

Numerical Simulation of Impact in Fruits and Vegetables Using a Discrete Element Model

(PHD)

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Numerical Simulation of Impact in Fruits and Vegetables Using a Discrete Element Model

(Discrete Element Models, DEM)

DEM

DEM

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. (Peleg, 1986)

(Bulk)

(Bulk scale)

(Particle scale)

(Fouts

and Thompson, 1993)

(Extrapolation)

. (Ooi *et al.*, 1998)

(Chen and

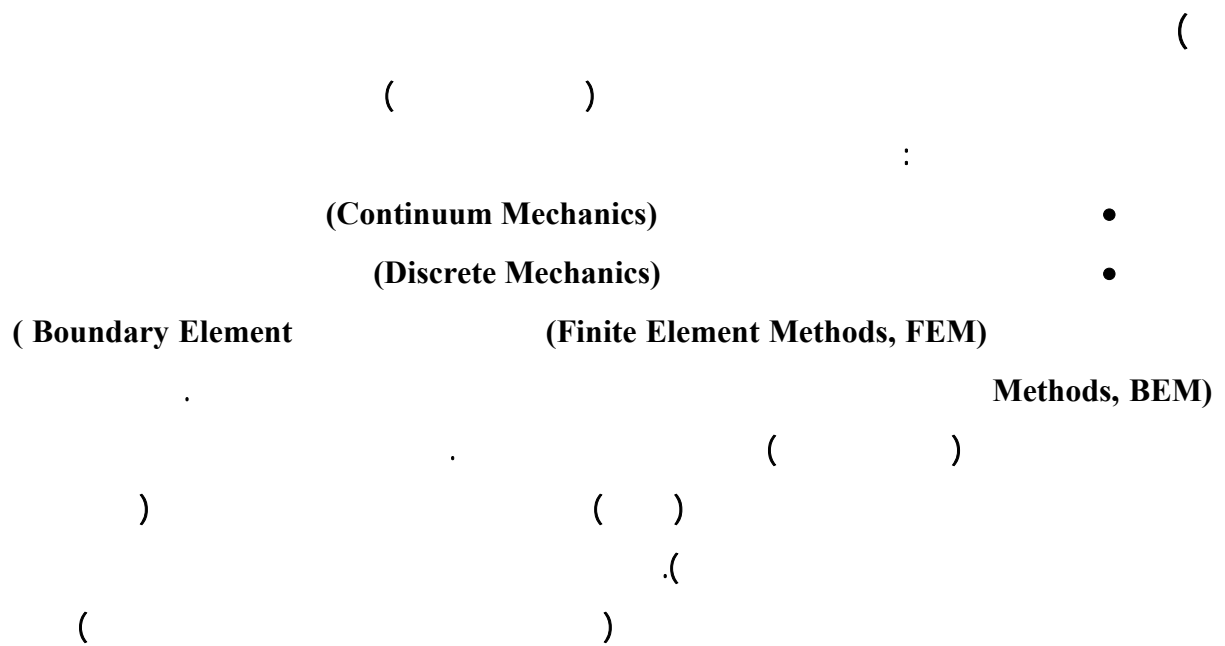
(Instrumented Sphere)

. Yazdani, 1991; Brown *et al.*, 1990)

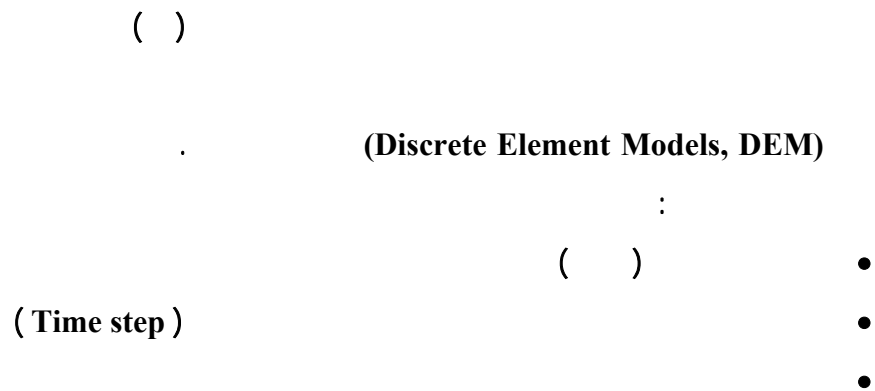
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(^۱) منظور از دانه همان (Particle) است که در این تحقیق منظور اجزاء گسسته در یک سیستم منفصل بوده که ممکن است هر چیزی مثل میوه، دانه غلات و غیره باشد.

