Photographic Obstruction Mapping

Andy McNeil, Kinestral Technologies Inc.
Daylight and Views are widely desired
  - Daylight is the most desirable benefit employers can offer to employees
  - Homes with ample daylight are more valuable than those with less

Humans are terrible at manual control of shading
  - We are triggered by glare
  - The un-trigger is ambiguous and rarely noticed

Shades stay down far longer than needed
  - Daylight is squandered
  - Views are blocked
Automated control is the way forward

- Automation needs to be cost effective at small scale
  - € / window for 10 windows vs. 1,000 windows

- Automation needs to do the ‘right thing’ all the time.
  - 95% correct = Wrong 2 hours per work week
  - 99.5% correct = Wrong 12 minutes per work week

- One thing that needs to be done right:
  Don’t activate shading when the widow is in a shadow!
Obstructions...

- Cast shadows on windows
  - Neighboring buildings
  - Static Shading devices, eg. overhangs, fins
  - Mountains / Hills
  - Trees (?)
Currently accounted for by ray-tracing CAD models

- Model preparation can be time consuming and costly
- CAD model availability is spotty.
  - Often limited to building outlines
  - Height needs to be estimated
- Errors are often baked into the schedule, and difficult to diagnose and correct.
- Substantial up-charge is passed on to the customer
  - Economical for large projects
  - Not practical for small projects
Photographic Obstruction Maps

- Collect obstruction information onsite with calibrated camera.
- Remap pixels to angular coordinates
- Identify sky vs. obstruction
- Query with sun position
Calibrated Camera (Prototype)

- 180° Fisheye lens
- Black shroud for positioning
Accelerometer

- Accelerometer to correct for crooked hand
Lens distortion

- Angular calibration to correct for lens distortion

\[
y = -6E-07x^4 + 7E-05x^3 - 0.0013x^2 + 0.9716x
\]
‘Orthonormal Pseudocylindrical’ Projection

- **X-axis:**
  - azimuth angle
  - projected into horizontal plane

- **Y-axis:**
  - profile angle
  - projected into vertical plane

- Lines that are orthonormal to the direction of view are straight lines in the orthonormal projection.
‘Orthonormal Pseudocylindrical’ Projection

Equirectangular Projection

Orthonormal Projection
Re-projection

- Fisheye to orthonormal projection
- Straight Line = Pleasant!
Equirectangular…

- Not straight line = awkward
Trace Visible Sky
Now it’s an angular obstruction map!
Validation
Sun begins to shine on the window

- Predicted time: 7:39
- Actual time: 7:42
- Error of 3 minutes, 0.4°
Sun ceases to shine on the window

- Predicted time: 11:06
- Actual time: 11:03
- Error of 3 minutes, 0.7°
Summary

- A calibrated camera can be used to generate angular maps of exterior obstructions.
- The maps are thought to be accurate to within 1°, though validation is ongoing.
- This method is economical for small projects.
Example:
Paris Hotel
Example:
New York City Office
Example:
Los Angeles Office