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BUILDING REALISTIC SAMPLES FOR ACCURATE DISCRETE MODELLING OF GRANULAR MATERIALS

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Discrete Element Modelling (DEM) has become a popular method for the numerical simulation of the mechanical behaviour of granular materials. A current difficulty, however, is to account for the possibly complex shapes of the particles, especially in the framework of geomaterials. In the 2D case [1], we proposed to use the so-called Fourier descriptors to generate random and yet well-controlled particle shapes, based on a material-dependant input discrete spectrum describing the frequency content of the shape irregularities. A first attempt to extend this work to 3D was proposed in [2], but some drawbacks remained. In the present work, we develop a new approach which overcomes these limitations and offers a consistent framework for flexible and well-controlled random generation of granular samples.

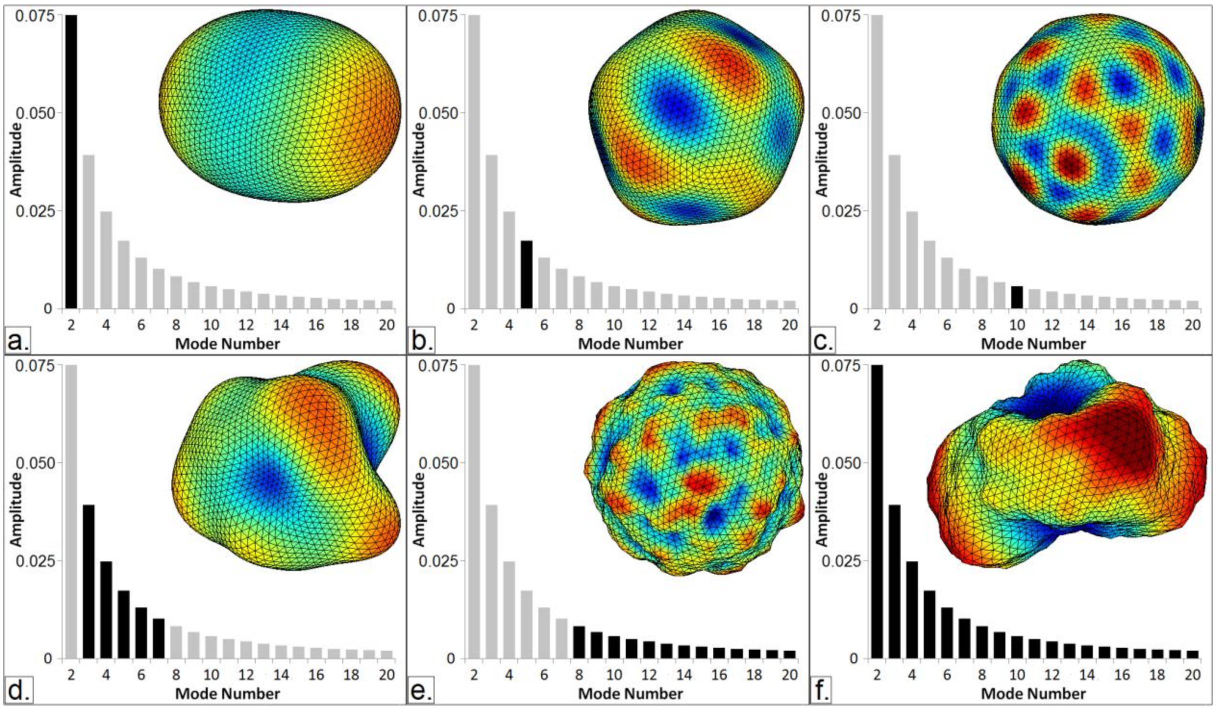

Figure 1*: Random particles generated using only selected modes (in black) of an illustrative input spectrum. a. Mode 2 ; b. Mode 5 ; c. Mode 10 ; d. Modes 3 to 7 ; e. Modes 8 and larger ; f. Full spectrum. Colour scales correspond to the distance to the particle centre.*

The proposed approach takes advantage of the mathematical links between the Fourier spectrum of a random signal and its autocorrelation function, and generates the external surface of a particle using the theory of random fields transposed in a spherical topology for this purpose. The same simple tool as in the 2D case (i.e. a discrete Fourier spectrum) is thus used as an input to control the frequency content of the grain irregularities (Fig. 1). Then, the generated grains are packed in an arbitrary container partitioned using a constrained Voronoi tessellation, each particle being entirely contained in a given Voronoi cell. A specific algorithm is implemented to fit the particle shape to the one of the surrounding cell, making it possible to add a prescribed degree of faceting to the particle (Fig. 2). Final samples provide a very good control on the size distribution and on the particle shape properties (Fig. 3).

