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Automatic Online Recognition of Foreign Fibers from Cotton Using Machine Learning

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Abstract ***As we all know that food, clothes and house are the important things. To get the best clothes purified cotton need to remove foreign fibers from being mixed with cotton. It is a tremendous and most challenging task to accurately classify foreign fibers from cotton. This article proposes a proficient recognition and classification system to accurately recognize foreign fibers mixed with cotton. In machine learning, the kernel extreme learning machine is the main component. It is an efficient classifier based on the two-step grid search strategy which collect a active search with a fine search and is adopted to train an optimal KELM recognition model in it. To find out the accurate result, the final model is compared with valid data set using tenfold cross-validation analysis. In this paper an experimental results show that the proposed recognition system can be achieve classification accuracy as high as 93.57 percent which is greater than the other two state-of-the-art systems.***

Index Terms**: *Foreign fibers in cotton, Kmean algorithm, kernel extreme learning machine, online recognition system***

I. INTRODUCTION

In cotton the hair, binding ropes, candy wrappers, iron coil, polypropylene twines and plastic films are the foreign fibers, have crucial impacts on the quality of cotton textile products and impact on to great economic loss for cotton textile industries [1]. Usually, the experienced farmers have manually detected these foreign fibers, which is a laborious and lengthy process as well economically high. In recent years, the machine-vision-based technology for online foreign fiber particle recognition has introduced and it trending too into researcher's attention [2]. The machine-vision-based online recognition systems are high recognition accuracy technique and it is having significant importance. The Foreign fiber particle recognition Page layout typically; adheres to the following procedures: (1) acquiring high quality images, (2) obtaining foreign fiber objects in the image, (3) extracting the features of these objects, and (4) constructing a classification model. The accurate object classification is an final step in foreign fiber recognition plays an important role in it. There is a number of classification models have been developed for this purpose. Ji *et al.* [3] used a decision tree SVM (support vector machine) to identify the types of common foreign fibers in cotton. In this paper we demonstrated greater than 92 percent accuracy to identifying different types of foreign fibers particle. Yang *et al.* [4] proposed the use of a one-against-one directed acyclic graph multiclass SVM to perform classification; a mean accuracy of 92.34% was achieved. Other works have focused on feature selection procedures [5]-[7]. In most of the work on foreign fiber recognition has focused on Support Vector Machine (SVM) for constructing the final recognition model. In Recent, Huang et al. proposed a new learning algorithm; the extreme learning machine (ELM) [8], for single hidden layer feed-forward neural networks (SLFNs). In this method, the ELM randomly chose input weights and hidden biases, and the output weights were analytically determined using a Moorefi Penrose generalized inverse. More recently, in order to tackle the problem of large variation in the classification accuracy found in ELM in different trials, Huang *et al.* [9] proposed a kernel version of ELM (KELM), which required no randomness in assigning connection weights between the input and hidden layers. KELM can achieve relatively or

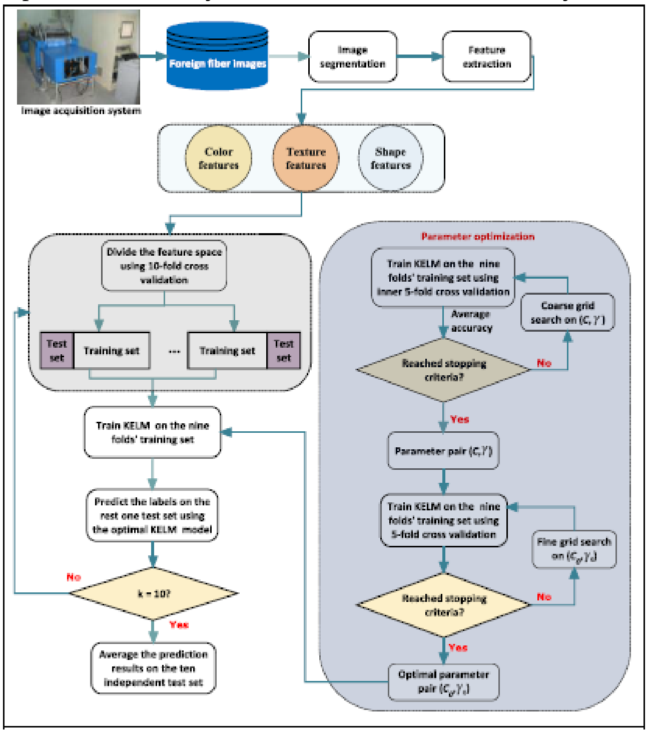

Figure 1: Architecture of the proposed system.

better performance than SVM, is easier to implement, and has a faster training speed in applications like hyper spectral remote-sensing image classification [10].

