

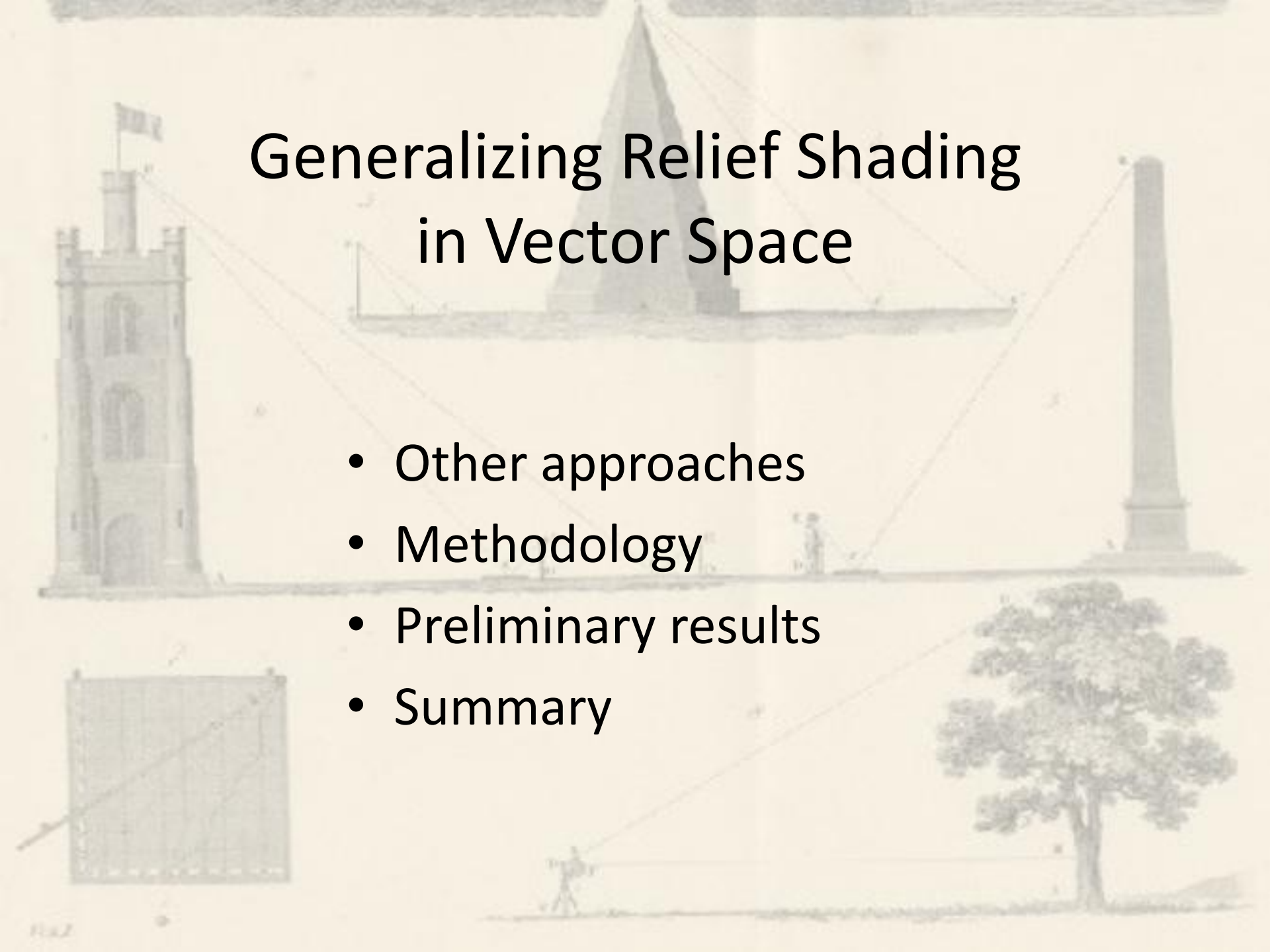


Generalizing Relief Shading in Vector Space

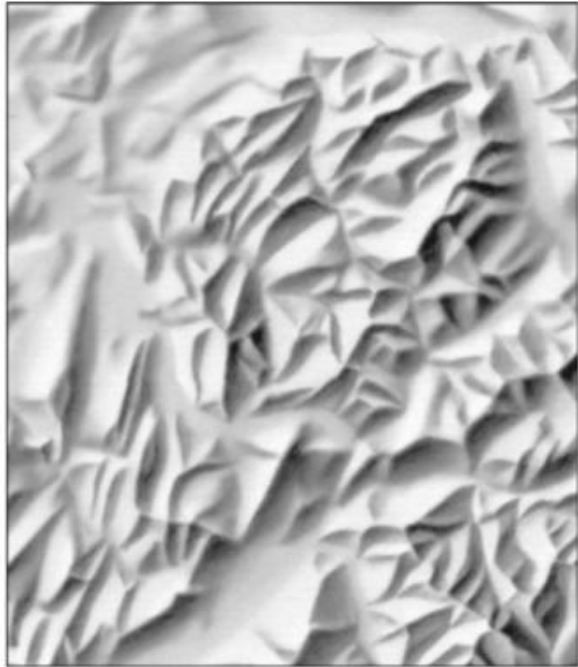
Patrick Kennelly
Long Island University
Brookville, New York, USA

Generalizing Relief Shading in Vector Space

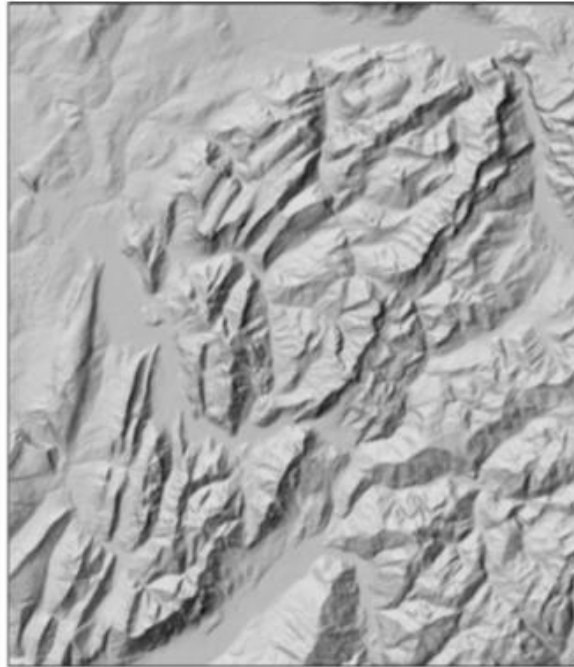
- Other approaches
- Methodology
- Preliminary results
- Summary



