Tarım Makinaları Bilimi Dergisi (Journal of Agricultural Machinery Science)
2008, 4 (4), 395 - 398

Phase Shift Moiré Supported Castor Bean (Ricinus Comunis) Seed Three Dimensional Geometrical Description

Celina de ALMEIDA, Inacio Maria DAL FABBRO, Fernando KUNINARI
Adilson Machado ENES
FEAGRI, UNICAMP, Campinas, SP, Brazil, 13083 – 875, Phone (19) 35211059
celinalmeida@yahoo.com.br

Abstract: This research work reports the application of a phase shift moiré technique in generating the Xi coordinates of castor bean seeds. The importance of that crop for the Brazilian economy is close associated to its broad application on pharmaceuticals, plastics, special lubricants, human prosthesis, biodiesel and so on. Brazilian production bares the figure of 152.300 tons per year. Seed geometrical three dimensional description is of major importance to engineering applications since seeding to harvesting operations, as well as to the final processing. Seeds were painted with white opaque color to improve optical contrast and magnified by 10X through convergent lenses. Four digital Ronchi grids were generated out of phase by п/2 and denoted by G1, G2, G3 and G4. Following, G1 was projected onto the seed face F1, obtaining the image I1. Images G1 and image I1 were converted to gray gradient by the software ImageJ. The difference of I1 from G1 generated the image M1 in gray gradient and in moiré fringes. By following the same procedure, G2, G3 and G4 generated M2, M3 and M4. By considering 05 faces, i.e., F1, F2, F3, F4 and F5, a set of 20 images Mi were generated. Images Mi were then filtrated through the Gaussian Blur method carried by the ImageJ software to eliminate the original grid to prevent undesirable interferences. The set Mi generated the final matrix expressed in Xi coordinates, refereeing to a unique origin O. The proposed method was considered reliable and of practical application as well as of low cost.
Key words: Castor bean seeds, moiré methods, seed geometry.

INTRODUCTION and LITERATURE REVIEW

The vast application of castor bean oil in a variety of products, since lubricants, pharmaceuticals, plastics, fuels and so on deserves a more accurate seed physical description as volume, density, shape, color and so on. Nagaoka, A.K. et ali. (2004), report experimental results on castor bean seed measurements, emphasizing the needs of size determination, which are mainly associated to machine design, storage and processing. However, the pertinent literature emphasizes the application of moiré methods in shape determination (Dal Fabbro et al., 2003), considering that class of techniques, feasible, reliable and of simple as well as of low cost application. Shadow moiré technique consists in illuminating the object in study after a grid by a white light source, generating, that way, an optical interference between the grid and its shade. Moiré methods are used either as a perfilometric as well as a photoelastic technique. The wave function describes the light propagation as waves (SALEH, 1991). When two waves of same frequency and amplitude exist simultaneously in the same space region, the total wave function is the summation of theses waves and their phase relationship will generate fringe patterns of different light intensities (SALEH, 1991). When two grids or screens are superimposed, fringes are generated as a result of these grids line combinations. These fringes are named moiré patterns or moiré fringes and the phenomena called moiré effect. CLOUD (1988) mentioned that D. TOLLENAR in 1945 found that these fringes have displacement magnifying abilities. HU (2001) reports that projecting and shadow moiré are the mostly employed shape surveying techniques due their simplicity and quickness. Moiré fringes can be sought as a superposition of two plane waves, which keeps an angle between their traveling directions. In the regions where the waves are on phase, a constructive interference is generated, showing clear patterns and in the case of destructive interference, dark patterns are formed (MALACARA, 1992). Such an approximation is derived from the interference between fringe patterns by means of the relations so called initial transition model (PISAREV, 2001). The objective of this work is to develop a shadow moiré technique to copy seed surface topography to generate a three dimensional geometrical description.

MATERIAL and METHOD

The experimental part of this research work was carried at the Laboratory of Mechanical Properties of Biological Materials at the Faculty of Agricultural Engineering at UNICAMP, Campinas, SP, Brazil. A shadow moiré technique has been selected to generate the fringes. Testing setup included a Carl Zeiss binocular lenses set at an approximation factor of 0.68 and coupled to 6.2 MP Nikon digital camera. Castor beam seeds were firstly painted with white opaque color to improve optical contrast and placed on the lenses viewing field and conveniently illuminated. A 0.01 mm mesh size Ronchi grid was positioned before the seed at a distance smaller than 1mm. The seed was properly fixed to a small pin in order to guarantee a rotation of 1800. So, moiré fringes were directly obtained, stored and processed as follows. Image processing was carried by means of the ImageJ software to eliminate the grid as well as to improve fringes contrast. Furtherly they were forwarded to the AutoCad 2005, ®Surfer 8, ®MatLab 6.5 e dxf2dat softwares. Images were directed to the AutoCad in rasters image followed by the moiré fringes vector transformation and also applying the Spline function to mark the contour lines. In the following steps the images were exported in the .DXF format to generate the .DAT archives by means of the dxf2dat computational tool. The process mentioned before included the processing of two images identified as the top view (A) and the bottom view (B), as shown on. Image archive expressed in .DAT was then read by means of the MatLab software, where each column corresponds to each Cartesian axis Xi. The union of the two surface array (A) and array (B) generated a third array containing the seed geometric coordinates. Third array plotting generated the three dimensional view of the seed surface as shown on Figure 01 Figure 02 Figure 03 exhibits the image views obtained from (.DAT) data archive processed by the Surfer software. Figure 04 shows the MatLab output, in three dimensional view of the seed surface. The scale determination which was necessary to provide a real dimensions to the objects under test was carried by applying he same procedure as describe above to a solid of known Xi dimensions, represented by a small square base pyramid, generating a correction factor.

