

Countering Bias in Computer Graphics Requires Structural Change

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Hello everybody, good morning, afternoon, or evening to you all, depending on where you're joining us from.

Here's how we'd like to run things. We have an hour and a half carved out here, and we'd like to devote most of this to open discussion.

Schedule

- Intros & Bias in Research - Prof. Kim (10 min)
- Bias in VFX - Prof. Syed (10 min)
- How to go forward? – Prof. Kim (10 min)
- Open Discussion (60 min)

To help position things, for about the first 30 minutes, I'm going to speak, and Professor Syed is going to speak, then I'll propose some ways forward.

After that, we're all interested in what ***you all*** have to say.

Introductions

We'll start with intros. I'm Professor Ted Kim from Yale University, and I used to be a Senior Research Scientist at Pixar. I work on simulation of smoke, water and solids, and one of my fluid simulation papers won a SciTech Oscar back in 2012.

Raqi goes next
Then Wojchiech
Then Holly

Professor A.M. Darke from UC Santa Cruz is also listed as an organizer, but unfortunately she can't make it here today. She's in the middle of preparing her tenure packet, which if you're in academia, know is the bright-line make-it-or-break-it moment in every faculty member's career. So, best of luck to her, hopefully she'll get tenure and then we'll get to see her at every SIGGRAPH from here onwards.

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I know that there's a diversity of knowledge levels in the room at the moment, and I don't want to assume that you came here having read our articles, or having watched my talk at the DEI Summit yesterday. What I'm going to do is give a quick 10 minute overview of the issue of racial bias in computer graphics research

Okay. A quick overview of racial bias in research. I'm going to cut and paste several longer-form overviews of these issues into the chat window.

If you don't have a passing knowledge of these issues, I'm going to give a quick overview of this now, with the warning that: this is going to be brutal. These are very ugly issues, and there's no pretty way to present them in an hour, much less than 10 minutes.

This is basically a trailer for the talk I gave yesterday. If you want more details, I gave an hour-long talk yesterday that I'll cut and paste into the window.

"Anti-Racist Graphics Research" talk, SIGGRAPH 2021
<https://youtu.be/ROuE8xYLpX8>

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Scientific American Op-Ed from 2020:

<https://www.scientificamerican.com/article/the-racist-legacy-of-computer-generated-humans/>

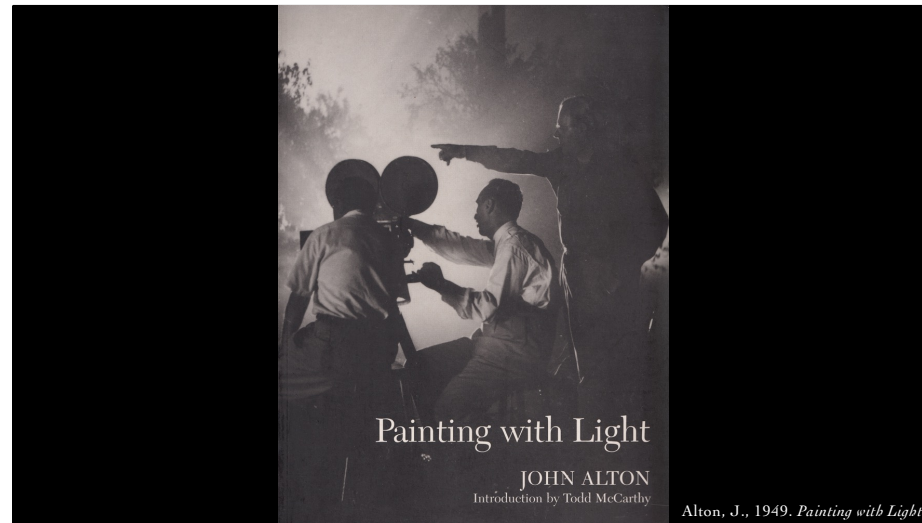
Computer graphics research has a race problem

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Systemic Racism

The term systemic racism has been appearing more and more lately, and we're not exempt from it. Racism is baked into our everyday institutions, whether we like it or not, and if we don't try to deal with it directly, we will just end up reproducing existing inequalities.



This has actually already happened. If you look at old classic manuals on movie lighting, like John Alton's *Painting with Light*

LIGHT AND THE HUMAN FACE

The first step in illumination is the study of light and the human face. If you watch carefully, under varying circumstances in subways, buses, streetcars, in the open, on beaches, at home, or elsewhere, you will find that faces look absolutely different when silent and expressionless than when they laugh, smile, talk, or cry. Hitherto unsuspected hidden wrinkles and harsh lines suddenly appear

Alton, J., 1949. *Painting with Light*.

when he talks about lighting a “human face”, he’s talking almost exclusively about lighting a white face.

Alton, J., 1949. *Painting with Light*.



So of course he did, it was the 1940s, this was pre-Civil Rights, things were different back then.



