

SketchAR

collaborative, immersive free form modelling in virtual and mixed realities

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During the last decade, product development processes have been greatly influenced by virtual reality (VR). Many decisions which were formerly made through the evaluation of a physical model (physical mock-up – PMU) are now made through the evaluation of a virtual model. This procedure significantly reduces the time it takes to reach decisions and therefore accelerates product development and promotes the development of product variants in the same amount of time as before.

Anyhow, VR technology is not used to its full potential, today. Most VR systems only deal with predefined objects and scenes which are visually evaluated or virtually assembled. Moreover, VR has replaced many physical models but did not make them superfluous. Thus, there is a need to develop solutions to enable designers and stylists to create and modify 3D models easily and intuitively in virtual environments plus augment physical models with computer generated information. The key to accomplish this is a collaborative Computer Aided Styling system, which supports direct 3D interaction

as well as augmented reality (AR). The SketchAR system (our Augmented Reality, computer-aided styling system) is one of the first systems to support three-dimensional modelling not only in space but also in augmented realities, while synchronizing visual data with the precise CAD representation of the product. The integration of a modelling kernel, modelling functionality and data export and import capabilities distinguishes SketchAR from traditional VR systems. Additionally, SketchAR supports collaborative scenarios where e.g. multiple users model different parts of a virtual model.

Features

- Curve and surface creation directly in 3D
- Curve and surface modification with 3D input devices
- real-time collaboration
- tangible mirror and working planes
- 3D tape drawing in virtual and augmented realities (for car styling)
- configurable package model (for car styling)
- data import and export

German Abstract

Virtuelle Umgebungen und Virtuelle Realität hat sich in den vergangenen zehn Jahren von experimentellen Systemen in Forschungslabors hin zu Produkten entwickelt, die insbesondere in der Automobilindustrie dazu beigetragen haben, Entscheidungen früher an einem virtuellen Modell zu treffen und neue Modelle schneller bzw. mehr Varianten in der gleichen Zeit zu entwickeln. Bei vielen heutigen industriellen VR-Installationen beschränkt sich der Einsatz von auf die Visualisierung z.B. auf Design-Review-Zwecke oder Fly-Throughs durch existierende Szenen. Die Interaktivität solcher Anwendungen ist beschränkt. Zusammenfassend kann festgestellt werden, dass VR im heutigen betrieblichen Einsatz mehr Visualisierung denn Interaktion ist und dass damit die Möglichkeiten von VR nicht voll ausgeschöpft werden. Ein hohes bislang kaum genutztes Potential liegt in generativen virtuellen Umgebungen, also solchen, in denen Modelle erzeugt und verändert werden können. SketchAR ist eines der ersten Systeme, das das Skizzieren von Freiform-Geometrie sowohl in virtuellen als auch in erweiterten Realitäten unterstützt.



Figure 1: Free from surface sketching in Augmented Reality

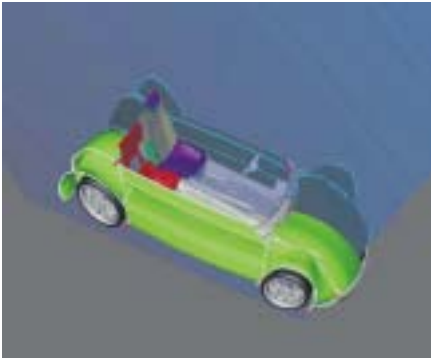


Figure 2: Sketch of a car body

Basic Functionality

SketchAR provides the user with a semi-immersive environment. Using his two hands and hand movements directly in 3D space he/she can create free form models in real-time. To do so, the positions of the user's hands are acquired using optical tracking. The scene is displayed 3-dimensionally in a perspective correct way taking the user's head position into account (head tracking). SketchAR supports a variety of hardware setups, e.g. PowerWalls, HMDs, etc.

Modelling Functionality

The principal approach of the system to model curves and surfaces is by creating 3D strokes in free space using a 3D input device. In this way the user can create different types of curves and surfaces, e.g. coons patches, skin surfaces and net surfaces. It is our goal to allow the user to directly sketch a free-form surface in 3D space without prerequisites. Intuitive interaction is achieved through the intelligent processing of input data, e.g., a »Coons« patch can be sketched in a single 3D movement. To ease curve sketching we developed the concept of the »eraser pen« which combines the curve creation and deletion (erasing) process into one single tool just by interpreting the direction of the user's movement (gesture). To update the user on each iteration of the surface or 3D object modelling task, a simplified preview is generated, reflecting the current state of the result. This way, a sketch of for instance a car model can be created very easily and intuitively within a few minutes (see Figure 2).



Figure 3: Virtual 3D taping on a physical model in AR

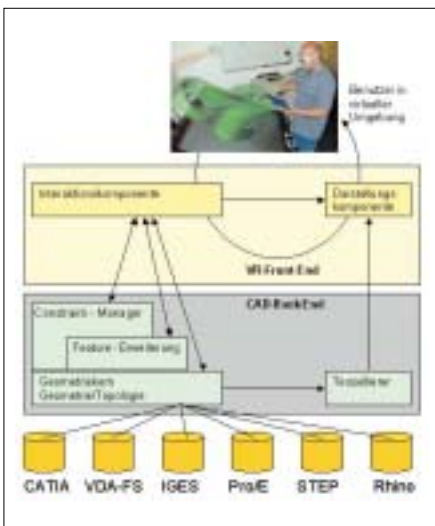


Figure 4: System architecture

Virtual 3D Taping

Taping is a widespread technique in automobile design for the definition of two-dimensional characteristics lines in 1:1 views of models. For this purpose, a special duct tape is spread between the left and right hand; while the right hand remains above the surface and directs the orientation of the curve (tangent to a fixed point), the left hand sets the path of the curve by pressing the tape onto the surface. We have translated this concept into a two-handed,

three-dimensional input technique that enables virtual tape-drawing not only on virtual models but also on physical ones (Figure 3).

Annotations

Today, it is hard to sketch suggested modifications onto physical models (even onto virtual ones) in a design review session. Therefore, our system supports annotations to document changes in certain areas of a model and make them visible for the participants of a design review session.

System Architecture

SketchAR is based on a modelling kernel (see figure 4) which allows to import and export CAD models in various formats. As already mentioned all surfaces created within the virtual environment are precise in a mathematical way. Models created with SketchAR can be imported into other computer aided styling (CAS) systems for refinement as well as CAS models can be imported into SketchAR.

Future Developments

- hardware accelerated high quality rendering
- non photo realistic rendering
- interactive painting and texturing

Point of contact

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