RESULTS

Figure 1 shows moiré fringes generated on the seed surface by direct grid projection. Figure 02 illustrates the fringes vector transformation applied to the top view (A) and the bottom view (B) of seed surfaces and Figure 03 exhibits the top view (A) processed by the Surfer software meanwhile Figure 04 shows the same face (A) processed by the Surfer software in a perspective view. Figure 05 exhibits a three dimensional view of the surface (A) as processed by the surfer software.

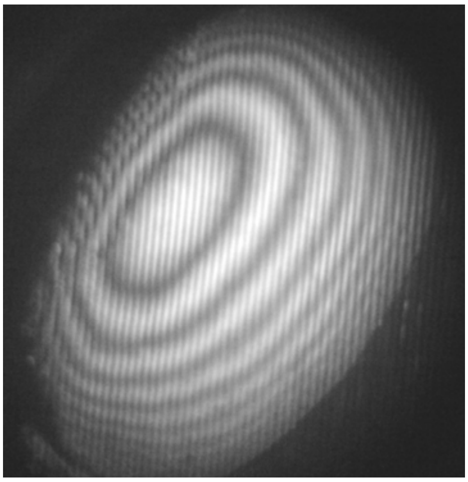
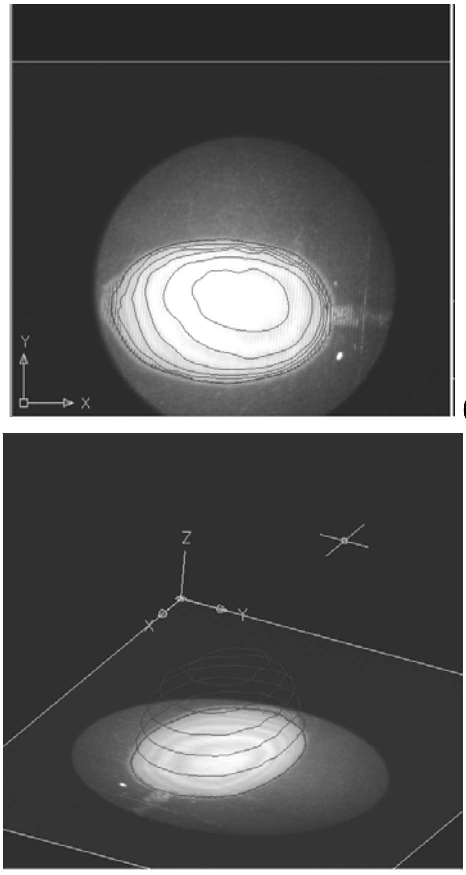


Figure 1. Moiré fringes generated on the castor beam seed surface.



(A)

(B)

Figure 2. Moiré fringes vector transformation generated by means of the Engineering AutoCad Software.

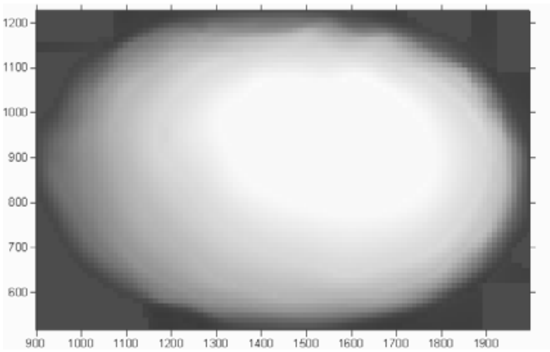


Figure 3. Top view of the of the seed interpolated by the Surfer software.

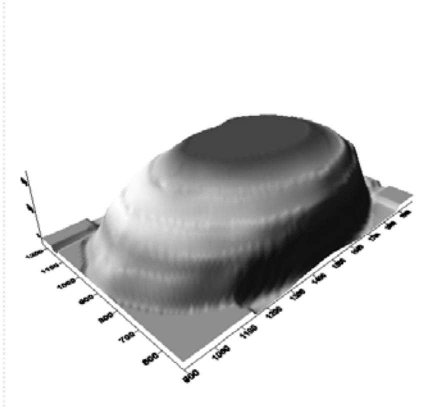


Figure 4. Perspective view of the top surface interpolated by the Surfer software.

