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Surface profiling of the underground infrastructure in the technology of IT platforms - Part II

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. This section presents information on the technology of SURFACE UNDERGROUND INFRASTRUCTURE using VIRTUAL REALITY 3D. This technology is extremely useful for interactive support of investment processes. It can be useful for effective engineering work associated with interactive remote visualization in real mode.

Keywords: IT platform; Virtual profiling; Underground infrastructure

The IT PLATFORM technology is one of the most modern and one of the most developing technologies, which in the coming years may have a huge impact on the computerization and robotization of investment processes as well as on the development of remote management of investment works.

In the coming years, there may be very serious changes in the implementation of investment processes and the works performing construction works and drones acting as building supervision inspectors will not be unique. Information technologies currently being developed will allow for very high automation of investment works and the robots will take over the most onerous and dangerous works that are currently performed by people of various specialties.

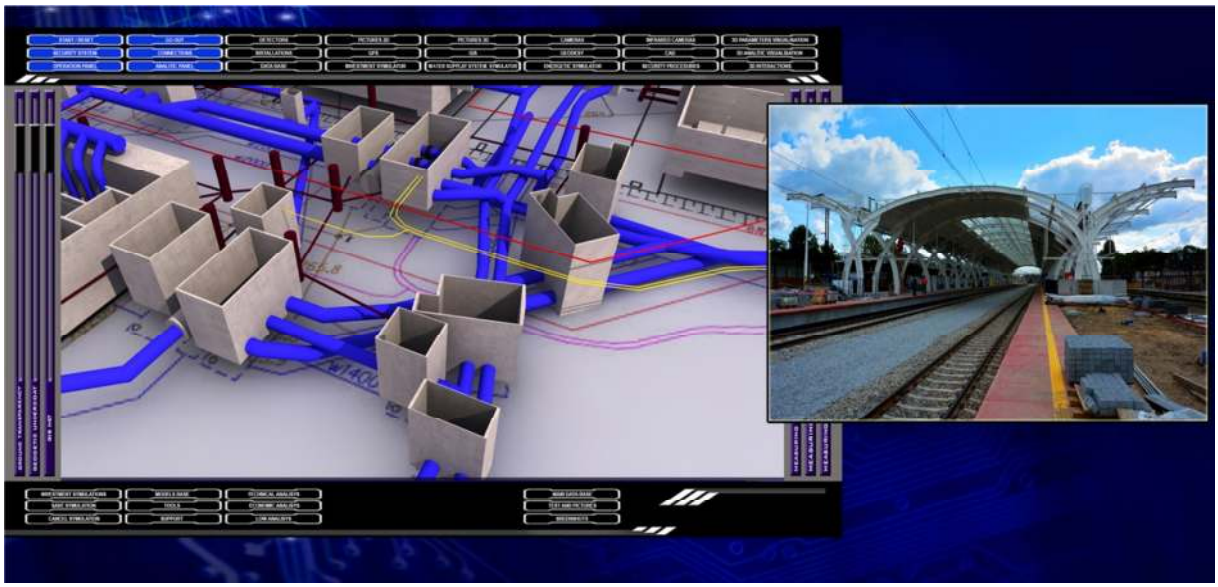
Of course, in order for construction works and semi-turnovers to perform work accurately, quickly, and without collisions, an excellent inventory of the investment area and synchronization of investment works are necessary. Sometimes it is also necessary to add motor coordination, as is the case, for example, on active railway routes.

For now, let's start from today and the current investment realities. Before we employ robots and semi-turnovers, we must learn how to accurately and quickly inventory investment areas and then how to use the collected data, visualized in Virtual Reality 3D technology, to organize and manage construction works.

Part I of this article presents the general idea of using IT PLATFORMS and the SURFACE PROFILING OF INFRASTRUCTURE function in Virtual Reality 3D

visualization. It's time to learn more about this and present examples of how this technology can be used in practice.

SURFACE PROFILING OF UNDERGROUND INFRASTRUCTURE is best done for virtual investment land models, already in the inventory phase, in order to update maps for design purposes. Currently, surveyors, designers, and investment management are working on flat vector maps, which before the update contain up to 20-30% of inconsistencies with the actual state. There are many reasons for this, but in this article, we will deal with issues related to the technology of very accurate and quick updating of information about the state of underground infrastructure and the efficient and effective use of this data in the design and investment process, and then in the long-term administrative process.



