IN:SHOP - Using Telepresence and Immersive VR for a New Shopping Experience

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Abstract

IN:SHOP uses the blue-c 3D video technology to implement distributed shopping in a shared virtual world. IN:SHOP combines traditional shopping and marketing structures with 3D computer graphics, telepresence, spatially immersive displays, and internet shopping paradigms to create a flexible and adaptable commercial environment. The application is an enhancement of the traditional, physical shopping and the shop itself. It redefines the experience and architecture of commercial spaces. We implemented the concept for a haute couture fashion shop and a car seller using two interconnected virtual reality theaters. In this paper, we present the concept of IN:SHOP and the implementation inside the blue-c environment.

Keywords: Virtual reality application, Telepresence, Collaborative environments, 3D video, Personalized shopping

1 Introduction

IN:SHOP is our first example application to investigate and analyze the possibilities that the blue-c technology offers to architecture. The blue-c project [8] provides a collaborative tele-presence environment with simultaneous acquisition of 3D video and immersive projection. IN:SHOP not only showcases our 3D video technology for tele-immersion (see Figure 1), but also proves its benefits in a practical application.

Today, multimedia elements such as large projection walls and information terminals form an integral aspect of the architecture of modern shops [10]. IN:SHOP takes this trend one step further by integrating the latest information and communication technology, including spatially immersive displays and telepresence. As opposed to current one-way communication media, interaction and remote collaboration form an integral part of the concept. Unlike approaches that concentrate on the technical aspects of selling customized products online [16], we designed IN:SHOP with a focus on the user's experience of the virtual space from an architectural design point of view and the possible integration into real shopping locations.

Figure 1: Telepresence in action in the blue-c. The customer sees the remote sales clerk as a 3D representation inside the virtual shop environment.

Telepresence using 3D video technology [23] enables natural interaction between the customer and a remote sales assistant. Automatic three dimensional acquisition technology dramatically reduces the modelling overhead for presenting products in our virtual environment.

2 Related work

Internet shopping as well as tele-immersion technology is an active field of research. The IN:SHOP concept aims at integrating the best of both worlds to create a new interactive shopping experience which bridges the gap between purely virtual and real shopping spaces.

2.1 Multimedia shopping concepts

Digital technology accompanies shopping at Prada™ stores in New York as well as later in Los Angeles, San Francisco and Tokyo [10]. Prada's epicenter in New York is fully wired. The new Prada store is equipped with technical innovations from the IT sector. Within a research project, AMO developed the virtual part of the shop. Rem Koolhaas and his architecture and research company OMA/AMO integrated innovative display technology, intelligent mirrors, and interactive dressing rooms into the shop. A shoe section that converts to a theater for performances and other "non-shopping events", an electronic customer-identification and service system that tracks shoppers and their needs, and smart dressing rooms are provided. The dressing rooms (Figure 2) feature simultaneous, digitally-produced front, back, and side-views of the customer, phones for requesting assistance from the sales personnel or for communicating with people outside, and walls that can be switched from transparent - so the customer can model for her friends - to opaque for privacy. In the near future, the customers' profiles will also provide the input data for customized web pages to support shopping at home.

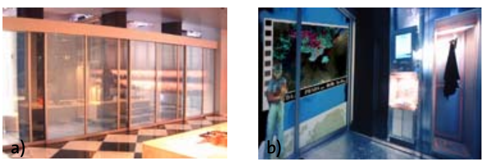

Figure 2: a) Interactive dressing room at Pradas NY store. b) Concept image: Integrating IN:SHOP into the room. [1]

Using virtual reality techniques to support distributed collaboration of people has been explored in different applications. The idea to support designers, buyers and manufacturers in the design of a garment to reduce the production cost has been researched in Fashion Pilot [6]. Virtual Try-On [16] is motivated by the growing sales-volume of online shopping and the further development in multimedia. Avatar technology is used to enable online shopping. A three dimensional animated electronic representation of the customer wears the product before the customer buys it. British Telecom (BTexact) also investigates the use of avatars for fashion applications [2]. These approaches are complementary to IN:SHOP as their primary target is desktop digital product presentation and customization for internet shopping, whereas IN:SHOP concentrates on the social communication channels, collaborative and distributed sales process, and the use of highly immersive display devices.

