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Surface profiling of the underground infrastructure in the technology of it platforms Part I

Abstract: The article is devoted to one of main elements of the technology of IT PLATFORMS, i.e. VIRTUAL PROFILING of the underground infrastructure. Implementing of this technology to the wide scale can very much change investment and administrative processes. VIRTUAL PROFILING of underground infrastructure is an example of using IT PLATFORMS VR3D in real investment tasks. This section presents examples of how to use this technology in practice.

Keywords: IT platform; Virtual profiling; Underground infrastructure

Introduction

The IT PLATFORM technology is currently one of the most modern technologies for modeling underground infrastructure on the market, for the purposes of inventory, design, investment supervision, operational supervision and crisis support. It is a technology conceptually similar to BIM technology.

The IT PLATFORM technology, thanks to the extensive use of VIRTUAL REALITY 3D modeling, allows for unlimited observation of all identified and presumed elements of underground infrastructure in the modeled area. Appropriate software contained in IT PLATFORMS allows for smooth adjustment of the soil transparency, from zero to full transparency, which makes the soil model a fully transparent "glass block" with precisely positioned installations and underground objects.

Issue

The development of digital technologies allows for the creation of more and more detailed maps of underground infrastructure and for more and more accurate modeling of the shape of the ground surface, including all urban elements.

However, the basic problem that arises during earthworks is the precise adjustment of maps on the construction site to the actual location of underground infrastructure elements. Unfortunately, the accuracy of these actions is often from 1 to several meters.

It is possible to precisely determine the location of underground infrastructure elements using GPS measurements, however, by using GPS technology only point

measurements can be obtained. It is a time-consuming and sometimes complicated activity in the investment area. In addition, it requires the constant presence of a specialist on the construction site with appropriate measuring equipment, which generates additional costs.

It is also a double implementation of the same measurement task because the first time measurements in GPS technology are performed during inventory works and the second time they must be performed during earthworks in order to determine the exact location of underground infrastructure elements.

In light of the information technologies available on the market, it is an activity that consumes additional time and financial resources. In addition, after completion of the earthworks, another post-completion measurement in GPS technology must be made and the collected data are unfortunately still stored in 2D imaging technology.

Solution

The ideal solution to the problem would be to develop an IT technology that would significantly reduce the time-consuming and cost of measurements in GPS technology before and during investment works, and that would make it possible to use it on the construction site by the management staff as well as by operators of construction machinery and construction workers, at a fixed level of access to information.

An ideal IT technology would offer many auxiliary functions, such as EXTENDED VIRTUAL REALITY elements or "VIRTUAL LIMITS" for performing earthworks, with operational coupling with construction machines. Then the earthworks could be carried out in the same way as complex surgical operations using laparoscopic robots.

1. A laparoscopic robot that allows performing complex surgical operations without extensive cutting of the skin tissue, but only by introducing multifunctional laparoscopic grippers into the patient's body through small holes in the skin. The robot's software allows for the introduction of "boundaries" of the operating field, which protect the surgeon from damaging healthy tissues adjacent to the operating field.

2. Remote controlled, GPS positioned and highly automated construction works can operate with the precision of surgical laparoscopic robots and have similar assistive software**.**

If appropriate machines were built for earthworks to mimic the operational capabilities of laparoscopic instruments, earthworks costs would drop dramatically and would be performed with "surgical precision" so as not to damage any adjacent underground utilities and avoid any underground obstacles. These works could also be performed in a highly automated and remote manner.

However, before we start using intelligent machines for earthworks on construction sites, we can already significantly improve the parameters of these works, such as time, costs, accuracy, archiving, and data processing in 3D technology and observation of the terrain in VIRTUAL REALITY 3D technology.

So how to start the process of computerization and the "robotization" of earthworks? The solution is IT PLATFORM technology. It is a technology that allows for the integration of several types of operating and analytical software within one IT product.

IT platforms allow for the very precise building of 3D models of underground infrastructure, with an accuracy of fewer than 10 centimeters. Such accuracy is absolutely enough for earthworks to be carried out collision-free and safely for adjacent installations.
IT PLATFORMS also solve another problem, namely PROFILING UNDERGROUND INFRASTRUCTURE ON THE GROUND SURFACE.

You can of course paint on the ground surface with chalk or paint, the course of underground installations, but the same task is much better performed by the VIRTUAL REALITY 3D visualization technology in the form of VIRTUAL SURFACE PROFILES.
So how does this technology work?