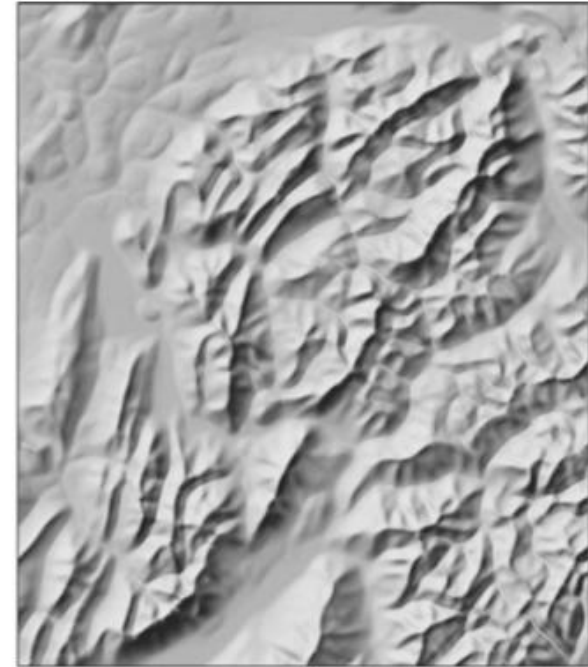
Other Approaches Terrain Sculptor



Manual



Digital



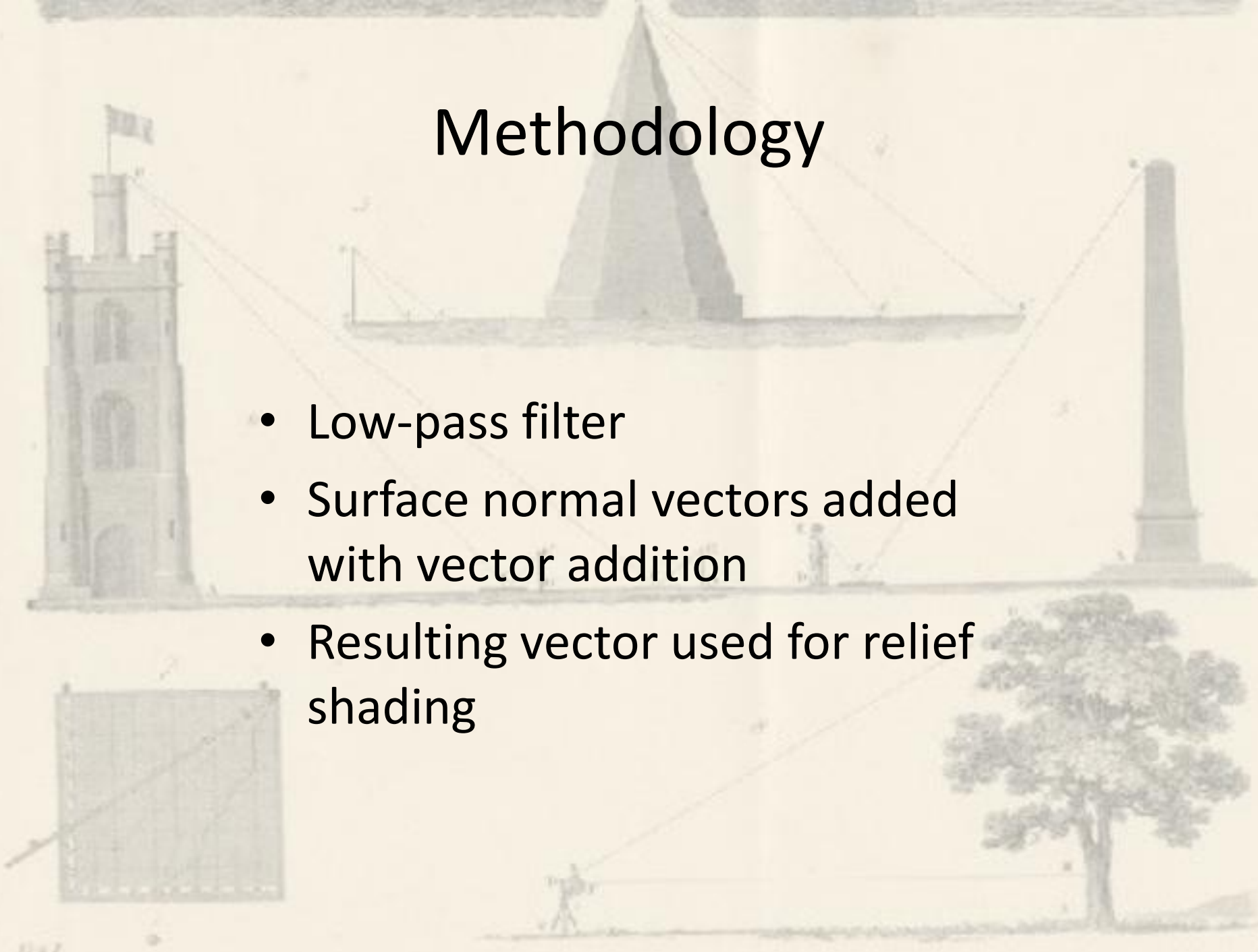
**Digital
Terrain filtered with Terrain Sculptor**

Terrain Sculptor

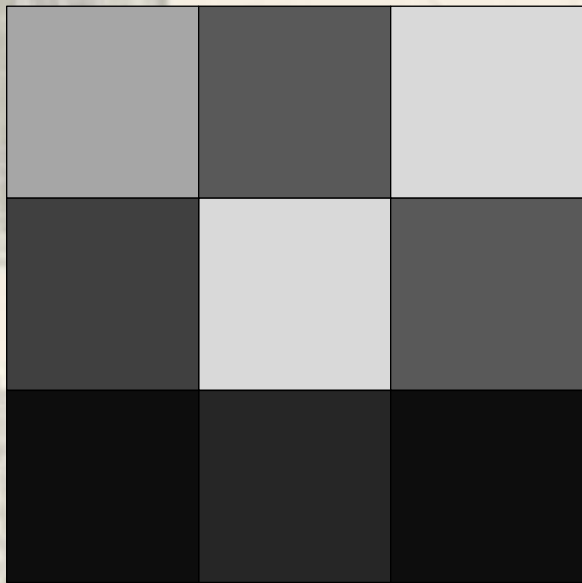
- Low-pass mean filter
- Curvature coefficients to identify valleys and ridges
- Vertically exaggerate and deepen smoothed terrain model
- Mountain and lowland grids create with weighting factors applied to exaggerated/deepened and smoothed grids
- Grids recombined with smoothed slope grid
- Shaded relief created from recombined grid

Methodology

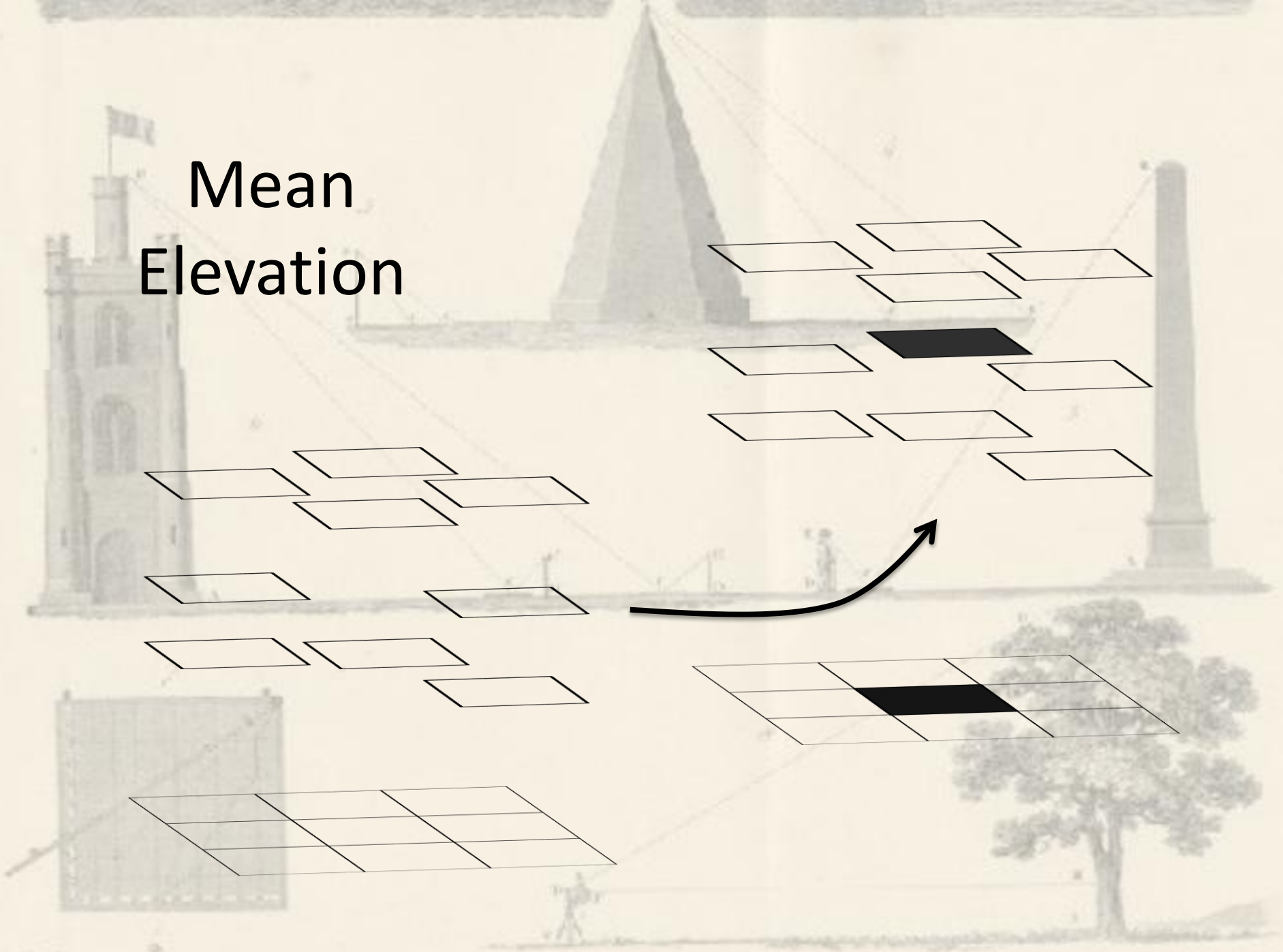
- Low-pass filter
- Surface normal vectors added with vector addition
- Resulting vector used for relief shading



