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SIZE CLASSIFICATION WITH 3D IMAGING USE FOR WOODCHIPS

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Abstract: Visual appearance is a key factor for many industrial and agricultural products in terms of quality assessment and classification. Digital image processing is a popular and important application in the respective fields of agriculture [4]. Determination of visual characteristics is a basic criterion in classification and processing of agricultural energy crops. Surface characteristics of choppings is an important parameter [1]. Assessment of such characteristics is nevertheless very difficult or impossible with conventional means. The article presents 3D imaging as a size classification analysis tool in the assessment of crop choppings.

1. INTRODUCTION

Image processing provides a well applicable technique for the determination of visual characteristics. In the case of agriculture products image processing algorithms are used most frequently for the measurement of colour and shape parameters [6]. Algorithms dedicated to respective tasks provide results only in a narrow spectrum and under proper environmental conditions. This also means that an imaging algorithm for apples will have a very low rate of applicability for oranges. It is important therefore to state out that for the analysis of specific products dedicated algorithms have to be developed, as no generally valid imaging algorithms exist. This applies to the field of crop choppings. In the assessment of choppings the initial colors of different components cause significant challenge. Further source of problem is that analysis does not follow immediately after harvesting (like in the case of fruits.). Thus color and the decolorification caused by fungi is strongly dependent on the method of storage and on the length of delay between the plantation's harvesting and its analysis.

This means that examination of the same set of choppings will result in different colours and colour transitions at different points of time. For conventional 2-dimensional methods this continous variation causes the uncertainty experienced in the identification of individual elements of the set. In 2-dimensional analysis the appeareance of fungi imply the appeareance of a new colour transition, object edge or a completely new object. Conventional 2-D analysis only allows for a rough estimation of the surface of woodchips [5]. This certainly can be sufficient for certain technological processes but generally is not satisfactory.

Applying three dimensional imaging results in colour information loss of the examined objects but provides significant additional information over the results of 2-D methods. During 3-D imaging a finite element dot-grid is formulated which allows for real surface measurements instead of estimation surface sizes. In the case of bulk homogenous materials variance of surface unevenness is not just an occasional data but can be used as a distinctive characteristics [3]. This is true to minced materials, wood choppings, slicings, chaff and other milled structures.

Essentially the 3D surface model of a set of plant choppings also enables depth measurement. Elements covering the surface of the set influences the overhead in-depth visibility range. The smaller the elements covering the surface the better their cover and the smaller is the in-detpth visibility of the set of choppings. Assuming complete mixing, elements on the surface are typical for the complete set. Characterisation of the set will thus not be given by the description of the individual element sizes but their distribution. Therefore if a statistically well founded method can be given for the distribution of the elements then fundamental characteristics of the set can be determined. The necessity of size classification and identification of distribution is emphasised in [2] where the author finds that combustion quality is influenced by the extent of mincing.

In the following sections the article establishes a method of evaluating information inherent in 3D-models. The proposed method can provide size classification for a set of choppings without performing direct geometrical measurements.

2. METHODS AND MATERIALS APLIED

2.1. THE APPLIED EQUIPMENTS

Throughout the experiments a 3D laser scanner of the type Zscanner 700 was used. The main technical parameters were: sampling rate 18000 sample / sec., 2 built in cameras, improved resolution of 0,1 mm, maximal accuracy of XY positioning is 50 μm if the investigated volume is 100 mm x 100 mm. The applied computer was a PC with the following features: I7 quad processor, 6Gb memory, graphical subsystem with 1Gb memory. The connection between the scanner and computer was an IEE1394 interface.

2.2. THE INVESTIGATED MATERIALS

The examined material is woodchips. A filtering method was applied to the original mixture in the following manner: 3 classes were applied, one under 4mm, one between 4 and 8 mm, and one over 8 mm. The widely applied winnowing has to be accompanied by noting that size classification is undertaken only by considering two dimensions. The fractional selection resulted in three size classes, but the size filtering only applied to two out of the three physical dimensions; it was of course possible that in the 4 mm fraction a chopping of 4mm diameter but 40mm length could penetrate. From this it can be observed that a given set can be characterised only by a given probability distribution as individual element size can be assessed only statistically.