.(Ting *et al.*, 1995)



.(Rong *et al.*, 1995)



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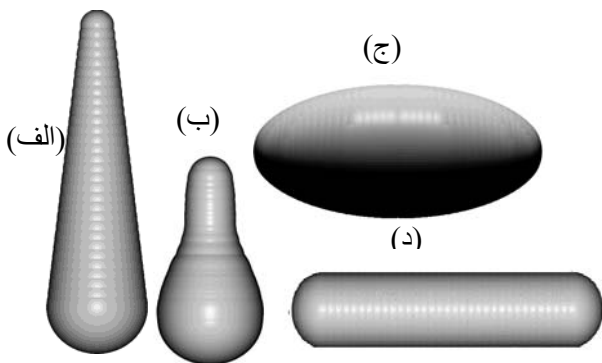
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Ng and Dobry (1994)

(Multi-Sphere Method, MSM)



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$$\mathbf{f}_c = \mathbf{f}_n + \mathbf{f}_t \quad ()$$

$\mathbf{f}_t \quad \mathbf{f}_n \quad \mathbf{f}_c$

:

$$\mathbf{M}_{t_{ps}} = \sum_{c=1}^C (\mathbf{r}_{psc} \times \mathbf{f}_{t_{psc}}) \quad ()$$

r_{psc}

$C \quad c$

$\mathbf{f}_{t_{psc}}$

:

$$\mathbf{f}_{ps} = \sum_{c=1}^C \mathbf{f}_{psc} \quad ()$$

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$$\mathbf{M}_p = \sum_{s=1}^S [(\mathbf{d}_{ps} \times \mathbf{f}_{ps}) + \mathbf{M}_{t_{ps}}] \quad ()$$

\mathbf{d}_{ps}

S

:

$$\mathbf{a}_p = \frac{\mathbf{f}_p}{m_p} + \mathbf{g}$$

(\mathbf{g})

$$\alpha_p = \frac{M_p}{I_p} \quad ()$$

$\alpha_p \quad a_p \quad I_p \quad m_p$

:

