An Accurate Method for Acquiring High Resolution Skin Displacement Maps

Gino Acevedo Sergei Nevshupov Jess Cowely Kevin Norris
Weta Digital

Abstract

The talk will focus on a fast, affordable, validated method for acquiring very high-resolution, high-quality displacement detail using alginate, plaster, silicone, a flat-bed scanner and digital image processing techniques. We reliably achieve facial and hand displacement maps at a resolution and accuracy that surpasses that of expensive capture/scanning systems.

1 Introduction

The ultimate goal for a CG artist has always been to create a totally believable synthetic human. The human body has many complexities - everything from shape, color, and the delicate flow of pores in the skin - that have always made this a difficult challenge. Complete realism requires modeling or accurately capturing the highly detailed mesostructure for skin, especially for faces, for which human observers are sensitive to incredibly small details. We describe a technique developed during the production of "Avatar" that is very easy to perform, requires no expensive scanning equipment or calibration and produces accurate, detailed displacement data that can be used directly to create "digital doubles" of the scanned actors or through projection painting to add realism to animated character's appearance.

Acquiring accurate and precise displacement maps is essential for rendering realistic skin as many elements of the shading model heavily depend on an accurate representation of the skin's mesostructure. For example it is very hard to properly represent the appearance of a face or a hand without modeling in very high detail the pore, crease and wrinkle detail, since most of the appearance of the skin is determined by high frequency detail.

2 The Technique

Our process was inspired by our previous experience applying silicone for creating realistic synthetic prosthetics and puppets in the physical effects world. Silicone has a unique ability to capture the required mesostructure in a very thin, easily to manipulate layer, and also is translucent and flexible, enabling a simple, high-resolution capture technique using a flat bed scanner.

The entire process involves three casting steps followed by a scanning step and an image processing step. An initial cast is first made with a material that sets quickly and can be safely removed from the face or hands. Plaster is used to create a second cast from first onto which the silicone can then be cured (a 12 hour process). Thin silicone layers can then be easily scanned, and a final data processing step generates the displacement data from the scanned images.

Life casting is done using a material called alginate, which is made from seaweed and is mainly used by dentists and orthodontists to make impressions of teeth. A batch of alginate is mixed and then slowly rubbed onto the face, pushing it into every pore and wrinkle - but leaving the nostrils open so the person can breathe. Once the face is covered with an even coating, it is left to set into a soft, flexible rubber. To support the shape of the person's face, a "jacket" must be made by applying plaster bandages onto the surface of the alginate. Once the bandages have set into a hard shell, they can be removed and the alginate skin can be carefully peeled away from the face and put back into the jacket. This leaves a perfect negative impression of the person's face. Next, a very hard plaster is mixed up and poured into the negative. Once the plaster has set, it is removed from the negative casting leaving a

Figure 1: *From left to right: Alginate application, plaster bandages applied, negative cast, positive plaster cast.*

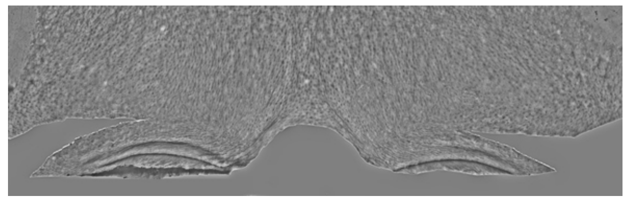

Figure 2: *Sample displacement detail.*

solid duplicate of the persons face. Next we mix up the translucent silicone, which we rub onto the surface of the plaster cast and then leave to drain off. What remains is a very thin layer of silicone spread out evenly across the face. Once cured, it is then peeled off leaving a thin, negative impression of the face.

The silicone skins are scanned after first being cut up so that each piece will lay as flat as possible on the scanner and will represent a mostly homogeneous pore structure (given the different characteristics of the various areas of the face or hand). This step basically corresponds to the texture unwrapping that would normally be performed digitally as part of the UV mapping. If the displacement maps are to be directly applied to a digital double, replicating the appearance of the scanned actor, care needs to be applied to properly map the texture to the model, following the almost uniform stretch applied to the silicon layer. If instead the displacement map is to be used as the basis for projection painting, the scale and orientation will be decided by the texture artist. By performing a physical unwrap, we are able to minimize stretches, and make them homogeneous across the various sections. We split the head up into 3 sections, the forehead, nose, and sides of the face and neck all as one large piece maintaining as much of the face as a whole as possible. A small layer of baby oil on the scanner between the glass and the silicone acts to merge the two with minimal refraction. The method is capable and capturing details that are visibly resolved in a 1200 dpi resolution scan.

An image processing step to derive displacement from the scanned images follows: the images are normalized to remove low frequency density variations due to the uneven distribution of the silicon, touched up to remove artifacts, bubbles, and are aligned and applied to characters either directly or through projection painting in Mari, Weta Digital's 3D painting software.

Different techniques can be used to perform the normalization step, however, given the need for some touch up and preparation for painting, in most cases, manual correction is the easiest and best solution.

The end result is a very highly detailed displacement map that shows the intricacy of the natural lines and pore flow greatly helping the realism of digital humans and animated characters.

Copyright is held by the author / owner(s).
SIGGRAPH 2010, Los Angeles, California, July 25 – 29, 2010.
ISBN 978-1-4503-0210-4/10/0007