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Research Article

Food Quality Detection Using Machine Vision Based on Genetic Optimized RBF Network

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Abstract: This study aims to investigate the food quality detection using an intelligent method. The machine vision applies image processing softwares to monitor the food quality. The Artificial Neural Network (ANN) in the image processing softwares is crucial for food quality detection precision. However, improper structure parameters of ANN may lead to the low detection performance. In order to overcome this problem, a new detection method based on Genetic Algorithm (GA) -Chaos optimized Radial Basis Function (RBF) neural network is proposed in this study. The GA-Chaos was used to optimize the structure of the RBF as well as its weight values to obtain high generalization ability of the RBF-detection model. Then the RBF model was employed to train and test the food data sets. Experimental results show that the method could enhance the food quality detection rate and outperforms the traditional GA-based methods.

Keywords: Food quality detection, image processing, machine vision

INTRODUCTION

In China, the food safety problems are very serious (Li, 2013), for instance, the Sanlu milk powder, Tonyred, etc. How to guarantee the food safety has attracted extensive attention. The request for safe and high-quality food industry supply chain supervision is still open (Bennedsen and Peterson, 2004). Therefore, it is imperative to effectively monitor the food quality to guarantee food quality and safety.

Machine vision applies computer vision to process monitoring. By the use of machine vision, one could make the food quality management very effective. Generally, machine vision has been widely applied to inspect the quality of produced goods like electronic devices. Some specially designed image processing softwares are necessary for these applications in the machine vision systems. Therefore, image processing is very crucial for the food detection performance.

To ensure the food detection performance, the artificial intelligence methods like Fuzzy logic and Artificial Neural Network (ANN) have been introduced into the image processing in the machine vision systems (Fu *et al*., 2012). According to literature review, the detection rates of popular artificial neural network methods are only about 70%, which obviously cannot achieve the requirements of food safety protection (Sergio *et al*., 2011; Liang and Meng, 2012). Therefore, an urgent problem for current food quality defence is how to improve the food quality detection precision. Since the Genetic Algorithm (GA) has a good global search capability, researchers have applied GA to optimize the neural networks (Vapnik, 1995). However, GA is not sensitive to the fitness function (Xiao and Peng, 2012), which in turn will influence the food quality detection. Very limited work has addressed this issue in the food quality detection.

In order to investigate the food quality detection using GA optimized ANN, this study proposed a new method based on the Chaos GA and the RBF neural network. This method has been marked by chaotic technology, which can improve the GA optimization process. The RBF network structure and weights could be optimized by Chaos GA and thereafter a food quality detection model with good generalization performance is being established. Through the analysis of the detection performance on optimizing before and after the RBF networks, the experimental results demonstrate that the detection method in this study has acceptable detection capability.

MATERIALS AND METHODS

In this study, a new food quality detection method using machine vision based on GA-Chaos has been proposed. In this development, firstly the food images were processed by the Principal Component Analysis (PCA). Important features were hence extracted from the food images. Then, the extracted features were treated as inputs to train and test the RBF network for the purpose of food quality detection. In order to enhance the detection rate, the GA-Chaos was applied to optimizing the structure of the RBF network. Figure 1 shows the diagram block of the proposed food quality detection method.

The processes based on the chaos-genetic algorithm to optimize the RBF network food quality detection are as follows:

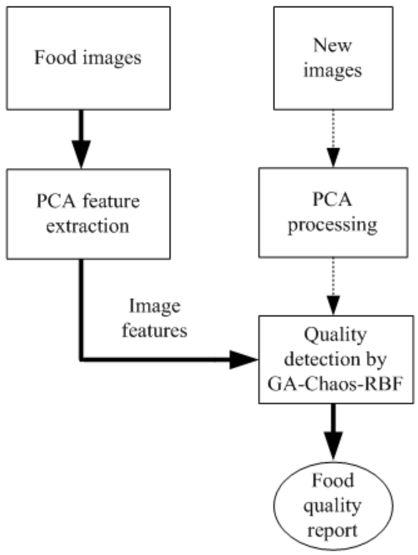

Fig. 1: The workflow diagram of the proposed food quality detection method

- Chromosomes will be coded by hidden nodes number, the base function of central values and the width of the RBF network. These three chromosomes form an individual.
- Individuals will be initialized and set the genetic operation parameters.
- The corresponding value of the fitness function will be calculated according to the solution space value.
- Crossover and mutation of genetic algorithm will proceed.
- Newborn progeny populations of each chromosome will be decoded and the corresponding fitness value will be obtained.
- The optimal individuals in groups will be selected for chaos optimization by the chaotic algorithm, if the new individual fitness value is bigger than the original individual, the individual will be substituted, otherwise the original individual stays unchanged.
- If the results can satisfy the conditions for the termination, then stop to the end, otherwise return to (3) for iteration.

RESULTS AND DISCUSSION

In this study, the real food image data are analyzed to validate the detection performance of the proposed algorithm. In the image datasets there were 50 healthy apple images and 50 bad ones, 50 healthy potato images and 50 bad ones and 50 healthy tomato images and 50 bad ones. Therefore, there were 300 images in total.

In the experiments, half of the images were used to train the RBF network and the other half were used for testing. Table 1 lists the testing results of the proposed method and its detection performance was compared to other algorithms in Table 2.

As shown in Table 1, the proposed algorithm in this study can detect the food quality accurately. The detection rate was higher than 80%, the false rate was approaching 5.25%. Table 2 indicates that, after the optimization on the neural networks the food quality detection performance could be enhanced significantly. The detection rate and the false rate of the GA-Chaos were better than the traditional genetic optimization; meanwhile, the detection performance of the RBF network was better than that of the BP network.

CONCLUSION

The machine vision is applied to the food quality detection. In order to enhance the detection performance, this study develops a GA-Chaos optimized RBF network for the food quality detection. The innovation is that the development can eliminate genetic algorithm precocious phenomena by the use of Chaos searching. The experimental result has proven the effectiveness of the proposed method. Furthermore, the new method could afford technical support for the practical food quality protection.

Table 1: The food quality detection results by chaos-GA and RBF

	Training		Testing	
Food type	Detection rate (%)	False rate (%)	Detection rate (%)	False rate (%)
Apple	88.75	5.25	85.50	5.50
Potato	87.25	5.25	86.75	5.75
Tomato	83.75	5.25	83.50	5.25

Table 2: Comparison of food quality detection results

	RBF		BP	
Optimization method	Detection rate (%)	False rate (%)	Detection rate (%)	False rate (%)
Non	73.6	9.25	73.40	9.26
GA	80.4	7.25	79.60	7.36
Chaos-GA	86.6	5.25	85.25	5.50

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