ADVANCED AUGMENTED REALITY APPLICATIONS IN THE PRODUCTION PROCESSES

Abstract: The basic aim of this paper is to introduce possibilities of production process by using special virtual tools from scientific field named Augmented Reality (AR) and their implementation on the real examples. After the introduction which sketch basic information about augmented reality, the first point quickly provides view on the current situation in AR of production processes. The following step is oriented on explanation of main philosophy of AR in order to apply their in the particular applications. The last part of paper observes real examples of possibilities to create AR, not only by commercial software but also by virtual environment which is offered by open source platform. All these mentioned possibilities and examples are implemented in the special virtual environment of the AR, where engineers can see necessary information about material, mass, special conditions etc.

Key words: virtual tools, virtual reality, augmented reality, production processes

1. INTRODUCTION

Presented paper explains main problems and structural logical concept of the production section for two kinds of the Augmented Reality (AR) applications. The AR is scientific field which interprets processes where real environment is connected together by virtual elements and this new conjunction provides the augmented tool in form of a virtual working space for user. As is mentioned in abstract, the beginning of the paper is oriented on the interpretation of basic thought of augmented reality and general logical steps which are explained by algorithm.

The second part of the paper is focused on the current situation in AR of assembling processes and gives visual imagine by enclose figures. However, it can describe advantages and disadvantages of these mentioned processes. The following step is oriented on explanation of main philosophy of AR in order to apply their in the particular applications. By means of the previous information, the last part of paper observes real examples of possibilities to create AR not only by commercial software but also by virtual environment which is offered by open source platform.

The conclusion gives a quickly recapitulation of paper steps and it is focused on the special programming packet which improves elements for the increasing entire quality of the visual area of the AR.

2. THEORY OF AUGMENTED REALITY

Augmented reality systems generate complex view where the virtual areas are covered by real environment and offer the basic working place for the engineer. Production process of AR has new special tool for the engineering area which provides strong elements and hardware components for creation of construction ideas. Final production process proposal include all functional 3D items of assembly without montage mistakes. The production application of AR was developed to determine the exact position and orientation for production process. Thanks to its possibilities if finds the utilization in many industrial spheres [1].

The problem that must be solved during this visualization step is comprised of two underlying causes. The first one has explanation in transformation processes of three-dimensional environment into two-dimensional image on the display. The main task of second one is necessary to knows exact position values of real basic coordinate system of general working table. Many companies use variable devices for observing an exact position of working area. These techniques can be divided into these main groups [2]:

- Motion capture by tracking sensors.
- Motion capture by camera (markers, colour).
- Laser tracking.
- Tracking devices.
2.1 AR based on observing of marker position

VTT’s Augmented Reality group started developing virtual application for AR games and entertainment applications. This mentioned engineering group provides the powerfully tool which is used for displaying assembling process of the AR [3].

The software element was designed to gives important information about assembling processes where the engineer needs to know exact position and numerical order for the single parts of the entire assembly structure. Camera provides a real video from working space and exact data about the position and orientation of the working place are obtained from markers which are on the plane of the working place.

Observing marker has its own mathematical matrix which comprise important data packet about its appearance and all variants of its rotation. Marker is made by two different colours, ordinary black and white for better comparing during the tracking process. Comparing loop takes a signal from camera in order to compare signal with marker matrix. On the Fig. 1 is basic example of marker which general structure is made by black and white colour.

![Fig. 1. The example of augmented reality marker](image1)

Software of AR has to include an augmented core and library for comparing information packet which are harvested during the observing processes of markers position. On the base of this information the application know the exact position for working area in the real time during the assembling process. VTT’s Augmented Reality application for assembling process allows engineer to managed assembling process on the working table only around its own axis of rotation. The Fig. 2 offers a view on particular example of AR where the marker situated on the desk provide position information for motion capture.

![Fig. 2. Example of AR production process where virtual robot is covered by real view in the working place by marker](image2)

2.2 Laser projection technologies

Next example from industrial praxis can be found in 3D laser projection. It is accomplished by steering a single laser beam accurately through a series of specific points in space. The laser beam is directed at a pair of mirrors that are powered by a set of galvanometers called computer controlled servo motors which are capable of extremely rapid movement. The produced effect is a highly visible, glowing three dimensional template that is used as a location guide during a manufacturing process. The company Laser Projection Technologies Inc. use rapid characteristic of laser beam. Their systems replace conventional assembly methods and hard manufacturing templates in a wide variety of applications. 3D laser projectors use 3D component or part placement, paint masking and templates creating, vehicle and 3D items of assembly structure and core placement. The entire steps of this technology are described on the Fig. 3 and shows concept of method of laser projection.