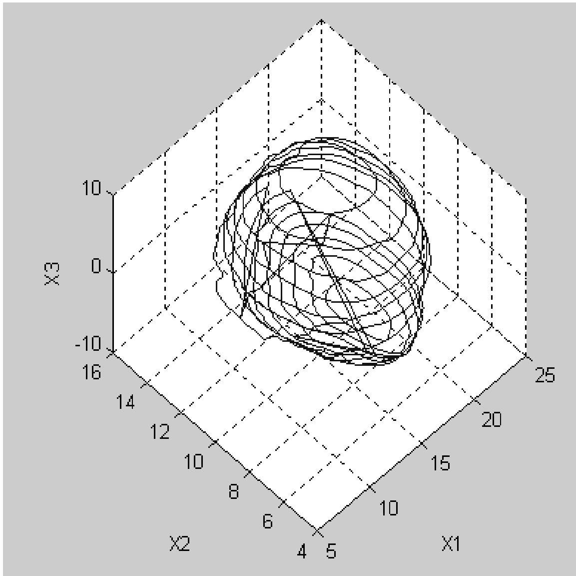


Figure 5. Three dimensional representation of the castor beam seed as generated by the MatLab software.

CONCLUSIONS

Based on what it has been exposed above the conclusions can be summarized as follows. The small dimensions of the seed when compared with other objects as fruits and other vegetative bodies, do not offer any difficulty t al. It just a matter of developing appropriate techniques to handle the seeds and to identify adequate instrumentations.Also, experimental error determination deserves a particular investigation, considering that it is close associated to instruments and methods. The proposed technique is reliable, it is of low cost and generates reliable results.

REFERENCES

Dal Fabbro, I.M.; Lino, A.C.L.; Gazzola, J.; Shitakubo, F.; Vieira, M. A. P. Shape survey of symmetric bodies through the moiré interferometry. Revista Ciência e Tecnologia. Revista do Centro UNISAL (ISSN 1677-9649), Ano VI, n. 9, pp.39-44. Campinas, SP, Brasil, dezembro de 2003.

FAIAD, M. G. R.; SALOMÃO, A. N.; FERREIRA, F. R.; GONDIM, M. T. P.; WETZEL, M. M. V. da S.; MENDES, R. A.; GOES M. de; MIRANDA, A. R. de. Manual de procedimentos para a conservação de germoplasma-semente a longo prazo na Embrapa. Brasilia: EMBRAPA-CENARGEN, 1998 21p. (EMBRAPA-CENARGEN. Documentos, 30).

IPGRI. Genebanks Standards. International Plant Genetic Resources Institute, Rome: 1994. 15p

Lino, A.C.L.; Dal Fabbro, I.M.; Peche Filho, A.; da Costa, A.. Aplicações da técnica interferométrica ótica de moiré de sombra com mudança de fase. Revista Ciência e Tecnologia. Revista do Centro Unisal (ISSN 1677-9649), Ano V, Vol.1, Fac.7, pp.31-37, Campinas, SP, Brasil, outubro de 2002.

Lino, A.C.L; Dal Fabbro, I.M. Determinação da topografia de uma fruta pela técnica de moiré de sombra com multiplicação de franjas. V. 28, N. 1, 2004, p. 119-125. Ciência e Agrotecnologia (ISSN 1413-7054). UFLA, Lavras, MG, Brasil.

Proceedings CISCE 2002. Urbana, United States: CISCE2002 Technical Committee, 2002. v. 1. p. 401-403.

RODRIGUES FILHO, A. A cultura da mamona. Belo Horizonte: Emater-MG, 2000. 20 p. (Boletim técnico).

SAVY FILHO, A.; PAULO, E.M.; MARTINS, A.L.M.; GERIN,M.A.N. Variedades de mamona do Instituto Agronômico. Campinas: Instituto Agronômico, 1999. 12 p. (Boletim Técnico, 183).

SEVAST'YANOVA, L.B. Botanical and Biological Properties of Castor. In: MOSKIN, V.A. Castor. New Delhi: Amerind, 1986. p.11-64.

SHEPETINA, F.A.; SEVAST'YANOVA, L.B. Seed technology. In: MOSCKIM, V.A. Castor. New Delhi: Amerind, 1986. p.175-8.

TÁVORA, F.J.F. A cultura da mamona. Fortaleza:EPACE, 1982. 59p.

WETZEL, M. M. V. S. . Viabilidade de sementes de ervilha (Pisum sativum L.) conservadas a longo prazo (-20 C). In: XIIII Congresso Brasileiro de Sementes, 2003, Gramado. Informativo ABRATES. Gramado : ABRATES, 2003. v. 13. p. 163-163. Anais.

WETZEL, M. M. V. S. ; FAIAD, M. G. R. ; D. B. da SILVA ; L.M.ROCHA, . Braziian Soybean Base Collection - Monitoring. In: China International Soybean Conference & Exhbition 2002, Beijing, China.