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Augmented Reality System for Virtual Training of Parts Assembly

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Abstract

The term 'augmented reality' is not as widespread as the term virtual reality. Augmented reality has become very popular with cheap "smart devices". There are many more applications for manufacturing companies such as logistics, evaluation of workshop layout, prototyping and virtual training. Cheap and easy to implement virtual training support is the goal of this work.
The proposed system uses a conventional webcamera to shoot a referential workplace with a worker. There is a characteristic marker on the assembly table. The software environment can define a plane and transpose data according to the position of this marker in the real world space. The proposed software solution processes the webcamera image data and adds virtual 3D model instructions to the real image. The final image is presented on a monitor placed in front of the worker. We were able to measure a time improvement in assembly tasks using proposed system in comparison with classic methods.

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1. Introduction

Augmented Reality represents new challenges and new common usage in everyday life[4]. With a smart device and the proper tools a car, for instance, can be fixed directly at the place of breakdown without the need for an expensive tow. If the problem can be diagnosed, a normal, non-mechanic could wear see-through glasses and follow the dynamic and interactive instruction process projected directly into the glasses. A virtual 3D object accompanied by 2D instructions can be projected and the user simply follows the steps in the "virtual repair manual". In practice there is no need for expensive glasses, as a common tablet or smart phone can be used with similar efficiency. These

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kinds of applications, not yet available to the general public, are used by automotive companies [5] such as BMW[9] and VW[10]. There are also more general virtual assembly systems [15][16].

Augmented reality is anything which combines digitally processed reality with digitally added objects. One view considers that these artificial objects could also be 2D "flat" objects (like the information about soccer game results). On the other hand, most definitions allow only 3D objects immersed into the scene [3].

This concept was first used for military purposes. A jet pilot can see a beautiful sunrise from his cockpit which is in terms of navigation not so helpful. If there is poor visibility the landscape relief is projected directly into a special helmet, or other navigation intel. Soldiers also use special monocles which are able to display tactical data.

The biggest advantage of augmented reality is the minimal or zero purchase expense because it uses conventional hardware used in many cases (only the see-through glasses can be more expensive). Let us describe how it is possible to add brand new digital elements into a scene:

1. Capturing the scene – Scene is captured in real-time (but it is possible to utilize a pre-captured record for the next phases). In fact a conventional webcamera is sufficient (auto-focus function recommended).
2. Scene recognition –characteristic markers are set in the scene (see Fig. 1), pictures or scene can be 3D scanned ('3D markerless tracking'). A marker is recognized and upon its transformation the position of a 3D model is established (e.g. a sink in our case)
3. Scene procession – On the basis of the previous step 3D objects, 2D pictures, video, etc. are transformed and displayed.
4. Scene display - The complete scene, supplemented by the new object, is displayed on a monitor, projector, tablet, see-through glasses, etc.

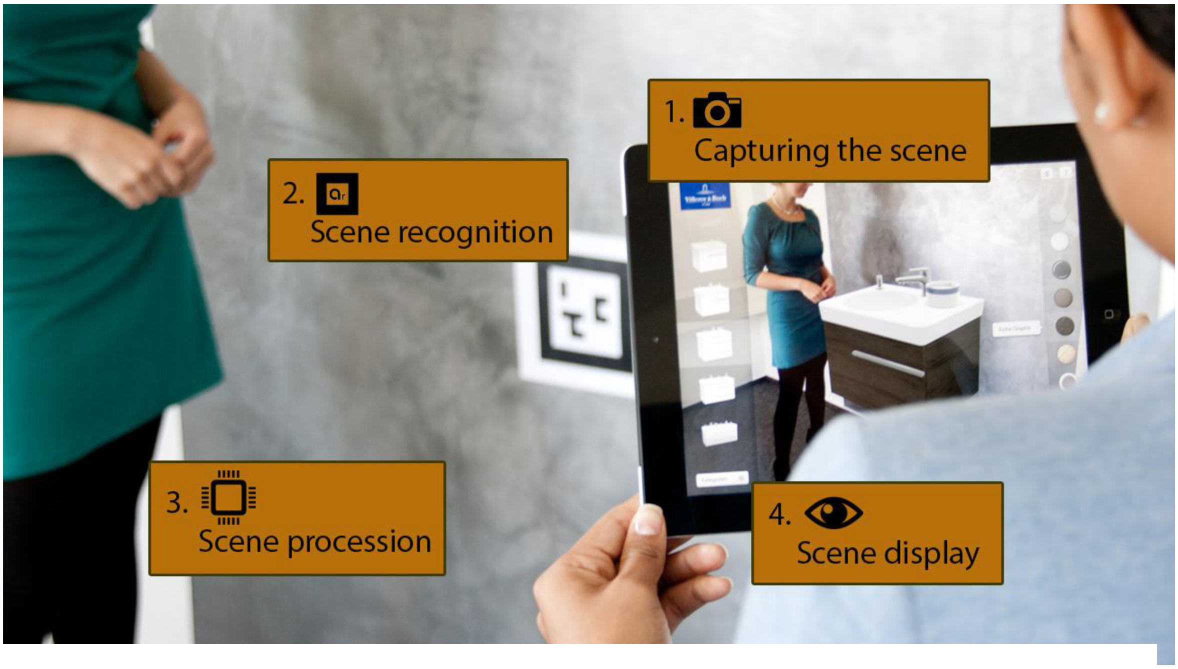

Fig. 1. Augmented reality display principle - V&B Augmented Reality App [11].

The application presented in this paper is mainly focused on virtual training using augmented reality. Commonly in manufacturing there are more areas where this new approach can be applied[6]:

- **Logistics** - The study of the company DHL from 2014 [13] discovers 11 possible applications of augmented reality on logistics