2.2 Telepresence systems

The IN:SHOP concept heavily relies on telepresence and remote collaboration. In the past, several systems that support collaborative VR applications have been developed, such as NPSNET [12], RING [5], DIVE [4], DIS/HLA [3] [9] and Avango [22] . A detailed overview of these and similar systems can be found in [20]. These systems, however, lack telepresence features. Systems that support telepresence include Teleport [11], MASSIVE [7], the Office of the Future [15], and more recently the National Tele-Immersion initiative [18]. Most of them either feature simple texture mapping to billboards or provide basic 3D vision using stereo cameras. The core idea is typically to extend a real office space into a virtual world. None of the current systems provide a full real-time 3D acquisition of the user that would allow the other participants to freely navigate around the user. This is a unique feature of the blue-c.

3 IN:SHOP Concept

IN:SHOP combines traditional shopping and marketing structures with internet shopping paradigms to create a flexible and adaptable commercial environment. IN:SHOP connects and extends the physical shopping floor into virtual and remote spaces. Immersive projection booths, built using glass walls with switchable transparency, form a portal into the computer generated world. IN:SHOP uses these portals to implement a solution for distributed shopping. Connecting several sites allows remotely located users to meet, communicate, and collaborate in the virtual shopping space.

Figure 3 illustrates the distributed application concept. In the virtual world, the customer gets direct access to a personalized shopping environment. This virtual shopping environment allows presenting a large collection without cluttering the real shop and relieving the requirement for a large,

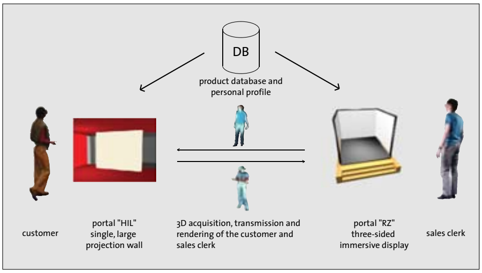

Figure 3: Remote collaboration in the blue-c environment with a shared database and network transmission for telepresence.

directly accessible warehouse. In addition to this already exploited advantage, we create a unified shopping space among distant shops using telepresence and networking technology. Telepresence in the unified space allows the international travelling customer to get remote assistance from an acquainted sales person, e.g. a sales clerk from a patronized shop or simply from the same cultural background.

The use of a fully three dimensional remote user representation greatly enhances the sense of presence and allows for a natural interaction between the customer and the sales clerk. The customer and the sales clerk can communicate in a natural and intuitive way, comparable to the traditional sales situation where all participants are physically present. The existence of expert users such as the sales clerks alleviates novice customers of the burden of interaction and navigation training inside the virtual environment.

3.1 Application storyboard

A customer arrives and enters the application, attracted by a commercial campaign. The system identifies the customer and his personal profile is loaded. The profile consists of personal data, bought items, and items of interest. Based on the customer's history, the shopping environment is customized, appropriate new items and personalized advertisement are presented.

The customer is fully immersed in his personalized environment where she meets the sales clerk (Figure 4) from her patronized shop. Together they browse through the personalized product catalog.

As an expert user, the sales clerk has direct access to the full content database and can therefore present additional items on the customer's demand. If the customer has indicated interest in certain items, the sales clerk selects them. The selection is stored and the content for the following stages is processed accordingly. The customer can then freely navigate between different presentations modes.

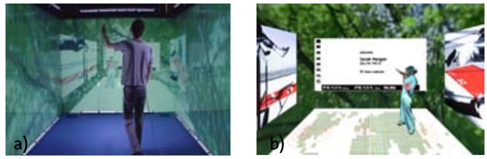

Figure 4: Sales clerk and customer meet in the virtual environment using 3D telepresence technolgy. a) The sales clerk enters the portal. b) Screenshot, showing the customer at the remote location.

The sales clerk presents the selections to the customer using a variety of traditional and virtual based media. Different forms of data can be presented in the immersive space, ranging from pre-recorded 3D representations of humans and objects (Figure 5), 2D movies, images, hand drawn graphics, to simple text (Figure 6). During the shopping process, the customer sees the product gradually becoming more detailed and interactive until she finally acknowledges the purchase.

Figure 5: Screenshot: Product presentation using 3D video technology.

