The case for avatar makeup

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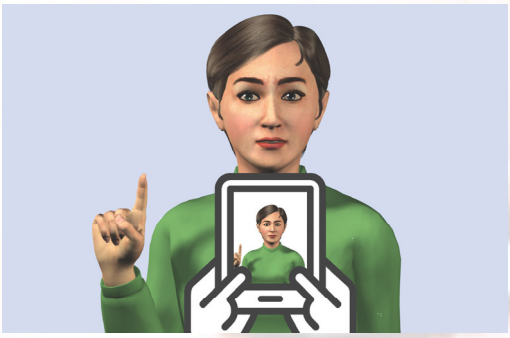
Fine details are essential.

- Crucial information in a signed utterance can be carried by Brows, Lips and Eyes.
- These features are small when compared to the size of a human body.
- However, if they are missing, crucial parts of the utterance can be lost.
- This can alter or destroy the meaning of a signed utterance.

Fine details are often not visible.

- Avatars are small compared to humans.
- Avatars take up a smaller field of view than a human in a face-to-face conversation.
- Fine details can disappear.



Conventional CG is inadequate.

- Modeling details with polygons (geometry) using the Phong illumination model is not sufficient.
- Bump mapping is ineffective.
- Displacement mapping is ineffective and expensive.

"Outside our box": the theatre

- Actors have the same problem, since they are quite far away from the audience when communicating the very important small changes in the face.
- The makeup they use emphasizes the parts of the face in which these subtle changes show.
- Rather than prosthetics or special effects makeup to make 3D changes to the face, makeup emphasizes light and shadow on the natural surface of the face.

Uuve Jansson, performer with Cirque du Soleil

Prior Work

- Schnepp [5] used texture mapping to create forehead furrows when the avatar lifted her eyebrows to pose a Yes/No question in ASL.
- He structured the texture map not as a single image but a suite of images, each with a transparency control.
- Transparency controls caused visual effects to appear and disappear on the avatar.
- He controlled the appearance of the furrow by calculating an opacity factor for the foreground simply based on height of the eyebrow lowering:

```
// let bg be the backround image
// let fg be the foreground image with a furrow
p = (browZ – browZmin)/(browZneutral – browZmin)
p = clamp (p, 0, 1)
image = fg * p + bg * (1 – p)
```

- The effect was global to the entire face.
- It was not possible to combine multiple effects.
- The following images demonstrate the effect:

100% bg 0% fg

70% bg 30% fg

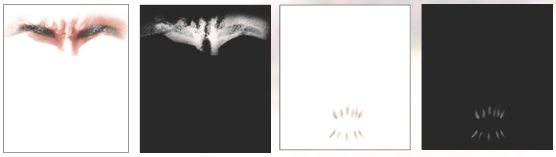
50% bg 50% fg

30% bg 70% fg

0% bg 100% fg

Extending the technique

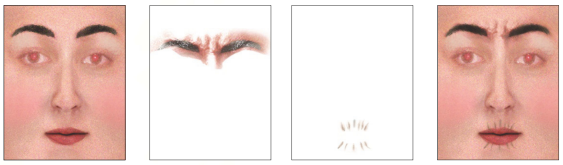
- In addition to the red, green and blue channels and the global transparency control, each layer is extended by the introduction of an alpha channel.
- The alpha channel controls the visibility of individual pixels within the texture map.



Brow furrow RGB | Brow furrow alpha | Lip pucker RGB | Lip pucker Alpha

- Alpha channel of each layer controls *local* visibility
- Transparency control determines *global* visibility of the layer.
- Pseudo code is given below:

```
fn parameterize (ilayer, feature, upper, lower)
{
   Use the feature that specifies the geometry
   in layer ilayer and the range defined for
   ilayer by upper, lower to create a parameter
   ranging between zero and 1
}
for pixel (i,j)
{
  finalRGB = backgroundRGB(i,j)
  for each layer l
  {
    layerRGB = rgb(l, i, j)
    localAlpha = alpha(l, I, j)
    globalAlpha = parameterize(l,geometry, max, min)
    a = localAlpha * globalAlpha
    finalRGB = a * layerRGB + (1 – a) * finalRGB
   }
  pixelRGB(i, j) = finalRGB
}
```



Background | Brow furrow | Lip pucker | Added together

Advantages

- The local visibility information in the alpha channel allows multiple layers to affect the appearance of the texture map.
- Timing of each layer can be independent of the other layers.
- Global control becomes less complex.

Results, Future Work

- The approach has been implemented as a shader in GLSL. It runs at video rates on mid-range graphics hardware
- Future plans include incorporating device responsiveness and user evaluation.

References

- Please see the QR link.

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