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Towards Accurate Non-Contact Moisture Inspection using THz Imaging and Thickness Information

This study proposes an approach for non-contact moisture inspection in dried food products, which is crucial to maintain optimal quality and shelf-life, using terahertz signal intensity and thickness of a test sample. To achieve this, a sample-specific calibration curve needs to be determined first. The HAITAI crackers were chosen in this work for demonstration purposes. Four different stacks of crackers were moisturized by spraying water on a tissue paper and then covering it on the sample. Actual moisture percentages were also determined immediately after data collection by a gravimetric method of the moisture analyzer, whose results served as ground-truth measurements. The moisture of the samples varied between 3 and 40%. The terahertz source emitted wave continuously at 0.1 THz while the detector was a 1D-array camera having 256 pixels and receiving waves in 0.05 −0.7 THz frequency range. Transmitted terahertz signal of each sample, placed on a conveyor belt system between a terahertz source and detector, was measured 5 times, while the sample thickness was measured by a vernier. The 3D RGB camera was also used for measuring thickness of sample as well as obtaining RGB image. All dataset of known-thickness, and actual moisture measurements were used to calculate the coefficients necessary to define the signal absorption equation according to Beer-Lambert' s Law. Once a calibration curve was obtained, it was used to estimate the moisture percentages in samples with different thicknesses. The mean absolute error (MAE) of moisture is found to be less than 11%, when the sample thickness was taken into account for constituting the calibration curve. Therefore, the utilizing of 3D RGB camera for color-terahertz image registration and automatic thickness determination is promising for an accurate non-contact moisture inspection. This approach can be also integrated into production line to improve quality control in the dried food industry without interrupting existing processes.

Keywords: terahertz moisture imaging, calibration curve, correction

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