose of the first step is to collect and properly pre-process by using a Self Organizing Feature Map (SOFM) the significant data for the development of the color classification tool.

The data assembly is performed in three consequential procedures:
- Database creation; a relevant number of differently colored cloths is stocked and their spectra are acquired by means of a portable spectrophotometer.
- SOFM development; A SOFM is developed in order to process the spectra collected in the database so that a relevant sub set of spectra can be identified.
- Training data assembly; the spectra selected by the SOFM are used for creating the training, early stopping and validation sets for developing the second step.

The second step consists in the development of the classification tool by means of a statistical method, called "Matrix Approach" and a Feed Forward Back Propagation Artificial Neural Network (FFBP ANN) based method created on the basis of the information gathered from the first step i.e. using the significant data as a training set for the network. The Matrix approach, used as a stand-alone classification tool, is very useful when the cloth to be classified is very similar to at least one cloth found in the database. In this case we have a high confidence value for the cloth classification and an overall satisfactory behavior of the classification tool. On the other hand, when cloths very different from the ones that are found in the database must be analyzed, the method may lead to low confidence values. To overcome the limitations described in the previous paragraph, a FFBP ANN was coupled with the Matrix Approach. The classification tool described in this work has been validated using a set of 5000 differently colored cloths to be recycled. The classification system proved to respect all the objectives proposed for the work and in particular recognize the new cloths with an error within 3%, being capable of respecting the selection criteria provided by human know-how. Moreover the system is highly automated and is capable of performing real-time classification since the only required operation is to place the cloth to be classified on the spectrophotometer and to start the acquisition.