Industrial Use of Mixed Reality in VRVis Projects

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Some of the first actual application examples motivating the use of Augmented Reality (AR) were industrial in nature, such as Boeing's wire bundle assembly needs and early maintenance and repair examples.

Industrial facilities are becoming increasingly complex, which profoundly affects their planning and operation. Architectural structures, infrastructure and machines are planned using CAD software, but, typically, many alterations are made during actual construction and installation. These alterations usually do not find their way back into the CAD models. In addition, there may be a large body of legacy structures pre-dating the introduction of CAD for planning as well as the need for frequent changes of the installations, for example, when a factory is adapted for the manufacturing of a new product. Planners would like to compare the "as-planned" to the "as-is" state of a facility and identify any critical deviations. They would also like to obtain a current model of the facility, which can be used for planning refurbishing or logistics procedures.

Traditionally, this is done with 3D scanners and off-site data integration and comparison. However, this process is lengthy and tedious, and results in low-level models consisting of point clouds. AR poses the opportunity for on-site inspection, bringing the CAD model to the facility rather than vice versa. Georgel et al. [1] present a technique for still-frame AR, extracting the camera pose from perspective cues in a single image and overlaying a registered, transparently rendered CAD models.

Figure 1. AR can be used for discrepancy analysis in industrial facilities. The images show still frames overlaid with CAD information. Note how the valve on the right hand side was mounted on the left side rather than on the right side as in the model.

Schönfelder and Schmalstieg [2] propose a system based on the Planar (Figure 2), an AR display on wheels with external tracking, which provides fully interactive, real-time discrepancy checking for industrial facilities.

Figure 2 (left) The Planar is a touchscreen display on wheels, which can be used (right) for discrepancy analysis directly in a factory hall.

Utility companies rely on geographic information systems (GIS) for managing underground infrastructure, such as telecommunication lines or gas pipes. A variety of situations require the precise location of the underground assets. For example, construction managers are legally obliged to obtain information on underground infrastructure to avoid any damages during excavations. Likewise, locating the reason for outages or updating outdated GIS information frequently requires on-site inspection. In all these cases, presenting an AR view derived from the GIS directly registered on the target site can significantly improve the precision and speed of outdoor work [3]. Figure 3 shows Vidente, an outdoor AR visualization system.

Figure 3 (left) Tablet computer with differential GPS system for outdoor AR. (right) Geo-registered view of a virtual excavation revealing a gas pipe.

Nowadays, Mixed Reality, likewise encompassing AR and Virtual Reality (VR) technologies, is recently receiving significant attention from industry, as it is considered a key concept for future modern human-computer interaction. Due to advances in mobile hardware and considerable improvements in computational capabilities of current computers, the real-time application of principle concepts in this area already known for decades now really becomes practically feasible. The development and marketing of ultra-mobile hardware, such as head mounted displays and heads-up displays further serve as key enablers to deploy Mixed Reality in the industrial wild. Mixed Reality (MR) is therefore considered a key concept for future user interfaces to tools deployed in all kinds of industrial use cases, such as manufacturing, product design, workflow and process planning, safety precaution and quality management, amongst others.

VRVis GmbH is closely collaborating with several partners from industry in order to deploy modern Computer Vision (CV) approaches, in conjunction with MR technologies into customer products. Special emphasis is thereby put on individual applications that help customers to intuitively solve real-world problems optimized with respect to several major and correlated aspects, such as for example:

i. time consumption: modern MR technology can be used to guide a user to complete a given task in less time, following clear instructions along an optimized workflow;
ii. error prevention: tools can help users to prevent human errors due to fatigue, exhaustion or unawareness of certain conditions, requirements or procedures;
iii. cost reduction: tools and their use might considerably reduce training time for workers and thereby cost efforts, allowing for optimization of processes and the elimination of unnecessary steps;
iv. improved remote collaboration: MR concepts in combination with telepresence systems can help at remote locations, with experts assisting users through visualizations to facilitate certain tasks in maintenance or error recovery.

In this respect, currently investigated projects target several of these points as follows.