![Fig. 3. The example of 3D laser projection method](image3)

3. APPLICATION OF AUGMENTED REALITY IN PRODUCTION PROCESSES

The Department of Manufacturing Technologies team created AR application intended to be used as a supporting tool in production processes but can be used also in many other application areas. Following parts of this paper describe the functional principles of this application. It is built on the mechanism that uses logical loops for realization of observation, collecting, evaluating and comparing activities and processing of all these obtained data in order to exploit them in final visualization output. Virtual environment called Virttools was used to create simply example of AR application. Working environment and its elements are based on principles of object programming, where initial conditions, actions and relations are prescribed for particular objects that according to their function change to the so called building blocks of the application (BBs). Rules and actions running between individual blocks or their sections can be graphically expressed in form of behaviour graph which at the same time serves as programming tool itself. Functionality of entire application can be then described through tasks that they are realized thanks different behaviour graphs [4].

BBs present the tool with simple graphical interface that can be used for creation of necessary logical
connections defined in form of information packages. Each BBs included in virtual library has an input/output pin that can be tracked and its properties defined with respect to user orders. The environment of application that operates with special software tools offers the possibility for collection and monitoring of information about the data flow between single BBs.

Task of first behaviour graph is to fill the data array with correct values of assembly parts like information about assembly name and their initial conditions (position, geometric data and shape value). Filling process is activated by confirming message which is sent from the BG for the starting button. The first point in this process is an operation where the names of all 3D items from working environment are loaded into the exact position of the data array. This array is filled by means of adjustments of the behaviour conditions of the BBs called Iterator. By using the logical BBs called Get Position and Set Row the name of a 3D part from working environment assigns initial condition and behaviour about its position in the data array. Simple example of logical script of data array is presented on Fig. 4. This method, where the program or composition is realized by logical connection between BBs is called visual scripting.

Next part of paper investigates the establishing process of virtual tool that in its logical core utilizes an approach based on the Open Source philosophy exploited for the work with the environment of augmented reality. The goal of this part is to clarify application process for creation and development of virtual software and hardware elements that are necessary for work in the augmented reality environment. The traditional possibilities of how the engineer can use tools of augmented reality in form of normal commercial devices to collect the information about position of observed object in the working environment concern special devices with general structure formed by elements of motion tracking systems or technology of visual markers.

The first step in developing process was creation special device for adjusting of exact position of the operating desk in the working space. This element is described as device which gives possibilities to manage the process during the realization of whatever manufacturing situation.

This new device for augmented reality that is outlined as special positioning table which is able to adjust to an exact position of the working desk not only by using the computer interface and its own logical commands but optionally also by manual changes. Exact information about a position of the operating desk are obtained in real time during the process from special sensors that utilize the essential idea of possibility to accumulate the changes of orientation values in the real environment.

First sensor allows the collection and comparing in logical core of software in order to manage the data packets which comprise values about the spatial change of the desk position (X, Y, Z). Second one provides information about rotary motion around the main axis of rotation which is in the centre of operating desk. To simplify, base on this information about the special device and sensors elements the engineer is able to collect and explore the exact data about general movement from the real observed environment.

A process called visual scripting was used for developing procedures and programming orders for the work with logical behaviour loops in open source virtual environment. By using these tools, the application allows engineer to manage an entire data flow between different logical cores of the application (Fig. 5).

In the following phase the general processes and logical steps of new application are described in the theoretical level. The application consists of the 4 main logical levels where the data packets come not only from inner computer elements but also from outer devices such as sensors and measuring devices [5].

First of these loops observes the button section which gives information about the confirming processes. By means of these buttons the logical loop called displaying section tarts viewing process (initial and final position).

Next loop consists of two basic areas (area for testing and comparing, area for position setting). Data packet from these mentioned areas include information about the names of all virtual items and their relevant values of initial vectors together with information about final parameters of position. Then the collected data from outer sensors are sent to the area for testing and comparing with each other and also to area for setting of position (initial, final one). On the basis of these processes, all new information of position and
orientation are sent again into the logical core of the application where the newly received parameters are tested, compared and evaluated between each other. After that, the displaying section is able to see the motion process of virtual item according to its trajectory. The entire process of AR assembling is presented on the Fig. 6 and Fig. 7 where the 3D part is moved on the virtual trajectory and offers exact value about final position for each part (real and virtual part in the same environment). For better understanding the Fig. 8 gives view on improvement elements of application where each part has different colour and it allows to create assembly more clearly without mistakes [5].

4. CONCLUSION

This paper inform about implementation possibilities of AR for the purposes connected to the sphere of assembling structures creation. The first section presents current situation in an area of AR process. From middle to end part of article, text is focused on the real application not only from commercial side but also from Open Source platform. It concerns software issues reflecting the model geometry (single 3D items) as well as displaying of final boundaries for all geometry shape of models of the whole structure. Created application was focused on the particular part of the problem where engineer needs to know exact positions of single 3D component of assembly structure in the real environment eventually with respect to auxiliary object. Main feature of prepared software application is utilization of motion tracking system based on the working principles of capture markers. Implementation of augmented reality elements in this manufacturing area shows that these problems are free to be developed and their solutions realized in many industrial spheres.

5. ACKNOWLEDGMENTS

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6. REFERENCES


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