II. PROPOSED FOREIGN FIBER RECOGNITION SYSTEM

The main purpose of our proposed system is to improve the recognition accuracy of identifying

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foreign fibers in cotton. The system consists of 5 components viz. image acquisition, image segmentation, feature extraction, model training, and foreign fiber recognition technique. The foreign fiber image acquisition method [11], is built to acquire foreign fiber images in cotton. Then, the image segmentation is performed to locate the foreign fibers in the images which are given. Next, one is multiple types of features, including color, shape, and textures are extracted from the images provided. Then, all of the features are fed into the KELM classifier for training an optimal model using the two-step grid search strategy method. Lastly the, KELM conducts the recognition task using the trained optimal model for cotton fiber. The proposed architecture of the foreign fiber recognition system is shown in Figure 1.

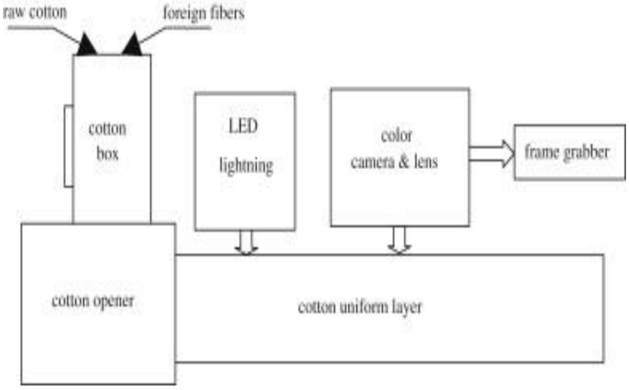

Figure 2: Foreign fiber system

A. IMAGE SEGMENTATION

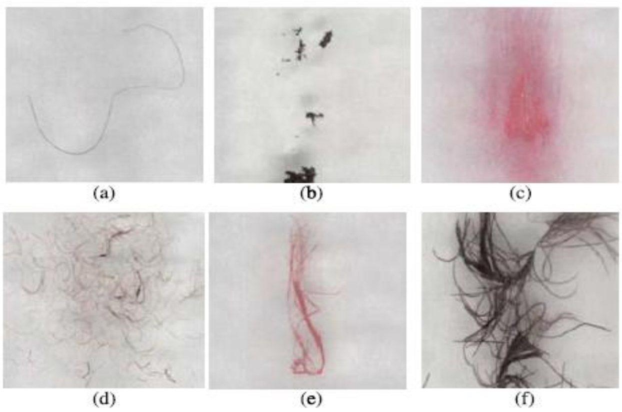

Figure 3:. Local Cuts of Sample images. (a) hair (b) black plastic film (d) red cloth (d) hemp rope (e) red polypr -opylene (f) black feather.

The image segmentation is used to partition an image into a set of meaningful connected components for system. In this study, the objective of image segmentation is to locate the foreign fibers in the image. The located parts, which only contain foreign fibers, are called the foreign fiber items. Discovery of these foreign fiber objects is the precondition of machine vision-based foreign fiber recognition system. It can help accurately extract the features of foreign fibers. A number of different image segmentation methods have been proposed, some of them have been applied to automated visual recognition systems in agriculture industries [1]-[2].In

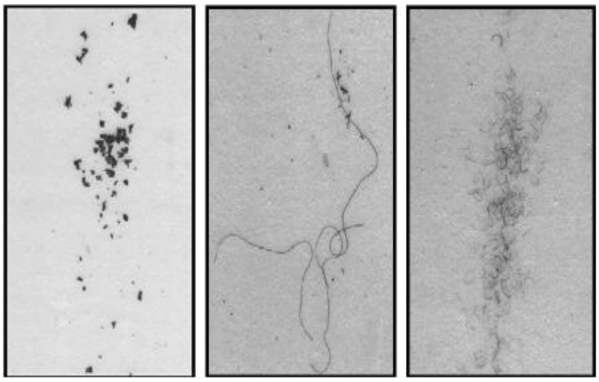

Figure 4: Original images. (a) plastic film (b) hair (c) hemp rope.

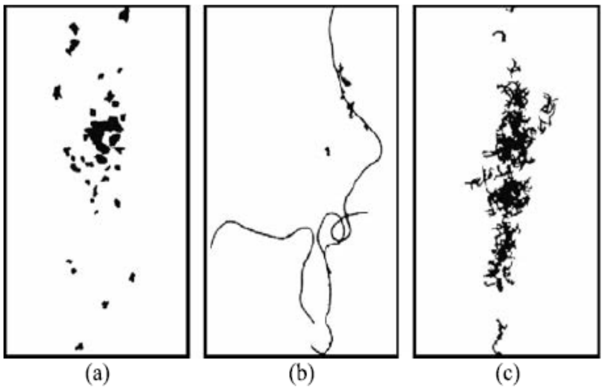

Figure5: Results of image segmentation. (a) plastic film (b) hair (c) hemp rope.

these systems, the traditional threshold method is used, which has the advantages of computational simplicity, high speed, and easy implementation. In this method, the regularity of the gray distribution of the images is used to enhance the images and the improved Otsu's method is used to partitioning the images likewise. The closing operation of mathematical morphology is used to fill the gaps generated in the process of image segmentation, and noise produced by small objects is removed by an area calculation. Figure 6 shows the original images before image segmentation. Figure 7 shows the objects of the images corresponding to Figure 6 after image segmentation. As we can be seen from the figure, the method is able to accurately locate the foreign fibers in the cotton.