Augur - Advanced Measurement Tools for Construction

In this project in cooperation with HILTI AG, Liechtenstein, new methods for performing measurement tasks in construction are investigated, such as area or distance measurements for drilling and fastening tasks, for example. State-of-the-art procedures and products for this kind of application mainly rely on laser-range measurements and human manipulation. However, the goal is to deploy CV methods in conjunction with MR visualization and user interface concepts to automatically fulfill a given task. The individual steps are derived and completed from a higher level of abstraction (i.e. inferring individual measurements and completing those automatically, given a task description like 'estimate the area of this window'). In order to facilitate this, edges and lines are detected in images, distance sensors are used to infer the distance from the observer, and the final result is inferred from the individual measurements (see Figure 4).

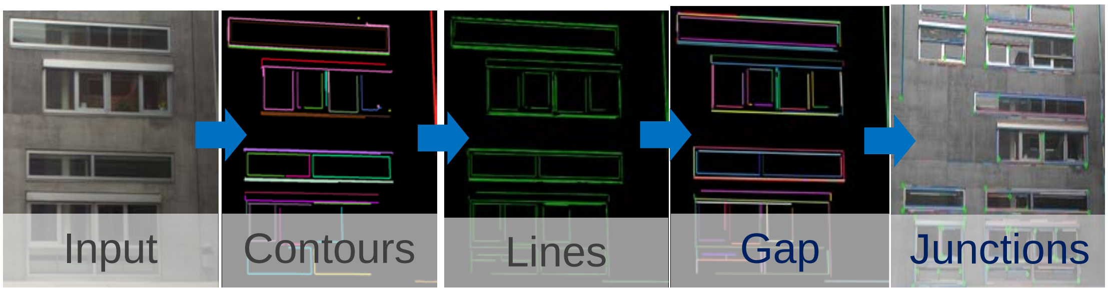

Figure 4: Line and Corner detection in order to find anchor points for distance measurements and using certain measurements to infer the result of a certain task automatically

Simplify - Augmented Reality Authoring for Machine Maintenance

This project, in cooperation with AVL GmbH., Austria, is about translating written manuals into automatic annotations for maintenance instructions and analysis for engine test stands. The current procedure is to follow written documentations to perform one or the other task in measuring pressure and flows in certain parts of the system, and to follow written instructions to search and replace, to disassemble and to reassemble components of a machine. In this project, the goal is to develop techniques and a workflow to translate written documentaries into digital instructions and procedures, which help in training, working and actually practically facilitating a certain complex task in the industrial field (see Figure 5) [4].

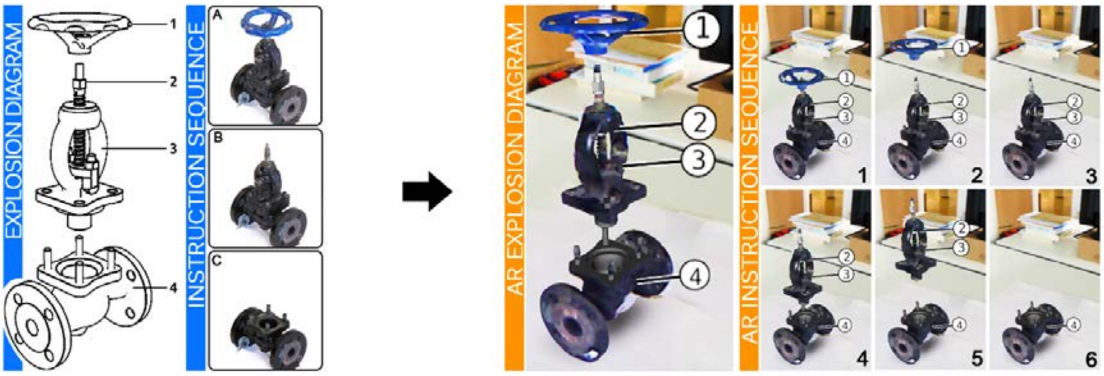

Figure 5: Implementing methods to translate written documentations (left) to automatic assembly and disassembly instructions using AR (right).

References

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