THE EXAMINATION OF SURFACE SCRAGGINESS MAKES IT UP WITH 3 DIMENSIONAL IMAGING

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Abstract

Visual appearance is a key factor for many industrial and agricultural products in terms of quality. The most important attributes are colours and shape. Digital image processing is a popular and important application to investigate visual appearance. Conventional 2D-imaging provides a good implementation of colour identification, but is not a perfect solution for surface monitoring. 3D laser imaging as a new technology provides some additional data on the investigated objects, beyond conventional imaging. Three dimensional representation looses colour information of the object, but provides a point to point surface mapping. This article presents results of a research which applied 3D image analysis in order to demonstrate and utilise advantages in terms of additional data over conventional images. It is concluded that the additional information gained can be used to describe object surface features in a more thorough manner.

Keywords

image processing, surface analysis

Introduction

In the field of agriculture post and pre harvest and in many other cases digital image processing is a popular and important application (Molto, 1996). For example the visual appearance is a key factor in quality assessment and sorting plants. Therefore applied procedure, are based on visual inspection. In this paper in scragginess analyses of applicable 3 dimensional imaging procedures are described.

Surface unevenness is not only a potential characteristic data in the case of homogenous materials, but also in bulk material sets. Elements on the surface of the material sets causes irregularities on the whole set according to its size. Assuming complete mixing we can characterise the size of elements in the whole set based on the knowledge of the surface element sizes. In the case of multiple element material sets fundamentally not the respective sizes of the elements themselves but the distribution of the elemental multitudes (size classes) will be a characterising data.

Thus, if we can give a good description of the elements of the set with a statistical methodology then we can assign this characteristics to the set and compare sets based on this information. A typical such material set can be firewood chopping utilised as a renewable energy source for heat production. The chopping size introduced in the combustion area has a definite influence on combustion quality (Bense, 2006). It is therefore straightforward that knowledge of firewood chopping provides additional information for configuration of combustion parameters.

The applied system and materials

The applied apparatus

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.

The investigated materials

The examined material is wood chopping. The filtering method was as follows: 3 classes were applied, one under 4 mm, one between 4 and 8 mm, and one over 8 mm. 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 40 mm length could penetrate. This resulted in a given probability distribution of size inside the given size groups, and the somewhat blurred distinction of the fractions.

Nevertheless it is understood that the sets formulated in the above manner carry distinctive size characteristics, and can only be assessed statistically.

The developed investigation method

During the experiment lighting was applied with no extra requirements in mind. In the preparation of the scanned recordings exclusively a filtered artificial lighting was used to ensure minimal bias over the scanner's own lighting apparatus (Szalay, 2011). Fractions of chopping was placed in boxes with open tops. Size of the boxes was selected to ensure the largest possible cover for chopping with multiple layers of cover. Multiple layers was necessary to provide an environment which is possibly the closest to the surface exhibited by real material sets. Surface was always equalised to ensure that its unevenness only relates to size irregularities of respective elements.

Figure. 1. One case of the investigated material

The investigations

During the analysis all size classes were 3D-scanned after applying 3 different mixings to each of them.

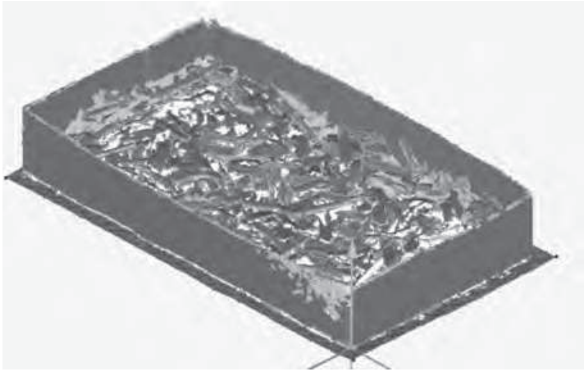

Figure 2. The scanned material

Scanned images represent the allocation of firewood choppings distribution on the examined material surface. The respective points of the image can be stored 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 cross section is selected perpendicularly to the surface of the set, we get a cross cut image of the original set.

Figure 3. The selected sections form 3D matrix

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 interfraction crosscuts show significant difference.