1. Slide of the presentation presenting the virtual technology of underground infrastructure modeling from the IT PLATFORM operation menu

In order to update the basic maps in 3D visualization technology, all updating works must also be performed in 3D technology. It is absolutely not unnecessary and too costly. It is very often much cheaper than the currently used methods of recording and storing information about underground infrastructure, imaged in a 2D system.

Taking into account the tendency in the development of IT for investment processes, which is inevitably moving towards 3D imaging, it is necessary to learn these technologies and become proficient in using them today. Until the standard of 3D visualization is not yet the generally accepted officially standard for the exchange of geodetic and construction information, work should already be started on the science and implementation of technologies with 3D visualization and Virtual Reality 3D. Data obtained with this technology can always be transferred to 2D visualization systems, but acting in the opposite direction is becoming more difficult. Education is most important.

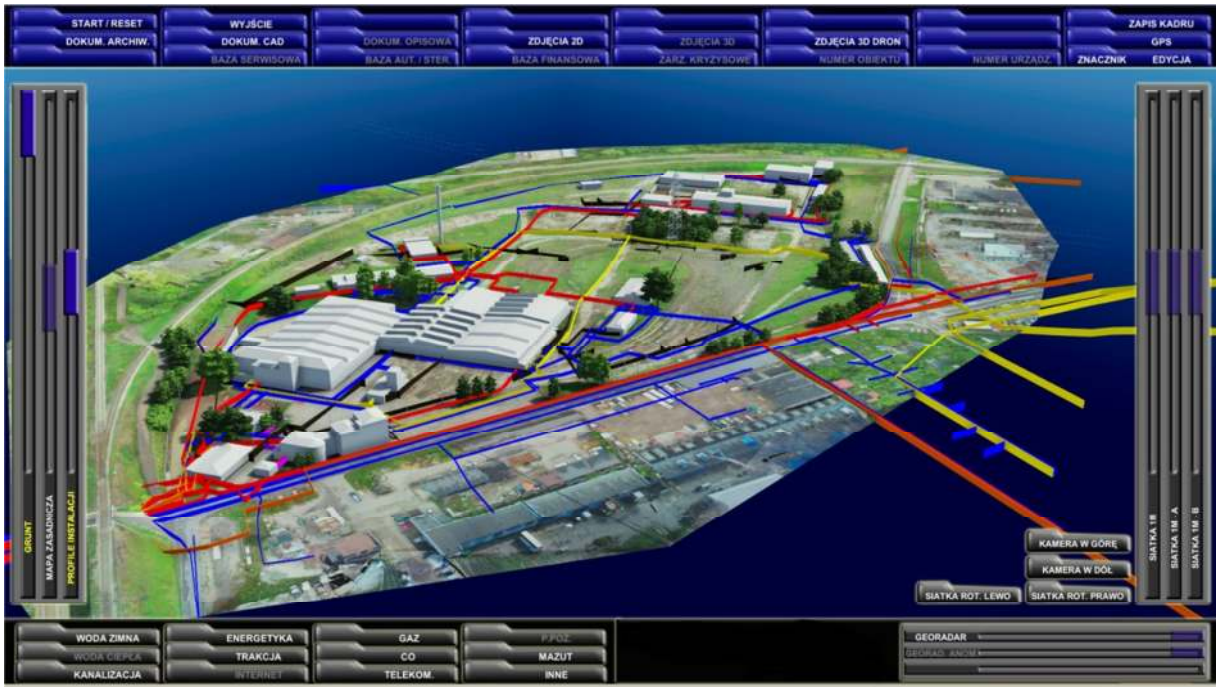
The market analyzes carried out by the authors of this article have shown that the barrier to learning to work in the Virtual Reality 3D environment is not the lack of technology or the lack of access to appropriate programs, computers, or cooperating devices.

The main barrier is the human mentality and the strength of getting used to the so-called "old methods". The result of this opportunism is a serious slowdown in the implementation of modern IT technologies for the implementation of investment and administrative processes. Unfortunately, the "human factor" is one of the most serious development barriers in the field of computerization of investment activities.

That is why so much emphasis should be placed on information processes and training of engineering and technical staff, who must learn to spontaneously generate interest in modern technologies such as Virtual Reality 3D.

Now let's go back to the technology of VIRTUAL PROFILING OF INFRASTRUCTURE OF UNDERGROUND INFRASTRUCTURE. The very dynamic development in recent years of GPS positioning technology, mobile networks as well as virtual and augmented reality technology created the basis for the development of technologies supporting investment processes with a very high degree of accuracy and very short access time to measurement data.

