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Detection of Particles from Particle Cluster using Hough Transform

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ABSTRACT: Particle size analysis is one of the most demanding tasks in material science and technology. Detection of size and shape of particles is important for gaining information about better control over the quality of the product. Particle size is a critical process parameter in pharmaceutical production, which highly affect physicochemical and biopharmaceutical properties of drug substances and dosage forms. Detection of the particle present in the agglomerated particle cluster is one of the major challenges in controlling the size of particle. Image processing techniques provides effective analysis of size and shape features of pharmaceutical drug particles by segregating occluding particles. This paper presents Circular Hough Transform based detection technique, which collects the contributions, or votes, from the edge pixels for an accumulator describing the parameter space (or sometimes called the Hough space) which represents the circle's center. Then, circles are extracted by finding the local maxima of the parameter space. In this paper, the Circular Hough Transform based detection technique is applied on different pharmaceutical laboratory microscopic images in order to effectively achieve parameters such as particle number, area, size, roundness and size distribution, etc.

KEYWORDS: Image Processing, Transmission Electron Microscopy, Circular Hough Transform, Morphology, Size Analysis, Particles Counting.

I. INTRODUCTION

Understanding the behavior of different materials and characteristics of their particles has gained enormous importance in many industry applications e.g. in pharmaceutical industries. In pharmaceutical industry, particles are most important elements for analysis of drugs. Specification of particle size is required if the size of particle of the drug substance is critical to performance of drug product (i.e., solubility, dissolution, content uniformity, bioavailability, product appearance, or stability) or manufacturability of drug product (i.e. processability). Particle properties measurement is required to make sure better control of drug quality and for better understanding of products, processes and ingredients.There are different methods present to analyze particle characteristics such as sedimentation technique, sieve analysis, laser light scattering analysis technique, etc. But methods like these have certain disadvantages associated with them. In case of sieve analysis, the range of quantitative information fetched is relatively small and range of size is defined inside only two sieve sizes. In sedimentation method, the results response to very slight changes in sample preparation. The laser light scattering technique is comparatively time consuming method.

In comparison to these methods, transmission electron microscopy (TEM) and image analysis techniques are adopted by researchers to overcome these disadvantages [1].With the expeditious development in technology, image processing techniques have started to be used as one of the standard parameter measurement techniques. Particle analysis using image processing technique is a high resolution direct method for distinguishing and characterizing particles. Contour of a particle is the primary information required for image analysis method, which is different from other methods, because information about particle size as well as shape is present in the images. Shape and size of a particle are two important parameters in particle analysis in order to determine area, perimeter and roundness of particle. Distribution of these particles can also be plotted in different size range using shape and size analysis of particle images.

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II LITERATURE REVIEW

Pyrz et al. [2] performed a nanoparticle size distribution analysis to study thecapabilities of nanoparticle synthesis. Based on their results, for effective nanoparticle characterization, the properselection of imaging type (bright vs dark field), magnification, and analysis method (manual vs automated) is criticalfor the subsequent analysis efficiency, and the proper determination of the particle-background boundary. These decisions control the measurement resolution, the contrast between the particle and background, the number of particles in each image, the subsequent analysis efficiency, and the proper determination of the particle-background boundary and affect the significance of electron beam damage to the sample

Karin et al. [3] focused on the particulate emissions from diesel engine, where PM (Particulatematters) structures were presented with TEM images.They used an image processing method, including black andwhite operation to estimate the distribution of carbon platelet length and atom density of PMs.

DeTemmerman et al. [4] developed a semi-automatic image processing method in whichthe primary particles are detected based on watershed segmentation. In their study, the minimal size and overlapcoefficient were measured based on a Euclidean distance map. The focus of their research was to measure theminimal size in one dimension of primary particles in aggregates.The principle of a semi-automated approach to measure the minimal size in one dimension of primary particles in aggregates by transmission electron microscopy is developed using the model of the powdered, aggregated titanium dioxide representative test nanomaterial NM-100 with a mean primary particle diameter near the 100 nm limit. The primary particles are detected based on watershed segmentation and their minimal size and overlap coefficient are measured based on an Euclidean distance map. A high level of automation allows measuring the diameter of the maximal inscribed circle efficiently. The maximal inscribed circle is a measure for the minimal primary particle size in one dimension and is shown to be commutable with Feret min measurements.