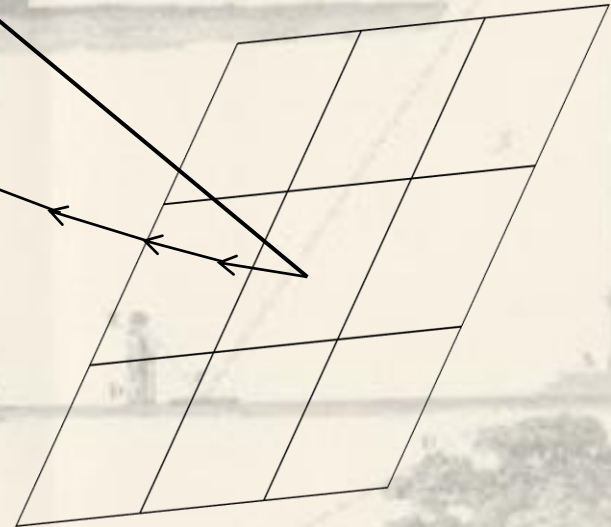
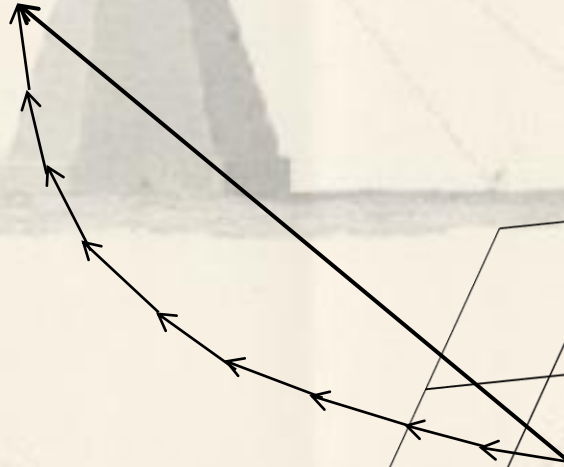
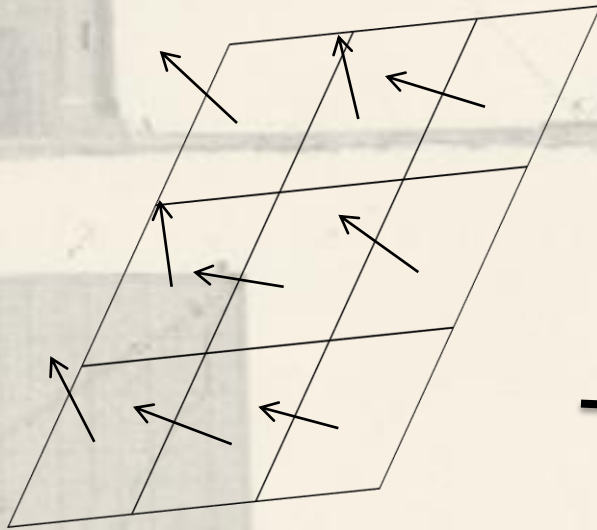
Mean Shading Value



