AUTOMATIC HOMOGENIZATION YARD CAPACITY ESTIMATION WITH USAGE OF IMAGE PROCESSING

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Abstract

Homogenization yard is used for holding dust ore and ore concentrates. The raw materials for agglomeration are transported to the industry premises usually by railway and with help of spreader machine are stored on so called homogenization yards. The goal of this article is not the description of homogenization yard function, but describe proposed method to estimate its actual proportions and capacity. Proposed system usage several cameras, which convert real image of homogenization yard to its digital form. Used algorithm is then capable to estimate its proportions, shape and capacity. This information is accessible online, so there are only a few seconds difference concerning real state. Up to date informations can increase effectiveness of logistic processes concerning blast furnace raw material base control and also homogenization yards loading.

Keywords: Homogenization yard, image processing, capacity, estimation, online, shape, stereoscopic

1. INTRODUCTION

This paper address issues concerning volume estimation of homogenization yard. The example of complex functional relations systems control can be homogenization yard. This is a final component of technological flow when creating melting charge for blast furnaces. The purpose of homogenization yard is to homogenize chemical and physical properties of raw materials intended to production of agglomerate. It is very important to achieve perfect homogenization of ore material together with addition of some support materials like chalk. The resulting agglomerate has to have uniform distribution of iron (Fe) and proper basicity. For transportation to homogenization yards loading of iron powder, concentrates, additives (chalk) are used conveyor strands. [1]

According to its chemical composition and grain properties are the ore and additions continuously dosed by conveyor scale in preselect aspect. Then is the treated ore mixed in trommel mixer along with dehumidification. As the final stage is the treated ore transport and load to homogenization yard in proper order. Homogenization yard consist of several layers. Each layer has its purpose. Homogenization yard is about 69 m wide, 13 m high and about 700 m long. Final chemical and physical compositions of the batch mixture is left ageing. In homogenization yard is batch mixture stored in horizontal rows and draw off by bucket elevator (**Figure 1**). [2]

It is very difficult to find out, how much materials is present in homogenization yard. It is a common problem, not only in metallurgy. The similar issues has in quarry or cellulose plants, where the knowledge about product volume is vital. The volume of homogenization yard or other product stored can be calculated, if basic dimensions of the stack are known. In general, from time to time comes geodesist, which locate all necessary dimensions and calculate volume of the stack. This approach is inefficient and extremely slow. The better way is to have some automated process, which can estimate stack volume anytime and provide relevant data to control system. The proposed diagnostic system is based on stereoscopic computer vision and with minimum effort is capable to deliver relevant data. The further text is dedicated to description of stereoscopic computer vision and its usage in industry environment. [3], [4]

Figure 1 Homogenization yard and draw off bucket elevator

2. MEASUREMENT USING STEREOSCOPY

The method of measuring point positioning using stereoscopy uses principles based on similarity to the human eye. People can visualize the size and position of the object, even in space. We have this feature with a pair of eyes. Likewise, stereoscopy uses two sensors that scan the same scene (**Figure 2**).

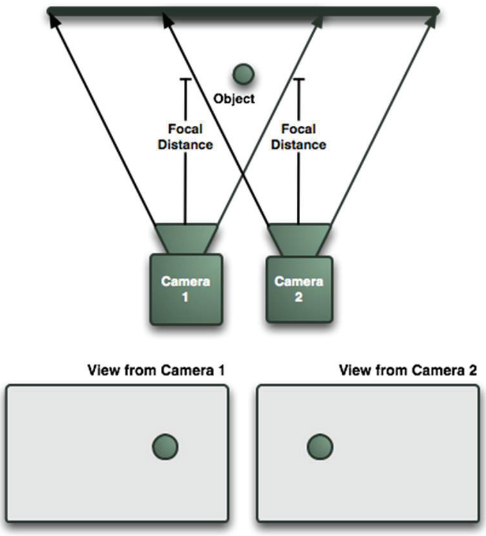

Figure 2 Illustration of stereoscopy

The sensors have parallel axes of the optical systems and lie in one plane. They are separated from each other by the well-known length. Horizontal positioning is most often used and the sensors are marked as left and right. Another condition is the use of sensors with the same optical and sensing properties. If we record scenes on both sensors at the same time, we get two scene images from different views. Each point of the scene will have a different position on each picture. Coordinate centers are located in the image penetration and the optical axis. The display is shown in the following picture (**Figure 3**). Where the I_{lef} and I_{right} surfaces represent images, *f* is the focal length of the lenses, *T* is the distance between the lens axes and *O* are the centers of the optical systems. [5], [6]

