Technology of augmented reality applications in dispatching control of industry processes and mining

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Abstract. The article describes approaches to creating products based on Augment Reality technology, examples of their practical application in production, including for dispatching, prospects for development in industry, including in the mining sector. The given examples demonstrate the production and economic efficiency of the introduction of modern computer technologies, including the technology of augmented reality. The article was prepared with the financial support of the Russian Fund for Fundamental Research within the framework of the scientific project No. 18-37-00356.

1. Introduction

The modern stage of civilization technological development is characterized by a significant integration of mobile devices into many spheres of human life. Using mobile device applications, users get fast access to an impressive amount of information and functions, for which before it was necessary to spend more time and use several devices instead of one. The use of Augmented Reality (AR) technologies in these applications allowed not only to improve the interface control, but also to obtain a tangible economic effect.

It is generally believed that the development of virtual reality began in the 50s of the past century. The augmented reality technology development went hand in hand with the virtual one, until 1990, when scientist Tom Codell first proposed the term “augmented reality”. In 1992, Lewis Rosenberg developed one of the earliest functioning augmented reality systems for the US Air Force. The Rosenberg exoskeleton allowed the military to control the machines virtually while in the remote control center [1].

2. Research objective

Augmented reality technologies are at the peak of popularity the last few years. Virtual elements or clues: geolocation tags, addresses, recommendations, pointers are superimposed on the real environment with the help of special glasses or mobile devices. Similarly, augmented reality has practical application in industry, only in production we have mechanisms and schemes instead of buildings and streets which are supplemented with data that help the operators, technicians, maintenance personnel to make decisions [2].

Scientists from all over the world are engaged in research into the augmented reality and its implementation in the industry. For example, the Chinese scientist Shou-xiang Zhang in his article “Augmented Reality on Long-Wall Face for Unmanned Mining” examines aspects of introducing

augmented reality into technology of unmanned mining [3, 4]. A team of scientists from N. Soete, A. Claeys, S. Hoedt, B. Mahy, J. Cottyn from Gent University in their research paper "Towards Mixed Reality in SCADA Applications" gives an example of SCADA system interaction and applications using technology augmented reality on the basis of an experimental setup [5]. This setup is an automated logistic process, which is very integrated into the Computer Integrated Manufacturing (CIM) structure.

3. Methodology

Solutions that use the augmented reality technology, consist of hardware and software parts. The first includes the means to ensure the virtual presence of a remote specialist on the spot - such a tool can be a pad, a smartphone or special glasses. The IT infrastructure should also be referred to the equipment involved in data transmission, which include switching equipment, storage servers, etc. At the same time, the software part can vary considerably depending on the specific manufacturer. The software part, as a rule, is unique for each project, currently there is no single or at least several major platforms accepted by the developers as a standard. Glasses, a smartphone or a pad project the data on the actual image that the technician needs at a given moment of time, be it diagrams, assembly order, the location of a possible malfunction or the replacement part serial number.

One example of the augmented reality technology successful introduction into the industrial sphere is Boeing aerospace concern, which began to use smart Google Glass, in order to speed up its employees work. One of the labor-intensive processes in the corporation is the cables connection between the aircraft onboard system components. Workers need to maintain concentration and carefully monitor to ensure that the cuts of the required length have been laid on according to the exact pattern and fastened between them into harnesses. They had to follow the assembly instructions, checking information on the laptop and constantly switching between direct work and information retrieval. To speed up the work, a special application for Google Glass was developed: using smart glasses and QR codes, the employee receives a step-by-step instruction for laying the wires, while his hands are free. As a result, the assembly time was reduced by 25%, the number of errors significantly decreased [6].

4. Discussion

One of the brightest domestic AR projects was implemented by Formika Lab. On the basis of the Moscow oil refinery, one of the pilot sites of "Gazprom Neft" for the use of digital technologies, the company proposes to implement a complex IT solution involving AR technologies. Initially, the company planned to launch a training program for the instruments' maintenance.

For the experiment, complicated equipment was specially selected, requiring special qualification of workers - infra-red gas measuring heads. Instruments are designed to control the explosive gases' concentration in the ambient air, and therefore, are critical in such production. Having studied the site and discussed with the workers, Formika Lab found out that the plant uses more than 1100 infrared gas-measuring heads [6]. At the moment the project is undergoing an industrial testing.

