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PHYSICAL PARAMETERS MEASUREMENT OF SEED WITH IMAGE ANALYSIS

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ABSTRACT

In this project the setup is used with two cameras one for top view and another for side view. The 3d image is built from these images using image processing algorithms and the parameters like seed length, width, surface area, volume, shape factor, roundness are computed. To analyze various seed properties, the seed image analyzer system uses the 2 CCD cameras.

One camera captures the top view of the seeds and another CCD camera is used to capture the seed side view. 3D image of the seed is constructed from these two images. The parameters are computed for each seed. To get the proper images the backlight is used. Backlight, is the constant light source which is required for proper seed identification. Overall system is placed in mechanical assembly. The entire system is called as seed analyzer setup.

KEYWORDS: CCD Camera, Backlight, 3D

INTRODUCTION

Agriculture is prime sector in India. These days the farming land is being used for other developing sectors. Hence there is a need to use technology for agriculture to increase the production. Indian govt. is concentrating on this sector. The latest technology is being used.

There are many organizations and universities involved in agriculture research and development. Study of seed is one of most important in this research since the crop growth is the mostly depend on the seed. To increase the productivity, seed properties need to be studied.

There are physical, chemical and other properties in which research is being done. Physical properties like seed length, width, height, volume, surface area, roundness, are measured to find the seed quality. These properties are mostly measured manually. The technology is now being used to make this automatic which saves the time and give more accurate analysis.

ALGORITHM

- Image capturing– The two images would be captured from top view camera and side view camera.
- Edge detection – To identify seeds from both the images (top and side), edge detection algorithm would be used. This would be multiple edge contour / canny edge detector.
- Seed Identification– From the detected edges, the false objects need to be removed. This step identifies seed objects / edges from all identified edge objects. Edge sharpness, seed size are some parameters used to filter the false edge objects.

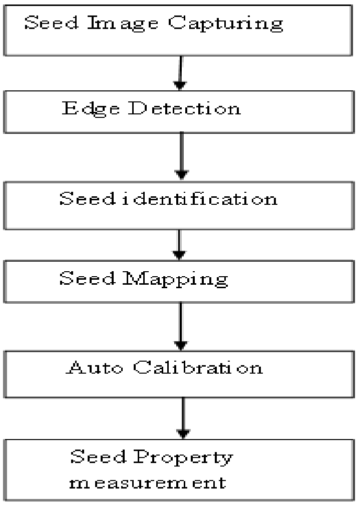

Figure 1: Algorithm

Figure 1gives algorithm of seed analyzer.

- Seed mapping – Seeds identified from two images need to be mapped (identification of same seed from both the images). In this step the seed mapping is done.
- Auto calibration – The calibration of the seed bottom plane and side plane will be done in this step. This is important to find the accurate measurement of the seed properties.
- Seed Property measurement - Various seed properties like seed length, seed volume, seed surface area are measured in this step.

SEED IDENTIFICATION METHODS

Segmentation First step in seed analysis is identification of the seeds. Different techniques are used for image object identification, gray level segmentation [2], color segmentation, edge detection etc. These methods work well under controlled light environment. For seed analysis the backlight is used to highlight the seeds. The other lights are not controlled. Seeds of various colors, shapes and sizes make it difficult to get the results with any segmentation method. Defocused areas in the image makes seed edge edges blurred. The contour based methods are also used for seed identification. The novel algorithm of multilevel fast edge detection contours is proposed for seed segmentation. The gray intensity and the colors vary. Multilevel edge detection algorithm identifies contours of the intensities. The image is formed by pixels. Each pixel has the brightness value which is called as the intensity. For color or gray image this is the luminance value. If mark all The pixels of luminance 10 which has neighbor pixel with luminance value higher than 10, this there will be closed line. Figure 2 shows Seed Image

Figure 2: Seed Image

This is the intensity contour. When lines are identified at all luminance variations from 0 – 255, this will create various contours in the image. There will be many contours at the seed edge since at the edge the intensity changes from white to black. To identify the seed, single boundary contour of each seed need to be identified. Figure 3 shows many contours at the seed edge since at the edge the intensity changes from white to black. The novel algorithm of multilevel edge detection is proposed for seed segmentation. The gray intensity and the colors vary. Multilevel edge detection algorithm identifies contours of the intensities.