Such high precision and speed of data processing now enable the real-time generation of virtual images superimposed on real images in a "passive" and "interactive" form. "Passive" superimposition is a simple superimposition of a virtual image on a real image, and "interactive" superimposition is a combination of a real image with an interactive, or variable, virtual image, parameterized in real-time.

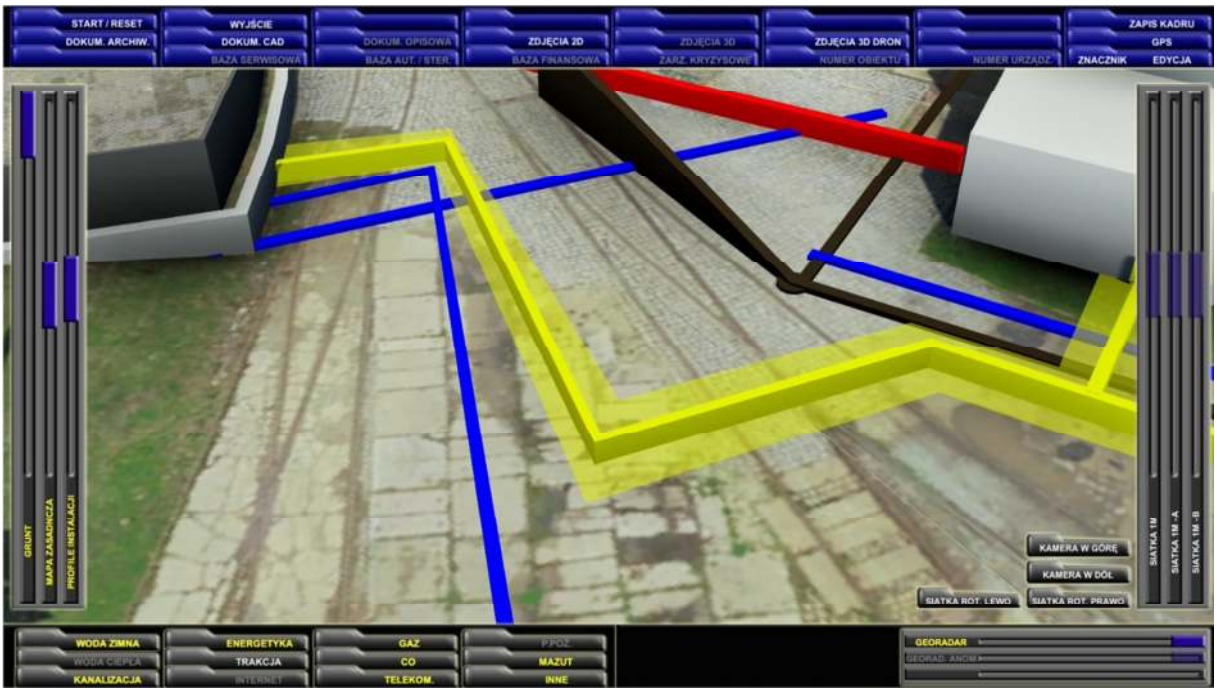


2. Screenshot of the investment area with rail infrastructure, with 3D visualization of VIRTAULAR PROFILES of underground installations.

The VIRTUAL PROFILING technology described in this article uses the "interactive" method, because to the image of the real investment area, seen through special goggles or glasses, it is possible to add a virtual image of PROFILES of underground installations and perform various interactive functions in 3D visualization or Virtual Reality 3D.

For example, a person moving around the investment area can move the PROFILES of underground installations up and down, which allows for continuous (in real-time) adjustment of the profile of a given installation or all installations simultaneously, to the shape of the terrain surface. Thanks to this interaction, the course of a given underground installation can be seen all the time through the virtual glasses, despite the distortions of these routes that arise on the hills and depressions of the investment area. This is a very important function that helps to locate the places where earthworks start. Regardless of the slope of the terrain, the virtual image of the PROFILES of underground installations is displayed on the ground surface, which greatly facilitates the correct placement of machines and control of their work, especially in places where they run at a short distance or cross.

Virtual profiling in 3D models also allows for very precise determination of the depths at which underground pipes and cables run and how they intersect, i.e. what is the vertical distance between intersecting installations.



3. Screenshot from an IT PLATFORM of an underground gas installation profile with a safety margin (yellow color with 50% transparency). Blue color means cold water installation, black color means storm sewage system and red color means electrical installation.