The use of AR-technologies is not limited to the automation of services engaged in the maintenance of various industrial installations "workplaces". For example, using the augmented reality technology, it becomes possible to create dispatching simulators, the use of which is possible on real objects of control systems. An example of such simulators is the start, landing and taxiing air traffic controller trainer described by Yeliseev et al. [7], which allows creating training off-optimum situations on a real airfield, and also mastering in the training classes a combination of existing and new air traffic control equipment presented in the form of virtual objects. Such a simulator is described as follows.

The controller is at the workplace and watches the airport's airfield. Along with real planes, virtual planes or other objects-cars, people, etc., controlled by real operators from special consoles, are moving over the field or in the air over the field. Virtual planes seem to be practically the same as real ones. Virtual airplanes can safely participate in training scenes on the ground and in the air, simulating

any situation, including emergency ones. Trained controllers communicate with pilots of virtual aircrafts in the usual ways, as shown in figure 1.

Figure 1. Example of application of a simulator in real conditions.

In the conditions of the mining enterprise technological process specific character, the territorial distribution of individual work sections, the decisive importance is acquired by the operational management of both individual work sections and the whole enterprise activities. At the same time, dispatching ensures uniform loading of all the enterprise parts, continuity, rhythmicity and economic fulfillment of all the production cycle main technological processes, uninterrupted operation of auxiliary and servicing sections.

With large industrial and other associations emergence in the sphere of mining, as well as the rapid improvement of transport, dispatching becomes an essential means of operational management of a complex set of technological processes and transport systems.

One of the most vivid examples of dispatching processes in mining production can be considered a single dispatching-analytic center SDAC-SUEK of Siberian Coal Energy Company. Under the control of SDAC there are nine underground mines, two open-cast mines, six auxiliary production units, seven service enterprises, it includes 24 types of different equipment and analytical programs. The dispatcher receives information in the real-time mode from all working extraction faces of underground and open-cast mines both schematically and through video cameras, he has the opportunity to view each object in more details. SDAC introduction allowed to reduce significantly the equipment downtime, to reduce the risks of incidents and breakdowns. So, in 2009, the average daily downtime of conveyor transport of the Kotinskaia mine due to problems with the drive systems in March (the month of maximum production) was about 3.5 hours (there were five conveyors in operation) [8]. In 2015, this indicator was about 0.4 hours and only due to the problems with automation systems (clipping, oxidation, fiber optic communication line breakdown, etc.). A photo of the video wall fragment installed in the central dispatching company is shown in figure 2.

In this context, an example of the augmented reality technology prospective application is its consideration as part of the control system, within the operator's mobile working place organization concept framework and integration with the neurocomputer interface (Brain computer interface, BCI) equipment for the mining industry [9, 10]. The main idea is to combine the technologies of the BCI and the AR for the control system of mineral deposits underground mining technological processes. The possibility to show the complex state information right before the operator with the detailed representation of interactive controls is designed to solve the problem of eye contact long time loss of indicators that display information about the state of operating mining equipment, thus reducing the likelihood of an emergency situation [10, 11].

Figure 2. Operative-dispatching control automated systems ODCAS.

However, not all AR-devices can meet the requirements of the production environment. In some cases, the devices must be shock- and explosion-proof. For example, Microsoft Hololens, with which developers often work, in their current configuration cannot be used. The first certified AR-device for production purposes was HMT-1 from the German company RealWear. The reality headset device is ergonomic: it can be attached under the helmet, it does not interfere with the use of protective glasses in the industrial environment. The device allows workers to get access to documents and communicate with other employees, helps with production navigation

A significant limitation for implementing the augmented reality at the enterprises are also the safety requirements - in addition to the fact that glasses and pads must exactly correspond to industrial regulations on explosion protection and shockproofness, in some enterprises it is also inadvisable to use open technology to spread information over the Wi-Fi. Therefore, at the plant territory AR-devices must operate in off-line mode. All the performed operation information is stored on the device. Database is used for data synchronization on devices. You can synchronize data in a specially designated place where the use of Wi-Fi is acceptable.

5. Conclusion

This article demonstrates the diversity of approaches to the creation and application of augmented reality products for industry. Developers are often “carried away” by technological innovations, their characteristics and technical capabilities, while for “industrialists” it is important how much this is useful and promising for the technological process, the employee and the business as a whole. At the same time, it should be noted that “industry”, in turn, does not always have the technological and organizational flexibility to integrate the augmented reality technology into the production and management process.

As a result, we can conclude that the augmented reality technology is firmly embedded in everyday life. At the same time, they can be used not only in the entertainment industry, but also bring significant economic and technological effect in many industries, including the mining sector.

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