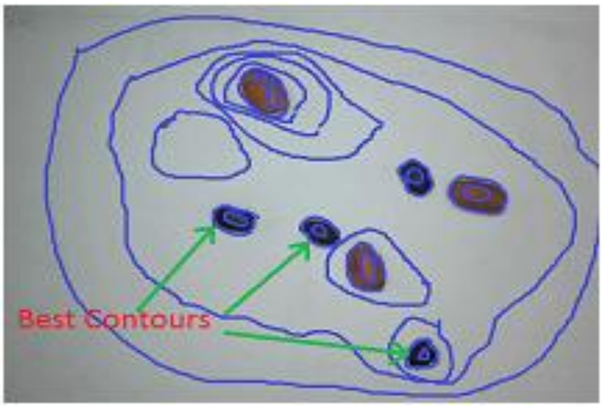

Figure 3: Multilevel Edge Detection(Contours)

Figure 4: Best Contour Selected

All the enclosing contours are identified and the best contour can be selected using criteria like edge gradient, contour shape etc. The contour which outlines the seed boundary will have highest edge gradient.

Region Labeling

In this an image is separated into several different regions based upon desired criteria. Such as pixels that are connected and that have same gray level are grouped together to form one region Segmentation algorithms are based on one of 2 basis properties of gray level or intensity values. First are discontinuities. It is based on abrupt change in intensity and image is subdivided such as edge of image. Second is similarity. It is subdivided into regions that are similar according to some predefined criteria's applicable to both static and dynamic images.

Edge Detection (Label Outlining)

Labeled objects are used to outline the objects i.e. detect the edges of the object. In this step one of the edge points is identified scanning object bounding box 3 X 3. The other edge points are scanned by following the boundary points. In scanning the direction of the edge is used. Initially all the directions are searched to find the next point. Figure 4: shows best contour selected.

SEED 3D CONSTRUCTION

The seed images captured from top camera and side camera are shown in Figure 5 and 6. The multilevel edge detection algorithm identifies the seeds from both the images. The seed mapping algorithm is used to map the seeds from both the images. First in top image the identified seeds are scanned and labeled from bottom to top. To map the same seed from the side image the algorithm scans the seed from left to right in side image. When this finds the same count of the seeds, it maps seeds one to one from both the images and links the information of the seeds to measure the 3d feature. The identified and mapped seeds are shown in Figure 7 and Figure 8.

Figure 5: Seed Top View

Figure 6: Seed Side View

To construct the 3d parameters from the two images the assumption is made that seed is made by the joining the elliptical slices of variable sizes, where each slice has a thickness of a pixel size. The Number of slices is the number of pixels on the horizontal axis (seed length). The major axis diameter of each ellipse “a” is width of the seed at the slice position on horizontal axis. The minor axis diameter “b” is the height of the seed at the slice position on horizontal axis. Figure 7 shows the sketch of the 3d approximation of the seed.

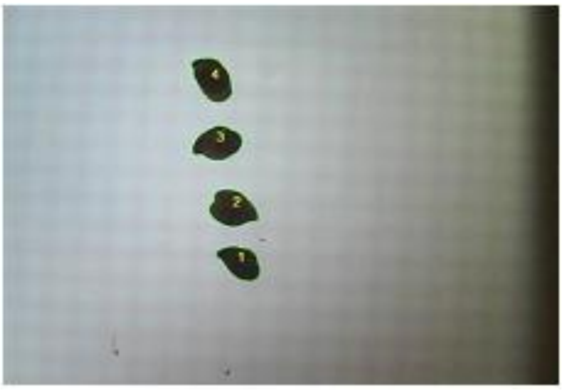

Figure 7: Seed Detected in Top View

Figure 8: Seed Detected in Side View

VOLUME EVALUATION

The outline images of each seed as shown in Figure 3 were used to calculate volume using the disk technique (Riddle, 1979). The volume of each cylindrical disk (Vi) shown in Figure 9 is equal to the cross sectional area of each ellipse (Ai) times the length of the disk (pixel). Eq. (1) shows the cross-sectional area of a elliptical disk and Eq. (3) shows the volume of the same seed.

