Humanikins: Humanity Transfer to Physical Manikins

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Abstract. Physical manikins are widely used in the healthcare field for simulation, training and teaching but are limited in their ability to dynamically change their appearance such as changing facial expressions and skin color. Virtual patients can be easily and dynamically animated to change their appearance, and are typically displayed on flat screens. Here we describe the augmentation of physical patient simulator manikins with virtual imagery.

Introduction

Currently healthcare practitioners use standardized patients, physical manikins, and virtual patients for simulation. Standardized patients are limited in their ability to change their physiology. Manikins can change their physiology but have a static appearance, making it very hard to change facial expressions, emotions, show pain, or simulate certain medical conditions. Virtual patients can easily change appearance but are typically displayed on a flat surface in their own separate space. Researchers explored projecting computer graphics onto physical objects [1-3]. We are working on a hybrid approach to augment existing manikins with an expressive face of a virtual human that we call "Humanikin".

Methods & Materials

We use a physical manikin (Manikin), a white solid party mask without pronounced features as projection surface that fits on top of the Manikin's head (Mask), a projector, the content that we plan to project on the Manikin which in our case is generated using computer graphics of a 3D virtual patient's face that we modeled (Content), and a control system that supports the interface to control the Content. We augment the Manikins with Content of dynamic projected imagery. Our approach can be relatively easily added to any existing manikin (low, mid, and high fidelity).(See Fig 1)

Mask

Projecting imagery on the Manikin as is without adding a white projection surface does not result in usable imagery. Painting the Manikin is destructive. In order to keep the process easy and accessible for everyone we explored using a mask that anyone can buy from a store. We chose a Mask with minimal pronounced features and no holes around the eyes, nose and mouth [4] then we painted it using white acrylic paint.

Content

By picking Content that is loosely matching to the Mask, we can use content from any patient's face. This content can be from what we already own, or download pre-built virtual character from websites such as turbosquid [5], 3DRT [6], and mixamo [7], or even create our own.

Mask-Content Matching

We explored a range from tightly to loosely matching the Content to the Mask in order to compare the results. To do so we created our own Content for a 3D face that closely matches the surface of an existing white/ semitransparent mask which has more pronounced features than the party Mask described earlier. We scanned the physical surface of an existing physical mask using photogrammetry, and then simplified the geometry into a low density animatable mesh (See Fig. 3). Facial expressions such as eyebrows upward, eyebrows inward, smile, sad, open/close eyelids, open/close lips (See Fig. 4) and visemes (A, O, F-V, PBM) are added. The model is exported to Unity3D where a virtual camera representing the real projector is positioned to match the extrinsic and intrinsic properties of the projector. The imagery is then sent to the projector to project the Content on both the closely matching mask and the Mask. (See Fig. 2)

Preliminary Results

While more accurate results were found when the content matches the projection surface, people from College of Nursing were excited about the results from the loose match using a Mask and Content for a face as it can be an effective, practical, and low cost solution to allow anyone to re-use their existing content on their existing manikins now (See Fig. 1)

Conclusions & Discussion

The Humanikin is a simulation instrument that combines visual cues content and a physical patient body in the same space allowing healthcare practitioners to "bring to life" their existing manikins that they already use. The Content is NOT limited to 3D virtual characters as people can also use live or pre-recorded videos. We present a simple and low cost way to consider the values of facial expressions, verbal and non-verbal communication added to simulators in a controlled manner with partially transparent technology. Using the Mask with projected Content is a more discrete use of technology compared to a tablet or a flat surface obviously placed on top of the Manikin's head.

Acknowledgments

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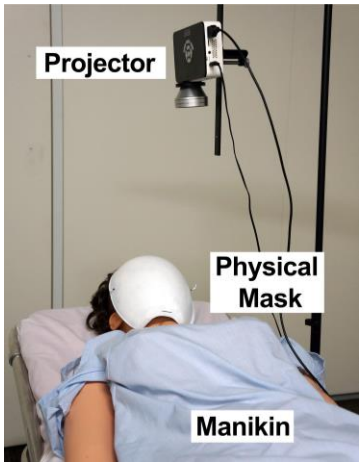

Fig. 1: Physical Setup showing a Manikin with a mask on top of the head and a projector above

