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A REVIEW :

Computerized seed imaging: It's applications in seed science research

■ **S.N. DEVKULE , A.D. AUTADE AND G.W. NARKHEDE**

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SUMMARY : Computer-aided image analysis, contributing to improving insight of seed morphology and biology with respect to seed quality and germination along with different concepts of seed image analysis like image acquisition and pattern recognition. Seed image analysis is a process in which digital images are acquired and processed and how imaging technology is applied in seed science research in terms of varietal identification, characterization, germination, moisture, grading and sorting by analysis of seed size, shape and colour parameters. Seed images showing external or internal features of certain quality factors such as size, shape, colours and defects. Image analysis technique widely applied in seed germination and vigour testing.

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KEY WORDS :
Seed size, Seed colour, Seed shape, Computer image analysis, Applications

Author for correspondence :
S.N. DEVKULE
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA
Email:sndevkule@gmail.com
See end of the article for authors' affiliations

BACKGROUND AND OBJECTIVES

Seed image analysis technique is one of such systems offers the prospect that researchers will be able to study seed surface features more closely and hence increase the available character set. Machine Vision System is a computerized tool for Image Analysis (IA). It refers to the acquisition of data (shape, size, etc.) via a video camera or similar system and the subsequent computer analysis of these data following suitable processing.

Image analysis technique widely applied in seed germination and vigour testing. The development of these technologies shows their potential in seed science study with the perspective of integrating traditional methods in seed quality assessment with those that provide more accurate and informative bio-morphological data.

The colour, size, shape characteristics of plant products and their capability to produce digital images suitable for further processing make modern image acquisition techniques highly adaptable tools. Bio-morphological seed features may be analyzed by computer-aided image analysis systems and data quickly processed and stored in the hard disk, plotted or statistically elaborated (Dell' Aquila, 2004). The digital seed image can be assumed as a 2-D object having both dimension placed along the orthogonal axes of a Cartesian plane. As a result, several descriptors of seed size (e.g., metrical measurements), shape (e.g.,

numerical factors normalized on the basis of those calculated at the steady state of the seed), and Red-Green-Blue (RGB) colour component density of the individual seed can be easily estimated.

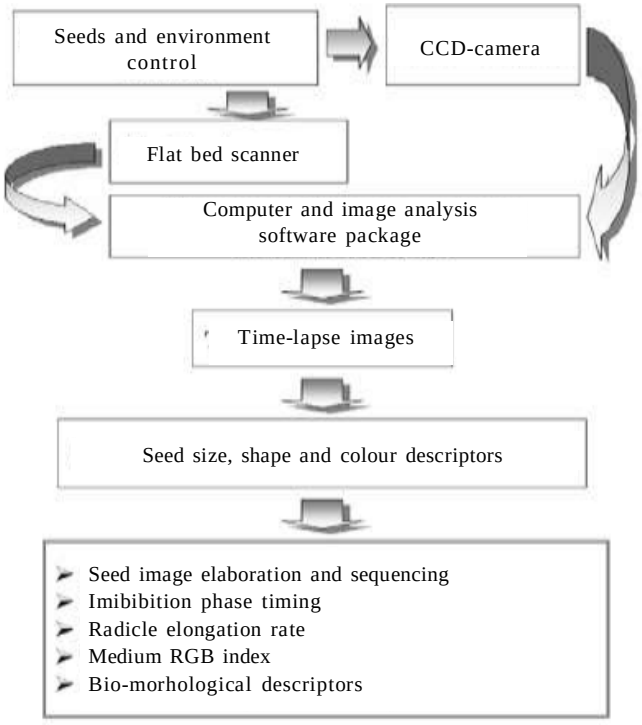

Fig. 1 : Scheme of image analysis systems (Adapted from Dell 'Aquila, 2006)

Applications in seed science research :

Varietal identification :

Visual assessments made using color, size, shape and texture are simple, but they can be highly subjective. Automatic systems can be based on seed images, from which the characteristics for the classification, such as size, shape, colour and texture, can be obtained quickly. Digital image analysis offers an objective and quantitative method for estimation of morphological parameters. This process uses digital images to measure the size of individual grains and mathematically extract features and shape related information from the images. Image analysis algorithms implemented by classification methods; appear to be useful for automatic seed identification (Granitto *et al.*, 2003).

