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Application of image processing & machine vision technology in seed quality analysis

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Abstract
Agriculture and farming are one of the oldest and most important professions in the world. It plays an important role in the economic sector. Worldwide, agriculture is a $5 trillion industry. Artificial intelligence is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. The goals of artificial intelligence include learning, reasoning, and perception. It has been trying hard to bring various kinds of technologies especially agriculture related, to a qualitatively new level. Quality inspection of food and agricultural produce are difficult and labour intensive. Simultaneously, with increased expectations for food products of high quality and safety standards, the need for accurate, fast and objective quality determination of these characteristics in food products continues to grow. However, these operations generally in India are manual which is costly as well as unreliable because human decision in identifying quality factors such as appearance, flavour, nutrient, texture, etc., is inconsistent, subjective and slow. Machine vision provides one alternative for an automated, non-destructive and cost-effective technique to accomplish these requirements. This inspection approach based on image analysis and processing has found a variety of different applications in the food industry. Considerable research has highlighted its potential for the inspection and grading of fruits and vegetables, grain quality and characteristic examination and quality evaluation. The automation in agriculture is the main concern and the emerging subject across the world. The current status of machine visual technology applied in inspection of agricultural products will be analysed in this text. Parts of problems in practical application will be summarized and its future develop direction will be discussed here.

Keywords: Artificial imaging, machine vision technology, artificial intelligence, seed quality parameter, seed testing

Introduction

Laboratory seed quality analysis aim to provide accurate and reproducible guidance, rather than absolute answers or predictions. Viability, germination and vigour tests all produce results that are usually greater than, and at best equal to, how the seed will actually perform in the field. An appreciation of what viability, germination and vigour measure can help maximise the understanding of the planting value or storage potential of seed. Apart from planting value the quality analysis is required for various reasons in seed technological research as well as by the seed companies. But the regular or conventional method of seed quality analysis require more time, many expertise man power and produce less accuracy result with more chances of error and the amount of seed used for the experiment purpose are destroyed. Therefore, there is a call for a non-destructive, accurate, less time consuming and less man power required method for seed quality analysis. So, Machine vision technology associated with image processing provides one alternative for an automated, non-destructive and cost-effective technique.

Basics of Image Processing and Machine Vision Technology

Machine vision is a rapid, economic, consistent and objective inspection technique, which has expanded into many diverse industries. Image Processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Its speed and accuracy satisfy ever-increasing production and quality requirements, hence aiding in the development of totally automated processes. Many applications using machine vision technology have been developed in agricultural sectors, such as land-based and aerial-based remote sensing for natural resources assessments, precision farming, postharvest product quality and safety detection, classification and sorting, and process automation. It has also been used successfully in the analysis of seed quality, grain characteristics and in the evaluation of foods. This is because machine vision systems not only recognize size, shape, colour, and texture of objects, but also provide numerical attributes of the objects or scene being imaged. Besides imaging objects in the visible (VIS) colour region, some machine vision systems are also able to inspect these objects in light invisible to humans, such as ultraviolet (UV), near-infrared (NIR), and infrared (IR). The information received from objects in invisible light regions can be very useful in determining preharvest plant maturity, disease, or stress states. It is very useful in determining plant and vegetable variety, maturity, ripeness, and quality. It is also useful in detecting postharvest quality and safety, such as defects, composition, functional properties, diseases and contamination of plants, grains and nuts, vegetables and fruits, and animal products. Advantages of using imaging technology for sensing are that it can be fairly accurate, non-destructive, and yields consistent results. Applications of machine vision technology will improve industry's productivity, thereby reducing costs and making agricultural operations and processing safer for farmers and processing-line workers. It will also help to provide better quality and safe foods to consumers. Machine vision discussed here is limited to camera machine vision systems. It holds great potential and benefits for the agricultural industry because of its simplicity, low cost, rapid inspection rate, and broad range of applications. Machine vision can also be performed using X-ray imaging and nuclear magnetic resonant imaging (MRI). X-ray and MRI imaging are widely used in medical applications. Even though they have potential for detecting diseases and defects in agricultural products and food, their applications in the agricultural sector are limited because of the high cost of equipment investment and low operational speed. Machine vision provides one alternative for an automated, non-destructive and cost-effective technique. Size, which is the first parameter identified with quality, has been estimated using machine vision by measuring either area, perimeter or diameter. Colour is also an important factor that has been widely studied.

