University of South Australia

LAB MAGIC VISION

# ClonAR: Rapid Redesign of Real-World Objects

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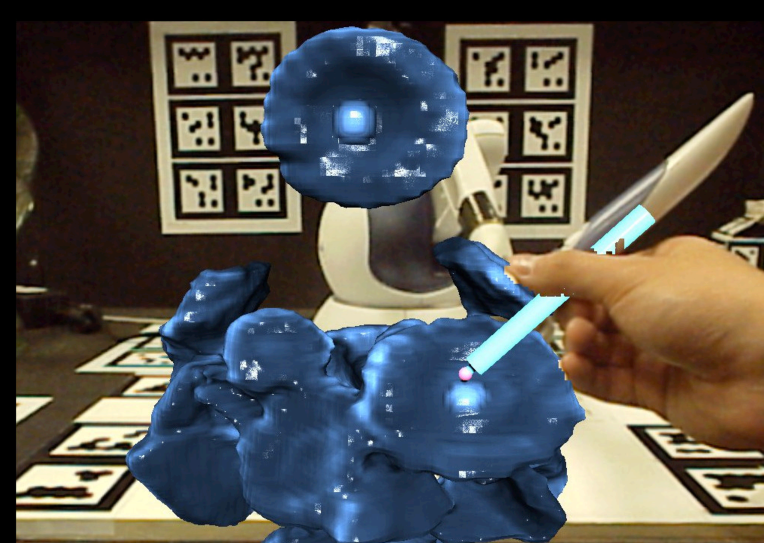
Users of our system can rapidly clone and edit real-world objects.


View through the head-worn display of scanned flower.


Final model after deformation, notice the added step.


Further example: a virtual hat was added to a cloned person.

## Overview

- Our Vision: enable users to rapidly clone and edit real-world objects.

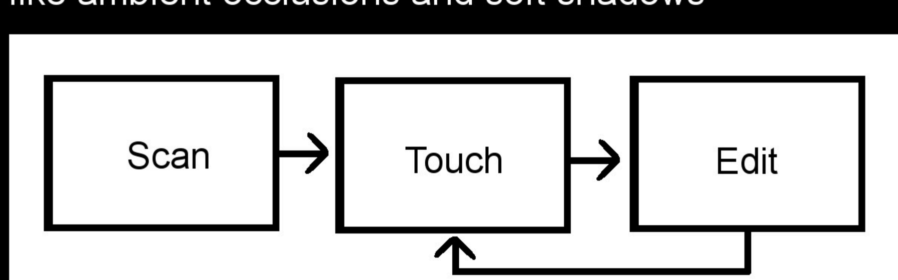
- Using a visuo-haptic Augmented Reality (AR) environment.

- Scanning real-world objects with Microsoft's KinectFusion [1].

- Objects can be observed through a head-worn display and edited with haptic feedback through the haptic device.

- Using Signed Distance Fields for haptic, which is faster and more flexible than rendering meshes.

-Visual rendering is performed by our custom-built raymarcher, which facilitates realistic illumination effects like ambient occlusions and soft shadows




## Implementation

- Canon VH2007 HWD for marker-based computer vision .

-The framework used is MR Platformproviding hand masking and preprocessing of video data [4].

-For haptic rendering, we used a Phantom Omni.
- Kinectfusion [1] is used to capture models.

- two SDFs buffers; one optimized for haptic rendering, the other for visual rendering.

- Our system is running on a single computer with an Intel i7 3.20 GHz, 6 Gigabytes of RAM running Windows XP 64bit. We utilize two 1 Gigabyte memory GTX 560 graphics cards.

