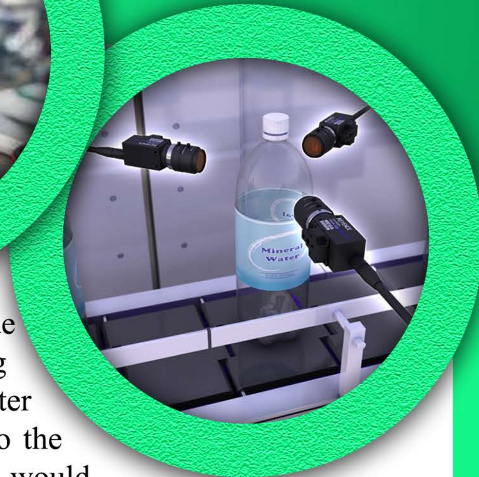
Nondestructive Evaluation of Food Quality

متن‌خوانی انگلیسی

محمد قوشچیان



Computer Vision Systems

Food quality is of paramount consideration for all consumers, and its importance is perhaps only second to food safety. By some definition, food safety is also incorporated into the broad categorization of food quality. Hence, the need for careful and accurate evaluation of food quality is at the forefront of research and development both in the academia and industry. Among the many available methods for food quality evaluation, computer vision has proven to be the most powerful, especially for nondestructively extracting and quantifying many features that have direct relevance to food quality assessment and control. Furthermore, computer vision systems serve to rapidly evaluate the most readily observable foods quality attributes – the external characteristics such as color, shape, size, surface texture etc. In addition, it is now possible, using advanced computer vision technologies, to “see” inside a food product and/or package to examine important quality attributes ordinarily unavailable to human evaluators. With rapid advances in electronic hardware and other associated imaging technologies, the cost-effectiveness and speed of computer vision systems have greatly improved and many practical systems are already in place in the food industry. Thus, many of the quality evaluation operations are now done in a fairly routine basis at speeds matching the production and high throughput requirements of the food industry. As the technology matures and finds more mainstream applications, further growth will be in improving and speed under challenging food processing environments – dusty, wet, hot etc. Turn-key applications that would require only moderate operator intervention will be further developed, which can operate trouble-free for prolonged durations. New advances in terms of non-visible defect detection and hyperspectral imaging will Food quality continue to evolve and bring additional computer vision innovations to the food industry, which would require intensive research and developmental work by many new scientists and technologists.

Computer vision, also known as machine vision or computer image processing, is the science that develops the theoretical and algorithmic basis by which useful information about an object or scene can be automatically extracted and analyzed from an observed image, image set, or image sequence. It is a branch of artificial intelligence technique and deals with simulating human vision. We see an object and perceive its optical characteristics based on the reflected light received from the object being illuminated by natural or artificial light. Thus, in essence the task of a computer vision system is to simulate human visual perception process.

Image Acquisition

Capturing image for processing is the foremost activity in machine vision system. It requires outmost care and manner which can be used repeatedly and image should be without any shades. A good light source or illumination system and a camera are important gadgets for acquiring a good digital image for processing.

Illumination

The prerequisite for any vision application is that the features to be examined can be seen in the image. Therefore, despite all the progress in image analysis/processing algorithms, the performance of the camera and illumination subsystem can greatly affect the success and reliability of a computer vision application. A well-designed lighting and illumination system is essential for the accuracy and success of image analysis by enhancing image contrast. Good lighting will improve feature discrimination and reduce processing time and hardware requirements. Thus, it is almost always cheaper to improve lighting than to enhancing image processing algorithms. Food materials are nonhomogeneous, randomly oriented; and may be dirty. Furthermore, simulation of objects, i.e., the ability to present objects one at time under the camera for image acquisition is often difficult. Therefore, we have to cope with objects that touch, overlap, and someway occlude hiding and/or casting a shadow during image acquisition. Overall, computer vision applications in the food industry are faced with unusual challenges, compared to those in other industries, for example in the automobile industry, when designing proper illumination systems.

Selecting appropriate light sources and identifying suitable configurations for the light sources so as to obtain the highest quality images is the essence of proper illumination for a computer vision system. The geometry of the imaging system should be well known. This requirement is especially important for dimension measurements. When the viewing geometry is more complicated, either because of the non-planar image surface or non-perpendicular imaging angle, measurements are more difficult and require determining the geometry of the imaging system. Most lighting arrangements can be grouped as either front-lighting or back-lighting.

Image Processing

The basic steps in image processing are image preprocessing, segmentation, and feature extraction. The purpose of image preprocessing or image conditioning is to enhance the quality of the acquired image, which is often degraded by distortion and noise in the optical and electronic systems of the input device. Image preprocessing steps include one or more of the following: noise reduction, geometrical correction, gray-level correction and correction of defocusing. These steps are typically applied uniformly and are context-independent.

Image segmentation refers to the process of partitioning a composite image into component parts or objects. Proper segmentation is very critical. Often, the first step in assuring successful segmentation is control of background uniformity. For monochrome images, segmentation normally is performed by examining the gray scale histogram – a bar chart of the number of pixels in the image at different gray levels. Segmentation algorithms are based on discontinuity or similarity of the gray-level values. Discontinuities in image gray scale indicate sharp changes in image brightness such as the background or the object. In general, autonomous segmentation is one of the most difficult tasks in image processing. A real-time adaptive thresholding is preferably used for on-line evaluation with line-scan cameras. Segmented image constitutes raw pixel data of the image boundary or a region of interest in the image. The image representation as boundary or region should be selected based on the intended application. For example, boundary representation is appropriate for image size and shape characterization; the region representation is suitable for evaluating image texture and defects. The feature extraction step is the key in deciphering require image data from the composite image information. Feature extraction facilitates obtaining some quantitative information of interest, which is then processed in conjunction with the knowledge base available for the feature studied. The "knowledge" of the features in consideration is also critical at this stage in designing appropriate algorithms to extract information pertaining to the desired feature(s).

Nondestructive Evaluation	ارزیابی غیرمخرب
Paramount	برتر، برترین
Machine vision	ماشین بینایی
Artificial intelligence	هوش مصنوعی
Illumination	نورپردازی
Discrimination	تفاوت قائل شدن، تمیز، تفکیک
Nonhomogeneous	غیرهمگن
Segmentation	قطعه‌بندی، جداسازی
Assuring	اطمینان دادن
Thresholding algorithms	الگوریتم‌های آستانه‌گذاری
Deciphering	رمزگشایی