A novel image analysis technique for 2D characterization of overlapping needle-like crystals

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1. Introduction

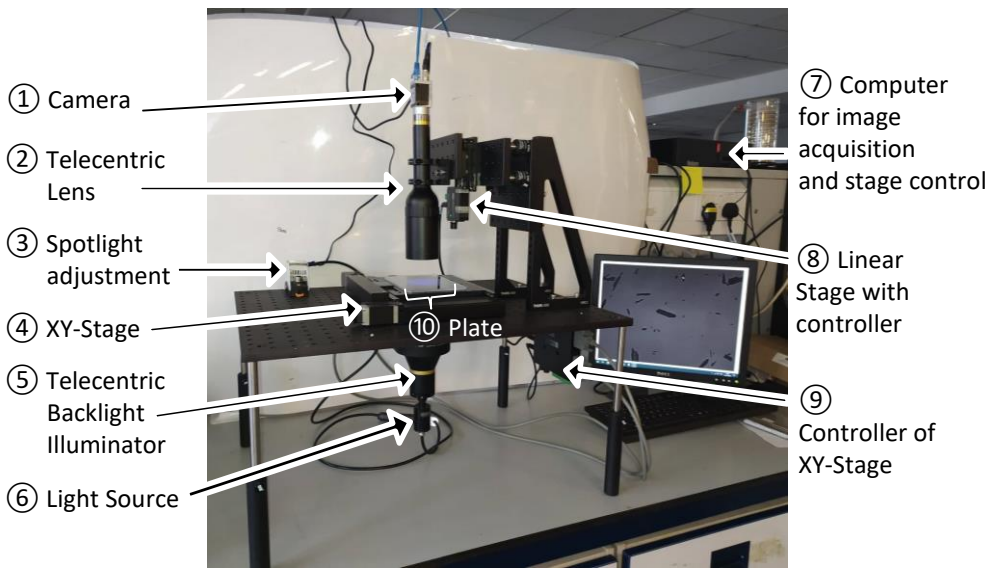
The size and shape of particles in powders significantly affect their processing and the quality of their end-products in a variety of industries [1-3]. Populations of needle-like particles can be successfully characterized using readily available imaging methods. However, most of them do not account for the overlap of needle-like particles in the images, which causes a bias in the size distribution. Building on previous methods [4,5], we have developed an algorithm that successfully separates three main overlapping cases of needle-like particles.

2. Objectives

- Establish an imaging device
- Create image-acquiring code
- Create the image processing software that will separately characterize needle-like particles

3. Methodology - Hardware

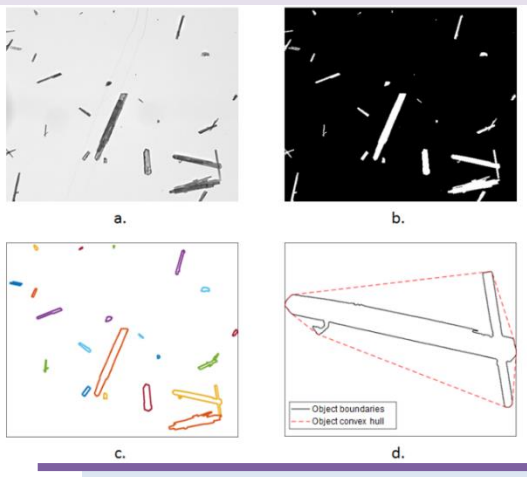
Following crystallization, the crystals are filtered, dried and dispersed on a transparent plate. The plate with the crystals is placed under a custom made microscope, which automatically acquires 2000 images.



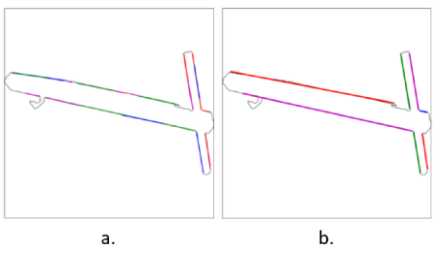
4. Methodology - Software

Classification: Three main overlapping cases

Pre-processing step: From grayscale (a) to boundary lines (d)