2.2. APPLIED METHODS

During the 3D-imaging experiment no special lighting was applied. Besides the scanner’s own light only the lowest level of (neon tube) lab lighting was switched on to allow for a minimal influence on scanner lighting and the work of the operator. Samples used for recording were placed in small boxes where multiple layers of cover was ensured. Samples were thoroughly mixed and placed in the boxes with their surface smoothed out. All sample groups were re-recorded after applying two consecutive mixings.

Figure 1. A sample of the examined woodchips

3. THE INVESTIGATION

During the investigation all size classes were recorded three times after applying a re-mixing.

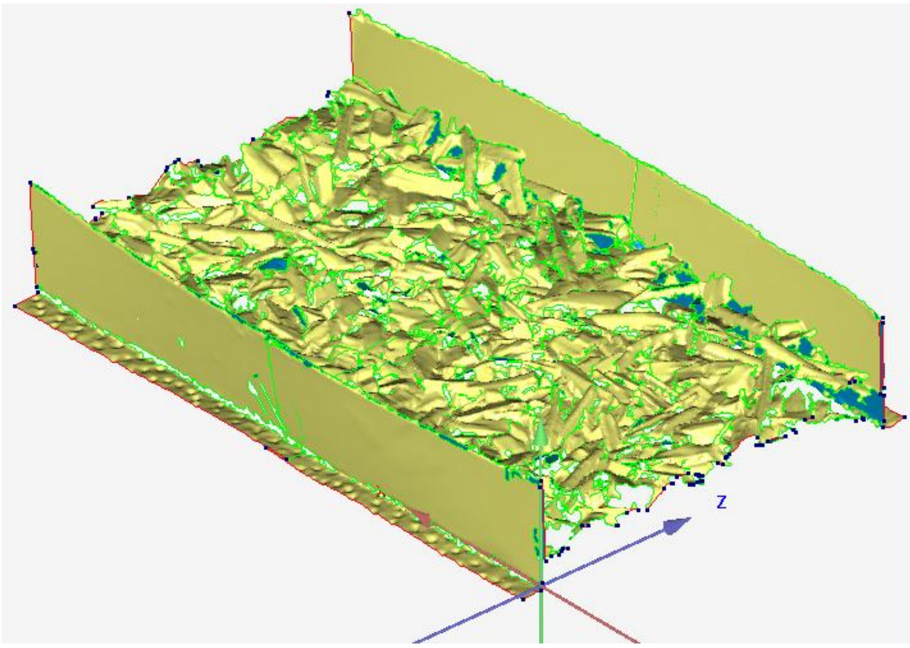

Figure 2. A sample scanned in 3D

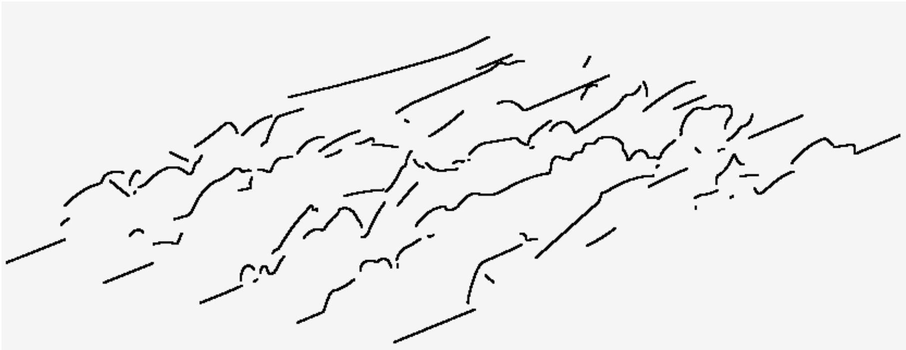

Figure 3. Set of slices selected from a 3D image

For the purpose of our analysis always 5-5 slices were cut from the surface descriptor matrices. Considering the triple repetition of the three size classes this altogether resulted in 45 cross cut images and data sets.

Putting the data of the cross cut samples in a two dimensional vectorspace it can be stated that the cross cuts from the same fractions are very similar, while crosscuts of different fractions show significant difference.