Image Processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Images are also processed as three-dimensional signals where the third-dimension being time or the z-axis. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging. There is some application of machine vision on seed technology research or quality analysis-

- DUS Testing
- Varietal Identification
- Germination
- Moisture content
- Vigour
- Colour and size
- Sorting and Grading
- Prediction of kernel weight

Machine vision systems commonly used in agricultural applications acquire reflectance, transmittance, or fluorescence images of the seed under UV, VIS, or NIR illumination. A basic machine vision system consists of a camera, a computer equipped with an image acquisition board, and a lighting system. Also, computer software is required for transmitting electronic signals to computers, acquiring images, and performing storage and processing of the images. Monochrome imaging, Colour imaging, Multispectral imaging, Hyper spectral imaging, these are different types of imaging system used in machine vision.

System Structure and Work Principle

Machine Vision actually replaces the human eye to do the measuring and judging. Machine vision system is to be up taken by the visual sensor object, which is converted into an image signal, then passed to the image processing system, according to the pixel signal distribution and collection brightness, colour and other information, image signal will be converted into digital signals; system will operate the signal features and compared with the data stored in the database, then estimate and determine the relevant features of the results. Characterized increases production flexibility and automation extent, and releases people from some danger, monotony, any error in the liberation of the working environment, and easy to integrate information, easy to implement the system intelligent. The processing ability of computer was weak in the past time. It usually needs visual processor to accelerate visual processing tasks. Video capture card now images can be quickly transmission to memory, and computer image processing capacity has greatly improved, so now generally use general-purpose processors and processing software can be realized, the working principle of machine vision as shown in figure 1.

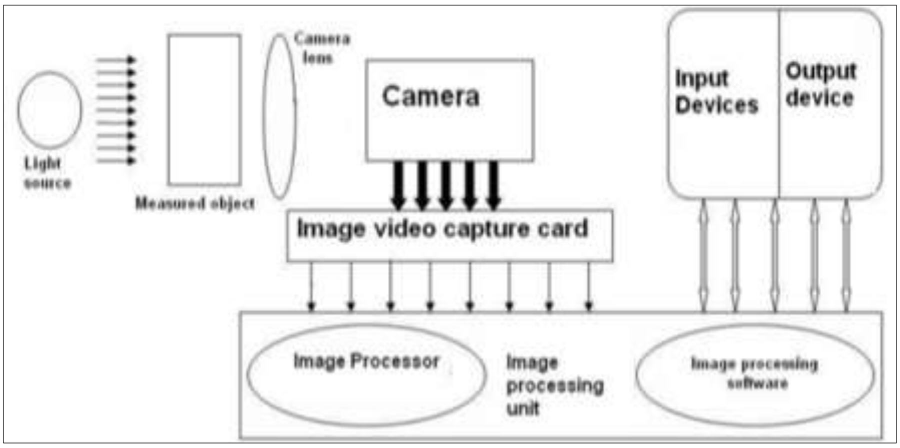

Fig 1: Working principle of machine vision

Principle components of computer vision:

A computer vision system generally consists of five basic components: illumination, a camera, an image capture board (frame grabber or digitizer), computer hardware and software as shown in Fig. 2 (Wang & Sun 2002a) [17]. The mechanical design for a specified machine vision system usually is uniquely structured to suit the inspection of a particular product. The lighting system, a critical part of a controlled machine vision system, must be carefully designed. The ultimate purpose of lighting design is to provide a consistent scene eliminate the appearance of variations, and yield appropriate, application-specific lighting. Proper selection of lighting sources (incandescent, fluorescent, halogen, Xenon, LED), lighting arrangements (backlighting, front lighting, side lighting, structured lighting, ring lighting), and lighting geometry (point lighting, diffuse lighting, collimated lighting) is the "key to value". Primary factors that influence the selection is whether the object under inspection is: a. flat or curved; b. absorbing, transmissive or reflective; and c. the nature of the feature to be imaged in comparison with the background. For instance, backlighting is usually used for detecting objects that are translucent or used to measure the geometric dimensions of obscured object.

