A New Method for Radiance Skies

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Harvard University
Graduate School of Design
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Outline

- Motivation
- Goals
- Sky models
- Implementation
- Results
My background

• Aerospace engineer
My background

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My background

- Aerospace engineer
- Artist
Goals

- Colorful sky for artistic renderings
- Accurate enough for wider applicability
- Plug-in replacement for gensky
Challenges

- Wide irradiance variation!

<table>
<thead>
<tr>
<th>Source</th>
<th>Irradiance (W/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>$1.3 \times 10^3$</td>
</tr>
<tr>
<td>Sky</td>
<td>$6.4 \times 10^1$</td>
</tr>
<tr>
<td>Moon</td>
<td>$2.1 \times 10^{-3}$</td>
</tr>
<tr>
<td>Venus</td>
<td>$1.3 \times 10^{-6}$</td>
</tr>
<tr>
<td>Starlight</td>
<td>$3.0 \times 10^{-8}$</td>
</tr>
</tbody>
</table>
Challenges

- Wide apparent magnitude variation!

Sun: -26.73
Moon: -12.6
Venus: -4.6
Sirius: -1.47
Human limit: +6.5
Existing Sky Models

- Image-based (next talk w/ Prof. Inanici)
- Computational: Klassen, Kaneda, Nishita
- Analytic: CIE sunny, overcast, Perez
- Wann Jensen et al., *A Physically-Based Night Sky Model*, SIGGRAPH 2001
Perez


\[ F(\theta, \gamma) = (1 + Ae^{B/cos\theta})(1 + Ce^{D\gamma} + E \cos^2 \gamma) \]

\[ Y_{Perez} = Y_z \frac{F(\theta, \gamma)}{F(0, \theta_{sun})} \]
Adjustment

- Errors at horizon and low sun angles

\[ F(\theta, \gamma) = (1 + Ae^{B/(0.004 + |\cos\theta|)})(1 + Ce^{D\gamma} + E \cos^2 \gamma) \]

\[ Y_{mod} = Y_{Perez} \min(1, \exp^{20(z_{sun} - 0.05)}) \]
gensky -t 2

Boston, Oct. 23, 2009, facing south, turbidity 2.0, pcond -v -s
genutahsky -t 2

Boston, Oct. 23, 2009, facing south, turbidity 2.0, pcond -v -s
genutahsky -t 4

Boston, Oct. 23, 2009, facing south, turbidity 4.0, pcond -v -s
Sun

- As gensky, but uses libnova for placement
- Accurate solar disc size
- Sun color varies from D65 to lower temp
- Multiple suns for smoother penumbras?
Non-D65 sun

6500K

5216K
Moon, Planets

- Moon brightness, position, disc size
- Venus, Jupiter, Mars - if above horizon
- Magnitude-to-luminosity conversion
- Solid disk--No Lunar crescent (yet)
Stars

- Data from Tycho-2 survey (2.5M stars)
- 8192x4096 RGB “MDR” colorpict
Stars

Stars

• Reduced 2:1 in cinepaint (10-bit range)
Merging sky and stars

void colorfunc skyfunc
4 skyr skyg skyb utah.cal
0
4 2.5 0.0965795 0.365116 -0.925939
Merging sky and stars

void colorfunc skyfunc
void colorpict starmapcolor
7 noneg noneg noneg
   TychoSkymapII.t5_08192x04096.hdr
   sphere.cal inf_u inf_v
0
1 0.5
Merging sky and stars

void colorfunc skyfunc
void colorpict starmapcolor
void mixfunc mixedcolor
4 skyfunc starmapcolor half half.cal
0
0
Merging sky and stars

void colorfunc skyfunc
void colorpict starmapcolor
void mixfunc mixedcolor
mixedcolor glow mixedglow
0
0
4 2.2.2.0
Merging sky and stars

void colorfunc skyfunc
void colorpict starmapcolor
void mixfunc mixedcolor
mixedcolor glow mixedglow
mixedglow source skydome
0
0
4 0 0 1 190
mixedglow source grounddome
0
0
4 0 0 -1 170
Merging sky and stars

7pm

8pm

9pm
Land model

- USGS 30m DEMs
Land model

- USGS 30m DEMs
- Long tool chain to get Radiance mesh
Results
Grand Canyon at sunrise from Desert View, looking West and North
Same, before sunset
Same, after sunset
Same view, serendipitous accident
Same view, midnight-to-midnight animation
Validation
Getting genutahsky

- Package at http://markjstock.org/radiance/genutahsky.zip
- Unzip into /usr/local/lib/ray/
- Consists of genutahsky.c, Makefile, .cal files, .hdr starmap
Building genutahsky

- Only external requirement: libnova package from sourceforge
- make
- Put files in ./ or ${RAYPATH}
Usage

- Original: `gensky 10 23 11EST -a 36 -o 112 -t 2.5`
- New model: `genutahsky 10 23 11EST -a 36 -o 112 -t 2.5`
- Forced values (-B -R -r ...) unsupported
Rendering tips

• Use generated ground haze material
Rendering tips

- Use generated ground haze material
- -lw 1.e-3 helps
Rendering tips

• Use generated ground haze material
• -lw 1.e-3 helps
• pcond -v -s (-h without -a -c)
Status

- “City” glow from distant light sources
- Wider range of turbidity (now: 1.75-5)
- Proper modifiers for aerial perspective
- Help?
Thanks!

- Greg Ward
- Christoph Reinhart and Kera Lagios
- Liam Girdwood, Petr Kubanek of libnova
- List geniuses: Rob G., Rob F., Lars G., Jack dV., Chris R., Ignacio M., Andrew McN.
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