LARGE INDUSTRIAL SCANNING

Sorin NISTOR, junior assistant eng., University of Oradea, ing_nistor@yahoo.com
Aurelian Stelian BUDA, lecturer Ph.D. eng., University of Oradea,budaaurelian68@yahoo.ro

Abstract: *This paper aims to present applications of the scanning process, using high speed scanner in industrial environment. Studies are made in rough environment such as a sugar factory. The main scanning application it is used for as-built-documentation for the tanks, pipe and for all necessary installation for production of sugar. There are two main directions for the applications: (1) problems that occur in the environment filled with sugar powder (2) calculation of an impressive number of stations.*

The aim of this article is to present the results and the problems occurred in the process of scanning and also in the registration and modeling process.

Keywords: *scanner, industrial environment, as-built-documentation*

1. Introduction

Because industrial development in Romania took place largely in the 1965s-1990s many of the factories built then, they have no plan to highlight the structure and complex machinery inside the factories. Thus the problem of creating an inventory of the objects that define a real factory was increasingly needed.

Complex shapes and the sizes of the factories can put problems not only in terms of the necessary documentation but also in terms of technology. Because of the loss or destruction of topographic documentation, and the aging of the staff that participated in the raising of the plants, makes laser scanning to be more than necessary.

The need to obtain information in a timely manner, with regard to industrial equipment, which due to wear, makes re-upgrading factories to be essential.

As a result of these considerations we can say that, it is not only working speed, ability to view 3D areas of interest, become decisive factors in the choice of equipment used, but also, additional costs that may arise by the delay in upgrading the factory. So, just the delay of a few days in replacing worn out equipment can generate very large financial losses.

Rapid development of the scanner's, that uses the phase shift technology they become faster and more accurate each year. The beneficiary that desires to obtain 3D products makes the using of scanners in the industrial field to be growing.

In comparison with the technology incorporated in the total stations, not only speed creates differences - from measuring speed of 1-15 PTS/sec to the scanners at speeds of 1 mil/PTS/sec. Not only the speed, it is a decisive factor, but also the precision, that we can obtain by using the laser scanner technology – 0.2 mm to a few millimeters.

So, scanning technique comes to help us to create new topographic plans, but this time includes visualization and decision making ability in a very short time due to the presentation of products in the form of 3D.

2. Data acquisition and used software

Due to the complexity and size of the object to be scanned, we were forced to use a scanner that allows retrieving information with very high speed. This necessity has appeared since in the factory, the manufacturing process of sugar could not be stopped, an action that could produced very high economic losses. The scan was conducted in the presence of the necessary technological processes of obtaining sugar, and in the presence of specialized personnel. All these have created a series of obstacles in the process of scanning and processing. For processing, modeling and visualization of data has been used a number of specialized programs in the field of scanning.

For data acquisition we used the Trimble TX scanner - figure 1. It is a scanner that works on the principle of phase shift. This principle uses high precision clocks that modulate the power of the laser beam. The light emitted is modulated in amplitude and projected on a surface. Isolated reflections are collected and a circuit measures the difference in phase between the shapes of the wave transmitted and received, therefore, the delay time.

Figure 1

Trimble TX5 is a high-speed 3D laser scanner that is able to measure up to 976000 pts/sec. The maximum range is 120 m. There is also an integrated color camera featuring an automatic 70 megapixels parallax-free color overlay. The end result is a detailed photorealistic 3D color images made from millions of points. This provides an excellent solution for documenting existing conditions for BIM, industrial facilities, where detail and color are very helpful [1].

For the integration work in Stereo projection system 1970 - we used double frequency receivers Trimble R4 and a Trimble S6 total station. We define a closed traverse of 112 points that define the necessary flat target used in registration process.

The software that we used for the processing was Trimble RealWorks 8.0. We also used Bentley Pointools V8i for viewing the point cloud, and creating the presentation movie. For the modeling process we used Trimble RealWorks 8.0.

Trimble RealWorks software was used for starters for the registration process, because of the unique way that allows us to see every scan station and extract only the necessary targets for the registration process. We can see the entire scan station without loading the point cloud, in scan explorer option where we can do also basic interrogation on the scan object – Figure 2.