Du [5] used low-pass filter and Wiener filter to denoise the TEM images. Noise reduction of micrographs is often an essential task in high resolution (scanning) transmission electron microscopy (HR(S)TEM) either for a higher visual quality or for a more accurate quantification. Since HR(S) TEM studies are often aimed at resolving periodic atomisticcolumns and their non-periodic deviation atdefects,itisimportanttodevelopanoisereductionalgorithmthatcansimultaneously handle bothperiodicandnon-periodicfeaturesproperly.His results showed that thedeveloped nonlinear filtering algorithm, can efficiently reduce the noises without noticeable artifacts with thecontrast of variation in the background and defects. However, his algorithm is particularly suitable for quantitativeTEM image, but cannot perform statistical analysis and the size distribution of the nanoparticles.

One of the most recent studies of this subject, has been performed by Dastanpour et al. [6].They developed a method for automatic determination of the average primary particle diameter based on thevariation of the 2-D pair correlation function P(r) at different distances r from the main skeleton of the aggregates. It is assumed that$P^* = P(d_p/2)$is nearly constant. The method has been applied to numerical agglomerates and real soot aggregates collected from several operating conditions of a gasoline direct injection engine and a heavy-duty compression-ignition engine. Using a constant value for P^*determined from the analysis of TEM images results in primary particle sizing errors (relative to manual sizing) of ~13% for single aggregates. The ensemble mean values of $d_p$for manual and automatic sizing differed by ~4%. Theaccuracy of their method is comparable to the best available algorithms for primary particle sizing which can beused for analysis of TEM images, but their method cannot provide information on the size distribution of theparticles in TEM images.

Grishin et al. [7] used Hough transform in the TEM images for automated identification andmeasurement of primary particle size distribution in individual aggregates. This method achieves a significant data reduction by decomposing the particle border into fragments, which are assumed to be spheres in the present application, consistent with the known morphology of soot aggregates. This method gives a direct measurement of the sizes of the aggregates and the size distributions of the primary particles of which they are composed. However, in their study, the accurateresults can

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only be acquired when prior information on the size range of the primary particles in each aggregate isknown. Their model relies on the assumption of perfectly spherical structures for primary particles, and can onlydetect primary particles touching the edge of the aggregate.

III PROPOSED SYSTEM

In this method, Circular Hough Transform (CHT) is used for detection of nanoparticles, which are most of the time circular in nature. In this method, chain of image processing methods is carried out to attain the required particle parameters. Block diagram of general particle detection is shown in fig.1.