B. FEATURE EXTRACTION

The foreign fibers in cotton are varying in terms of color, texture, and shape etc. For these we use it to obtain acceptable recognition accuracy, color, shape, and texture features are extracted in this article. For color features, we consider these features in three different models RGB model, HSV model, and Gray model. There are a total of twenty-seven extracted color features, which are listed in Table 1.We extract the four classes of texture features: gray-level co-occurrence matrix, gray-gradient concurrence matrix, gray-smooth co-occurrence matrix, and gray-level differences in the system. There are 41 total extracted texture features, which are listed in Table 2. Further we extract 7 shape features: Area, Euler number, Form factor, Eccentricity, Solidity, Rectangularity, and Sphericity. The 27 color features, 41 texture features, and 7 shape features, form the 75-dimensional feature vector.

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C. ELM for classification

Feed-forward neural networks are used for classification, regression, sparse approximation, clustering, compression and learning with single/multiple layers of hidden nodes; where the parameters of hidden nodes need not be tuned. These hidden nodes can be randomly assigned and never updated and can be inherited from their ancestors without being changed [12].This section shows that with the standard optimization method ELM can be linearly extended to SVM with less optimization constraints and the implementation of SVM can be made much easier. One of the aims of this extension is to possibly apply ELM learning approach in Support Vector Machine. Since, both ELM and SVM work for SLFNs and the hidden layers of both ELM and SVM are not tuned; the learning mechanism of ELM and SVM may be combined in some ways: (1) similar to the standard ELM but different from SVM, the random kernels are used; (2) similar to SVM but different from the least square solution of ELM, the standard optimization method is adopted to find the solution of ELM, resulting in support vectors as well. The Optimization method based solution to ELM Different from the standard SVM [7]. However, it is most possible that some testing data maybe within classification margin if zero training error is strictly obtained by it. In this sense, one may wish to separate the training data within acceptable minor training error instead of the zero training error so that the testing error can be reduced accordingly.

D. Clustering in ELM feature space

ELM maps the original data into the ELM feature space, and then, by constructing a linear decision function, finds the classifier in the feature space, which can get better results. Also, kernel methods have been used to do the clustering in the kernel space [12], and they also obtain encouraging performance. Since classification in the ELM feature space can get better results, we introduce the methods to do the clustering in the ELM feature space.

III. IMPLEMENTATION

A. kMean algorithm in KELM feature space

Compared to the kernel based methods, clustering in the ELM feature space is more convenient than older one. First, we transform the original data into the ELM feature space. The mapping is very instinctive and straightforward and according to the ELM universal approximation conditions, many nonlinear piecewise continuous functions can be used as the hidden-node output functions. The number of the nodes in the hidden layer is only the parameter needs to be specified by the users. According to the ELM universal approximation conditions and classification capability; a very large number of nodes can guarantee that the data will become linear separable, so we can set the parameter to a large enough numbers. After transforming the data into the ELM feature space, the traditional clustering method can be used directly on it. In this part, we use the simple kMeans algorithm and call the kMeans algorithm in ELM feature space as ELM kMeans algorithm for short.

Algorithm 1.For KELM, kMeans algorithm.

Input: k: total number of clusters,

H_L: the number of the hidden-layer nodes,

P: a data set containing m objects.

Output: B is the set of k clusters.

Method: 1: Initially, Mapping the original data objects in P into the ELM feature space H using

$$h(x)= [h1(x),h2(x)\ldots..hl(x)]^T$$

2: Randomly choose initial k objects from H as the initial cluster centers;

3: Calculate the Euclidean distance between initial point with all remaining data points.

4: Reassign each object to the cluster to which the object is the most similar, based on the mean value of the objects in the cluster.

5: Repeat the method to calculate the cluster means that is centroid.

6: Do change in the cluster centers or reached the maximal iteration number limit.

7: find out accurate cluster points and return B set of k clusters.