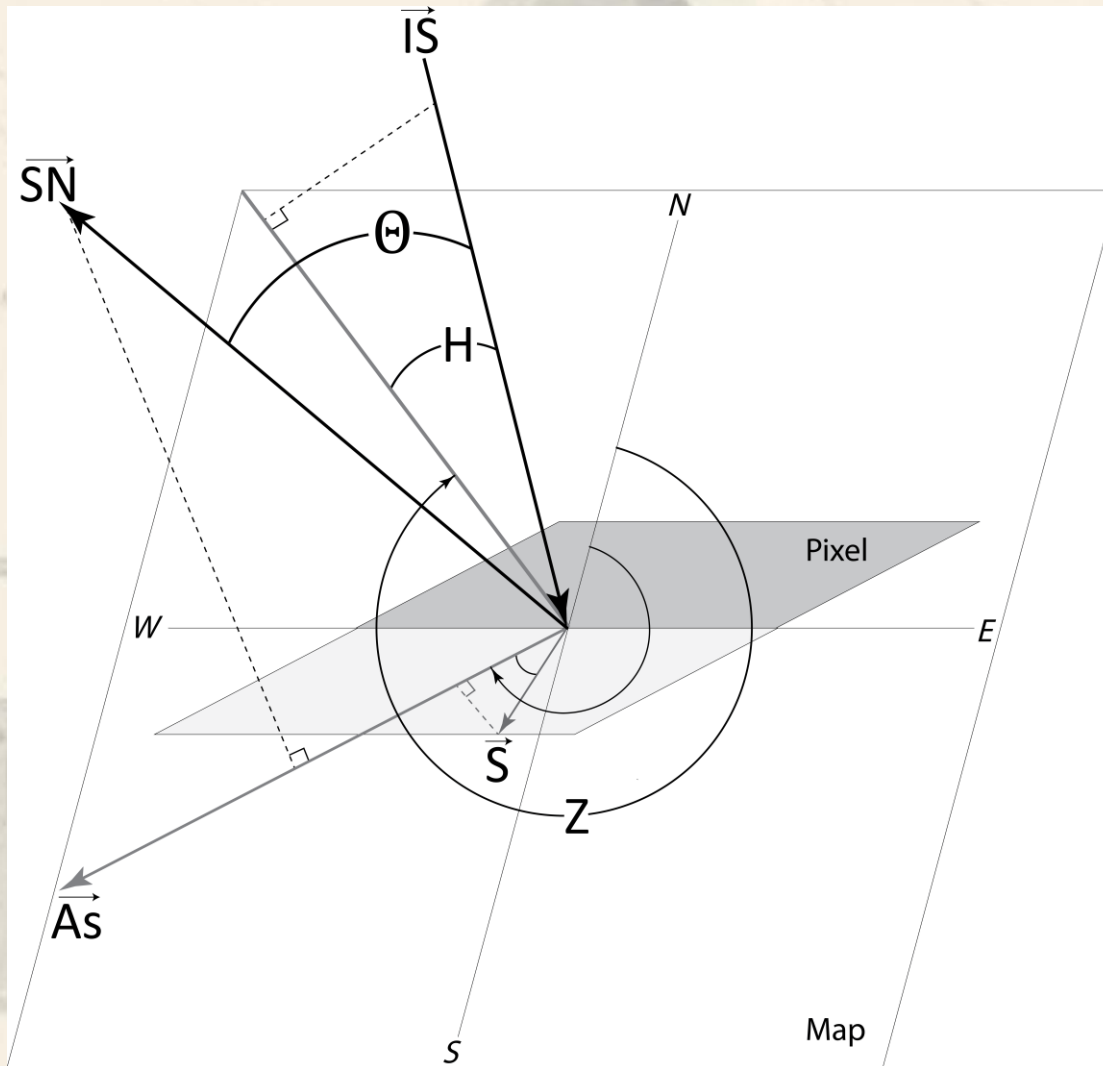
Mean Elevation



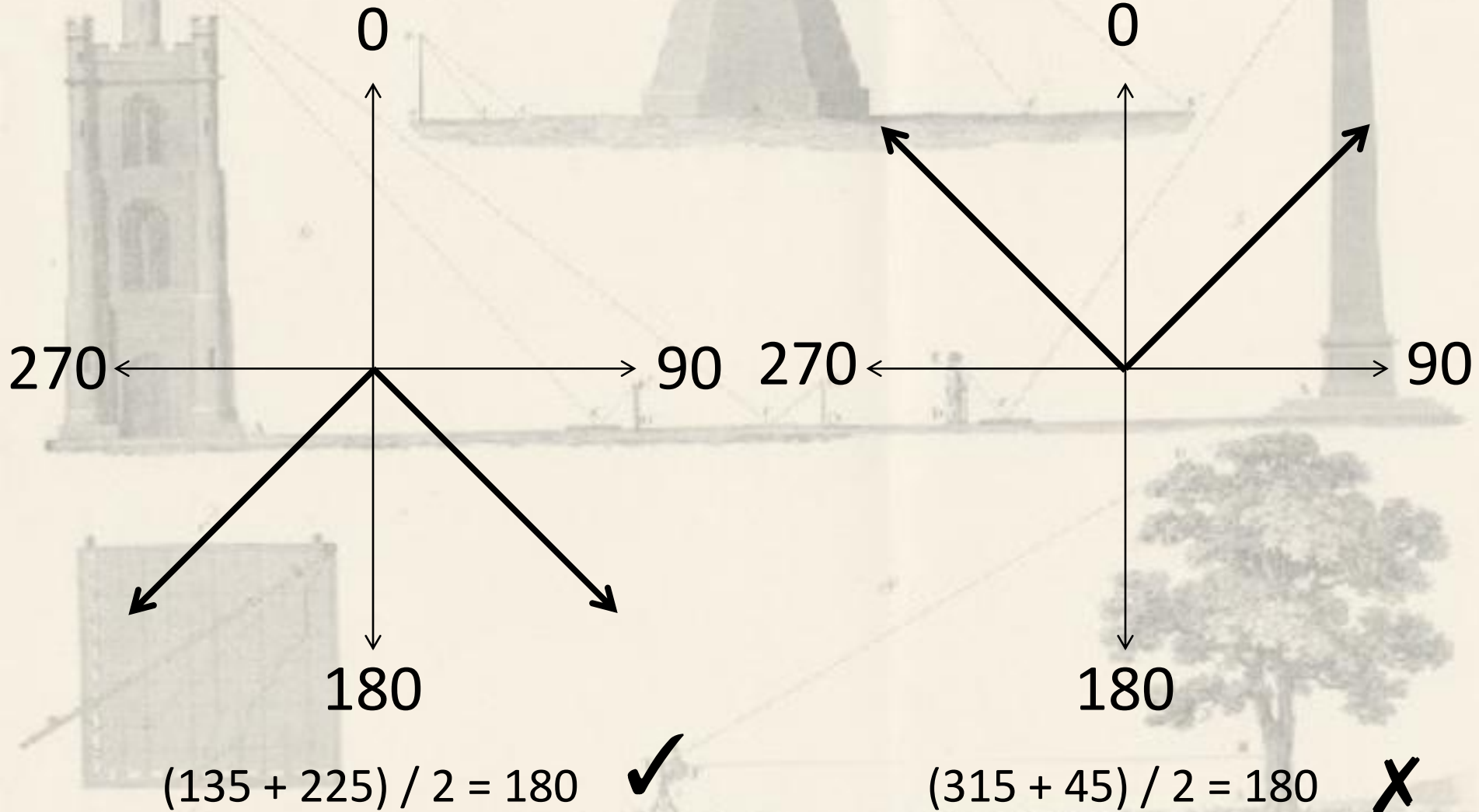
Sum of Surface Normal Vectors



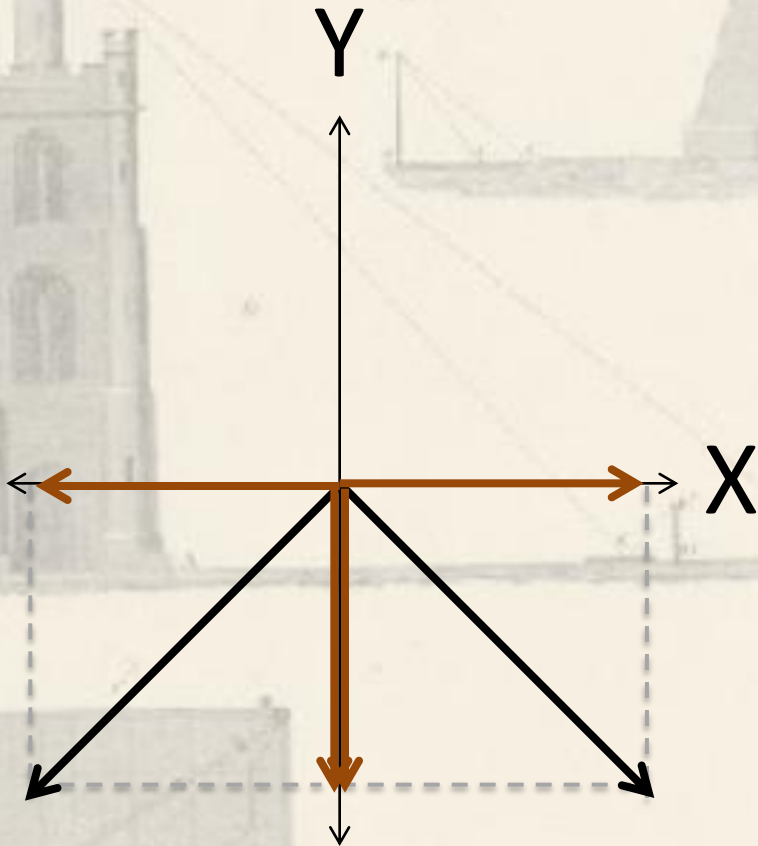
Relief Shading Vectors



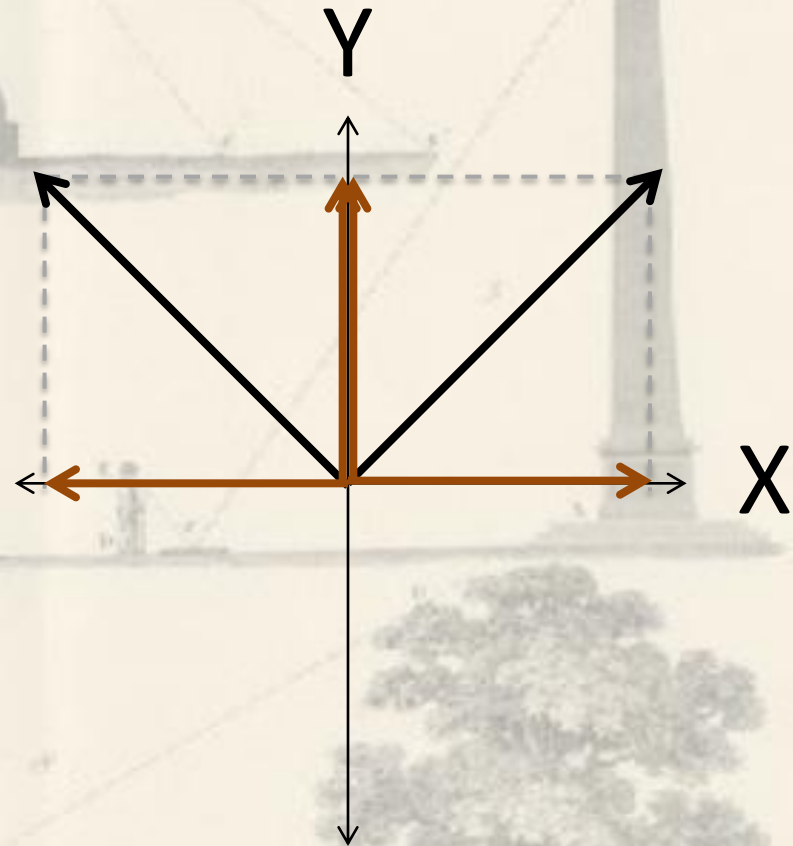
Finding an Average Azimuth



Finding an Average Azimuth



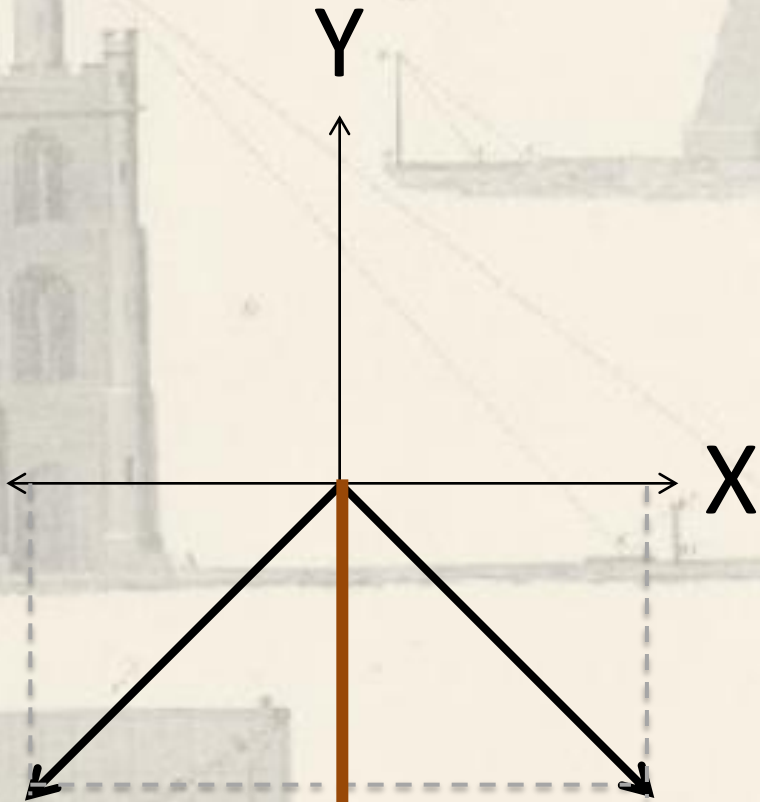
$$X = \sin(135) + \sin(225)$$
$$Y = \cos(135) + \cos(225)$$