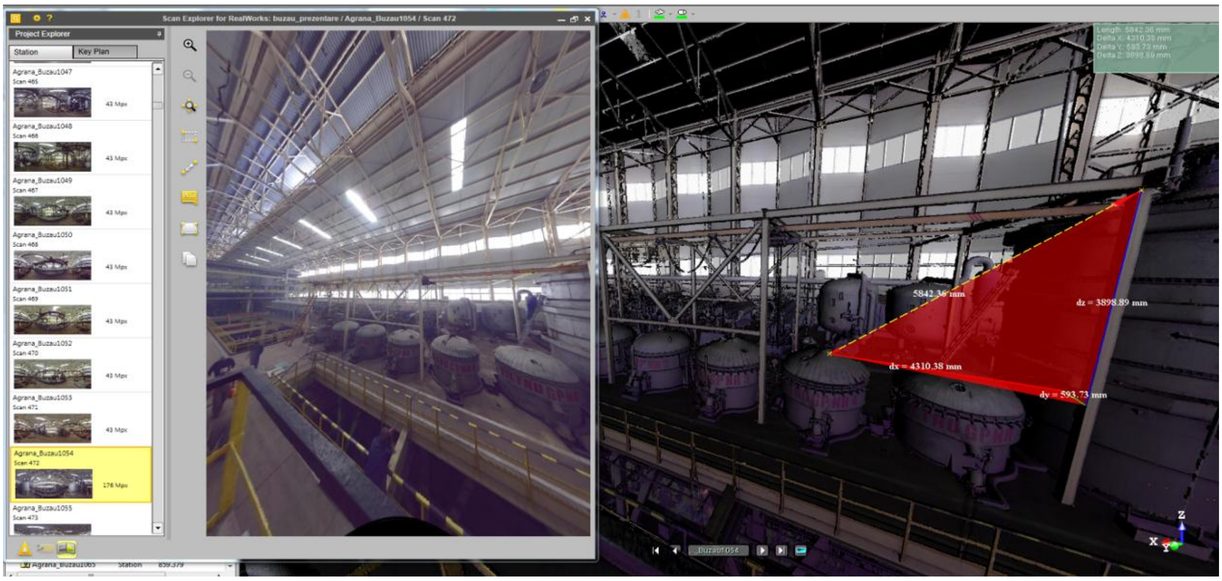

Figure 2.

In the left part is the scan explorer where we have only the picture and in the right part we have the point cloud.

So, we were able to do the registration process using only the points that define the necessary targets and not the entire scan station - Figure 3.