(a) Dipole (Jensen et al. 2001)



(b) Quantized-Diffusion

Figure 1: Rendering a **human face** using a single-layer skin model. The classical dipole model (a) is frequency-limited and results in a
d'Eon, Irving, *A Quantized-Diffusion Model for Rendering Translucent Materials*, ACM Transactions on Graphics (2011).

Fast forward to today, when we talk about rendering a human face, we're still talking the same way about the same thing.



You do a sampling of rendering papers, especially the foundational papers on this topic, like the Jensen et al. 2001 paper, and the language is the same.

Let's render a human face, and by human face, we're going to show exclusively white faces.

Here's a whole bunch of rendering papers, up until last year, that purport to be rendering "human faces", "human skin" or most insidiously "skin"

They only show white faces. If you look in these papers, there are no black or brown people.

Just like Alton in the 1940s, when we say "human face" we mean "white face".

“Skin” = White Skin

In graphics when we talk about “skin” we’re talking about white skin.

“Skin” = Subsurface
Scattering

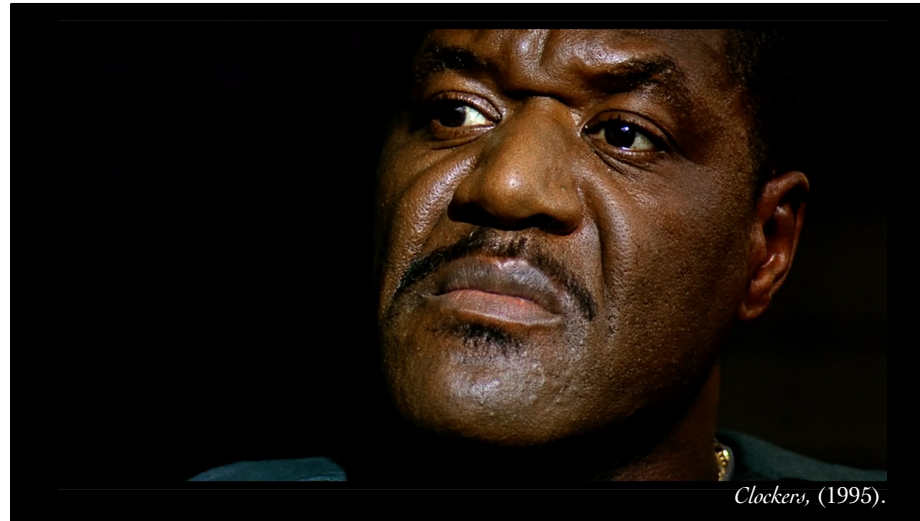
We’re going to codify the light transport phenomena that’s most important to white skin, subsurface scattering, and make that synonymous with skin

“Skin” → $L_o(\mathbf{x}, \boldsymbol{\omega}) = \int_{S^2} \int_{\partial\Omega} S(\mathbf{x}_i, \boldsymbol{\omega}_i, \mathbf{x}, \boldsymbol{\omega}) L_i(\mathbf{x}_i, \boldsymbol{\omega}) d\boldsymbol{\omega}_i d\mathbf{x}_i$

Now unfortunately, once you cast things as a double integral, it becomes essentially impossible for non-specialists to dispute.

$$L_o(\mathbf{x}, \boldsymbol{\omega}) = \int_{S^2} \int_{\partial\Omega} S(\mathbf{x}_i, \boldsymbol{\omega}_i, \mathbf{x}, \boldsymbol{\omega}) L_i(\mathbf{x}_i, \boldsymbol{\omega}) d\boldsymbol{\omega}_i d\mathbf{x}_i$$

So the racial assumption is now baked into the math.



We look at the faces of Black people, and it's not the ethereal glow of subsurface scattering that dominates, it's these really intricate and expressive specular highlights that dominate. Subsurface scattering does not characterize all skin, but because we live in a world freighted with a legacy of systemic racism, this is what our formulations look like.



There are papers that try to diversify, but they are in vast minority. And, they're hobbled from the start by the fact that they have to start from mathematical models that were custom-made for white skin. Where's the GGX or Burley function that capture the highlights on Delroy Lindo's face. There is none. We haven't done the research, because this is systemic racism in action.

I'm only picking on the rendering folks because it's the easiest to cram into 10 minutes. This has happened in other places in graphics.



When we talk about hair, we explicitly avoid talking about this kind of hair. Professional stylists call this “Type 4” hair, otherwise known as Afro-textured, or kinky hair.



This doesn't show up in graphics. You look at papers over the last 20 years, and it's all straight or wavy hair.

Again, the problems are systemic, and all this history predates us, and goes back to the analog era.

Alton, J., 1949. *Painting with Light*.



Look at the hair that Alton was lighting, this is what counted as human hair in the 1940s, but we have carried this bias forward into 2021.

Okay, I have described problems, but no solutions. We'll get to that later. But, I think this is a good moment to hand off to Professor Syed, who is going to talk about this all from a VFX perspective.

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