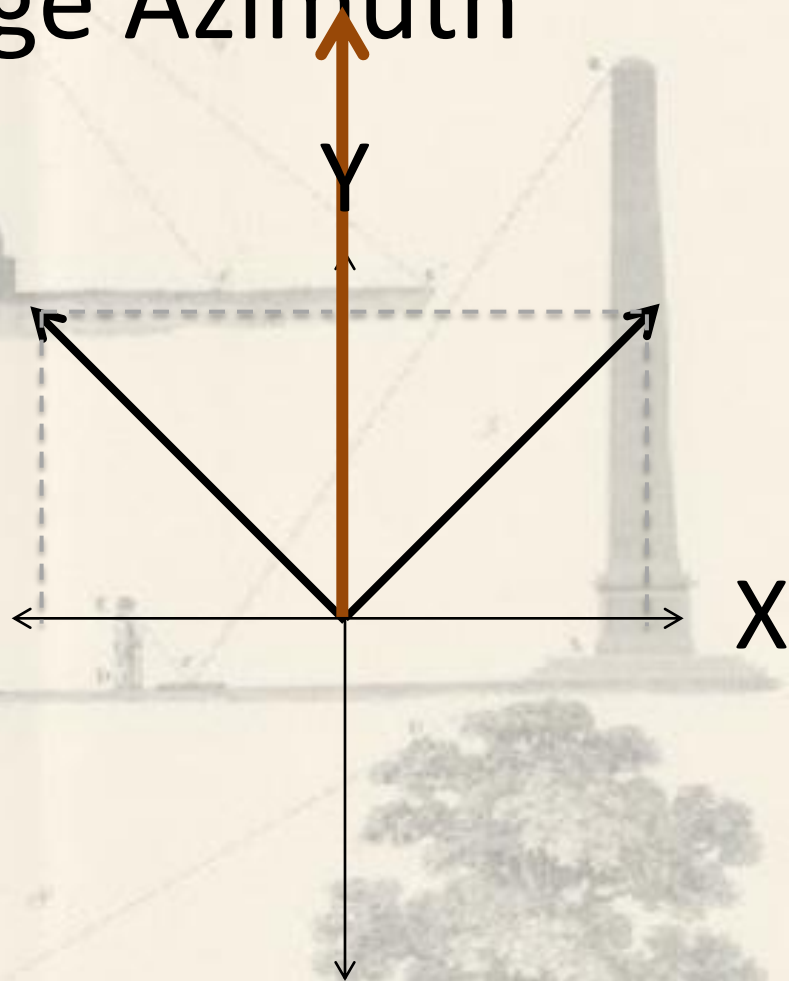
$$X = \sin(315) + \sin(45)$$
$$Y = \cos(315) + \cos(45)$$



Finding an Average Azimuth



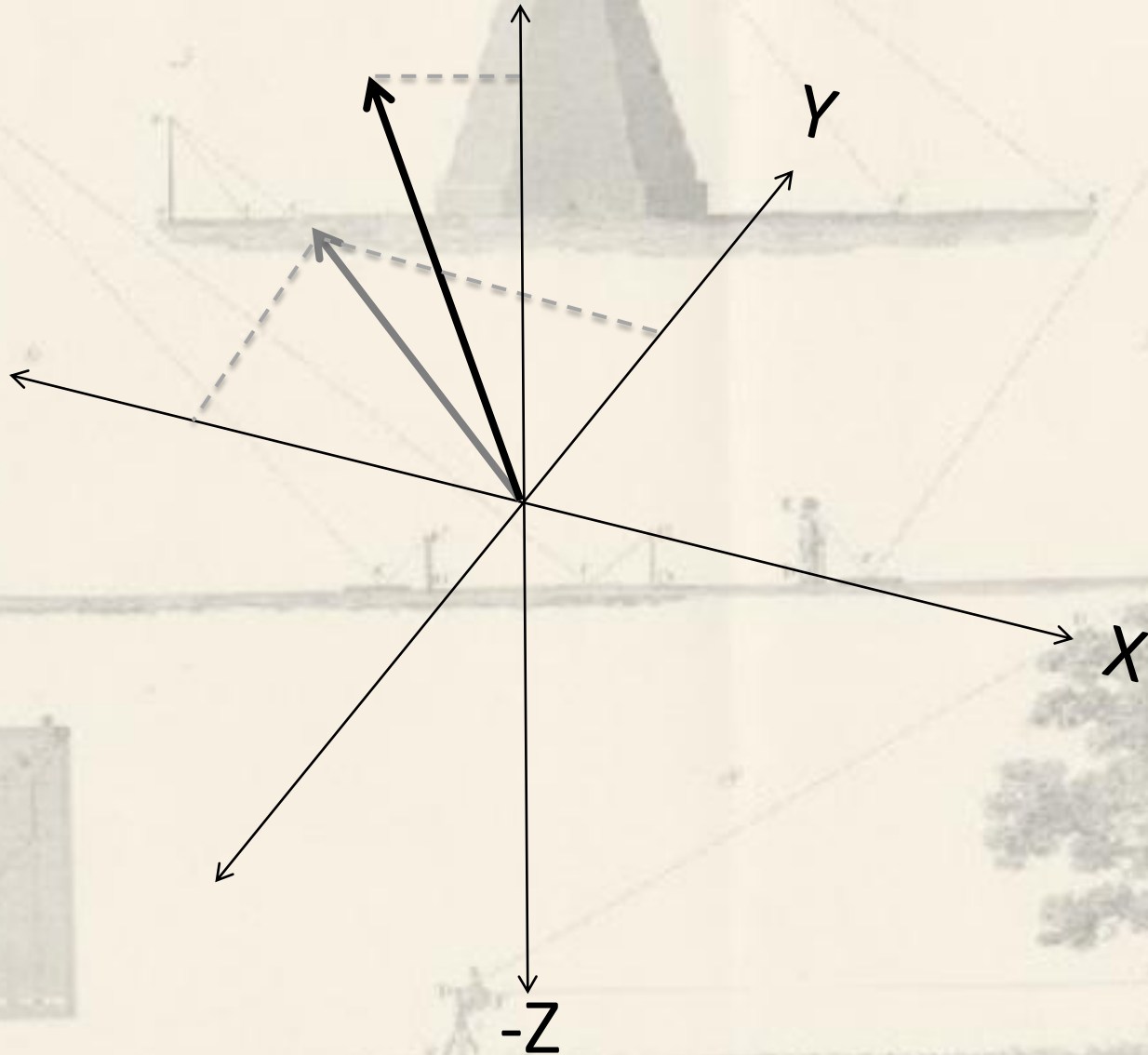
$$X = \sin(135) + \sin(225)$$
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$$X = \sin(315) + \sin(45)$$
$$Y = \cos(315) + \cos(45)$$