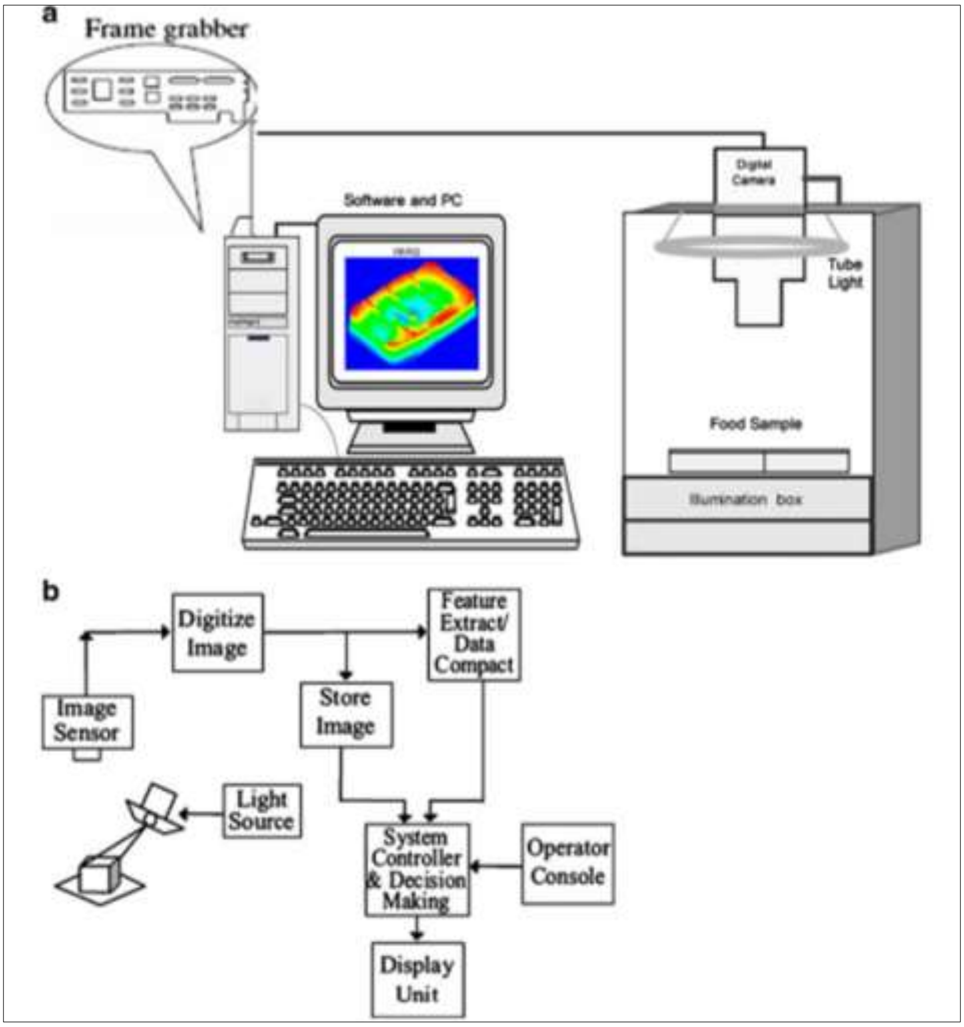

Fig 2: Principle Components of Machine vision system

Applications in the Agricultural Shape Size Detection Grading

Agricultural appearance not only can affect the size of its appearance and size of the agricultural growth of judgment and knocked wounded and defects, is now in the detection of popular agricultural research direction. Testing analysis of agricultural system mainly includes machine vision hardware platform and software. The processing software flowchart analysis mainly include the following: image input, image pre-processing, feature extraction and recognition, output four varieties. As figure 3 shows, test process is an important link of us to the original image acquisition process, including the grey-scale conversion and threshold image analysis is specified approach is analysed, the contour of key products. Size shape, the work is mainly based on the gray image processing and database are calculated or image data were compared, and the shape and size of agricultural products to analyse the results.

