QUANTIFYING RESOLUTION OF DIGITAL OUTCROP MODELS USING SYNTHETIC TEST OBJECTS
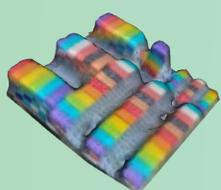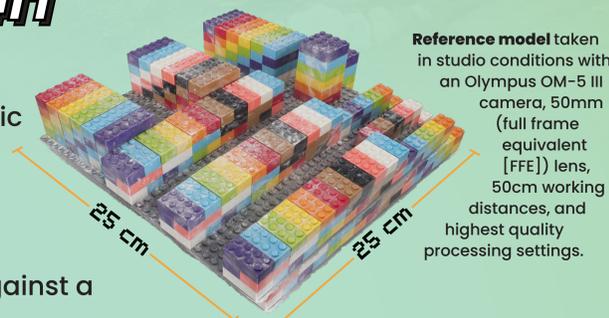
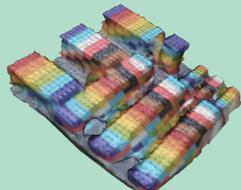**Alex Clarke,** *Richard Haas, Selina Fenske, Friedrich Hawemann, Virginia Toy*

THE PROBLEM

Photogrammetry is now a common tool for structural geologists to measure features at a scale and rate not previously practical; however, the spacial resolution of these models is difficult to quantify or communicate. The level of detail depends on, e.g. working distance, camera resolution/settings, processing settings, and downscaling, and cannot simply be predicted from the input parameters. Therefore, the model resolution must be measured from model itself.
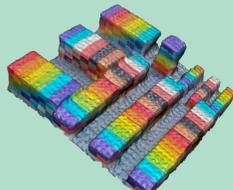
THE SOLUTION

To quantify the spacial resolution of photogrammetric models, we place an object of known geometry into the scene and compare the reproduction of the object against a higher resolution model. We measure angles between points at different spacings on both models to determine the difference at each length scale.
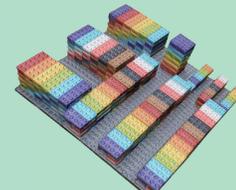
Reference model taken in studio conditions with an Olympus OM-5 III camera, 50mm (full frame equivalent [FFE]) lens, 50cm working distances, and highest quality processing settings.

25 cm × 25 cm

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21 mm/px GSD
Ground Sampling Distance

IPHONE VIDEO FRAMES
iPhone 11, 26mm (FFE) lens, 1280×720px, ~5m working distance.

ACCURATE TO WITHIN
2° ABOVE 18.4 mm

4.5 mm/px GSD
Ground Sampling Distance

DSLR PHOTOS ~5 M
Canon 90D, 56mm (FFE) lens, 6960×4640px, ~5m working distance.

ACCURATE TO WITHIN
2° ABOVE 6.0 mm

3.3 mm/px GSD
Ground Sampling Distance

IPHONE PHOTOS
iPhone 11, 26mm (FFE) lens, 4032×3024, ~1m working distance.

