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The Process Simulation using by Virtual Reality

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Abstract

Nowadays companies can solve production systems problems by variety of software solutions, but in practice it is known that it is often difficult to interpret these outputs, illustrate and to further integrate. One possibility is the use of augmented virtual reality for the planning of these systems. This article deals with the construction of the experimental sorting workplace as a model case of the production system. Weak points of solution are solved using augmented virtual reality, which helps to simulate the process in real time, in this case the virtual displayed product moving on belt conveyor before testing the real piece.

Keywords: Virtual reality; simulation; process; augmented reality

1. Introduction

Production is the process of transforming raw materials into finished products with added value for the satisfaction of human needs. In nowadays highly competitive and dynamic business environment, industrial production is facing new challenges that require holistic view of the four main classes of manufacturing characteristics, e.g., cost, time, quality and flexibility. Manufacturing companies try to produce innovative products at low cost and at the same time shortening period-to-market. The production process has become a complex task in order to address issues: increasing product diversity with reduced production volumes, customize according to customer requirements, increasing legislation, safety and environmental requirements for the product. In addition to these issues due to the globalization of the market is constantly growing, need for the exchange of information in different stages of the life cycle of a product (product design, planning, production, assembly, etc.). These aspects are put on production processes requirements to be increasingly flexible and systematic. These issues have already

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been solved and created numerous systems and software to support and streamline the production process. However, to interpret the results of design activities (design) still seems problematic. Results of design, simulation and test results are presented either in the form of sheets in two-dimensional form as illustrations of the production system, or using CAD, CAM systems [1], [2], [5]. This method is suitable for experts in field, but when address issues in multidisciplinary teams, there are also people from other departments of the company. Therefore, it is necessary to deal with the way the results are presented, if they are sufficiently clear and whether working with data is user friendly. In this case it the directly offers the possibility to use virtual reality applications.

1.1. Production system and safety

According to demands of companies and trade is necessary to take care about safety aspects of process directly in design phase. Today exists a lot of materials and methods how to inspect machine in whole process of production. From team which study risk analysis was found a possibility to use virtual reality for risk analysis [12], because it was found the biggest problem to simulate systems in retro-fitting. Theirs ideas was moved further with used augmented reality.

1.2. Virtual reality

Virtual reality (VR) is an imitation of the real space and human activities in it, used computer equipment. It consists of a computer model of a 3D environment the participant of virtual reality in this environment seems actually moving. It is a new user interface, which aims as much as possible to bring computing environment. Virtual continuum is divided by. For example, see Fig. 1.
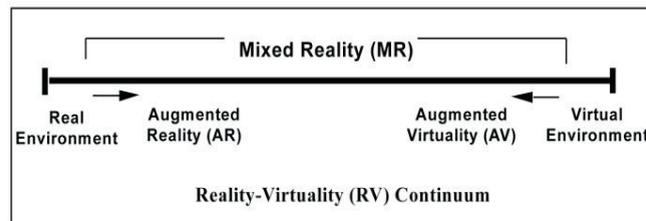

Fig.1. Virtual continuum [11].

Augmented reality - Information from the real environment [3], outside world is combined with supplemented elements of virtual reality, as shown in Fig. 2. [6]. Part of the system is camera whose position and orientation is synchronized with the movement of the user [8].

Fig. 2. Illustrative picture of augmented reality.

2. Virtual Reality Applications

One of the main motivations why was used augmented reality application is the problem in the simulation of mechatronic processes in the design and maintenance phase. If we use the augmented virtual reality, we can illustratively simulate selected mechatronics system. In the model case, where the conveyor moved the object, which it subsequently moved from the conveyor into the catapulting unit. Problematic case appears size of the object which was moving on a conveyor. When we inserted a large object, it can cause collisions and damage to the end effector mounted on a delta robot. This problem is solved on new devices, applications, where we need to reduce the development time of new devices in the prototype stage, but mainly in existing machines. So it was possible to quickly predict and reconfigure the production line and thus reduce financial costs of shutdown. After creating simulative model of mechatronics system, team can easily found possible risks and disadvantages.

2.1. Description of the simulation

On the conveyor belt was inserted circular shape object with a diameter of 50 mm and transported towards to sorting delta robot. For the separation of objects was selected delta-robot, driven by Beckhoff software [9]. After separation on the left or right side (depending on the object type) object was inserted into a part which was equipped with a sensor in the presed of the piece. After switching the sensor it leads to compression of cylinder that pulls catapulting shaft. Then the object is catapulted on the guide ramp and conveyor belt.

