Developments in the Classification of Optical Scattering (TAOS) Patterns from Heterogeneous Airborne Material Particles

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Abstract—

Experimental: *TAOS* (two-angle optical scattering) instruments record the intensity patterns of laser light scattered by single airborne material particles over a wide range of the scattering angles $\{\theta, \varphi\}$ [1]. Large data sets are available, which consist of scattering patterns from a variety of known materials and from environmental sampling.

Data analysis: In the lack of methods which exactly solve the inverse obstacle scattering problem, artificial intelligence techniques can be used. A classifier has been developed which is based on the spectrum enhancement algorithm [2], extracts vectors of morphological descriptors from *TAOS* patterns and submits them to principal components analysis. Supervised training of the classifier occurs by processing hundreds of patterns from known materials and maximizing a suitable figure of merit. The trained and validated classifier is applied to patterns from new materials for the purpose of recognition. A typical recent classification result is shown by Figure 1 below.

The purpose of ongoing work is to design classification experiments with patterns from new materials (NaCl crystals, soot, outdoor dust, ...) and apply the above outlined method to particle recognition and scoring.

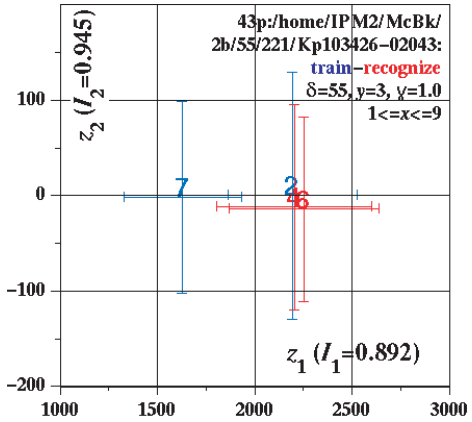

Figure 1: Classifier output on the plane of the first two principal components $\{z_1, z_2\}$. The centroids of pattern classes **2**, **4**, **6**, **7** are mapped on $\{z_1, z_2\}$. Training class **2** corresponds to single, 1.4 micrometer polystyrene latex (*PSL*) spheres, training class class **7** to single *Bacillus subtilis* spores. Classes **4** and **6**, respectively coming from pairs and clusters of four *PSL* spheres and used as confounders, are assigned to class **2** with 80% success rate. I_1, I_2 are the fractions of sample variance explained by z_1 alone and by z_1 and z_2 together.

REFERENCES

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