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基于偏振光和聚类分析的皮蛋壳裂纹无损检测

Nondestructive detecting cracks of preserved eggshell using polarization technology and cluster analysis

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中文摘要:

检测出缸皮蛋蛋壳是否有裂纹是确保皮蛋质量的重要环节。腌制好的皮蛋蛋壳表面大量的灰褐色斑点和一些大块黑斑使得其蛋壳表面的裂纹不易检测。皮蛋表壳斑点和裂纹的微细结构不同，对偏振光的退偏程度也不一样，可以利用皮蛋表壳各点偏振度的差异来识别其裂纹。该文设计了皮蛋表壳偏振图像采集系统，基于皮蛋0、45°、90°、?45° 4个偏振角度的图像和斯托克斯公式获得皮蛋表壳裂纹的偏振度图像，对偏振图像进行阈值预处理后，以皮蛋表壳偏振图像中像素最高且连通区域最大部分作为中心，截取100×100像素的图像，提取该图像裂纹长度、均方比、偏度和峰度等4个特征参数，采用Kmeans聚类分析算法准确识别了皮蛋表壳裂纹。试验证明，该方法综合准确率为93%，其中好壳皮蛋识别准确率为100%，裂纹蛋识别准确率为88.3%，这表明偏振光检测技术能有效地识别皮蛋蛋壳裂纹。

英文摘要:

Abstract: Pickled egg had lots of beige spots and some large black spots on its eggshell, so it is difficult to detect cracks on the preserved eggshell. A polarization optical system was designed to obtain images, and the system was tested by the Malus law. Polarization optical system was used to acquire images on different polarization angles, including 0, 45°, ?45° and 90°, and then the Stokes images and polarization images were processed by image fusion technique with the Stokes Formula. According to different depolarization mechanisms for black spots and cracks on preserved eggshell, it can distinguish black spots and cracks on the polarization image. The most connected area of high gray value was taken as the center to cut an image about 100×100 pixel area. Four characteristic parameters were extracted to distinguish the cracks on preserved eggshell, including the length of the crack, mean variance ratio, skewness and kurtosis. We put forward 4 characteristic parameters and use the cluster analysis to detect cracks. Info-Kmeans clustering algorithm was used in this study, and the clustering of high-dimensional sparse data were extracted from the images. The results showed that all preserved eggs were classified into intact and cracked groups, and the accuracy rate was 93%. In this experiment, the sensitivity and specificity were 100% and 88.3%, the detection rate of intact preserved egg was 100%. The validation experimental result showed that the accuracy was 94%, and the sensitivity and specificity were 100% and 88.3%. Results showed that the model could distinguished intact and cracked preserved eggs efficiently, and it was great potential to detect cracks on product lines.

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