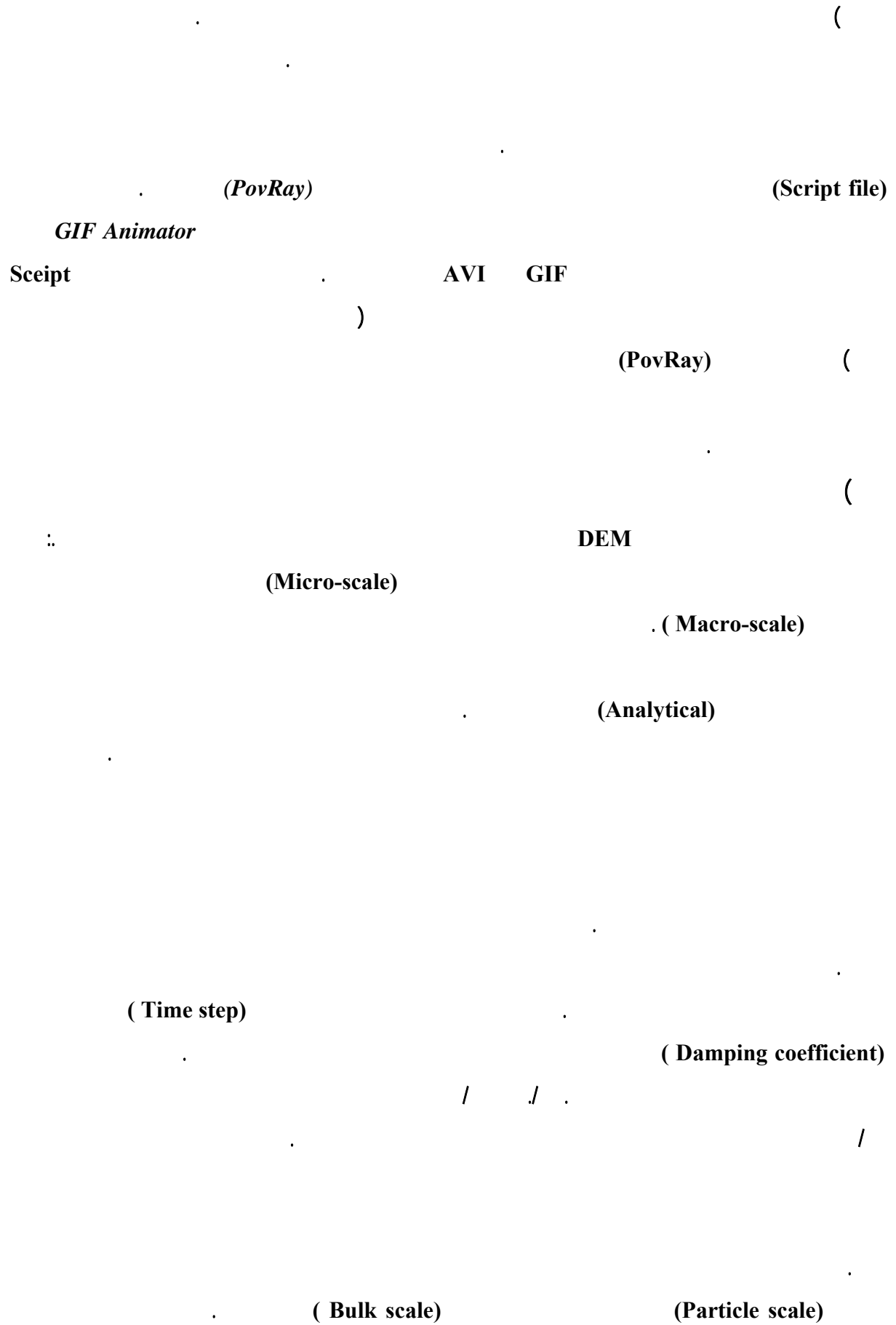
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(Random Generator)

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(

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()

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Frame grabber

Camcorder)

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Z,Y,X

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(Bed structure)

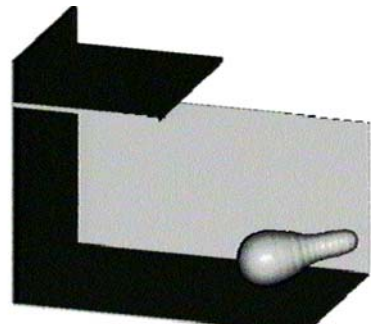
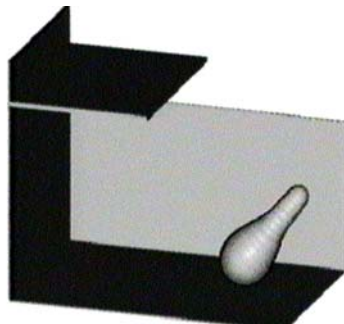
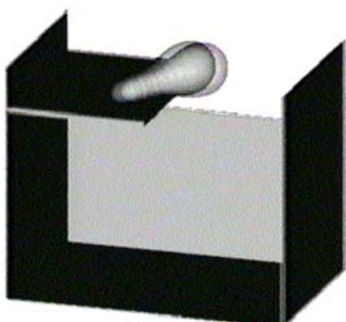
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MSM Multi-Sphere