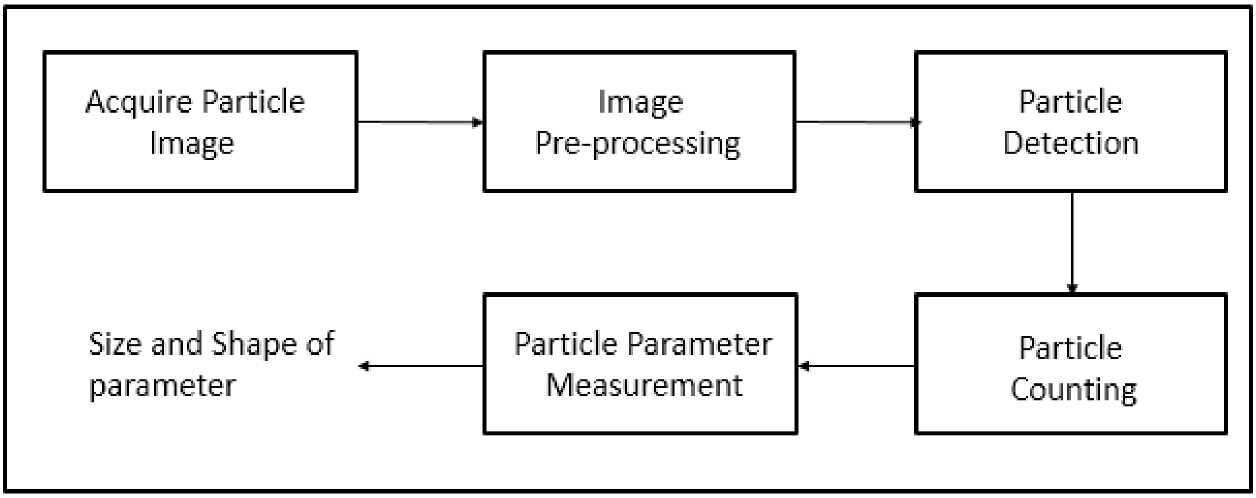

Fig. 1. Block diagram

A) Image Acquisition and Pre-processing

The aim is to first capture the particle image from transmission electron microscopy (TEM). The image is obtained (fig. 1) from drug used in pharmaceutical industries. The captured particle image requires to be pre-processed as it might contain some noise and void spaces. The aim behind use of pre-processing is to produce more satisfactory image than the original image for a particular particle detection technique. The linear filters used for pre-processing cannot successfully remove impulse noise, as they are more prone to blur the edges of an image. Therefore, nonlinear filters are used for this operation. Thus, to remove the image noise, a modified median filter is applied to the image. In this method, every image pixel is replaced by the median of its adjacent pixels based on the following algorithm:

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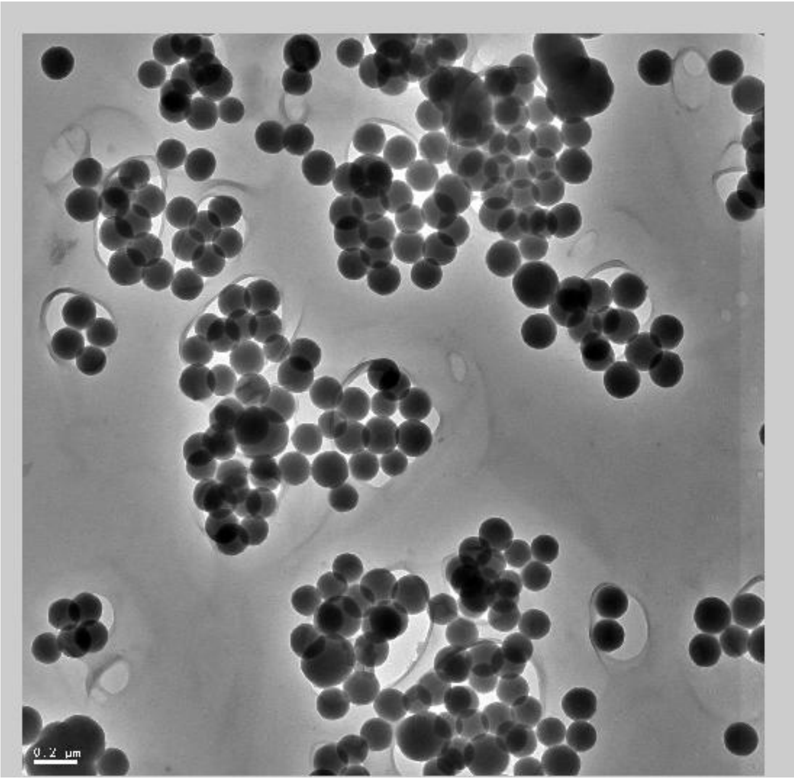

Fig 2. Original particle image

1. Consider each image pixel.
2. Select the adjacent pixels in all eight directions with two-pixel domain.
3. Rank the selected pixels in order based upon their intensities
4. Substitute the pixel value with the median value

B) Circular Hough transform based Detection

The Circular Hough Transform is used to convert the given feature points into accumulator votes in the parameter space, or the Hough space from the image space. The following equation in the 2D space point out to a circle located at the center (a, b) with radius r:

$$(x-a)^2 + (y-b)^2 = r^2 \qquad (1)$$

If (x,y) is selected as a foreground pixel of the image, the (a,b,r) parameters in 3D transform space can be found by Eq.1. Like traditional Hough transform, an accumulative matrix is formed based on votes in the transform space and local maximums will be selected as circle parameters. In the real time applications, the TEM image includes a large number of particles in a vast range of the particle size, the huge storage, large cost of computation and not-good detection of all particles will be the main disadvantages of the CHT. To tackle these problems, several improvisations to the CHT have been performed to both increase the measurement accuracy and increase the rate of detection of the particles, or to decrease its computational complexity. Centers can be calculated in 2D and radiuses will be computed in 1D space for complexity reduction of 3D computation. The circles having constant radii are considered and the true centers are considered with highest votes in the accumulator matrix. In the next step, the edge orientation information has been applied to increase the performance of CHT. The edge point on the boundary of a circle is in the direction of its center. This method decreases computational requirements by plotting arcs in accumulator space. This technique is subdivided into following procedures; first, the process is conducted on the thresholded edge map. In the next step, the resulting (a,b)-space is convoluted with a Mexican hat filter to enhance the hot spots. In the third step, the (a,b)-space is thresholded, and centers of the hot spots found. Then, we accumulate in r-space to search the most observable circle with the given center. Then selecting a suitable threshold allows for concentric and occluded circles. Lastly, the radius of every given circle is estimated.

C) Morphological Post-processing

After the detection of particles, a more desirable particle image with strengthened boundaries is achieved but there can be still some small objects present in particle image which can be falsely taken as particle during counting. Hence, post processing is vital for robust particle analysis. In this paper, we have performed mathematical morphology filtering (post processing) due to its benefits of effortlessly removing the undesired objects within the particle image. Erosion is primary operator of morphology technique which erode apart the region of interest. Set of coordinate points called as structuring element is important for the accurate effect of erosion on the input image. Therefore, the image is free from undesired objects after morphological operation and it can be applied for further parameter measurement techniques and counting of number of detected particles in the analysis.

D) Particle Parameters Measurement and Counting

Detection of size and shape of the particles are important for the information about the particles

1) Size analysis

Particle size is the most important parameter in material science industries. Transform space reduces to 1D radius space using centers obtained in the previous section. The corresponding radiuses are calculated based on radial histogram around each center.

2) Counting

Counting of objects in particle image is one of the major challenges in image processing. The local maximums of accumulator matrix are considered as circle's centers. By calculating number of chosen circle's centers, number of particles can be counted.

IV. CONCLUSION

To evaluate the performance and analyse algorithm, the literature survey is done and the best method is selectedto detectnanoparticles from particle cluster and carry out particle size analysis. This method enables us for particle size analysis of of the images consisting circular particles as well as occluded particles and images containing noisy and uneven backgrounds. Furthermore, the proposed technique could also measure the average, shortest and longest dimensions. The expected result shows that, the advantage of this method is the capacity to analyze high number of particles, which makes this CHT method satisfactory to process large stacks of TEM particle images

REFERENCES

[1] GuzayyaSarkhawas, Arti Bang and YogeshDandawate, "Particle Analysis Using Improved Adaptive Level Set Method Based Image Segmentation", in Proceedings of IEEE International Conference on Computing Communication Control and Automation 2015.

[2] Pyrz, W.D., Buttrey, D.J., "Particle size determination using TEM: a discussion of image acquisition and analysis for the novice microscopist", Langmuir 24, 11350-11360.

[3] Karin, P., Songsaengchan, Y., Laosuwan, S., Charoenphonphanich, C., Chollacoop, N., Katsunori, H., "Nanostructure investigation of particle emission by using TEM imageprocessing method", Energy Procedia 34, 757-766.

[4] De Temmerman, P.-J., Verleysen, E., Lammertyn, J., Mast, J., "Semi-automatic size measurement of primaryparticles in aggregated nanomaterials by transmission electron microscopy", Powder Technology 261, 191-200.

[5] Du, H., "A nonlinear filtering algorithm for denoising HR (S) TEM micrographs", Ultramicroscopy 151, 62-67.

[6] Dastanpour, R., Boone, J.M., Rogak, S.N., "Automated primary particle sizing of nanoparticle aggregates by TEM image analysis", Powder Technology 295, 218-224.

[7] Grishin, I., Thomson, K., Migliorini, F., Sloan, J.J., "Application of the Hough transform for the automatic determination of soot aggregate morphology", Applied optics 51, 610-620.