This paper should be cited as: Winkler, T., Michalak, D., Jaszczyk, Ł., & Rozmus, M. (2010). Use of Augmented Reality technology in life of technical means. Proceedings of the Conference: Interfejs użytkownika - Kansei w praktyce, Warszawa 2010 (pp. 15–20). Warsaw: Wydawnictwo PJWSTK.

Use of Augmented Reality technology in life of technical means

Teodor Winkler,
Instytut Techniki Górniczej KOMAG
ul. Pszczyńska 37, 44-101 Gliwice
twinkler@komag.eu

Dariusz Michalak, dmichalak@komag.eu

Łukasz Jaszczyk, ljaszczyk@komag.eu

Magdalena Rozmus, mrozmus@komag.eu
Instytut Techniki Górniczej KOMAG
ul. Pszczyńska 37, 44-101 Gliwice

Interfejs użytkownika – Kansei w praktyce 2010
ISBN 978-83-89244-87-1

Abstract
Experience in use of Augmented Reality on example of mining machine life is presented in the paper. Creation of resources from designing and manufacturing knowledge at the stage of mining machines designing process that will be available at the stage of machinery use is discussed. The knowledge resources are supplied in a feedback loop with information from laboratory testing and they are available through Augmented Reality. Different forms of aiding the process of mining machines maintenance and servicing by use of Augmented Reality are presented. Examples of machines' users training at the workplace based on the concept of movable training stand with use of Augmented Reality are given.
Technical means that are withdrawn from use became the components of industrial culture heritage. Use of Augmented Reality improves assimilation of history of technology by setting into motion of museum exhibits.

Keywords
Augmented Reality, Maintenance, Training materials.

Introduction
Augmented Reality is a new computer technology used in monitoring of life of technical means. Chronologically it is after CAD (Computer Aided Design) and Virtual Reality technology. Augmented Reality consists in delivery of computer image superimposed on the real object for a user need in a specified situation. In many cases the computer image is created (processed) in CAD environment and makes an impression of virtual reality. That indicates for interpenetration of those three technologies.

Life cycle of technical means includes the stages like: designing, stand tests (laboratory tests) of prototype, manufacturing, maintenance and withdrawal from use. In all of those stages knowledge resources are generated, collected and open to be accessible. Usefulness of Augmented Reality is especially important in making knowledge resources accessible.

1. Essence of Augmented Reality technology

Augmented Reality consists in delivery of computer image superimposed on the real object for a user need in a specified situation. In many cases the computer image is created (processed) in CAD environment and makes an impression of virtual reality. That indicates for interpenetration of those three technologies.

In oppose to Virtual Reality, Augmented Reality does not create 3D world but only adds information and gives meaning to real places and objects, Fig.1.

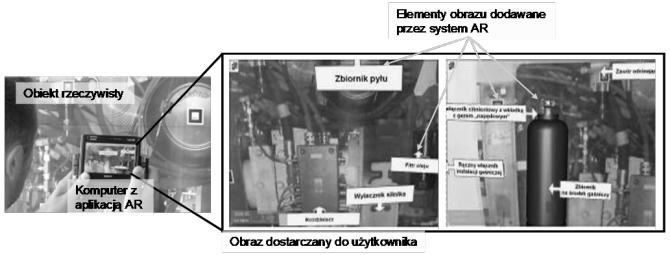

Fig .1. Idea of Augmented Reality technology

The main advantage of such approach is extension of real object's image by entering additional information from the selected range. In the case of trainings the information can include description of machine's design, principles of operation or any guidelines as regards servicing [2].

Augmented Reality technology is a quite new solution that is why there is no software available to make use of known functions or patterns. Special libraries made for recognition of images are available but their use requires knowledge of programming languages like C++ or C#. Present computer applications, developed in KOMAG Institute of Mining Technology are based on authors software solutions and on results from completed European projects. The software that is available on the market are the computer applications in amusement and advertising sector where such technology is used as curiosity.

In the systems that use AR technology superimposition of computer image on real image is realized after analyzing the user's position. User's position can be determined with use of movement monitoring systems like:

- global systems: GPS system of Hiball type – enable determining user's position outdoors or in a production room. Such approach requires use of additional equipment like GPS receivers or systems of optical sensors and LED diodes installed in special panels that enable to trace movement on long ranges.
- local systems: recognition of markers placed on the object, recognition of characteristic elements of the object. Method of tracing with use of graphic markers does not require additional equipment and only camera with a displayer is required. Characteristic points of the object need to be marked with any graphical markers.

Method of presentation of information on a displayer is important element of AR systems. There are the following types of display systems used in AR technology:

- Head-Up Display Systems. In that system the image is displayed on additional glass surface fixed ahead of the observer. On a transparent surface of the screen the elements that augment reality are

displayed. Due to high costs of such displays and the limitations associated with recreation of details and colors - mostly these solutions allow to display text or contours of objects. This technology has found widespread use in military aviation.