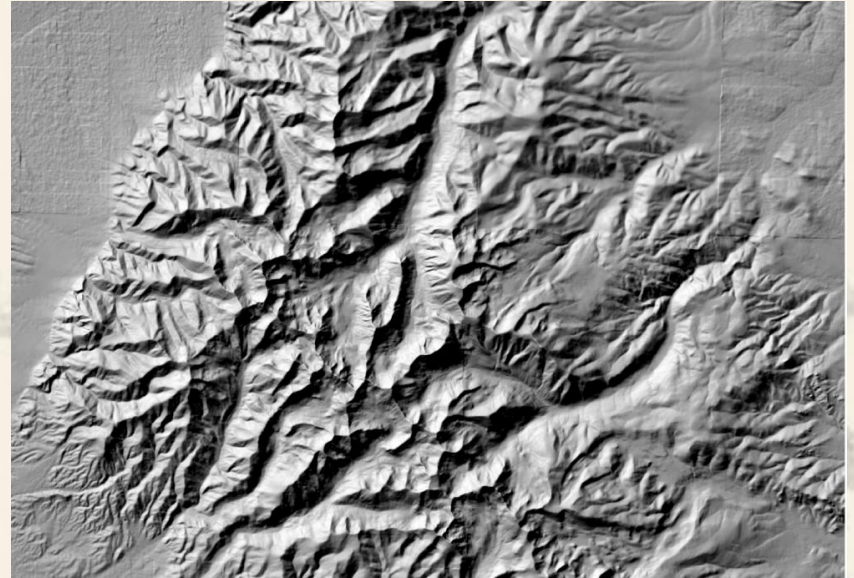
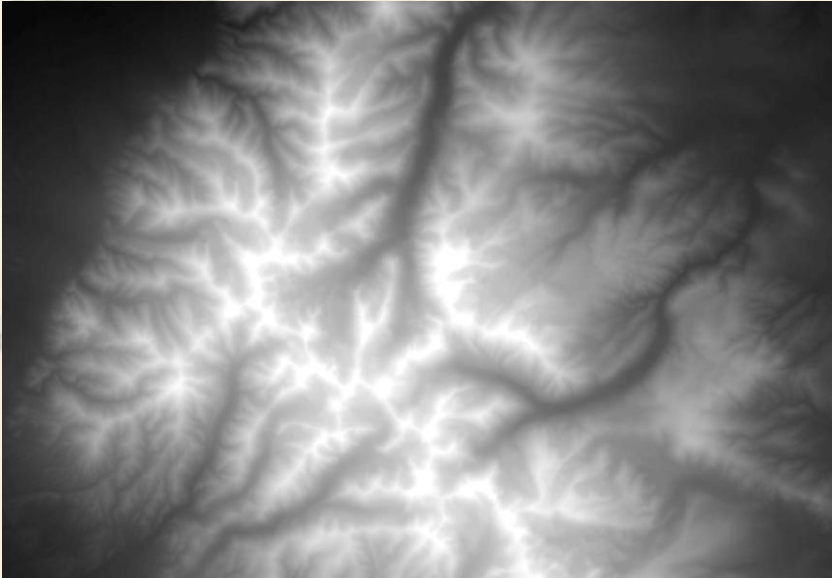
Surface Normal Vector Components



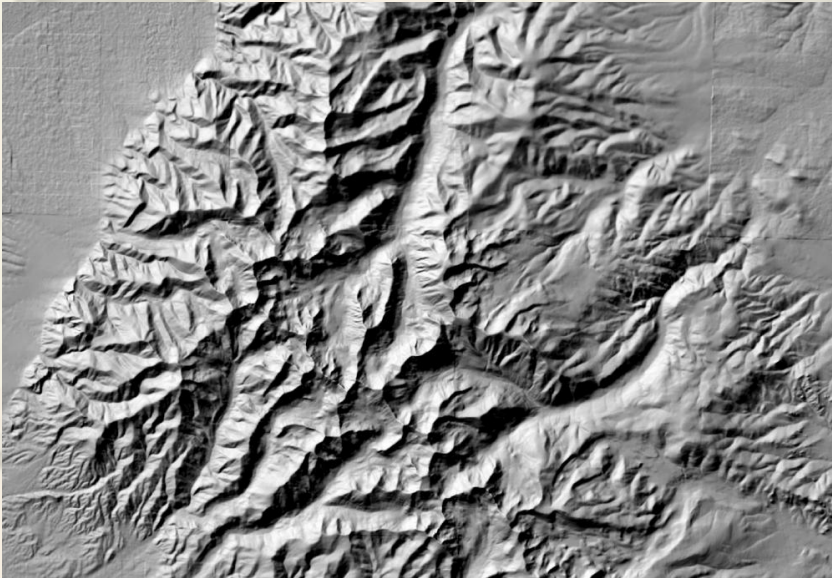
Results

- 30 meter DEM of Tobacco Root Mountains, Montana, USA
- Results of low pass filter on DEM and relief shaded grid (15x15 kernel)
- Results of generalization with vector components and after vector addition (15x15 kernel)

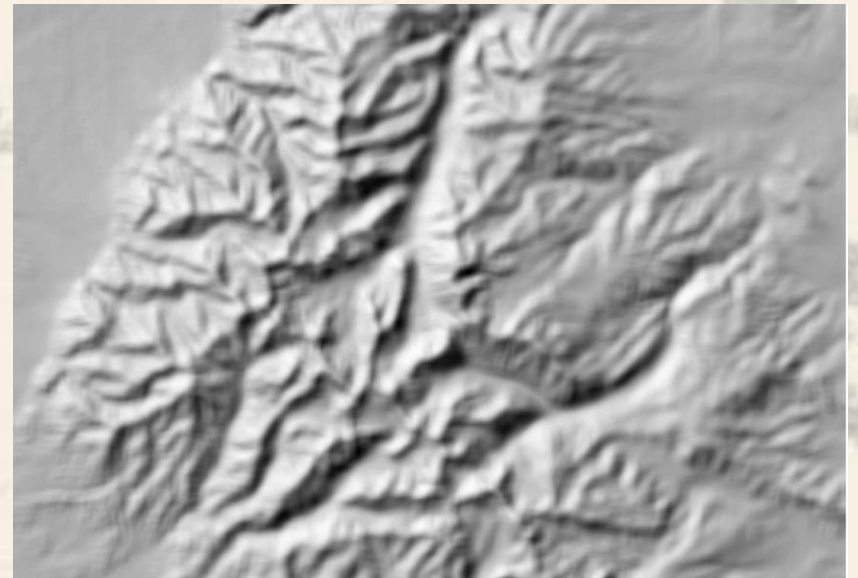
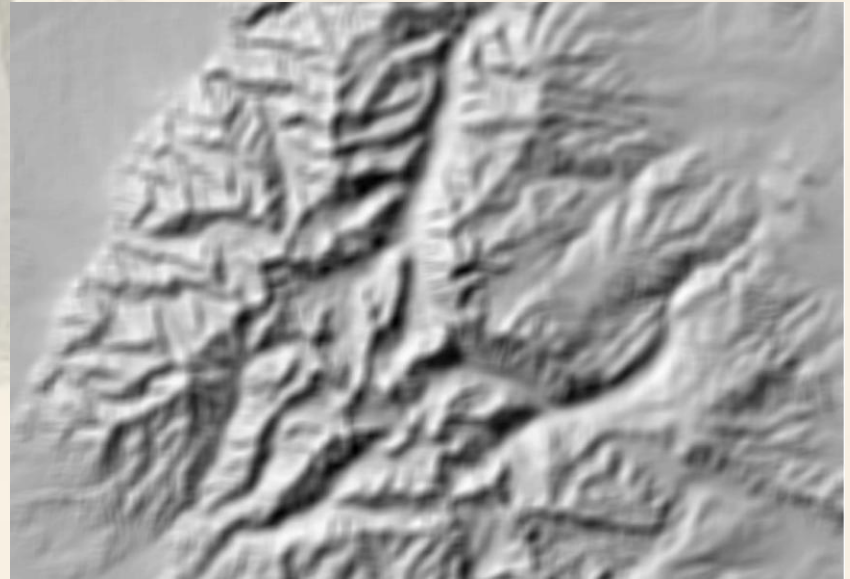
Results



Results

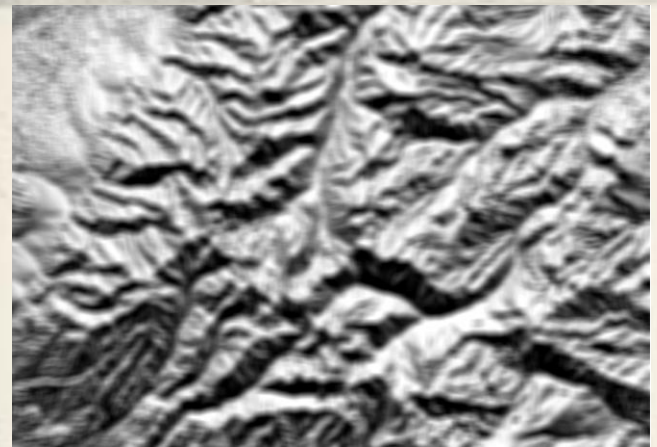
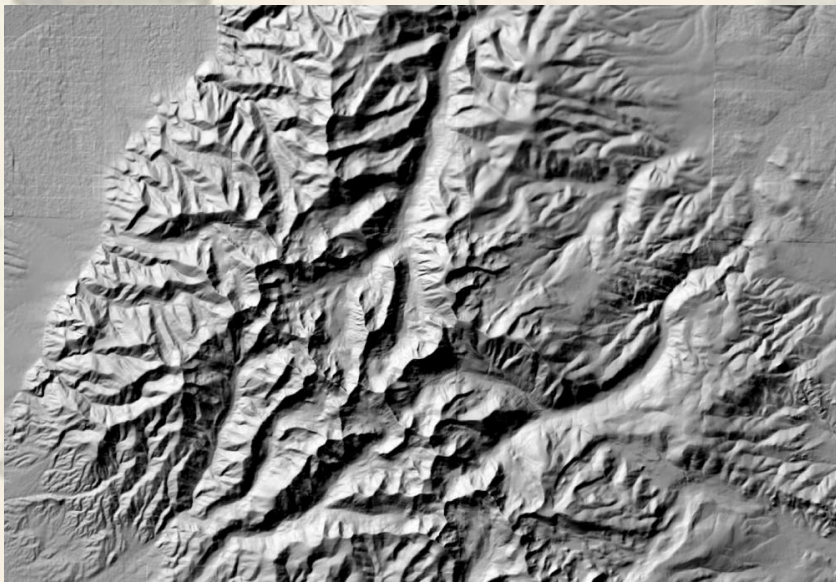