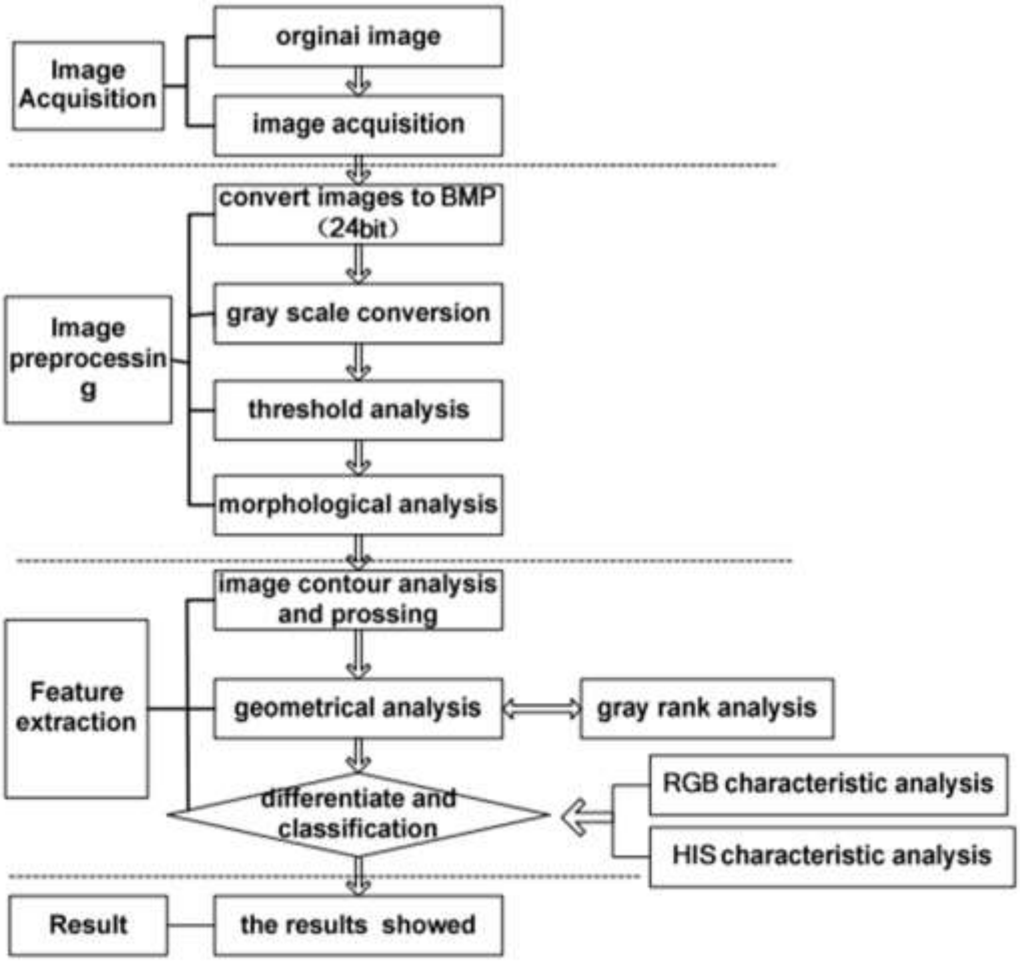

Fig 3: Detection flowing chart of agricultural products' dimensions

Advantages and disadvantages of Artificial Imaging and Machine Vision Technology

The Advantages of Machine Vision are

- High precision: such measurements do not need to touch, so there is no dangerous and wear on the fragile parts.
- Continuity: visual system makes people suffer from fatigue. Multiple systems can be set to run separately.
- Cost-effective: With the sharp decline in the price of the computer processor, the visual system operating and maintenance costs are much low.
- Flexibility: the visual system can carry out a variety of measurement. When the application changes, the software change or simply upgrade to meet the new demands.

