The use of Hyperspectral Imaging for cake moisture prediction

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Abstract: In this paper, hyperspectral imaging is demonstrated to be a valid method for predicting the moisture content of baked sponge cakes. The application of this technology in the cake production environment, empowered by sophisticated signal & image processing techniques and prediction algorithms has the potential to provide on-line, real-time, non-destructive cake moisture monitoring.

1. Introduction

Food production is constantly confronted with increasingly rigorous requirements on the product quality, ingredients and shelf lifetime. Hyperspectral Imaging (HSI) is one of the modern technologies that found an application, among many others, in on-line product monitoring. The inherent spectral data acquired by these systems, combined with appropriate chemometric analysis can provide means for extensive quality control. On-line applications of HSI ranging from mining industry [1], through textile, pharmaceuticals [2, 3] and many others, have also enormous potential in food industry [1]. There, the most common on-line applications of HSI are for the crops inspection and segregation [4]. HSI inspection of other groceries, having a potential for on-line implementations, was also documented and the bakery products are between them [5].

2. Results

A Partial Least Squares Regression (PLS-R) prediction model was build based on the hyperspectral data from 96 imaged sponge cakes and the moisture values predicted with this model are highly correlated with the moisture content measured using the Mettler Toledo, HB43-S Halogen Moisture Analyzer – the moisture monitoring device currently used for quality control in the bakery.

To assure high quality data used for building the prediction model, techniques for automatic avoidance of misleading data (spectra from air bubbles) are shown. Potentially, such techniques could also provide a platform for the development of other visual inspection tools - detection of cracks, location of air bubbles, etc.

The PLS-R model performs better for white sponges than chocolate ones which show a smaller range of moisture change over the measured lifetime and exhibit higher variance in the measurements. However, it is demonstrated that for both chocolate and white sponge, the hyperspectral imaging system combined with the PLS-R model can accurately measure moisture content.

The results of this study demonstrate the application of HSI for non-destructive cake moisture monitoring. If installed in the factory, it would also provide end users with a high quality image of every product that is analysed by the system on the production line. This could allow operators to detect other variations in the production process and explore new analysis and data mining methods for greater understanding of their products and processes.

References

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