- display systems of 3D goggles type + camera. Solution using stereoscopic goggles for projection coupled with the camera gives very good results at relatively low equipment cost. In this solution the user observes environment through goggles, which display the image captured by camera enriched with elements of augmented reality, Fig.2.

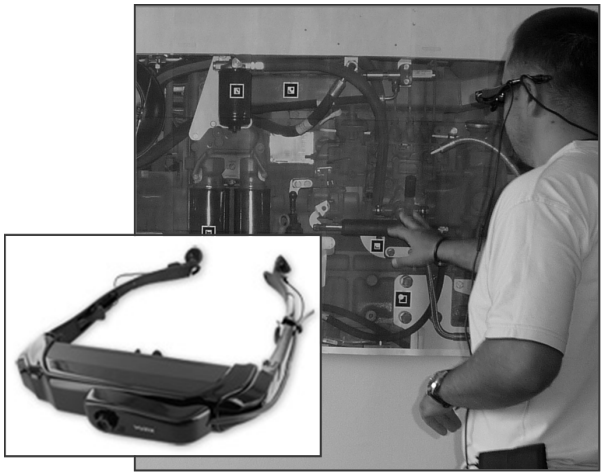

Fig.2. Use of 3D goggles in Augmented Reality

The quality of image displayed in this technology is strongly dependent on lighting. Poor lighting makes difficult to record image and thereby it prevents the presentation of additional information. The use of goggles as display may cause inconvenience resulting from a total covering of field of vision and replacement it with image from the camera.

- *presentation of information on UMPC computer.* In that approach the user by directing UMPC device, coupled with a camera, on the object gets the image on computer screen recorded by the camera and augmented by additional elements, Fig.3.

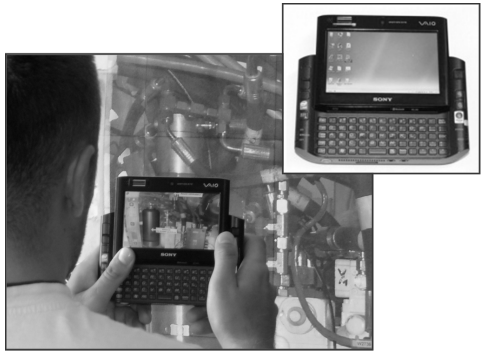

Fig.3. Use of UMPC computer in Augmented Reality

Use of UMPC computers in AR technology gives possibilities to be used for other applications, especially in trainings. Recognition of image is realized with use of built-in camera and there is no covering of field of vision and displayed image can be stopped and additional information can be analyzed at any moment.

2. Knowledge resources in technical means life cycle

Life cycle of technical means includes the stages like: designing, stand tests (laboratory tests) of prototype, manufacturing, maintenance and withdrawal from use. In all the stages knowledge resources are generated, collected and opened to be available. Usefulness of Augmented Reality is especially important in making knowledge resources accessible. Designing knowledge is transformed into operational knowledge and it is represented in form of:

- technical and Operational Documentation,
- collection of knowledge in knowledge repositories, IETM,
- aiding assembling/disassembling, servicing and repair operations.

3. Making knowledge repositories available by use Augmented Reality technology

Examples of trainings of machines users based on the concept of movable training stand with use Augmented Reality technology are given. In KOMAG Institute of Mining Technology a research work on using AR technology in training of operators and servicemen of suspended monorails was undertaken within MINTOS project [1]. Training programme that can be realized directly at the workplace – at the machine, which will be used by trainees in future, was developed. The programme does not only give knowledge about the given machine subassembly but also gives information as regards repairs of selected components of the machine. Block diagram given in Fig. 4 shows general structure of AR system prepared for training purposes.

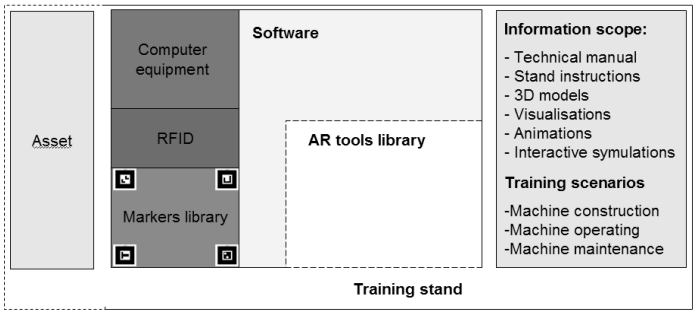

Fig. 4. General structure of AR system prepared for training purposes

AR system consists of the following:

- *software* – responsible for display of information associated with selected subassemblies of the machine and servicing procedures. This is the main part of the system containing procedures for recognition of markers placed on the machine and displaying precisely information on the object,
- *hardware* – in a suggested solution, UMPC device with Windows Vista operation system was used. Camera integrated with the device enables connecting the recorded image with the image displayed on the device's screen in real time,
- *library of markers* – labels placed on the object are important elements of the system, they enable identifying of currently recorded image by a camera, what can adjust displayed information to the currently observed part of the machine. Positioning of markers has to be realized according to regulations as the obtained results are repetitive and conform to reality.
- *object* – a mock-up of real machine - a diesel suspended monorail was made in scale 1:1 for testing purposes.
- *RFID* – also application that uses RFID technology is part of the system [2].