Machine vision system is seen as an easy and quick way to acquire data that would be otherwise difficult to obtain manually (Lefebvre *et al.* 1993) [8]. Since, the capabilities of digital image analysis technology to generate precise descriptive data on pictorial information have contributed to its more widespread and increased use (Sapirstein 1995) [13].

Quality control in combination with the increasing automation in all fields of production has led to the increased demand for automatic and objective evaluation of different products. Sistler (1991) [14] confirm that computer vision meets these criteria and states that the technique provides a quick and objective means for measuring visual features of products. In agreement it found that a computer vision system with an automatic handling mechanism could perform inspections objectively and reduce tedious human involvement (Morrow *et al.* 1990) [10]. In other study, Gerrard *et al.* (1996) [3] also recognized that machine image technology provides a rapid, alternative means for measuring quality consistently. Another benefit of machine vision systems is the non-destructive and undisturbing manner in which information could be attained (Zayas *et al.* 1996) [19], making inspection unique with the potential to assist humans involving visually intensive work (Tao *et al.* 1995b) [15]. Tarbell and Reid (1991) [16] noted that an attractive feature of a machine vision system is that it can be used to create a permanent record of any measurement at any point in time. Hence archived images can be recalled to look at attributes that were missed or previously not of interest. Human grader inspection and grading of produce is often a labour intensive, tedious, repetitive and subjective task (Park *et al.* 1996) [11]. In addition to its costs, this method is variable and decisions are not always consistent between inspectors or from day to day (Tao *et al.* 1995a; Heinemann *et al.* 1994). In contrast Lu *et al.* (2000) [9] had found computer vision techniques adoptable, consistent, efficient and cost effective for food products. Hence computer vision could be used widely in agricultural and horticulture to automate many labour-intensive processes (Gunasekaran 2001) [6].

Furthermore, Gunasekaran and Ding (1993) [5] also had agreed that machine vision technique's popularity in the food industries is growing constantly and they also pointed out that its development so for at a robust level and competitively priced sensing too (Yin and Panigrahi 1997) [18]. An ambiguity of computer vision is that its results are influenced by the quality of the captured images. Often due to the unstructured nature of typical agricultural settings and biological variation of plants within them, object identification in these applications is considerably more difficult. Also, if the research or operation in being conducted in dim or night conditions artificial lighting is needed. It offers potential to automate manual grading practices and thus to standardize techniques and eliminate tedious inspection tasks. Kanali *et al.* (1998) [7] reported that the automated inspection of produce using machine vision not only results in labour savings, but can also improve inspection objectivity.

Conclusion

The paper on machine vision system reviews the recent developments in computer vision for the agricultural and food industry. Machine vision systems have been used increasingly in industry for inspection and evaluation purposes as they can provide rapid, economic, hygienic, consistent and objective assessment. However, there are some difficulties still exist in the adaptation of machine vision system, evident from the relatively slow commercial uptake of machine vision technology in all sectors. In spite of this, with the advent of machine vision technology, a revolution has come in the field of automation. Automating an operation in a manufacturing plant requires a high degree of pre-installation systems engineering and post installation process integration. The use of machine vision technology in manufacturing can be as simple as producing an inspection quality report or as complex as total process automation. At the end, we can say that machine vision is a powerful tool of automation that includes both image processing and image analysis tools.

So, the application of machine vision and image processing in the agricultural sector in general and in seed quality analysis in very particular and identifies areas for further research and wider application the technique. By specified research and innovation we can minimize the error which can be occurred when we are doing the things by help of an artificial intelligence. But no doubt this is the future of the intelligence spectrum.

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