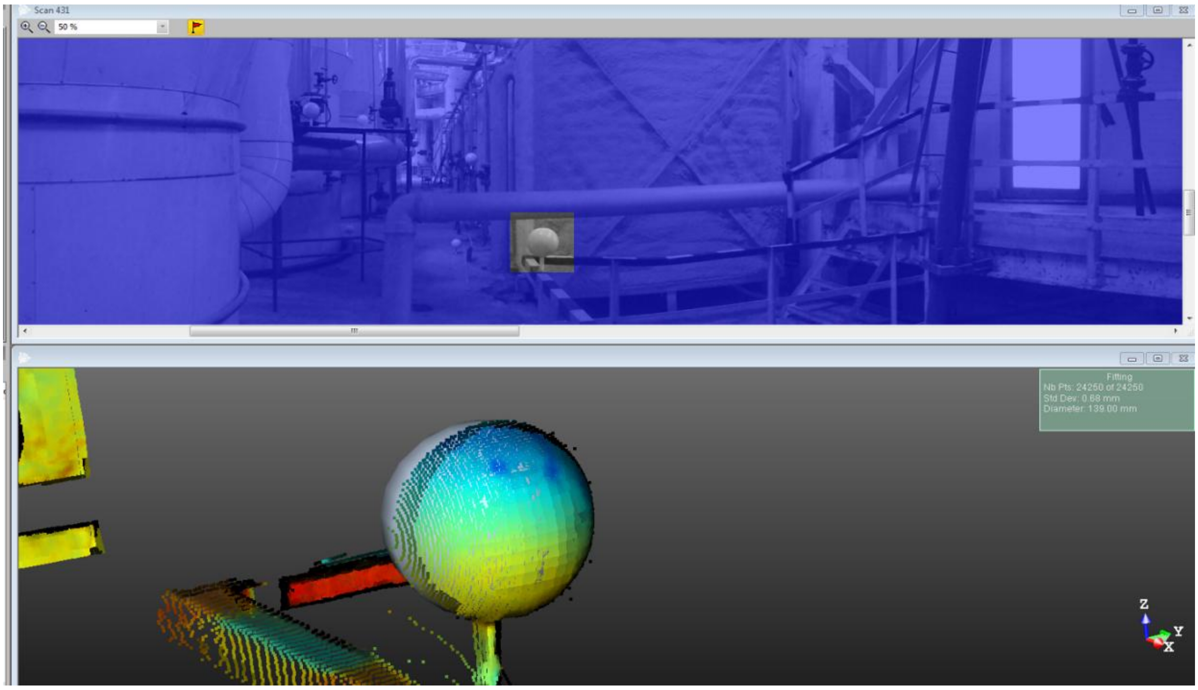

Figure 3.

3. Case study

The case study was made in Buzau city to the sugar factory Agrana. This is situated in the S-E part of the city – Figure 4. The factory occupies an area of approximately 6 ha.

Figure 4.

The main activity of the factory is the production of sugar, from sugar beet and brown sugar production of raw cane sugar.

The figure 5 represents the point cloud that defines the sugar factory containing the real colors.


Figure 5.

The aim of the scanning was to obtain the entire complex in 3D, and to model the technological process of obtaining sugar Figure 6. – the left part is in RealWork and the right part is in Autcad 2013.

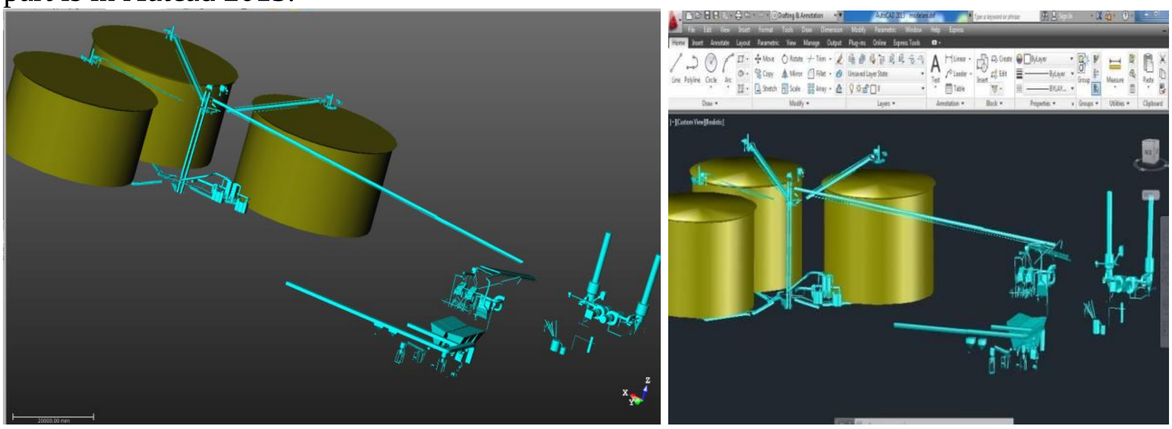

Figure 6.

Due to the complexity of the factory as well as the requirements of the beneficiary, we obtained 850 stations from which the scanning was made.

The resolution has been set depending on the environment where the scan was made - namely - outside of the buildings the resolution has been set to ½ resulting in approximately 180 million points, and inside the factory the resolution was been set to ¼ resulting in approximately 45 million points in each station. This resulted in the end in about 30 billion points.

For the registration process were used 11 spherical targets with fixed diameter of 139 mm, as well as flat targets - black and white - in each area in which it was necessary to determine the stereographic coordinates.

The field of view that we used was in general of 360^0 in horizontal and 300^0 vertical.

An advantage of this scanner is that it has incorporated photographic camera that can obtain a 70 megapixel of color.

The registration was made semiautomatic due to the fact, that many of the objects inside the factory have circular shapes - pipes, reservoirs - thus resulting in an automatic registration with a lot of wrong identifications of the targets.