3.2 Virtual shopping environment

The shopping environment consists of three main information displays (Figure 6). The main screen is for presentations to the customer and is connected to the content and the customer database. It can therefore display all kind of information. The screen is controlled by the sales clerk and helps to advise the customer individually. In addition to the main information screen, data sheets are used for the counselling interview to discuss details and to configure the product. They display the selection using various graphical representations.

Figure 6: Concept image: Multimedia product presentation using 2D images.

The side screens are used to provide the user with more information by showing related images and videos. The whole scene is surrounded by a large video wall that is used to generate the appropriate ambience, together with background music. Associated to the different stages, and together with an elevator-like movement, the background themes also support the user's orientation.

The application concept is versatile enough to suit different distributed shopping scenarios and products. We developed prototype implementations for haute culture fashion stores as well as for car sellers. The implementations mainly differ in the media presented, which is defined by the underlying product information database.

3.3 FashionShop

FashionShop is the first implementation of the IN:SHOP concept for selling haute couture fashion products. It features a fully immersive personal fashion show. 3D video recordings of mannequins are used to present selected items. The presentation is enriched with further meta information on the items and links to ensemble variations (Figure 7).

For customization, the customer selects the base models. Customizable items are presented with additional information, such as matching items, availability and number of sold items on the main information screen. The customer configures the product assisted by the sales clerk. They discuss parameters using detailed design sketches. The customer decides on style, accessories, fabric, color, etc. An overview of the configuration decisions is shown as two dimensional detail images. Previous customization can be changed at any time.

Figure 7: Concept image: Virtual fashion show, enriched with meta-data.

The customer is able to interact with a 3D representation of the personalized product before agreeing to buy the product, putting it into her personal virtual closet, or discarding the selection.

Back in the physical shopping space, the selected product is delivered to the customer. This can be either "prêt a porter", or as a custom manufactured item created from the consumer's data profile or from measured body data acquired within the theater itself.

3.4 CarShop

CarShop is a different scenario that proves the applicability of the IN:SHOP concept for selling luxury cars. It is based to a large extent on the same code base as the FashionShop implementation. The presentation and underlying media database is optimized towards the somewhat different sales process.

In Carshop, the customer and sales clerk configure the selected car. The configuration process leads through different stages, such as series selection, basic model selection, color, interior and extras selection, and finally financing plans. Base model information, such as design, measurements, extras, and available colors, is presented on the main information screen. Further technical details, such as engine configurations, board computers, air conditioning, car stereo systems, etc., are available on data sheets. Finally the 3D model of the personalized car is presented on a rotating platform (Figure 8). The car is experienceable in its real dimensions in a fully immersive show room. Due to a 3D audio system, the customer is able to even experience the sound of the engine.

Figure 8: CarShop screenshot: 3D presentation of the final product.

The traditional shopping basket metaphor is visualized using a virtual garage where the customer can store previous configurations and compare them later. Configuration details for the purchase are sent directly to the manufacturer.

CarShop allows potential buyers to interactively configure and experience 3D representations of the car they are purchasing. The system offers the customer the possibility to get a broad overview of the brand and the multifaceted program of the product. CarShop allows presenting a wide range of models and accouterment variety in small showrooms.

4 Implementation

Two prototypes of IN:SHOP are implemented based on the blue-c technology [8] which supports 3D acquisition and rendering of real users within a networked virtual environment. The blue-c system was developed as a large collaborative effort among 20 researchers of several different departments. This section will provide an overview of the key technologies used for IN:SHOP. A schematic overview of the blue-c system is presented in Figure 10.

With the two IN:SHOP prototypes, we built a testbed for the interaction metaphors presented in Section 3 to allow a verification of the benefits of telepresence in the sales process. The integration of a product database will be realized in a next step.

4.1 blue-c portals

We built two immersive portals into the blue-c environment (Figure 9). The first portal, located at the universitys main campus, is a three-sided, CAVE^{TM}-like spatially immersive display which supports simultaneous acquisition through the projection walls. It is driven by an SGI Onyx 3200 with 8 processors and two IR3 pipes. This portal features a high degree of immersion. It is the main testing site for the application development.

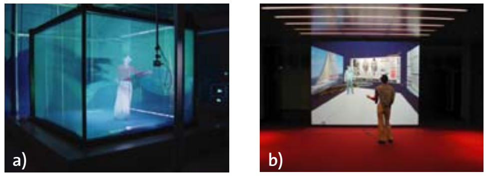

Figure 9: blue-c portals: a) “RZ” at the main campus, b) “HIL” at Hoenggerberg.