ACCURATE TO WITHIN
2° ABOVE 10.3 mm

0.5 mm/px GSD
Ground Sampling Distance

DSLR PHOTOS 0.5 – 1M
Canon 90D, 56mm (FFE) lens, 6960×4640px, 0.5–1m working distance.
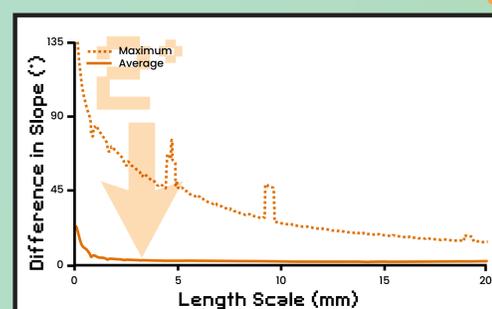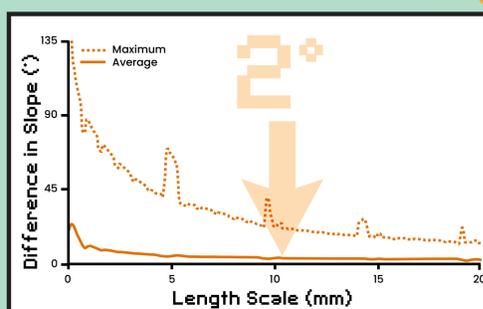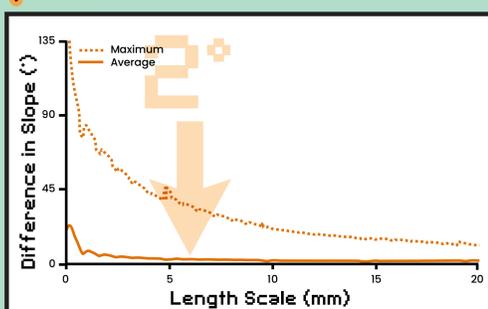
ACCURATE TO WITHIN
2° ABOVE 3.3 mm

Four plots, each with axes "Difference in Slope (°)" (y-axis: 0–135) vs "Length Scale (mm)" (x-axis: 0–20), showing Maximum (dotted) and Average (solid) curves, with a 2° marker.
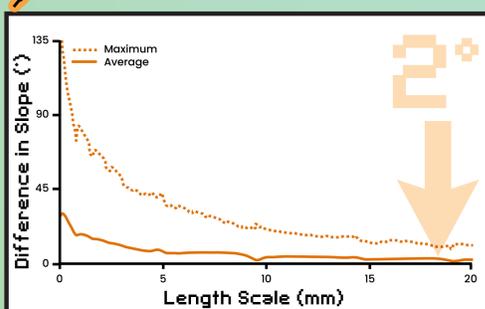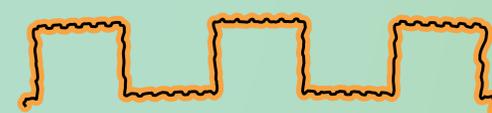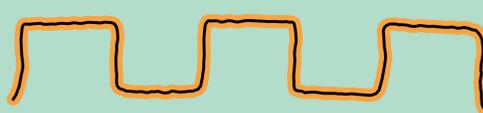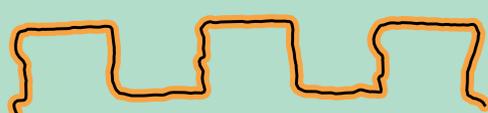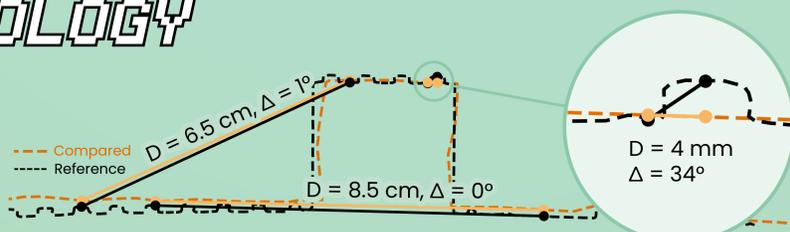
THE METHODOLOGY

To compute the accuracy of the model at each length-scale, we measure the angles between every point and every other point along a cross section of the test object on both the compared and the reference model and note the difference in angle between each model along corresponding sections. We then plot the average and the maximum difference in angle for each point-to-point distance. This quantifies the error at each length-scale for angles picked from the compared model on the basis of the distance between the picked points. At longer length-scales, the maximum difference in angles trends towards zero; however, the length-scale at which maximum and average difference in angles substantially increases reveals the resolution of the compared model. We define that the length-scale at which average error exceeds 2° is the resolution of the model.

Compared
Reference

D = 6.5 cm, Δ = 1°
D = 8.5 cm, Δ = 0°
D = 4 mm
Δ = 34°