Low pass filter on relief shading

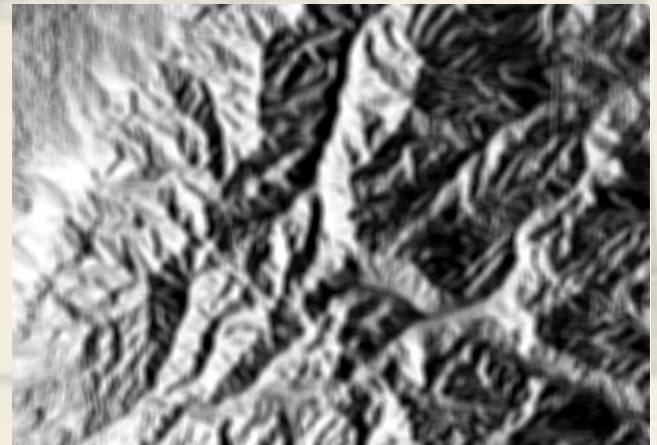


Low pass filter on DEM, then shaded

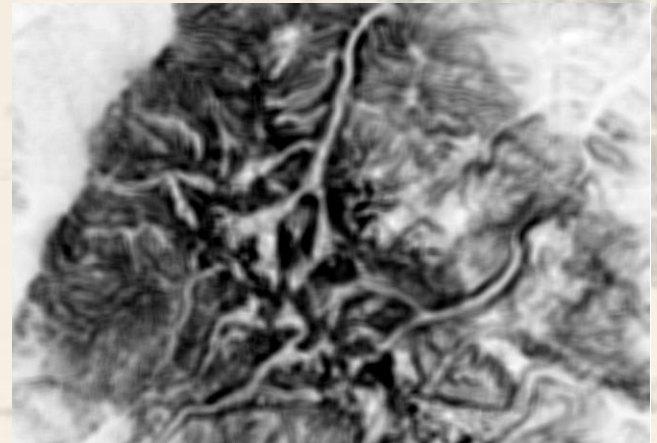
Results



X

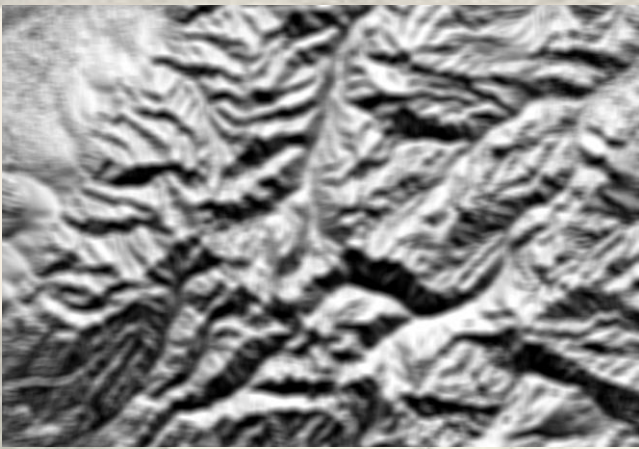


Y

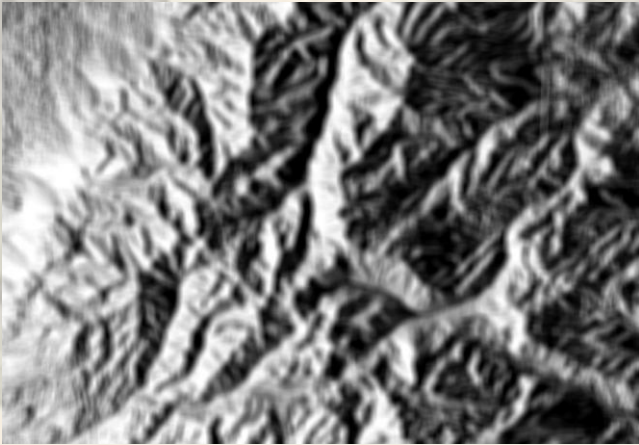


Z

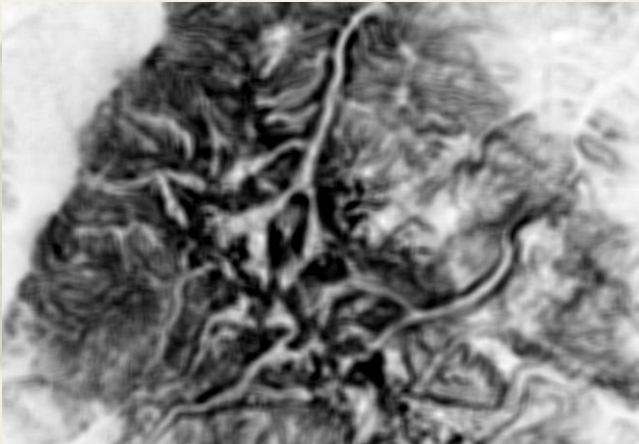
X



Y

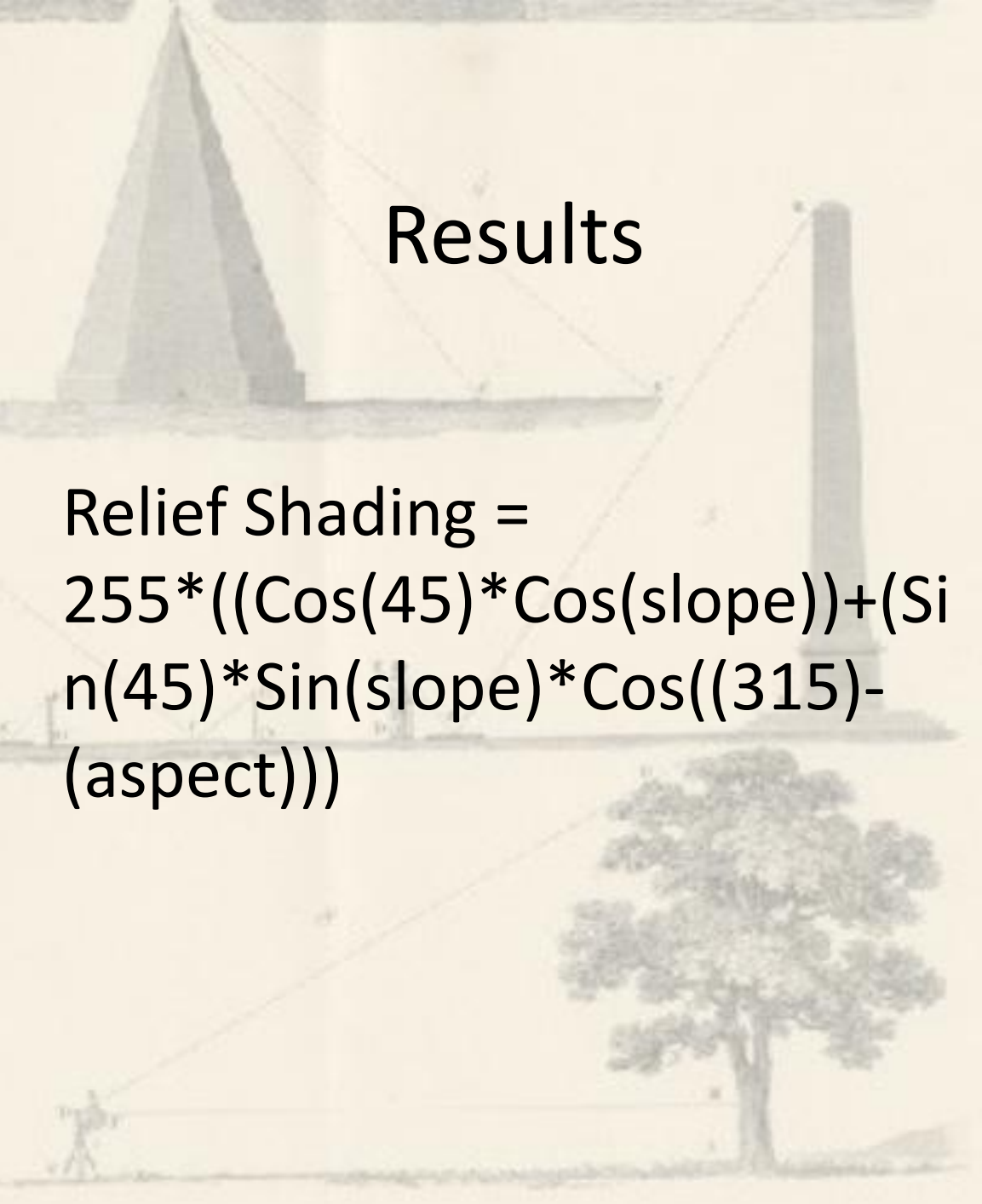


Z

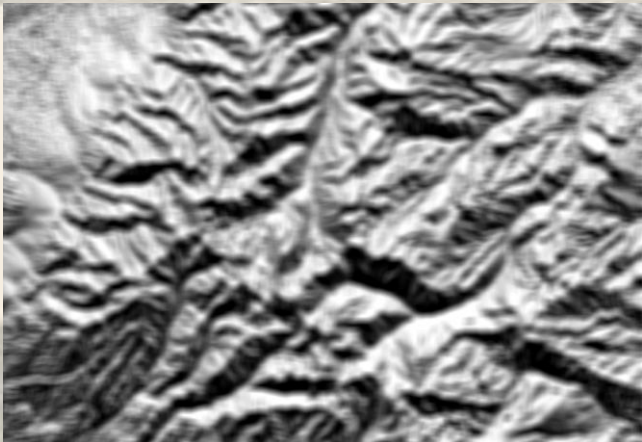


Results

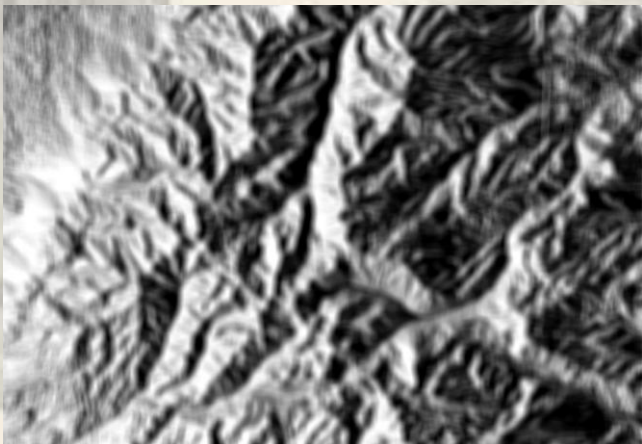