The second installation, located at the ETH Hoenggerberg campus a few miles away, features a single, large projection wall with an active stereo DLP projection system. It is currently driven by an SGI Onyx 2 with an IR2 pipe. In the near future, we will switch to a PC. This portal is located in an open public space, which provides us with interesting feedback from students and faculty and proves that immersive installations can be deployed to a larger public.

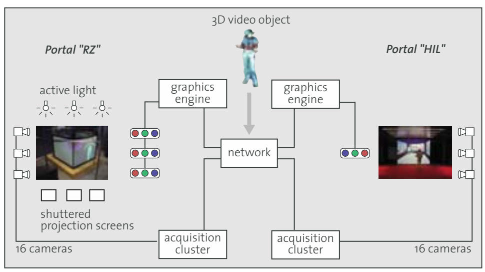

Figure 10: The blue-c system architecture.

Both sites feature a 16 camera video acquisition system with a PC for each camera. Additional dual-CPU machines are used for reconstruction tasks (see Section 4.3).

4.2 blue-c API

The blue-c API provides an application development environment which offers flexible access to all blue-c features, including graphics and sound rendering, device input, 3D video and scene distribution. These subsystems are provided as services and managed by the blue-c core (Figure 11).

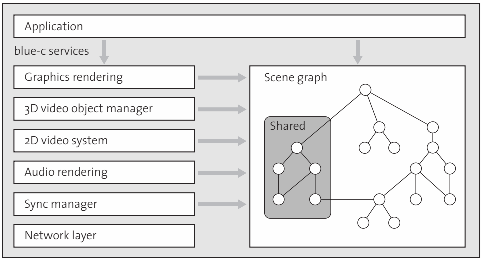

Figure 11: blue-c API overview.

4.3 Real-time 3D video acquisition and rendering

Real-time 3D user reconstruction and streaming is the distinctive feature of the blue-c system. This technology supports concurrent projection of the virtual world and acquisition of the user. Based on standard glass walls with switchable transparency [21], we capture camera images through the projection wall (Figure 12). The same glass walls are already used as part of interactive presentation booths at Prada fashion stores, making the installation of our technology in a real world application very feasible.

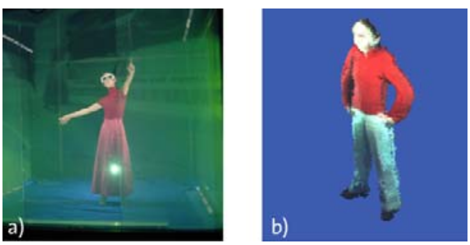

Figure 12: 3D video acquisition: a) Looking through the glass with concurrent projection. b) Reconstructed 3D person.

Based on a shape from silhouette method, a three dimensional video fragment representation is calculated, compressed and streamed to the other sites. These video fragments are integrated into the virtual world using hardware-accelerated point rendering. The multi-pass renderer provides blending and filtering to reduce aliasing and acquisition noise. It implements some ideas presented in [26]. We refer the reader to [23] for an in-depth discussion of the 3D video pipeline.

4.4 3D video recording and object acquisition

Our recording technology [24] further allows us to present the products as interactive 3D objects. This recording technology is used to play back sequences of mannequins presenting the latest fashion on our virtual catwalk. The user can freely navigate in 3D around these objects.

In addition, static 3D objects can be acquired using our multi-camera scanning system, represented and edited as surfed objects [25], and introduced into the scene using our multi-pass point renderer. This allows to quickly integrate real-world 3D objects into our scene without a major modelling effort.

4.5 Video and sound

IN:SHOP combines different media types in a single application. The blue-c API provides streaming of recorded 2D video sequences from disk into texture memory. Thanks to the high internal bandwidth of our Onyx 3200 graphics server, we can stream more than five videos simultaneously into texture memory without a significant performance impact, allowing both background theme videos as well as multiple information videos on the display panes.

Sound rendering is used for background theme music as well as sound events to support the user interface. We also use the sound service to enable a voice communication channel between the participants. Sound sources can be placed anywhere in a 3D space. They are rendered with additional room simulation effects (reverberation) by the blue-c 3D audio service [14].

4.6 Animation

IN:SHOP does not heavily rely on animated geometry apart from the 3D video inlays. Some smaller animation however is used as eye candy to make the world more interesting and to provide smooth transitions between the different stages of the shopping process.