Use of the application is preceded by preparation of the object – the machine, consisting in marking of selected points characteristic for the machine, according to instruction attached to application. Technology of use additional makers is an optimal solution as it enables obtaining higher efficiency of the system, irrespectively from dirt that covers selected part of the machine. High contrast of markers enables to get good positioning of information on the object. The application analyzes the image from the camera and in the case of detection of known marker (previously entered into the system) displays information associated with it (3D model, servicing procedures, instructions, photographs, video recordings). Developed system includes selected

information, including driving unit of DZ-1500 diesel suspended monorail manufactured by SCHARF Company [3]. Screen views from training programme, which makes a trained person familiar with basic systems of machine, explains their principles of operation and presents their position in engine compartment, are presented in Fig. 5.

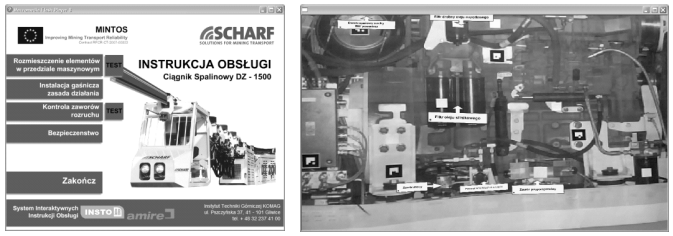

Fig.5. Arrangement of diesel engine systems in machinery compartment – training programme realized with use of Augmented Reality technology

The programme also includes selected maintenance procedures planned to be realized by mine service staff – with no need to call for manufacturer's service. Such formulated scope of trainings enables to prepare user to proper and safe maintenance of transportation system. Use of AR technology in trainings is justified especially due to the fact that a real object is a basis of all operations. Use of real object in trainings improves assimilation of knowledge and helps the users to accustom to the machine [4].

4. Use of AR technology in getting acquainted with heritage of industrial culture.

An interest of museum institutions in Augmented Reality solutions results directly from the fact that such applications attract young users who are interested in technologically advanced solutions Museum. State-of-the-art technologies result in higher attendance of visitors and perfectly reflect mission of such centres – making young generation familiar with the history.

The idea of applying AR technology during museum tours is presented in Fig.6.

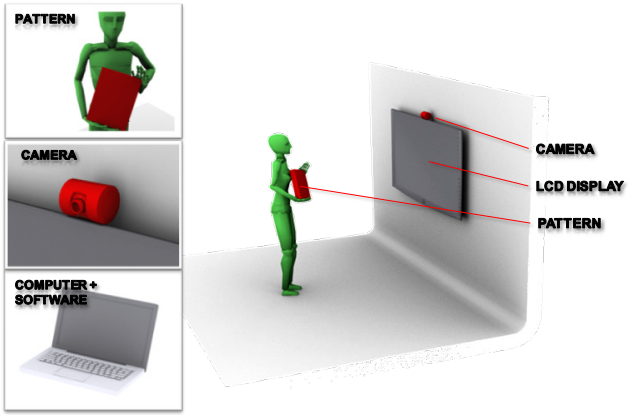

Fig. 6. Interactive stand made in Augmented Reality technology

AR technology enhances museums by additional flow of knowledge including virtual resources. The resources are presented in the context of real physical exhibits being watched by the visitor. So each exhibit might be augmented by its virtual counterpart. In many cases it is possible to show objects or processes that don't exist any more, so in a way it is possible to "recreate the past".

References and Citations

[1] MINTOS: Improving Mining Transport Reliability. RFCS Coal RTD Programme, Contract No.RCR-CT-2007-00003, 2007-2010.

[2] T. Winkler, D. Michalak, Ł. Jaszczyk, J. Rogala: Udostępnianie Dokumentacji Techniczno-Ruchowej nowej generacji przy użyciu

technologii RFID. Maszyny Górnicze 12/2008 str 48-51

[3] Materiał informacyjny firmy SCHARF: DZ 1500/1800 system transportu z napędem spalinowym.

[4] EMIMSAR - Enhanced Miner-Information Interaction to Improve Maintenance and Safety with Augmented Reality Technologies and New Sensors . Grant Agreement RFCR-CT-2009-00002