For a better behavior of the registration due to the ability of the software from each station's were extracted only the necessary points for defining the targets. So at the end of the work we gathered a number of about 1 billion points that have defined the used targets. This was the major advantage, that it wasn't necessary to load the entire scan, and after the registration, we exported the registration parameters to a *.txt file. Once we obtain the *.txt file of the entire registration we were able to load the scan's one by one, so we were able to model one station at the time, obtaining a good performance of the software, because to load the entire scans was impossible, not only from a software point of view but also from the hardware point of view.

The major problems that occurred during the scan it were the protection of the equipment used. Because in the processing sectors there was a very fine powder sugar that could damage the scanner, but also the problems appeared due to the restructuring of the factory – they were using welding equipment, cutters, etc. made these problems to be treated as a special risk hazard.

As if there wouldn't be enough physical problems, there were the problems generated by the complexity and dimension of the factory that generated 850 stations. We have done a bundle adjustment, and because of the paring of each target, the necessary time for the registration raised up exponentially.

The entire project was filtered until we did obtain approximate 3 billion points and than we did export the points in a *.las format. Also the modeled objects was exported in *.dxf format.

4. Conclusions

Conventional measuring methods due to the complexity of a factory, it can only provide minimal information because the obtain points do not provide all the physical characteristics of the object that is measured, but due to technological advances, namely development of scanners it makes it possible to obtain high resolution information in a relatively short time. Attaching or incorporation of photographic cameras allows us, acquisition of real color that define the objects, and coloring the point cloud which allows identifying the scanned objects to be made with easiness.

Also, obtaining complex 3D models allows us to perform from the simplest queries - measuring the distances, calculation of areas, surface, volume etc. - up to complex query – clash detection or collision detection. This type of interrogation was used in the E part of the main building and in the upper floor where it was necessary a modernization of the processing equipment - figure 8. The imagine from the left part was scanned the first time and we did done a simulation for clash detection. After we come to the conclusion that is it ok, they clean up the area and we did do another scan – right part of the imagine.

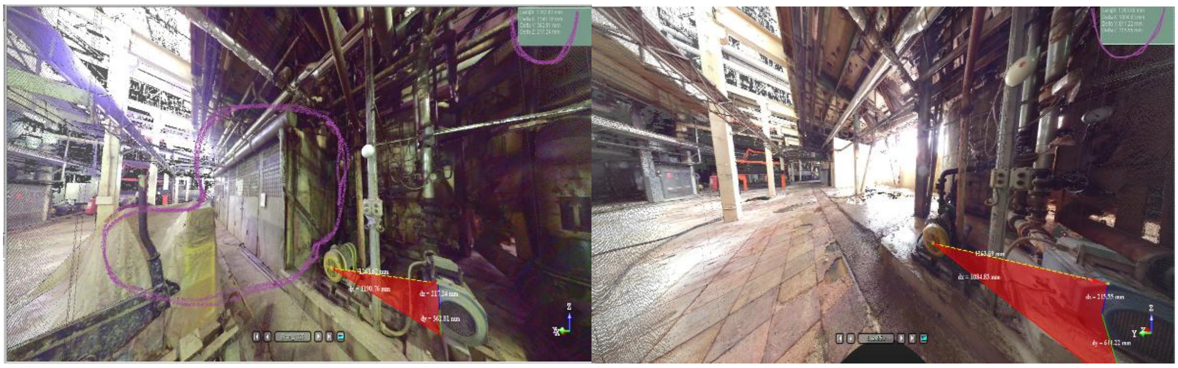

Figure 8.

This type of query was needed because tanks were introduced with a higher capacity than the previous ones and it was checked if they have enough space to be able to be fitted.

3D models allow both specialized personnel and non-specialized staff to perform with easiness different 3D simulations. Hence, different problems can be removed, like the over dimensioning of the various engines, containment tanks - which cannot be mounted, without affecting the various installations in the area that needs to be rebuilt. 3D scanned object also shifts responsibility and attendant liability to the construction engineers.

The main reason for the creation of a 3D model is that enables collaboration of several disciplines in real-time: project managers, site managers, construction engineers, plant engineers, electrical engineers, and persons responsible with security issues.

The scanning and the three dimensional modelling technique has a large applicability, but the development of the technological background, data acquisition hardware and dedicated data processing hardware and software, brings new possibilities of harnessing this technology.

5. References

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