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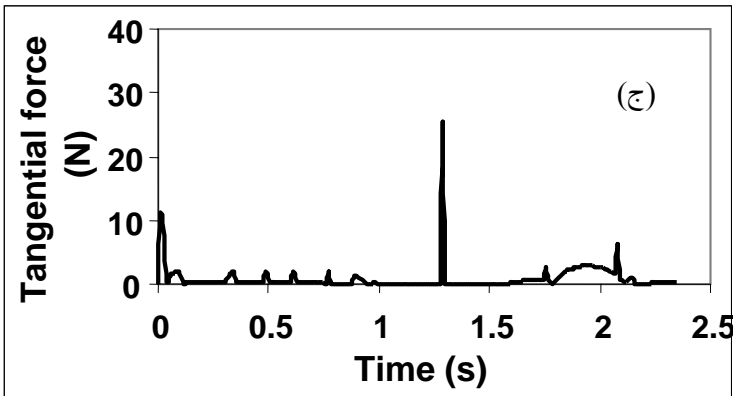
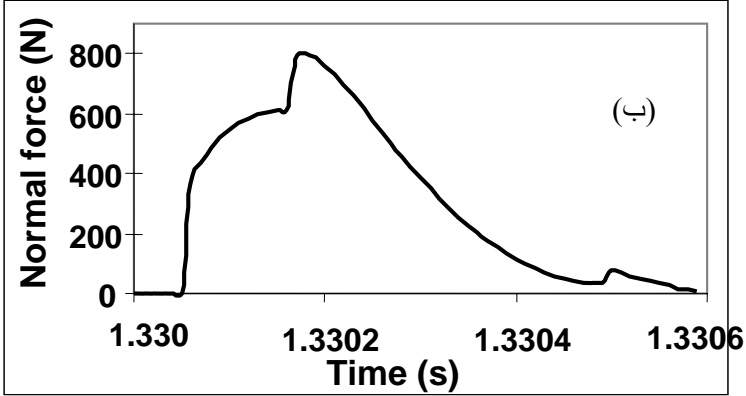
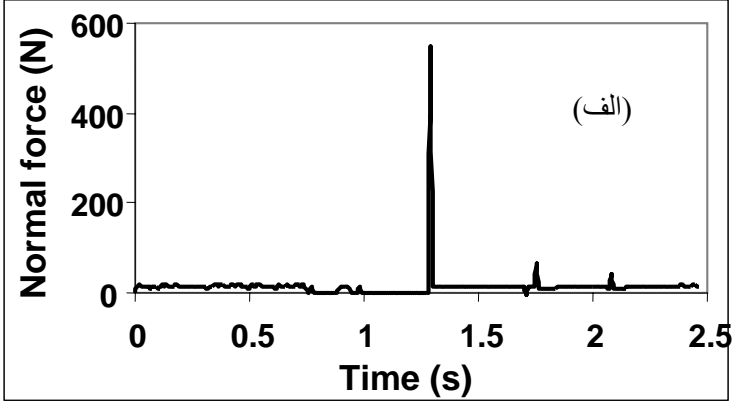
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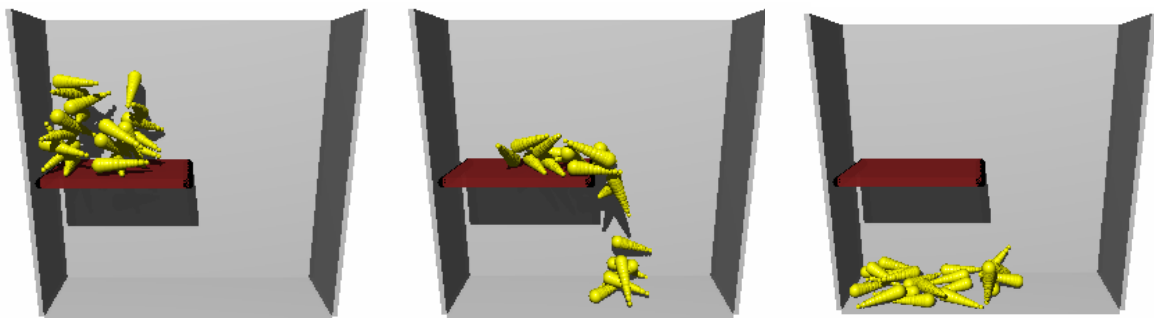
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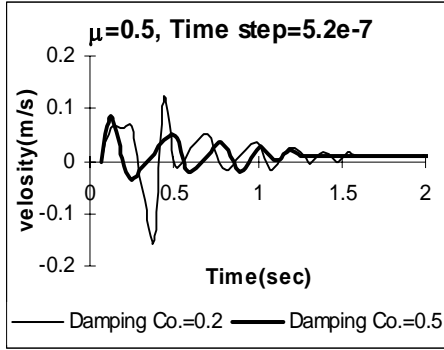
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شکل ۳: نیروی عمودی و مماسی وارد بر جسم در فرایند سقوط بر روی یک سطح تهیه شده بر اساس نتایج مدل MSM.