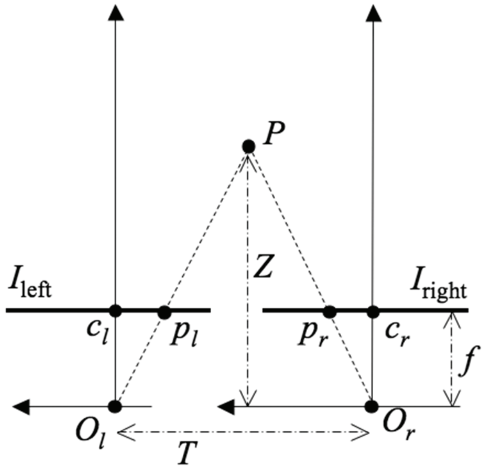

Figure 3 Schematic of point projection on the image

The difference of the point position on the left and right images is called disparity. Using disparity, we are able to determine the position of a point in space. The following relationships, which are derived from the similarity of the triangles, assume that the coordinates of the Y-axis are the same.

$$x_l = \frac{X_p \cdot f}{Z_p} \tag{1}$$

$$x_r = \frac{(X_p - T) \cdot f}{Z_p} \tag{2}$$

$$y_l = y_r = \frac{Y_p \cdot f}{Z_p} \tag{3}$$

$$Z_p = f \frac{T}{x_l - x_r} = f \frac{T}{d} \tag{4}$$

$$X_p = x_l \frac{T}{d} \tag{5}$$

$$Y_p = y_l \frac{T}{d} \tag{6}$$

The x_l, y_l, y_r and x_r are coordinates on the left and right picture. The c_l and c_r are picture centers. The O_l and O_r are picture's axis. The *T* is distance between picture sensors. The *f* is focal length and X_p, Y_p and Z_p are coordinates of *P* spot as a distance from picture sensor (dimensions of the picture sensor are neglect).

These equations are based on length units, but we see the pixel disparity from the image. It is again necessary to determine the ratio between pixels and length units. This will help us with the features of the sensor. Using the method, images can get the coordinates of any point in the image. To determine the volume, you will need to get points on the surface of the object being measured. Here is an example of homogenization yard (**Figure 4**). [7], [8]

Figure 4 Homogenization yard

To display the principle of the method, we highlight key points on the homogenization yard. By combining these points, we obtain a wire model of the measured object. The display is in (**Figure5**). From the model obtained, we can calculate the volume of the measured body. With a larger number of determined points, we obtain a more detailed model of object (**Figure 6**). The more accurate the model will be, the more accurate the calculated volume of the object will be.

Figure 5 The low resolution homogeneous yard model

Figure 6 High-resolution homogeneous courtesy model

This way, we only get an incomplete object model. The back side remains hidden by the object itself. To create a complete object model, we will use multiple-point capture as shown in (**Figure 7**).

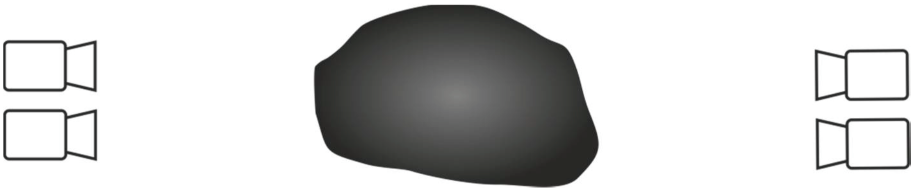

Figure 7 Scheme by scanning the entire homogenization yard

3. CONCLUSION

The paper tries to describe innovative approach to volume estimation in case of huge stack of material such as homogenization yard. The knowledge of right material volume is vital in many cases. Usage of stereoscopic computer vision is advanced method which can be used thanks to modern industrial type computers with fast processing speeds. Presented design of diagnostic system was used to proof, that idea is correct. We did precise background research and mathematical simulations, which tells us, the development trend is correct. The next step are laboratory tests followed by tests on real homogenization yard and comparing calculated data with geodesist's estimation. Proposed online volume estimation with usage of two or more cameras is unique system, which can be implemented as a part of Industry 4.0, more precisely as a part of augmented reality.

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