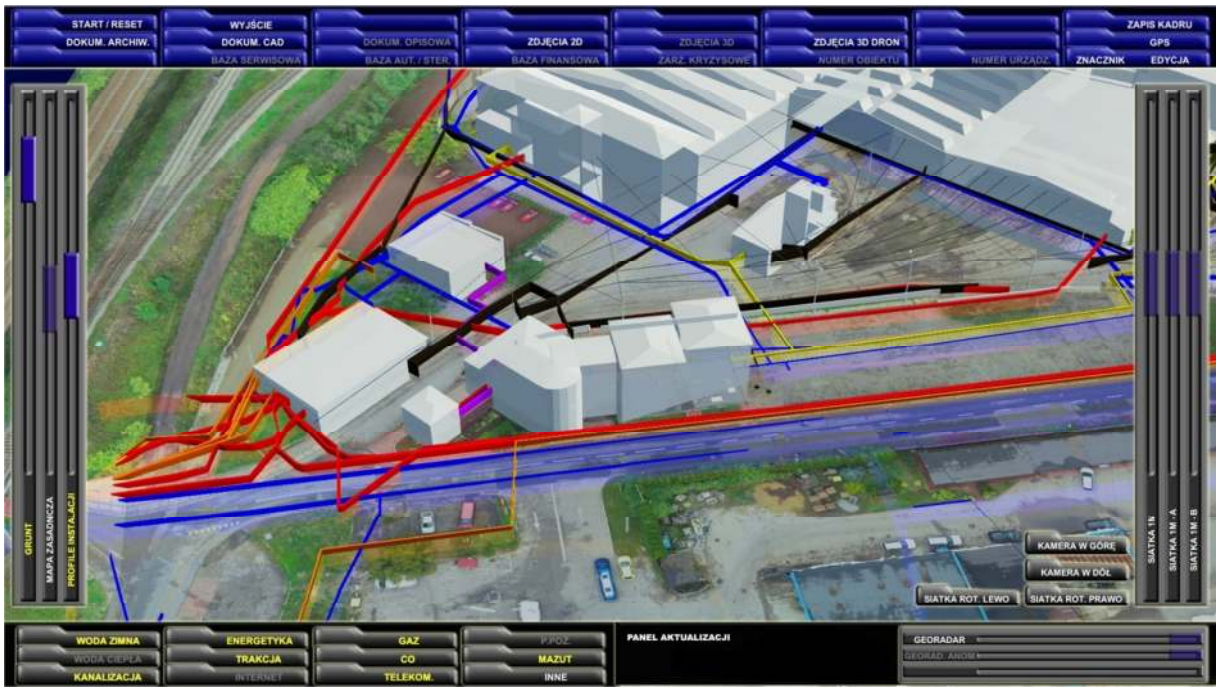
In the first phase of investment works, i.e. during the inventory of the investment area, a very precise 3D MODEL of all elements of the underground infrastructure is made. We are talking here about "3D models" and not about "digital 2D maps" as used today. These technologies are radically different from each other and the 3D modeling technology is far superior to 2D imaging. The exponent of this advantage is a physical, not a descriptive image

of the vertical dimension, i.e. in short, very accurate and visualized information about how deep underground the underground infrastructure elements are located.

During the inventory, GPS measurements, magnetic measurements, etc. are performed only once and they allow for the construction of a three-dimensional model of the investment area and its extensive use during the entire investment process and then for many years of operation and administration of the constructed installation or facility.

Now how to use precisely collected data in 3D models?

The answer is VIRTUAL PROFILING technology. It is the VR3D PROFILING technology that allows for "drawing" on the ground of the investment area virtual lines representing the layout of underground installations and facilities as well as the boundaries of safe earthworks. In order to use the VR3D PROFILING technology, a properly programmed IT PLATFORM and VIRTUAL GOGGLES are required.



3. The screenshot presents the colored profiles corresponding to various underground installations in the representation on the ground surface. Such an image is projected onto virtual goggles and allows for continuous and precise observation of the course of underground installations while moving around the investment area.

The 3D image of the inventoried area is displayed on the virtual goggles screen, and the appropriate program enables the inclusion of vertically oriented planes, which exactly coincide with the axes of underground pipes and cables. Similar planes with vertical orientation also mark the contours of underground structures and unknown objects that require more precise identification.

In the places of intersection of these vertical planes with the ground surface, we obtain an exact PROFILE on the surface, i.e. the course of the underground installation or object wall, in precise correlation with the three-dimensional terrain model.

For whom can this type of technology be useful?

The VR3D PROFILING technology is useful both for managers on construction sites as well as for operators of construction machinery and earthworks. It is enough to put on virtual goggles, which can take the shape of SAFETY GLASSES and activate the function of displaying a virtual image linked with GPS positioning. This means that each head movement in any direction will allow for the observation of the area in conjunction with the image of the

complete underground infrastructure and the image of VR3D PROFILES of these installations, which will be visible on the surface of the investment area.

4. A frame from the author's presentation showing the image seen through virtual goggles of the inventoried investment area. In this case, the transparency of the ground in the virtual goggles is about 90%.

Summary

IT PLATFORMS offer the possibility of using the latest IT solutions based on Virtual Reality 3D imaging. The technology of VIRTUAL PROFILING of underground installations is one of the main elements of visualization of underground infrastructure in IT PLATFORMS and is the future of inventory, investment, and administrative works because it not only allows for precise positioning of all elements of underground infrastructure but is also an excellent basis for programming the scope of earthworks performed by autonomous construction machines, which will more and more widely enter the construction market on a global scale in the upcoming years.

It will be possible to expand the knowledge about the technology of SURFACE PROFILING OF INFRASTRUCTURE using VIRTUAL REALITY 3D in PART II of this article.

Source materials

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