Continuous animation such as rotating logos is provided by the blue-c API. It is implemented using special scene graph nodes that update their internal state automatically once per frame. Additional one-shot animation sequences are provided by the application code. These sequence objects are evaluated once per frame and update the attached object automatically.

This software framework allows the introduction of animated sequences with minimal programming effort.

4.7 User interface devices

The users interact with the virtual environment using a standard six degree of freedom mouse with a small joystick (Fakespace Wand). The necessary drivers that generate motion and button events are provided by the blue-c API. The API also provides hit-testing, object identification, and a visual feedback for the pointing direction in the form of a colored sphere at the intersection point between the (invisible) ray from the tracker and the scene geometry. Navigation within the scene, including collision detection, is also a standard feature of the blue-c software environment.

To aid application development and debugging at the desktop, mouse and keyboard input is supported.

4.8 Distributed scene

Different users interact in the same shared virtual environment. The blue-c distributed scene graph [13], which is based on Silicon Graphics OpenGL Performer [17], provides the necessary synchronization mechanism. Most of the IN:SHOP scene is part of the shared partition and therefore guaranteed to be coherent across all participants. Large models, such as customized car representations, are loaded from the local disk to minimize network traffic.

4.9 Network layer

All networking code is provided by the blue-c communication layer. It is a framework based on the ACE/TAO [19] real-time CORBA implementation, which provides communication channel setup, reliable multi-casting for the distributed scene graph service, as well as streaming of real-time data for the 3D video fragments and audio.

The 3D video pipeline generates models of approximately 15k points at 9fps. It is updated with 30k up to 200k differential operations per second, generating a stream between 2.5 and 12.5 MBit/s. This bandwidth requirement is easily accommodated with current networking technology.

5 Discussion and future work

With IN:SHOP, we demonstrate a shop-in-the-shop concept with geographically disparate customers and sales clerks who communicate and interact with 3D representations of real objects in real-time. Architecture and computer science know-how is combined to introduce a novel approach to distributed shopping in a new interactive space. IN:SHOP is designed to bring distant physical shops together in a virtual space, providing a strong sense of corporate identity that goes beyond unified appearance and architecture. Digital technologies expand active spaces and reduce spatial and temporal interdependencies. The integration of media and information technology into architecture allows design spaces that are actively dynamic and communicative. The merits of Computer Graphics research is shown by adopting and integrating it into an architectural context and developing appropriate scenarios.

We investigated 3D representations of the users or any other object in a shared virtual environment as a new visual presentation media for communication and human-machine interaction.

We implemented two prototypes of IN:SHOP based on the blue-c technology. This allows us to test the interaction metaphors in a lab environment. Future implementations will profit from the improvements in the 3D video quality, which is a main focus of the blue-c project. In the future, we plan to cover larger areas with new 3D reconstruction approaches, enabling us to reconstruct a complete physical shop environment.

The current application prototype is not yet connected to a real product database. We are optimistic that navigation within a large product catalog will be facilitated using our approach.

6 Acknowledgements

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References

[1] Picture courtesy of OMA/AMO, 2001.

[2] J. Davies. ”Planet fashion.”*Insight Interactive*, July 2001.

[3] “IEEE standard for information technology - protocols for distributed simulation applications: Entity information and interaction.” IEEE Standard 1278-1993, 1993.

[4] E. Frécon and M. Stenius. “DIVE: A scaleable network architecture for distributed virtual environements.” Distributed Systems Engineering Journal, 5:91-100. Special Issue on Distributed Virtual Environments. September 1998.

[5] T. A. Funkhouser. “RING: A Client-Server System for Multi-User Virtual Environments.” In *Computer Graphics (1995 SIGGRAPH Symposium on Interactive 3D Graphics)*, pp. 85–92, Monterey, California, April 1995.

[6] S. Gray. “Virtual reality in virtual fashion.” *IEEE Spectrum*, February 1998.

[7] C. M. Greenhalgh and S. D. Benford. “MASSIVE: A virtual reality system for teleconferencing.” *ACM Transactions on Computer Human Interfaces (TOCHI)*, 2(3):239-261, 1995.