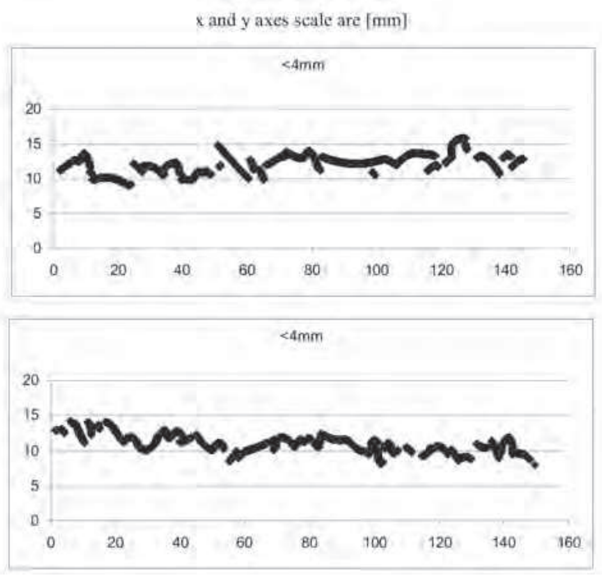

Figure 4. Comparison of the sections from same fractions (<4 mm)

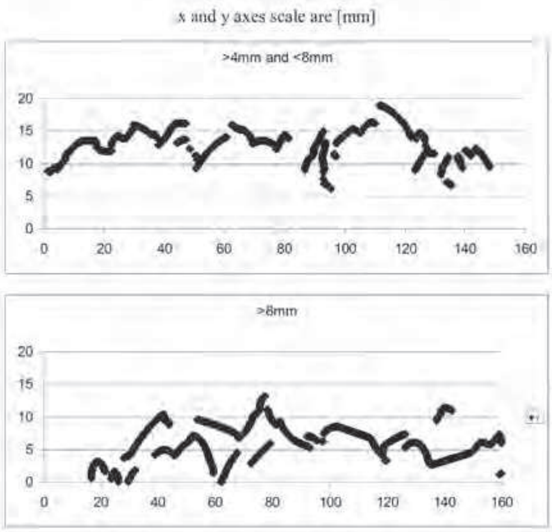

Figure 5. Comparison of the sections from different fractions (<4 mm and 4-8 mm)

Results and measured data

The above figures well demonstrate that depth encompassed by scanning differs radically. This is the consequence of the difference in depth of compression of the chopping, which is a function of the fill factor of the chopping. Space filling depends on the size of the elements in the set. Therefore it can be stated that the deeper 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.

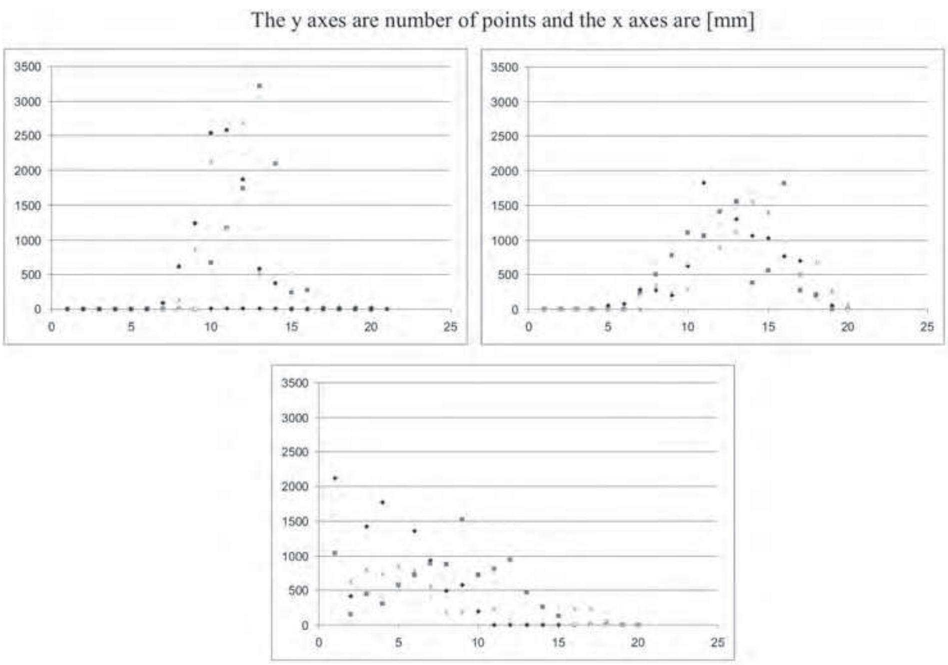

Figure 6. Development of frequencies

The images well depict that in the case of the smallest size class the frequency values surpass element numbers of 3000, and more than 90% of the points are positioned between 7 and 16 mm. The next size class already spreads out to the interval of 5-20mm, and the largest values fall under 2000 elements. The third image shows the frequency value of the largest size class, with an even more outspread range of values.

Examining the standard deviation of frequency we get the following values:

Case of <4 mm = 931

Case of >4 mm and <8 mm = 570

Case of >8 mm = 522

This shows that spread of image points is larger as the elements composing the set examined become smaller.

Conclusions

Summarising the results, we can state that the images of wood-chopping 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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