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Digital twins in brownfield projects

PROSTEP

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PROSTEP has developed a procedure that uses AI-based techniques to recognize engineering objects in point clouds and map them to BOMs, P&IDs, and other documentation.

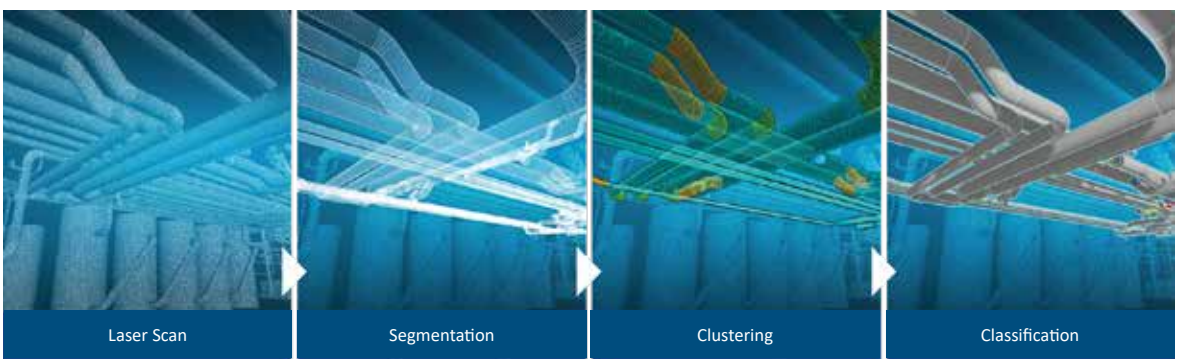
An elegant, faster and more cost-effective solution for creating a digital twin is the so-called 3DigitalTwin. At the core of what PROSTEP calls 3DigitalTwin is an AI-based software with the ability to create a digital twin from a point cloud in a three-step process. First, there is automated recognition of object structures, such as piping and equipment, which are subsequently converted into 3D models. Then the model of the plant or parts of it is enriched with the process knowledge from P&IDs. Pipelines 'know' their components and 'know' which equipment they are connected to.

In order to realize all this, PROSTEP and Schuller & Company have bundled their competences in a cooperation. The implementation of 3DigitalTwin is carried out by PROSTEP. Based on the DigiTwin research project, the AI developed there was further enriched into the 3DigitalTwin software. PROSTEP's decades of experience in data conversion with OpenDESC ensure excellent data quality of the results. Schuller & Company are recognized experts in plant engineering. Their know-how enables the AI not only to derive 3D models, but also to link the objects with the information from the P&I flow diagrams

Weak artificial intelligence (AI) has what it takes to bring a new quality to the post-processing of laser scanning, especially in industrial engineering & construction (E/C). PROSTEP AG from Darmstadt, Germany, has identified the huge potential and formed its own AI expert team. This text covers the background to this.

In the evaluation of 3D data, the difference to conventional image processing is that the spatial object geometry does not have to be reconstructed, but is directly available within the data. This facilitates object recognition, allowing the segmentation of 3D data and the evaluation of shape features independent of illumination conditions and color contrasts (1).

Weak AI focuses pragmatically on solving individual application problems, basically putting aside the nebulous term 'intelligence', which attempts to pay homage to the cognitive abilities of human beings. Rather, weak AI's goal is to achieve object recognition and metadata assignment using the various techniques of computer-aided learning without having to explicitly



program the system to do this. However, manual activities in the sense of supervision are still necessary.

The role of machine learning

A promising use case for machine learning (ML) is when large unstructured data sets are to be classified, which is especially true in the industrial E/C markets when laser scanning is used (2). The geometry of a scanned object is represented three-dimensionally solely by points that are defined exclusively by their coordinates in space, but initially have no component reference. Accordingly, the individual assemblies must first be recognized and assigned to object classes on the basis of these points. This assignment is called semantic segmentation. Because of the analogy of the systematics to image and object recognition, supervised learning can be used for this purpose.