[8] M. Gross, S. Würmlin, M. Naef, E. Lamboray, C. Spagno, A. Kunz, E. Koller-Meier, T. Svoboda, L. Van Gool, S. Lang, K. Strehlke, A. Vande Moere, and O. Staadt. “blue-c: A spatially immersive display and 3D video portal for telepresence.” In *SIGGRAPH 2003 Conference Proceedings*, ACM SIGGRAPH Annual Conference Series, pp. 819–827, July 2003.

[9] “Standard for Modeling and Simulation (MS) High Level Architecture (HLA) - Framework and Rules.” IEEE Standard 1516, September 2000.

[10] R. Koolhaas, M. Prada, and P. Bertelli. *Projects for Prada 1*. Fondazione Prada, 2001.

[11] V. Lalioti, C. Garcia, and F. Hasenbrink. “Virtual meeting in cyberstage.” In *Proceedings of the ACM Symposium on Virtual Reality Software and Technology (VRST) 1998*, pp. 205–212, November 1998

[12] M. R. Macedonia, M. J. Zyda, D. R. Pratt, P. T. Barham, and S. Zeswitz. “NPSNET: A Network Software Architecture for Large Scale Virtual Environments.”*Presence*, 3(4), 1994.

[13] M. Naef, E. Lamboray, O. Staadt, and M. Gross. “The blue-c distributed scene graph.” In *Proceedings of the IPT/EGVE Workshop 2003*, pp. 125–133, May 2003.

[14] M. Naef, O. Staadt, and M. Gross. “Spatialized audio rendering for immersive virtual environments.” In *Proceedings of the ACM Symposium on Virtual Reality Software and Technology 2002*, pp. 65–72, November 2002.

[15] R. Raskar, G. Welch, M. Cutts, A. Lake, L. Stesin, and H. Fuchs. “The office of the future: A unified approach to image-based modeling and spatially immersive displays.” In *SIGGRAPH 1998 Conference Proceedings*, ACM SIGGRAPH Annual Conference Series, pp. 179–188, July 1998.

[16] H.-C. Rodrian. “Virtual try-on.” In *International status conference for virtual and augmented reality, Leipzig*, November 2002.

[17] J. Rohlf and J. Helman. “IRIS Performer: A high performance multiprocessing toolkit for real-time 3d graphics.” In *SIGGRAPH 1994 Conference Proceedings*, ACM SIGGRAPH Annual Conference Series, pp. 381–395, July 1994.

[18] A. Sadagic, H. Towles, J. Lanier, H. Fuchs, A. van Dam, K. Daniilidis, J. Mulligan, L. Holden, and B. Zeleznik. “National tele-immersion initiative: Towards compelling tele-immersive collaborative environments.” Presentation given at Medicine meets Virtual Reality 2001 Conference, January 2001.

[19] D. Schmidt. “Real-time CORBA with TAO (The ACE ORB).” http://www.cs.wustl.edu/schmidt/TAO.html.

[20] S. Singhal and M. Zyda. *Networked Virtual Environments: Design and Implementation*. ACM Press - SIGGRAPH Series. Addison-Wesley, 1999.

[21] C. Spagno and A. Kunz. “Construction of a three-sided immersive telecollaboration system.” In *Proceedings of the IEEE Virtual Reality Conference 2003 (VR 2003)*, pp. 37–44, March 2003.

[22] H. Tramberend. “Avocado: A distributed virtual reality framework.” In *Proceedings of IEEE Virtual Reality 99*, pp. 14–21, 1999.

[23] S. Würmlin, E. Lamboray, and M. Gross. “3D video fragments: Dynamic point samples for 3D video.” Technical Report 397, Institute of Scientific Computing, ETH Zurich, 2003.

[24] S. Würmlin, E. Lamboray, O. G. Staadt, and M. H. Gross. “3D video recorder.” In*Proceedings of Pacific Graphics ’02*, pp. 325–334, October 2002.

[25] M. Zwicker, M. Pauly, O. Knoll, and M. Gross. “Pointshop 3d: an interactive system for point-based surface editing.” In*SIGGRAPH 2002 Conference Proceedings*, ACM SIGGRAPH Annual Conference Series, pp. 322–329, July 2002.

[26] M. Zwicker, H. Pfister, J. VanBaar, and M. Gross. “Surface splatting.” In *SIGGRAPH 2001 Conference Proceedings*, ACM SIGGRAPH Annual Conference Series, pp. 371–378, July 2001.