B. KELM WITH FEATURE SELECTION

To determine the optimal feature set and improve the performance of system, we adopt a feature selection approach based on the Fisher Score to select the optimal feature set for identifying foreign fibers in cotton in the next experiments. Then, we build the KELM based on the optimal classification subset method. The Fisher Score is an effective supervised feature selection algorithm and has been widely applied. Given class labels

$$Y= \{y1,y2\ldots\ldots\ldots\ldots\ldots\ldots yn\}$$

IV. RESULT ANALYSIS

Table 1: Classification results of ELM.

Foreign fiber class	Classification Results						Number of Samples	Accuracy (%)
	1	2	3	4	5	6		
1. Plastic film	34	0	0	0	0	0	34	100
2. cloth	0	31	1	0	0	4	36	86.11
3. hemp rope	0	1	34	1	2	3	41	82.93
4. hair	0	0	0	15	0	2	17	88.24
5.polypropylene	0	0	1	0	41	2	44	93.1
6. feather	1	2	3	0	0	56	62	90.32
Mean	90.17							

Table 2: **Classification results of the SVM.**

Foreign fiber class	Classification Results						Number of Samples	Accuracy (%)
	1	2	3	4	5	6		
1. Plastic film	33	0	0	0	0	1	34	97.06
2. cloth	0	33	0	0	0	3	36	91.67
3. hemp rope	0	1	34	0	2	4	41	82.93
4. hair	0	0	0	16	0	1	17	94.12
5.polypropylene	0	0	1	2	41	0	44	93.18
6. feather	1	4	0	0	1	56	62	90.32
Mean	91.07							

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Table 3: KELM classification results.

Foreign fiber class	Classification Results						Number of Samples	Accuracy (%)
	1	2	3	4	5	6		
1. Plastic film	34	0	0	0	0	0	34	100
2. cloth	0	35	0	0	0	1	36	97.22
3. hemp rope	0	1	36	0	1	3	41	87.80
4. hair	0	0	1	14	1	1	17	82.35
5.polypropylene	0	0	2	0	42	0	44	95.45
6. feather	1	3	0	0	0	58	62	93.55
Mean	93.57							

Detailed classification results for ELM and SVM are recorded in terms of a confusion matrix as shown in Tables 1 and 2. From the two tables, we can see that ELM and SVM have average accuracies of 90.17% and 91.07%, respectively. Compared with ELM and SVM, KELM has achieved, respectively, 3.39% and 2.5% higher recognition rates.

B. Experimental analysis:

The results of KELM classifier optimized by the two-step strategy. KELM with the coarse search achieved a mean classification accuracy of 91.58% and a standard deviation of 0.0556 in the system.

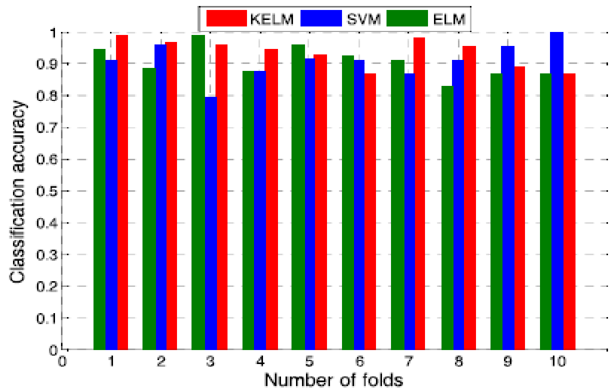

Figure 6: Classification accuracy of KELM, ELM and SVM.

After a accurate search, the performance of KELM is further improved. KELM has achieved good performance with a mean accuracy of 93.57% and a standard deviation of 0.0513 across over 10 independent folds.

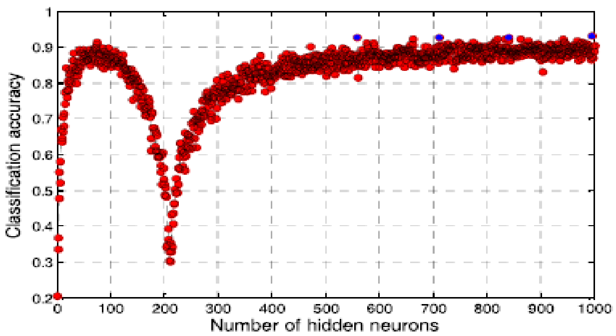

Fig 7: Relationship between the accuracy and number of hidden neurons for ELM.

V. CONCLUSION

We have improved an efficient recognition system for differentiating foreign fibers that can appear in cotton which is our main data. Here the main component of the proposed system is the KELM classifier. To verify the effectiveness of the KELM in identifying unknown or foreign fibers from cotton and other improved classifiers such as SVM and ELM are used for comparison with the KLEM. Hence, the simulation results demonstrate that the KELM is more stable than the other methods We have used feature selection and model optimization into the same optimization process to develop a recognition system that manages accuracy that can be built for the detection of foreign fibers from the cotton which is our main data

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