DUS testing :

One application is Distinctness, Uniformity and Stability (DUS) testing, where new varieties are compared to establish differences from existing varieties before they are given official recognition. There have been a number of attempts to use automatic methods to assess plant appearance. These have ranged from straightforward use of colour meters to the use of image analysis to extract shape features.

Characterization :

1) Characters: All those shape descriptors, which can be defined in mathematical expressions. 2) Variable: There is environmental influence on the characters; therefore an average of variation within a character between objects of optimum sample size is taken as reliable shape descriptors. 3) Parameter: The value of character obtained by the average of 'variable' is regarded as 'parameter'. 4) Database: The image is directly converted in the binary image by thresholding (Grey level).

To describing the shape of object, aberrant such as area, perimeter by counting pixels, length, width by X, Y Cartesian co-ordinates and the angles can be obtained by Tangent function.

The characters of cultivar are classified in database for the purpose of uniformity testing. Possible contaminants which are not uniform in shape can be identified within few minutes. Image analysis technique (machine vision system) offers the prospect that researchers will be able to study seed surface features more closely and hence increase the available character set.

Vigor assessment :

Vigour is the ability of a seed lot to establish normal (or usable) seedlings under diverse production environments. Use of computer-aided image analysis of seedling size overcomes many of the limitations that occur during manual vigour tests. Image analysis provides rapid measurement of an object's physical characteristics and allows quantitative, objective observation.

Germination :

The application of computational techniques to the study of seed germination covers three aspects: computer-assisted image analysis systems, descriptive simulation modeling, and combined relation modeling between morphological changes and biological processes.

A digital image of a plant seed can be regarded as a two-dimensional object which can be measured in size, shape and colour density during the development stage of germination by computer image analysis technology. Seed changes its biological structure passing from a quiescent stage to a proliferating one, and any morphological variation can be associated with the corresponding variation of seed geometry and color space components.

Prediction of kernel weight :

The image analysis technique allows the enhancement of images, as well as the identification and automatic isolation of particles for further study. In addition, it is a rapid and time-saving technique that allows for the acquisition of quantitative data that could be very difficult or even impossible to obtain otherwise. Recent researches on the inspection of cereal kernels by image analysis, computer vision or microscopic techniques have been reported (Edney *et al.*, 2002 and Brosnan and Sun, 2004).

Sorting and grading :

New algorithms and hardware architectures have been developed, and the availability of appropriate image analysis soft-ware tools suggests that the use of machine vision systems is becoming convenient in a seed biology laboratory.

The algorithm segmentation scheme described is a novel and simple approach to robustly segment an image of raisin into desired, undesired and background regions. By using this accurate algorithm, one can study all pixels of a digital image and obtain the necessary features.

Moisture :

Moisture content is the most vital factor influencing physical and mechanical properties of cereal crop seeds. Increase in all linear dimensions, projected area and volume of mature okra seeds (Calisir *et al.*, 2005).

Conclusion :

Image analysis has ability to emulate human intelligence in handling visual data. It is an important technology that will find many applications in modern varietal identification and seed certification. In the terms of seed production and processing image analysis techniques are capable of coping with the variability and therefore have wide-ranging applications in seed industry. A major research area is how to encapsulate, represent and implement an artificial version of human intelligence. If this can be done, many processes, which have defined automation, will become the subjects of automatic systems using image analysis as a major method of control. Image processing used particularly in varietal identification and quality. The accuracy of the technique has been reported to be in the range of 70-99%. However, the development in image acquisition, pattern recognition and decision making as well as improvements in software and hardware will help to improve the system assuming better return on investment and reduced costs.

Authors' affiliations :

A.D. AUTADE AND G.W. NARKHEDE, Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

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