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Characterising Spherical Packings by Principal Component Analysis

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Particle packings play an important role in the discrete element modelling of particulate systems as different packings can lead to different physical behaviour, and therefore need to be properly characterised and controlled. Apart from a few conventional approaches, there is still a lack of more general, comprehensive and quantitative approaches that can reveal some fundamental features of packings. The current work attempts to develop a novel packing characterising system based on two techniques: digitalised image representation of a packing and subsequent application of Principal Component Analysis to the resulting image. It will prove that the principal components or variances of a packing image can indeed qualify as the signature of the packing, and therefore can be utilised to characterise the packing. Furthermore, a dissimilarity coefficient or a similarity index will be defined which provides a single valued metric to quantitatively compare two packings.

Gaussian Quadrature is adopted to get the volume matrix of the particle packing. Then the digitalization image of the packing is obtained by converting the image matrix along the z direction to a column vector. Comprehensive investigations for several sets of purposefully generated particle packings are conducted to fully understand relationships of their principal variances with packing features. The difference between two packings with different features can be revealed by the principal variance (PV) and dissimilarity coefficient (DC). Furthermore, the value of PV and DC can indicate the different level of effects on packing caused by configuration randomness, particle distribution, packing density and particle size. The uniformity and isotropy of a packing can also been investigated by this PCA based approach.

REFERENCES

[1] I. T. Jolliffe, *Principal Component Analysis*. Springer Series in Statistics, 2nd ed., Springer, NY, 2002.

[2] Lochmann, Kristin and Oger, Luc and Stoyan, Dietrich, Statistical analysis of random sphere packings with variable radius distribution. *Solid State Sciences.*, Vol. **8**, pp. 1397-1413, 2006.