Problem

Conventional radiometric calibration
- One accessible camera with controlled exposure times
- Fixed viewpoint, illumination
- The same camera setting (except for exposure time)

Challenges using Internet images
- Multiple inaccessible cameras with uncontrolled settings
- Arbitrary viewpoints, illuminations
- Different camera settings (exposure time, white balance, ISO, etc.)

Key idea
- Image formation model
  - $B = f(I) = f(cp(n^T \int L(s) ds)) = f(cp(n^T \bar{I}))$
  - $B$ - brightness, $cp$ - inverse/response function, $n$ - white balance, $\bar{I}$ - lighting integration over visible hemisphere $\Omega$
- Key constraint
  - Ratio of pixel pairs with same normal and different albedos
- Major contributions
  - Solved: Simultaneously calibrate radiometric camera properties for a set of Internet images
- Potential: Bring photometric techniques (3D modeling, scene analysis, etc.) from lab setup to big and wild data on the Internet

Algorithm
- Identify pixel pairs with same normal but different albedos in each image
- Obtain surface normal from $\Sigma + M^T$ avoid
- Discard pixel pairs whose brightness ratio are equal or close to 1
- Project 3D points of selected pixel pairs to each 2D image
- Solve the problem via rank minimization

Solution
- 3D reconstruction from a photo collection
- Pixel ratios and rank minimization
- Pixel pairs with the same normal but different albedos
- Inverse radiometric response functions

Dataset
- Three real datasets containing mixture of Internet photos and images captured using controlled cameras

Result
- Output: Inverse response functions of all images up to the same exponential ambiguity
- Pairwise optimization - select two rows of $A$ as "base" image pair and all the other rows to the base in an incremental manner

Veriﬁcation
- [Lin04] S. Lin, et al., Radiometric calibration from a single image, CVPR04