Figure 2. is basically a representation of the points on the surface of the woodchips sample in a 3D matrix. Examining a 2D slice matrix of the 3D matrix allows us to get a cross-section of the scanned material set. If the selected cross section is perpendicular to the surface of the set, we get a cross cut image of the original set (Figure 3). Thus the visible range of dots is given by the cross cuts of parallel planes perpendicular to the plane of the surface.

4. MEASURED DATA AND RESULTS

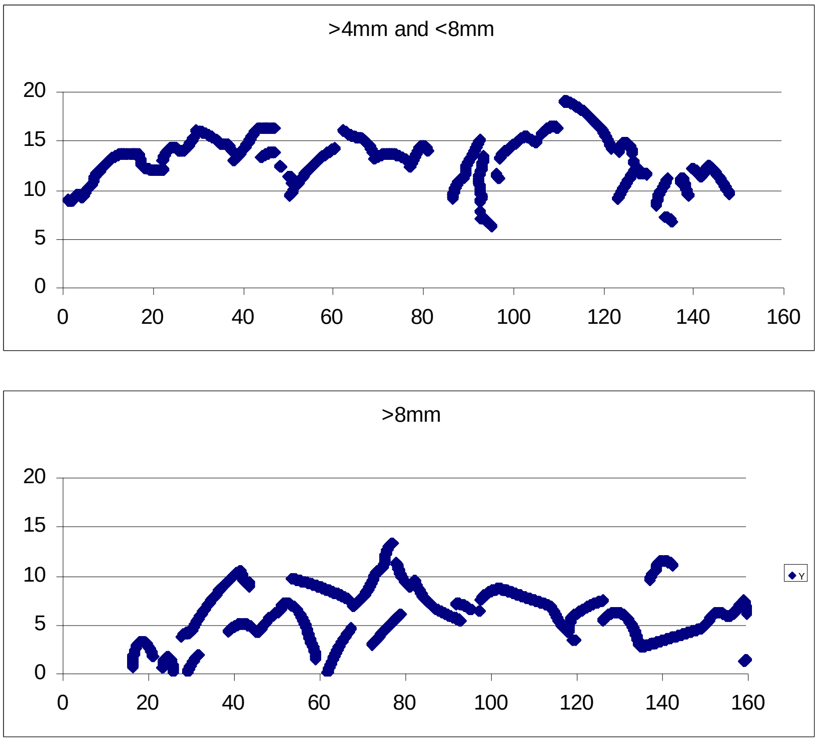

Figure 4. Comparison of the sections from different fractions (>8 mm and 4-8 mm)

The above figures well demonstrate that depth encompassed by scanning differs radically between size classes. This is the consequence of the difference in the closing depth of the respective choppings, which is a function of the fill factor of the chopping. On the other hand space filling factor depends on the size of the elements in the set. Therefore it can be stated that the deeper the insight we gain into the set the larger the size of the elements we can find on the top layer.

Enumerating the points composing the cross-section we get the frequency. The following distribution is shown by the set of points in the cross section of the three size classes after 5-times sampling (Figure 5).