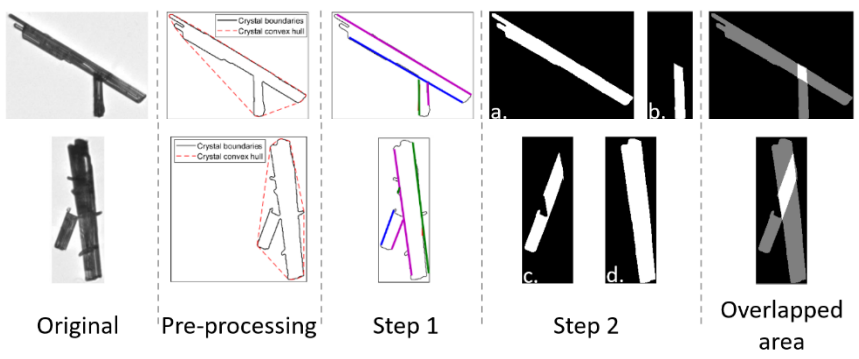


Step 1: Line identification (a) and merging (b) [4]

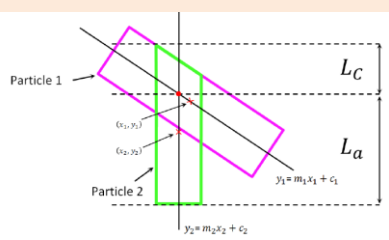


Step 2: Object identification and reject duplicates.

Step 1 & 2: Partially-Crossed and Touching cases



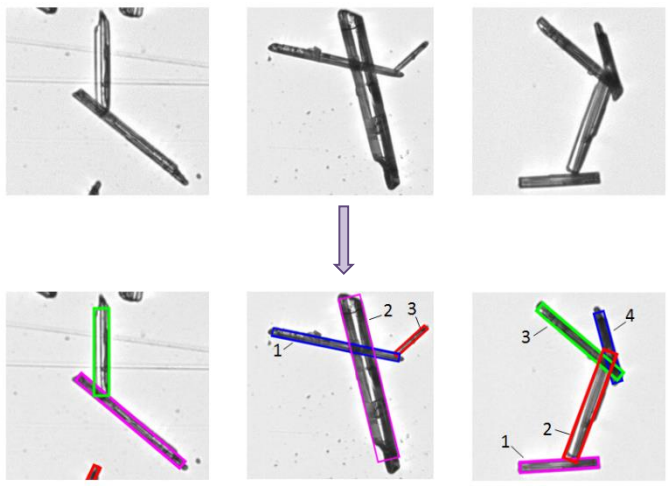
Step 3: Length approximation for partially-crossed case



Step 4: Watershed segmentation for touching case [5]

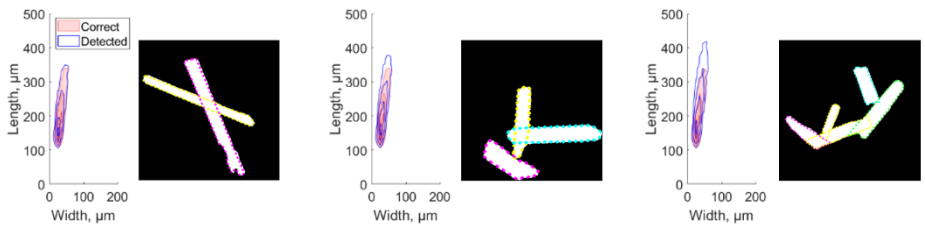
5. Results – Algorithm performance

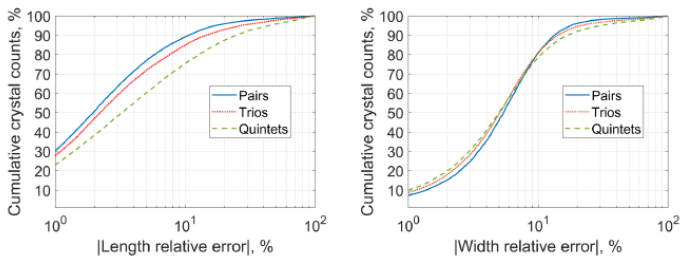
Visual evaluation



Artificial overlap evaluation

The algorithm was tested by separating binary particle projections (19000) that were artificially overlapped. Each population contains solely overlaps in pairs, trios or quintets. The contour plots show a normalised particle size and shape distribution at levels 0.2, 0.4, 0.6 and 0.8.





In the final evaluation, the sizes of the original particles were compared to those of the detected particles, one to one. Defining that a 10% relative error is acceptable, then at the highest overlap intensity tested, the length of 75% and width of 80% of the particles are correctly characterized.

6. References

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Acknowledgments

The authors would like to thank EPSRC, MSD and AstraZeneca for funding the PhD project of Petros Neoptolemou

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