Innovative approach

So how does PROSTEP's approach work? First, parts or an entire process plant are scanned in the old-fashioned way. Then, conventional, but powerful algorithms are used to recognize surfaces or coherent patch ensembles in the resulting point clouds with their enormous amounts of data. In addition, a combination of various machine learning algorithms is used. PROSTEP uses a variety of freely available ML libraries for this purpose. "We have not developed our own algorithms, but have trained neural networks, for example, to recognize objects representing machinery equipment. Our solution is designed to identify engineering items such as pumps, valves, pipes and their fixing from the scans. This is the first step," explains Karsten Theis, CEO of the software vendor.

In the second step, these identified objects are matched with existing drawings, for example with data from P&IDs. Based on these 2D documents or 3D models, the AI solution tries to map the contained metadata to objects located in the scan and thus in the physical plant. For instance, this allows the assignment of attributes from manufacturers and specifications. This is the decisive step, by the way.

More than 'just' use cases

Business cases can be found in revamps, modernization or upgrading of existing process and manufacturing plants ('brownfield projects') in order to accelerate the accompanying approval process. Meanwhile, 3D models are now mandatory for this procedure, which was not the case in the past. Owing to the lack of alternatives, up to now, existing plants have been remodeled in 3D, in outsourcing countries like India – a process requiring enormous investment and which is also time consuming. This can almost be prevented by PROSTEP's approach, as more than 90 percent of the modeling effort can be saved. "After all, reconstructing such a plant usually costs more than ten million euros. The hit rate with our process is currently around 80 percent guaranteeing huge saving potential," emphasizes the member of the board. A higher hit rate is hindered, among other things, by the fact that objects can be hidden or overlapped by others or other ambiguities occur. Karsten Theis does not believe that a hit rate of more than 90 percent can be achieved with reasonable effort.

In order to enable augmented reality use cases, e.g. in the context of maintenance work, a whole range of information is required. All components of a plant must be known and clearly identified. Moreover, 3D models help the plant engineer to understand the structure of a component and the plant structure puts the individual components in context with each other. Due to maintenance, repair, and overhaul measures during the utilization phase, a plant changes continuously. The 3DigitalTwin acts here as a source or sink of information

Manageable investments

It is not uncommon to hear that AI is expensive. Is that true? “No, the costs are not that high. If the AI libraries are purchased, the investment is really manageable. There are also free versions available,” the CEO points out. However, it is also obvious that if AI is to be implemented, large amounts of data must be processed permanently. And the hardware infrastructure required for this can incur considerable costs, whereby cloud computing does not necessarily make things cheaper, because it is usually billed per transaction.

Note, a scan takes a few hours, as does the post-processing – that’s not a big cost factor. On the other hand, Siri’s speech recognition really draws power. The electricity bill alone is already significant! What is more significant for AI applications in the industrial environment is the associated engineering.

The team of AI experts now established at PROSTEP serves to respond quickly to client requests. Since many innovations can still be expected in this area, also with regard to new business cases, there are a lot of open questions. By the way, AI can also provide excellent services in the area of the entire development process in the form of assistants that suggest certain solution paths to the designer. Karsten Theis believes that 50-time savings in order processing will be feasible in the not-too-distant future.

Closing remark

“The world is changing so fast that ‘the question of why’ should be asked at least once a day. AI cannot provide answers to this question. So it can’t bring insights into the causes of any change,” Theis points out. Nevertheless, AI holds considerable savings potential when it comes to automating engineering-relevant processes. Thus: Let’s try to implement repeatable procedures. (bv)

References

(1) www.iosb.fraunhofer.de/de/kompetenzen/bildauswertung/objekterkennung/3d-sensordaten.html

(2) en.wikipedia.org/wiki/Machine_learning

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The hit rate with our 3DigitalTwin approach is currently around 80 percent guaranteeing huge saving potential.

Dr. Karsten Theis,
member of the board, PROSTEP AG