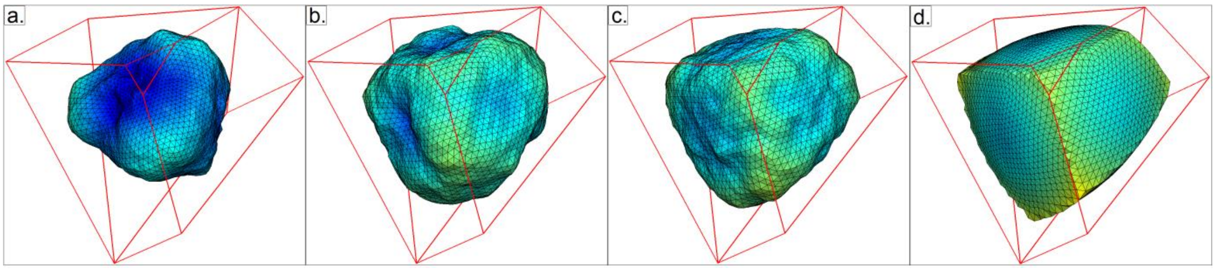

Figure 2: *Particle-filling of an illustrative Voronoi cell using the full spectrum used in Fig. 1, with increasing degrees of fitting of the particle shape and subsequent faceting.*

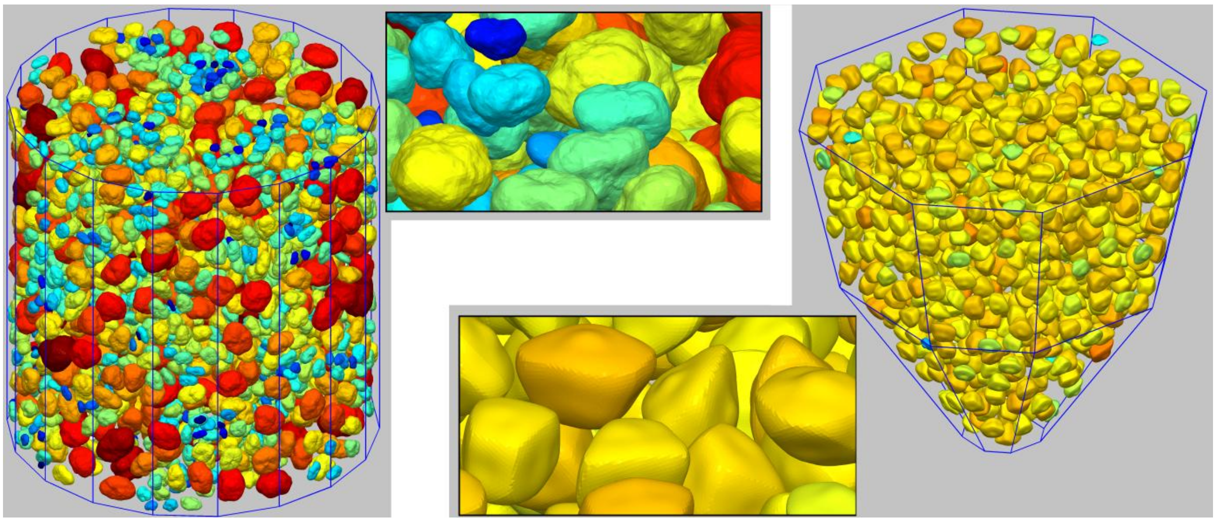

Figure 3: *Two illustrative samples generated with the proposed algorithm. Left: 2500 sand grains packed in a cylindrical container, with a large size distribution, complex shapes and rough surfaces, and no faceting ; Right: 1000 pebbles packed in an octagonal hopper, with a narrow size distribution, low angularity, smooth surfaces and important faceting.*

REFERENCES

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