$$\text{Relief Shading} = 255 * ((\text{Cos}(45) * \text{Cos}(\text{slope})) + (\text{Sin}(45) * \text{Sin}(\text{slope}) * \text{Cos}((315) - (\text{aspect}))))$$



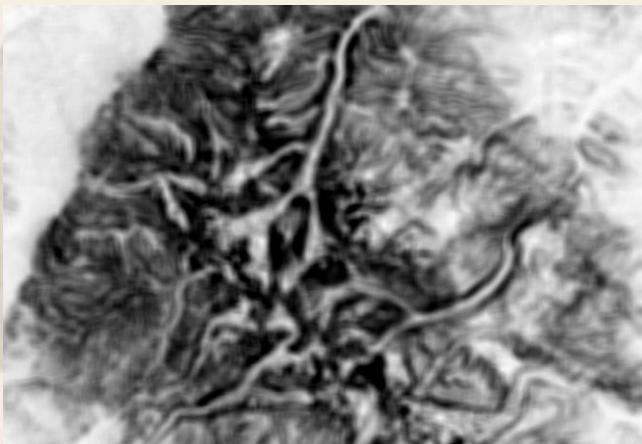
X



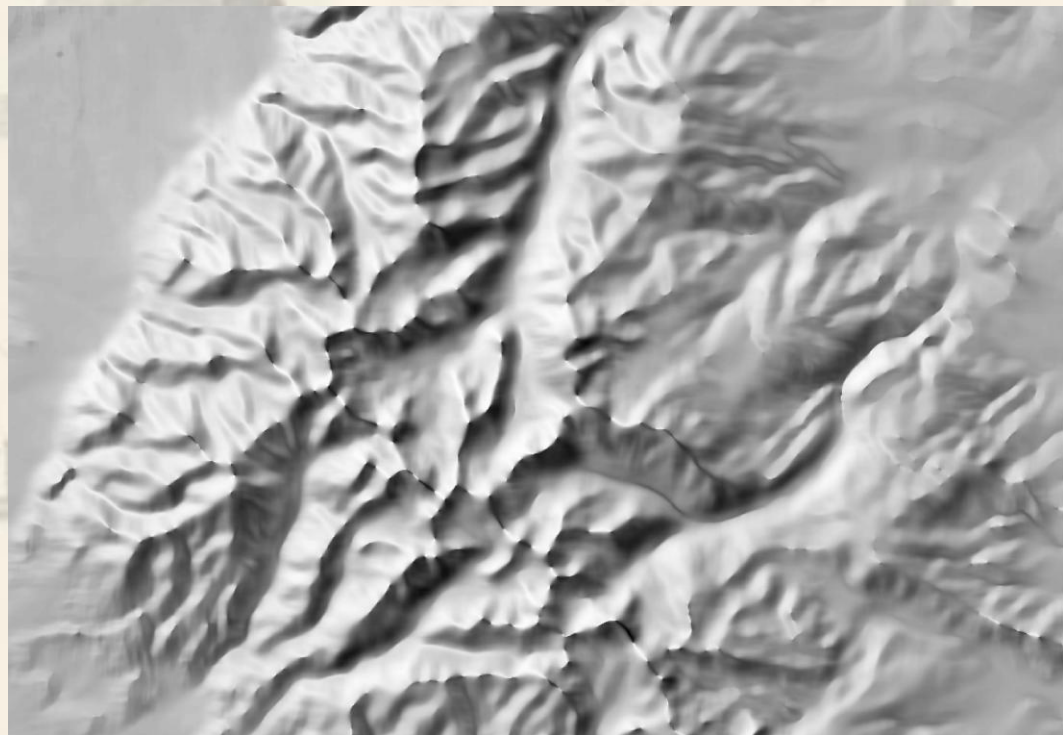
Y



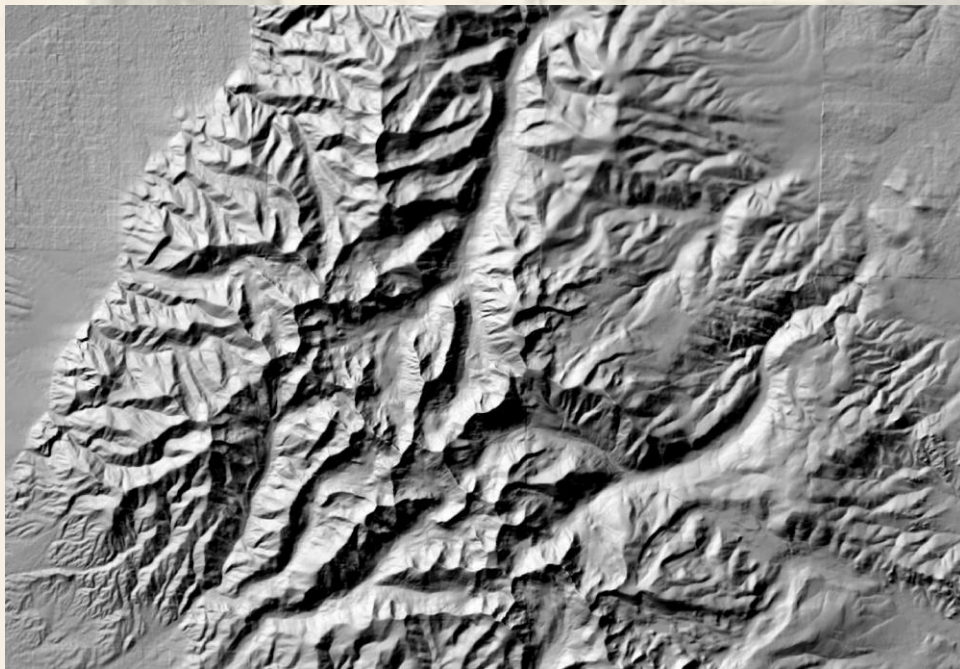
Z



Results



Results



Summary

- A low pass filter can be used to smooth relief shading
- This method sums the surface normal vectors in a kernel
- The smoothing removes details of the terrain while preserving major landforms