To simulate the object in sorting process was chosen a variant of augmented virtual reality, because it was necessary to monitor the process of positioning the virtual object that moved along the belt in real time, as shown in Fig. 3. Whole system architecture is in Fig. 4.
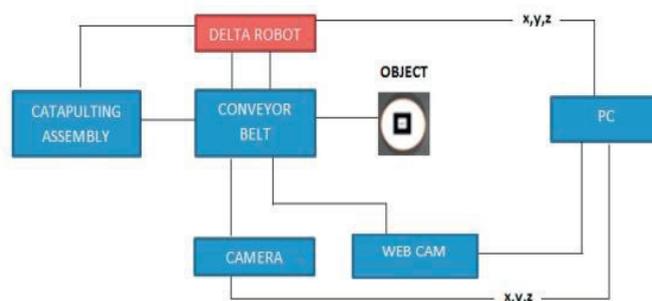

Fig.3. Sorting workplace with delta robot.

Fig.4 System architecture.

2.2. Setting the augmented reality simulation

For creation of augmented reality applications was used software interface [4]. Among the possible software which allows to display virtual objects on tracking marker with the camera via ARToolkit [7] library. With this open-source library is possible to use programming languages to apply this library.

In the first phase was created 3D model, which represent possible new product. Object was used for a simulation at sorting process in inspection of collisions with platform on delta robot. The volume model was edited by Deep Exploration software environment that allows conversion to other formats. Then it was created polygonal model from a solid model and spatial scene (product model) described by VRML in Fig. 5. Language VRML was selected because model could be edited by library ARToolkit.
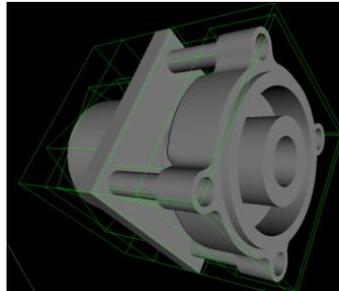
Fig.5. Polygonal model (7637 polygons).

The next step was to connect the ARToolkit with our unique marker defined in Fig. 6. The marker has to be created with clearly defined orientation. Orientation of the feature on the marker was necessary from reasons of clarity location and rotation model at the marker. Size of the marker was chosen to be sufficiently distinctive by used camera (web cam - Logitech C910). The whole system was then necessary to test and to adapt the position of the product on the tracking marker.
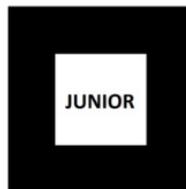
Fig.6. Tracking marker.

Tested and calibrated model for the marker was necessary to put on the disc body. Disc body was designed to reach compatibility with the ejection device. On the disk body was placed marker into the center. Marker could not exceed across the region and shall not be damage during handling by effector with the disk body. Subsequently, it was necessary to set the size of the virtual model.

2.3. Augmented reality in sorting process

For process simulation of sorting products were used a pair of markers in Fig. 7, which only differed in their sizes in the ratio (15 mm: 18 mm). Size of the marker sufficiently distinguished piece OK and consistent. Scales of the models had to be adapted to current view of both markers to match their size. After evaluating piece to industrial camera is sent information about the center of gravity of disk body and identity of piece to delta robotic control software, [10] piece is subsequently moved to the ejection device.
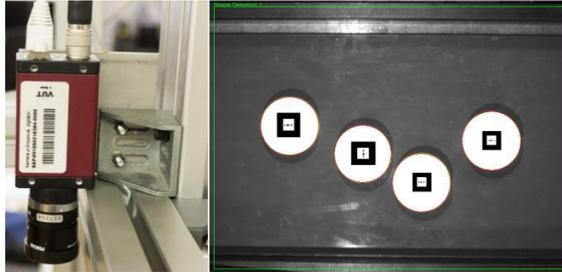

Fig. 7. Scan disk bodies with CCTV.

In a picture Fig. 8 is shown a virtual model on a conveyor belt. When object approached to delta robots platform, we can monitor the forthcoming collision. If we use a real product, then it can cause a collision and destruction. In this phase could be done a risk analysis. Project team could quickly and easily determine risks and finish whole process.

Fig. 8. The movement of the virtual object on the conveyor.

3. Conclusion

The main advantage of use the augmented reality applications was the ability to graphically highlight the phenomenon that take place in real time before the running real application. In the case study was selected model of sorting device, which was based on a parallel kinematic structure. The problem was found in collision between the end effector and future product and could lead to damage. It was used plastic disc that not intruded into the space of delta robot and its surface was coated with tracking marker. Subsequently, it was possible to easily determine problems and risks in design phase. In next research would be determined collisions without markers with another possible technique of virtual reality. Development in this tasks it could decrease time for reinstallation of whole system and it is possible to predict safety aspects. Another future work in risk analysis could be possibility to use cheaper and wider use of immersive systems of virtual reality.

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