Now let's move on to the more advanced interactive "overlays" on the real image. Such an overlay can be the UNDERGROUND INSTALLATION PROFILE MARGIN, which defines the strip on both sides from the PROFILE axis (i.e. from the axis of the profiled underground installation) in which earthworks can be performed, so as not to cause negative effects on the installation and objects adjacent to the profiled underground installation. The margin may also be cylindrical around the axis of the installation.

PROFILE MARGIN can not only be used to display virtual glasses on the lenses, but it can also be EXTERNAL INFORMATION sent to construction machines carrying out earthworks. In such a situation, the PROFILE MARGIN becomes at the same time: an "IT command" controlling autonomous construction machines and "control information" displayed on the glasses of the person performing or supervising earthworks.

PROFILE MARGIN can be freely programmed, of course, according to the physical properties of the soil in which the profiling takes place. For example, in loose soil it will be possible, at most, to arrange a margin in the form of vertical trench walls. In rocky soil with adequate consistency, the PROFILE MARGIN does not need to have vertical walls. Data on the type of investment land should be entered at the initial stage of creating a 3D model of the investment area, before programming the movement of construction machines.

In order to synchronize the distribution of Virtual Reality 3D image and "IT orders" for construction machines, it is necessary to use an IT PLATFORM with the appropriate software.

And why should these activities integrate IT PLATFORMS?

Because IT PLATFORMS have this ability and can also transmit at any distance, Virtual Reality 3D image or 2D image (on the monitor screen) presenting the entire course of earthworks. It is an invaluable function that significantly increases the safety of earthworks

because IT PLATFORMS allow these works to be controlled by supervision inspectors, industry specialists, consultants or contract engineers from various places. These people can control the work performed separately or together, at one time and from different places in the world.

Such IT and technical possibilities give a completely new meaning to the notion of "HOME OFFICE". The IT PLATFORM technology enables the planning, design, and implementation of investment works from places distant from the construction site, and these works can be performed "on-line" by teams of the best specialists selected by the investor. Specialists may never even meet, but despite the lack of physical contact with each other and physical absence at the construction site, it is possible to organize investment processes perfectly. This is likely what the future of investment and administrative processes will look like.

Summary

Underground INFRASTRUCTURE PROFILING technology based on VIRTUAL PLATFORMS is an extremely useful IT technology for interactive support of investment processes, with visualization in the Virtual Reality 3D system. IT and technological development bring us closer and closer to the point where investment processes will be implemented by autonomous robots, controlled by IT systems with functionality similar to IT PLATFORMS. Engineers and construction workers will perform their tasks remotely, on computer screens or in virtual goggles, "working" hundreds of kilometers from the investment sites. There will be no residential barracks on construction sites, there will be no people in helmets moving between construction machines and engineers and construction workers will work at desks with panoramic computer screens or will move in rooms with cameras recording virtual movement ... but will in the virtual world continue we will call them "construction workers" ...?

Source materials

[1] Dyduch J., Dubiński J. – Metoda aktualizacji dokumentacji geodezyjnej do postaci map do celów projektowych (2019),
[2] Dyduch J., Dubiński J. – Nowoczesne zarządzanie infrastrukturą kolejową w technologii platform informatycznych VR3D (2018),
[3] Dyduch J., Dubiński J. – Platformy informatyczne jako baza dla zitegroanych programów symulacyjnych, w procesach dydaktycznych (2019).
[4] Dyduch J., Kornaszewski M. - Systemy Sterowania Ruchem Kolejowym (2012),
[5] Dyduch J., Zielaskiewicz H., Marciniec T. - Centra logistyczne jako istotny element sieci infrastruktury logistycznej (2019),
[6] Głowienka E., Jankowicz B., Kwoczyńska B., Kuras P. - Fotogrametria i skaning laserowy w modelowaniu 3D (2015),
[7] Koc W., Specht C., Chrostowski P. - Projektowanie i eksploatacja dróg szynowych z wykorzystaniem mobilnych pomiarów satelitarnych (2018),
[8] Michałowska K. - Modelowanie i wizualizacja danych 3D na podstawie pomiarów fotogrametrycznych i skaningu laserowego (2015),
[9] Strach M. – Pomiary dróg kolejowych i obiektów z nimi związanych oraz opracowanie wyników na potrzeby modernizacji kolei konwencjonalnych (2009),
[10] Uchański Ł., Karsznia K. - Pomiar inwentaryzacyjny obiektów przemysłowych przy użyciu naziemnego skaningu laserowego w aspekcie wdrażania technologii BIM (2017),

[11] Vatan M., Selbesoglu MO., Bayram B. - The use of 3D laser scanning technology in preservation of historical structures (2009),