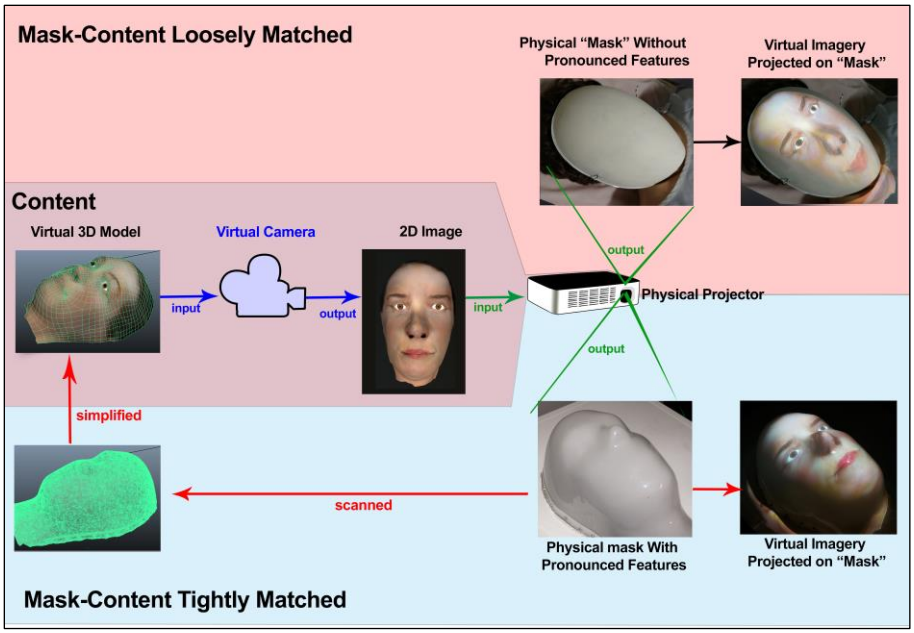

Fig. 2 : Method showing the process to project Content of the 3D virtual character's face on a matching mask (bottom in blue area) and on the "Mask" (top in pink area). The purple area is the Content whid is a common part of the process.

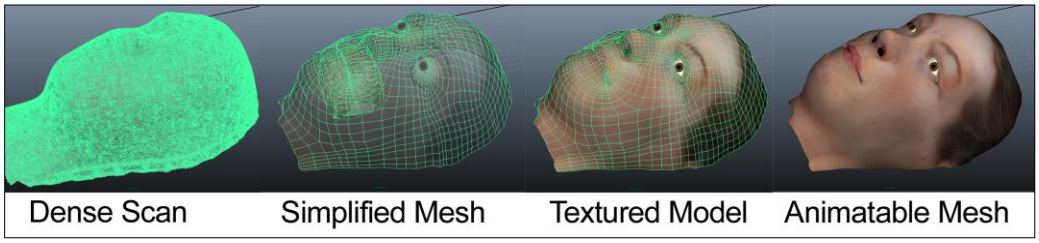

Fig. 3: The Mask is scanned into a dense mesh, which is simplified, then textured and rigged for animation.

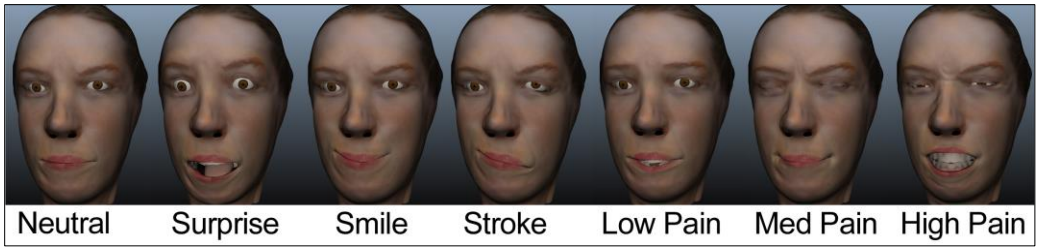

Fig. 4
Few emotional and non-emotional facial expressions modeled using blend-shapes.

References

[1] Diego Rivera-Gutierrez, Greg Welch, Peter Lincoln, Mary Whitton, Juan Cendan, David A. Chesnutt, Henry Fuchs, and Ben Lok. Shader lamps virtual patients: the physical representation of virtual patients. Medicine Meets Virtual Reality 19 - NextMed, Studies in Health Technology and Informatics, IOS Press, 2012.
[2] Greg Welch, Diego Rivera-Gutierrez, Peter Lincoln, Mary Whitton, Juan Cendan, David A. Chesnutt, Henry Fuchs, Ben Lok, and Rick Skarbez. Physical manifestations of virtual patients. Simulation in Healthcare, 6(6), December, 2011.
[3] Jason Hochreiter, Salam Daher, Arjun Nagendran, Laura Gonzalez, Greg Welch. Touch sensing on non-parametric rear-projection surfaces: A physical-virtual head for hands-on healthcare training. Proceedings of IEEE Virtual Reality 2015, pages 69–74. Arles, France, March 23– 27, 2015.
[4] http://www.partycity.com/product/adult+no+face+chrome+mask.do
[5] http://www.turbosquid.com/
[6] http://3drt.com/store/
[7] https://www.mixamo.com/