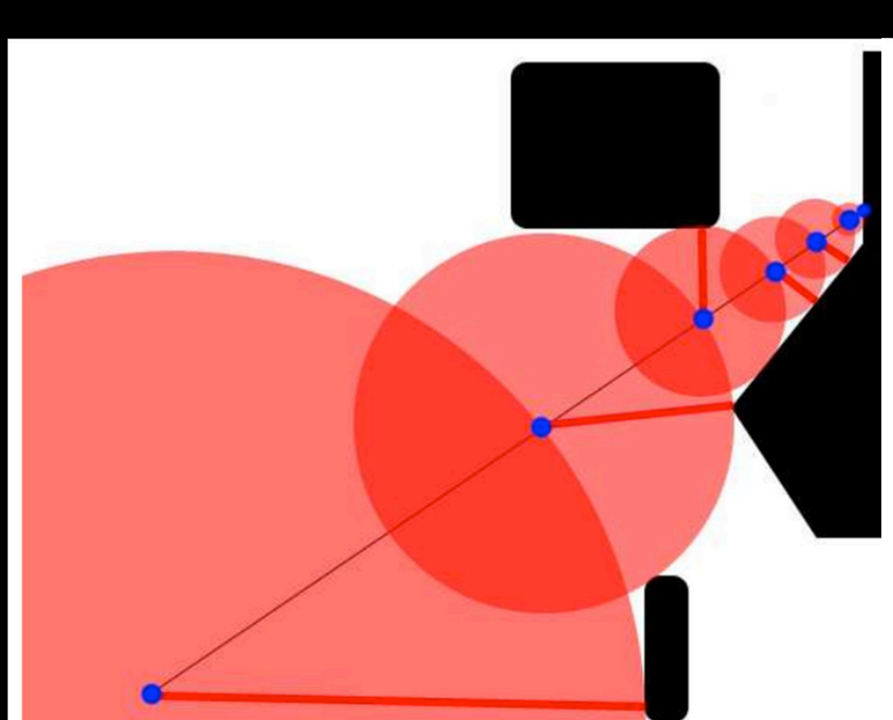

Diffuse


Specular


Final result


Soft shadows


Ambient occulsion

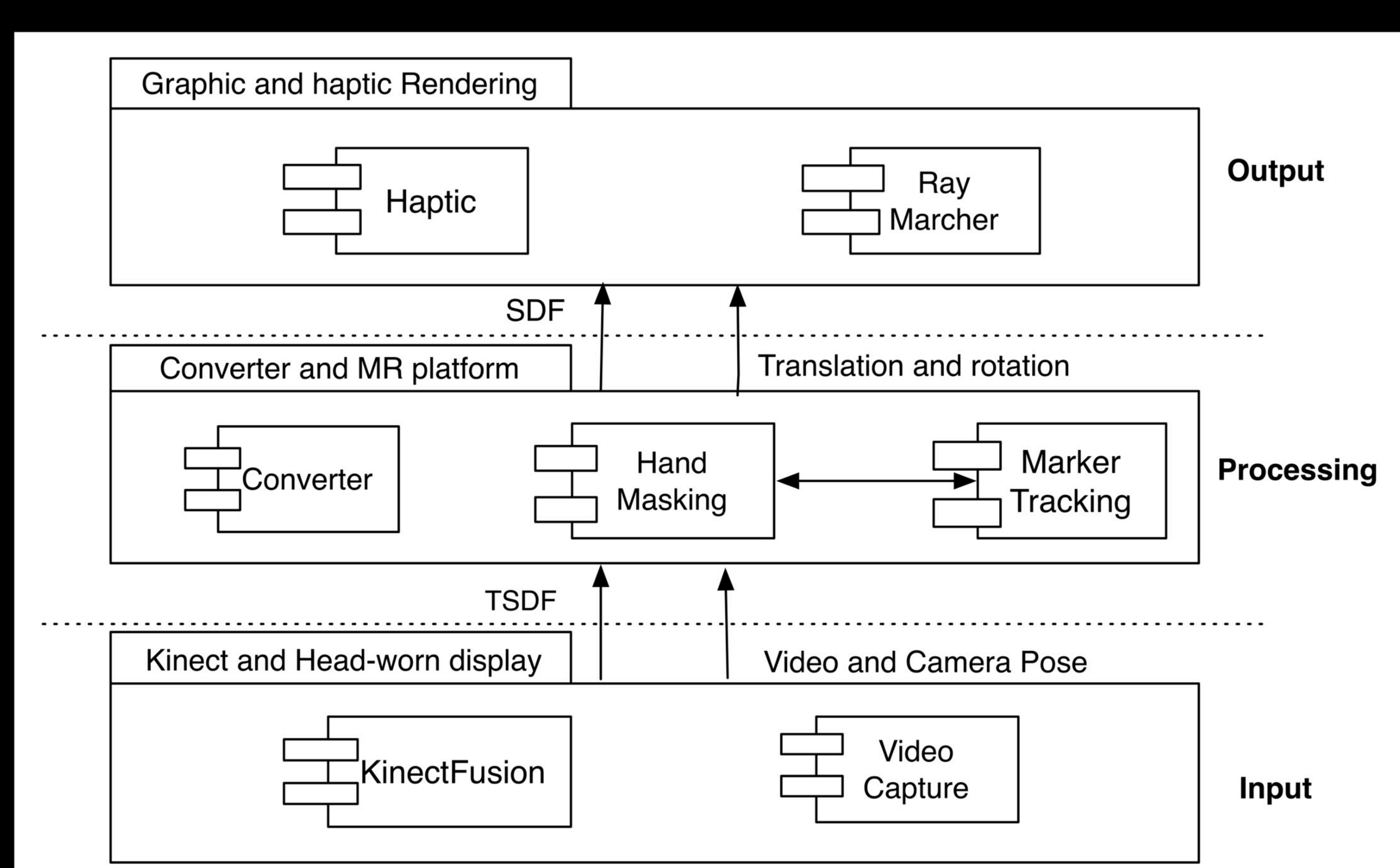

Ray marching is simular to Ray tracing but has an adaptive stepsizes, which is obtained from SDF.