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شکل ۵:

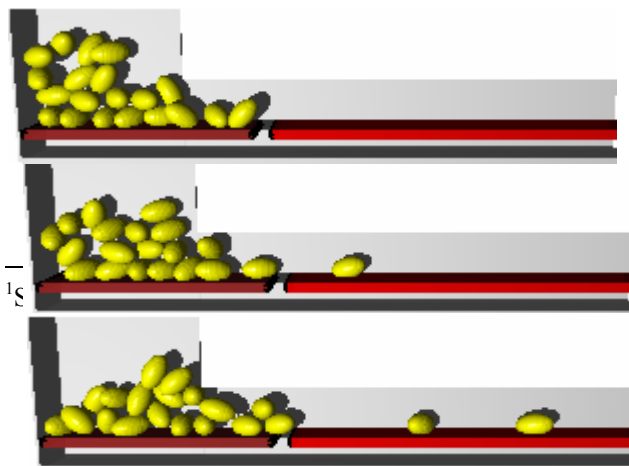
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.(McRae, 1985)

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: (References)

- 1) **Brown, G. K., Pason, N. L. S., Timm, E. J., Burton, C. L., and Marshal, D. E. (1990).** Apple Packing line Impact Damage Reduction. *Applied Engineering in Agriculture* **6**, 759-764.
- 2) **Chen, P., and Yazdani, R. (1991).** Prediction of Apple Bruising Due to Impact on Different Surfaces. *Trans. of the ASAE* **34**, 956-961.
- 3) **Foutz, T. L., and Thompson, S. A. (1993).** Comparison of Loading Response of Packed Grain and Individual Kernel. *Trans. of ASAE* **36**, 569-576.
- 4) **Ng, T. T., and Dobry, R. (1994).** Numerical Simulation of Monotonic and Cyclic Loading of Granular Soils. *Journal of Geotechnical Engineering* **120**, 388-403.
- 5) **Ooi, J. Y., Chen, J. F., and Rotter, J. (1998).** Measurement of solids flow patterns in a gypsum silo. *Powder Technoly* **99**, 272-284.
- 6) **Peleg, K. (1986).** Simulation of Vibration Damage in Produce Transportation. *Trans. of ASAE* **29**, 633-641.
- 7) **Rong, G., Negi, S. C., and Jofriet, J. C. (1995).** Simulation of the Flow Behaviour of Bulk Solids in Bins, Part 1 :Model Development and Validation. *Journal of Agricultural Engineering Research*. **62**, 244-256.
- 8) **Ting, J., Meachum, L. R., and Rowell, J. D. (1995).** Effect of Particle Shape on the Strength and Deformation Mechanism of Ellipse Shape Granular Assemblies. *Engineering Computations* **12**, 99-108.