Elliptical disc area

$$Ai=\pi(a*b)/4 \quad (1)$$

The volume of each cylindrical disk

$$Vi = Ai\Delta x \quad (2)$$

Where

i – each elliptical disc

a – Major axis diameter at the disc position

b – Minor axis diameterat the disc position

The program developed in VC++ considered each disk as having a thickness of 1pixel and used an algorithm to determine the major and minor diameters of each disk. The area of each disk was then summed to estimate the total volume as shown in Eq. (3). Finally, the same conversion factor was used to estimate the volume of each Seed.

Seed Volume

$$Vi=\sum Ai \quad (3)$$

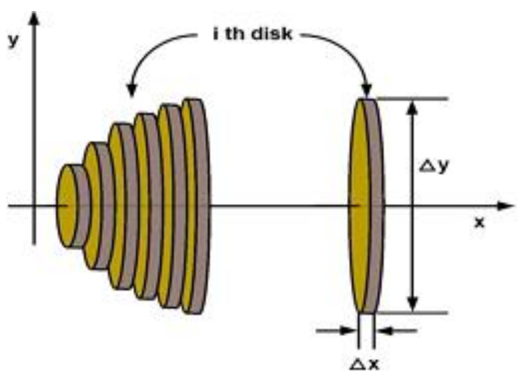

Figure 9: Connected Elliptical Slices Making the Complete Seed

Surface area of each seed is the computed as the summation of perimeter of each ellipse.

$$p \approx 2\pi\sqrt{\frac{a^2 + b^2}{2}} \tag{4}$$

Surface area = ∑ pi.

RESULTS

Various Seed properties are computed by image analysis system. These are

Seed Length – Length of the Seed in mm

Seed Width – Width of the Seed in mm

Seed Height – Height of the Seed in mm

Seed Volume – Volume of the Seed in mm3

Seed surface area – Seed surface area in mm2

Aspect Ratio – Aspect ratio of the Seed

Roundness – Roundness of Seed

Sphericity – Sphericity of Seed

Table 1. Shows Length, Breadth, Height volume, roundness, spericity.

Table 1: Seed Analysis Report

Seed_Analysis_Report
Date:04/23/13
Time:22:04:09

Seed_no.	Length (mm)	Breadth (mm)	Height (mm*mm)	Volume (mm*mm*mm)	Surface_Area(mm*mm)	Projcted_Area(mm*mm)	Aspect_Ratio	Roundness	Sphericity	Arithmatic Mean Diameter (mm)	Geometric Mean Diameter (Size)(mm)
1	17.9	13.68	8.128	254.6	148.4	180.8	0.764	90.4464	0.7028	13.2373	12.57998
2	16.66	13.85	8.993	188.5	138.7	182.1	0.831	92.6375	0.7656	13.1657	12.75325
3	16.9	12.99	9.609	202.6	136	170.6	0.769	91.0744	0.7589	13.1661	12.82483
4	17.21	15.13	7.696	203.1	143	198.8	0.879	90.2647	0.7325	13.3476	12.60922

CONCLUSIONS

This analysis can be used as a powerful tool to comprehensively characterize seed samples. Different cameras and wave length ranges including fluorescence modes create completely new possibilities for a swift and efficient non-destructive assessment of seed samples and individual seeds.

A number of techniques for seed quality evaluation and sorting are based on the detection of various physical and physiological properties of seeds, and, more recently, the greatest efforts have focused on producing sophisticated non-destructive methods. The declining cost and increasing speed and capability of computer hardware of image processing and its integration with controlled environmental condition systems have made computer vision more attractive for use in automatic inspection of crop seeds.

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 speed of operation of a machine vision system must allow rapid image processing and recording of measurements. Data may be further processed statistically and displayed graphically, and a database may be developed to integrate image analysis.

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