## Ray Marching

- Traverses into the scene by the distance to the closest object

- Our approch is based upon parallelized GPU raymarching algorithms for Signed Distance Fields [2].

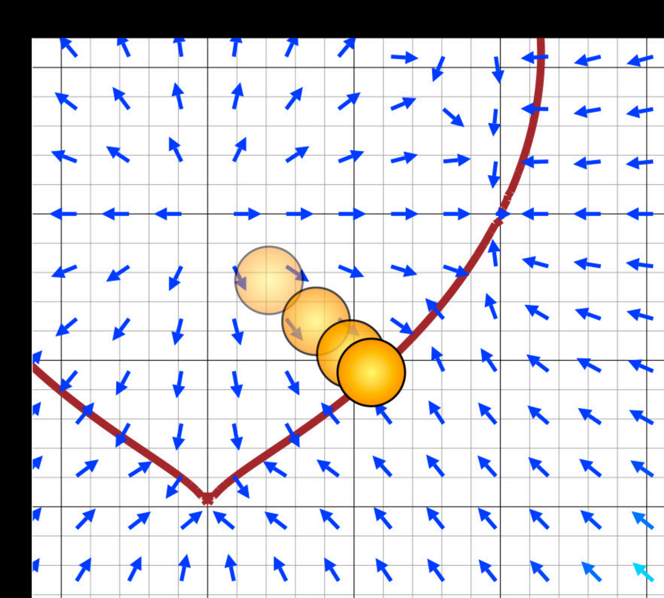
- The ability to deform and alter the models in real time through solid constructive geometry [2].




-Visual effects such as ambient occlusion, reflections, refractions, and dynamic soft shadows, are difficult to simulate using other rendering algorithms, but are a natural result of raytracing algorithms.

$$F = k * (p_c - p_t) - b * V$$

where F is the force vector
k is the stiffness
Pc is the surface contact point coordinate
Pt is the tool tip coordinate
b is the viscosity coefficient
V is the tool tip velocity.


MPVs are found by Ray marching from point to surface. Direction is obtained via sampling multiple points around the stylus tip.

## Haptics

- Our haptic rendering method is based on the god object algorithm [5].

- We derive the closest point, or Surface Contact Point, of the tool tip on the surface from Salisbury and Tarr [3].

- Apply a viscosity coefficient describedto the right

[1] R. A. Newcombe, S. Izadi, O. Hilliges, D. Molyneaux, D. Kim, A. J. Davison, P. Kohli, J. Shotton, S. Hodges, and A. Fitzgibbon. Kinectfusion: Real-time dense surface mapping and tracking. In Proceedings of the 2011 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), pages 99–107, Basel, Switzerland, Oct. 2011. IEEE Computer Society Washington, DC, USA.
[2] I. Quilez. Rendering worlds with two triangles. In NVScene, pages 289–296, San Jose, CA USA, Aug. 2008.
[3] K. Salisbury and C. Tarr. Haptic rendering of surfaces defined by implicit functions. In Proceedings of the ASME 6th Annual Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems, pages 61–68, Dallasm, TX USA, Nov. 1997.
[4] S. Uchiyama, K. Takemoto, K. Satoh, H. Yamamoto, and H. Tamura. Mr platform: A basic body on which mixed reality applications are built. In Proceedings of the 1st International Symposium on Mixed and Augmented Reality (ISMAR), pages 246–320, Darmstadt, Germany, Sept. 2002. IEEE Computer Society Washington, DC, USA.
[5] C. B. Zilles and J. K. Salisbury. A constraint based god-object method for haptic display. In Proceedings of the International Conference on Intelligent Robots and Systems-Volume 3 (IROS), pages 146–151, Pittsburgh, PA, USA, Aug. 1995. IEEE Computer Society Washington, DC, USA.

**Image acknowledgements**
CS 277 - Experimental Haptics Stanford University
http://www.stanford.edu/class/cs277/schedule/assets/cs277_lecXX_implicit+volume.pdf

I. Quilez nvscene 2008
http://www.iquilezles.org/www/material/

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