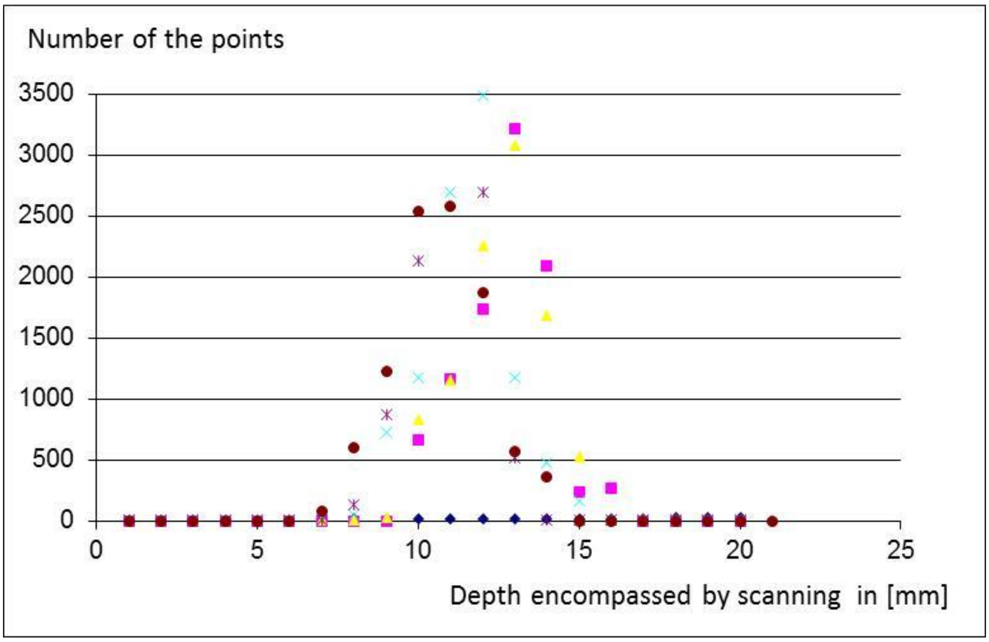

Figure 5. Number of measured points as a function of measured depths for a fraction with less than 4 mm's.

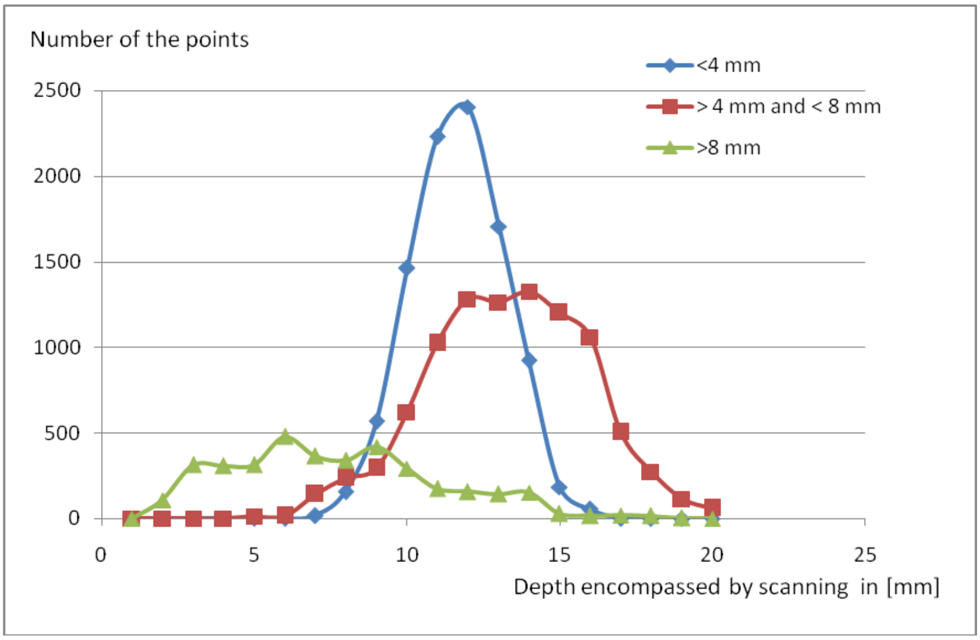

Figure 6. Number of points averaged for the three size classes

Figure 6 shows the distribution of measured points for the three size classes after 5 times sampling and averaging.

From the figure it can be observed that in the smallest size class the number of dots at a certain depth surpass 3000 and that more than 90% of the dots are located between the values of 7 and 16 mm's. In the case of the next size class the occurrence is spread to the range of 5-19 mm's and the most frequent values are under 2000 elements. For the largest size class the maximal individual element number stays under 500 and has the widest spread.

Thus, after examining the range of the spread of the dots characterising the cross cuts the following values are obtained:

<4 mm –class: 10 mm
>4 mm és <8 mm –class: 15 mm
>8 mm class:19 mm.

4. CONCLUSIONS

Summarising the results, we can state that the images of woodchips recorded in 3D can provide a valuable starting point to draw conclusions on the size of the elements in the examined material set. This relationship can be demonstrated in the under 8mm size class with strong reliability. The larger size classes could be assessed to be less coherent with the applied method and equipment. Applicability can be improved further with larger element image generation. The ongoing research is expected to provide applicability in a broader size spectrum by further refining and modifying the applied methodology. Additional objective is the crosscut image generation without 3D imaging as this would result in a real-time industrial applicability by making evaluation faster and simpler.

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