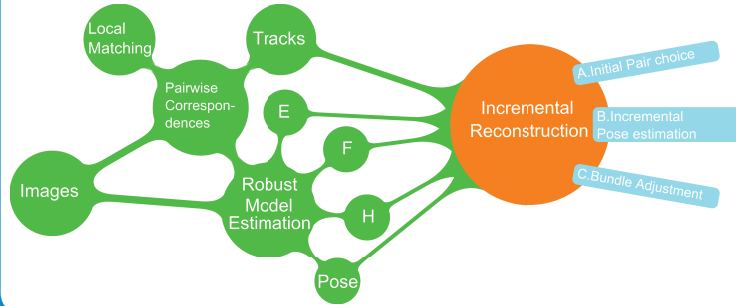


Adaptive Structure from Motion with a contrario model estimations

PIERRE MOULON, PASCAL MONASSE, RENAUD MARLET

STRUCTURE FROM MOTION: SFM

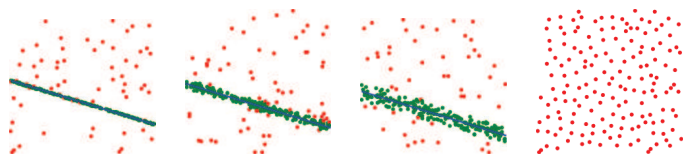
Structure from Motion depends on robust estimation; RANSAC is used to exclude outliers.



ROBUST ESTIMATION THRESHOLD DILEMMA

RANSAC requires the choice of a threshold T , which must be balanced:

- Too small: Too few inliers, leading to model imprecision,
- Too large: Models are contaminated by outliers (false data).



Goal: making T adaptive to data and noise.

Find a model that best fits the data with a confidence threshold T that adapts automatically to noise by using AC-RANSAC.

A CONTRARIO STRUCTURE FROM MOTION

AC-RANSAC. A threshold-less rigid model estimation framework.

- The method answers the question: "Could the rigid set of data have occurred by chance?"
- The threshold T adapts for inlier/outlier discrimination.
- It provides a confidence score for each model.

A *Contrario* criterion [3]:

- Use a background model \mathcal{H}_0 : uniform distribution.
- **Strong deviation from \mathcal{H}_0 is deemed meaningful.**

AC-RANSAC relies on the following definitions:

- Number of False Alarms (NFA) measures model fitness to data
- Given model M , assuming k inliers among n correspondences, T_k denotes the k^{th} smallest residual

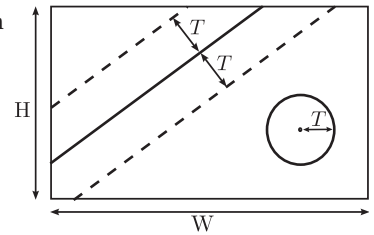
$$NFA(M, k) = N_{\text{tests}}(n, k, N_{\text{sample}}) \mathbb{P}(\text{residual} \leq T_k | M, \mathcal{H}_0)^{k - N_{\text{sample}}}$$

$$\text{Expectation: } NFA(M) = \min_{k=N_{\text{sample}}+1 \dots n} NFA(M, k) \leq 1.$$

RANSAC maximizes inlier count. AC-RANSAC minimizes NFA.

Application to Structure from Motion: estimation of

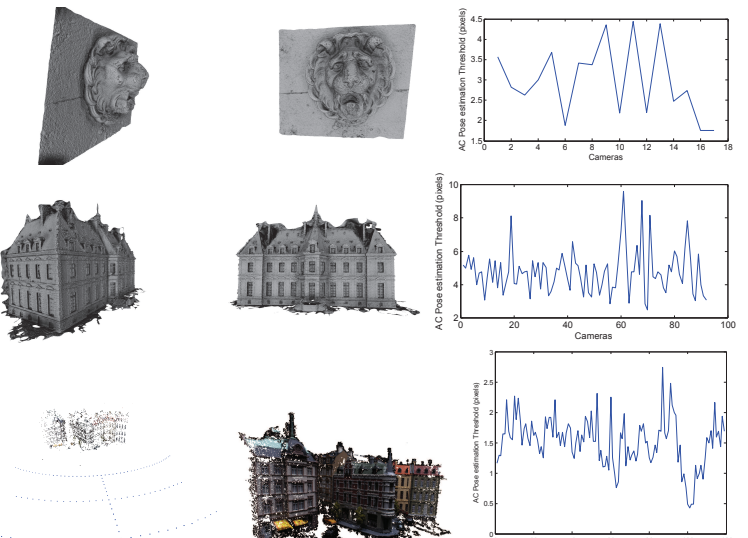
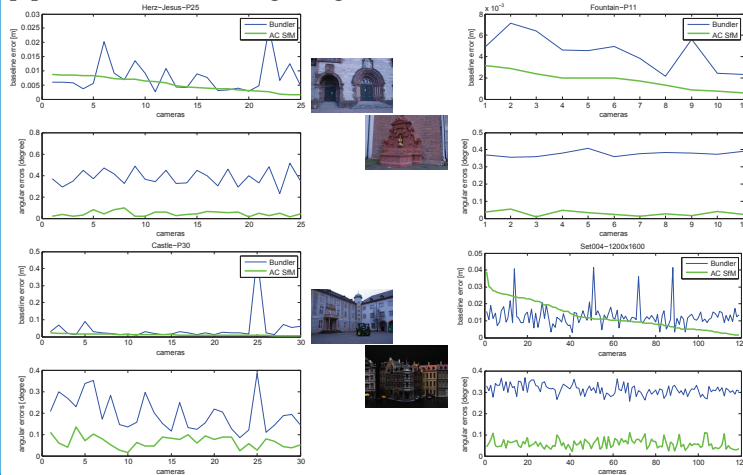
- * Homography
- * Pose/Resection
- Fundamental matrix
- * Essential matrix



Only assumption: returned model is fitted by at least $2 * N_{\text{sample}}$ data.

EXPERIMENTAL RESULTS

Comparable or better accuracy than Bundler [1] using a threshold-less pipeline. Evaluation: rigid registration to GT (rotation+translation).

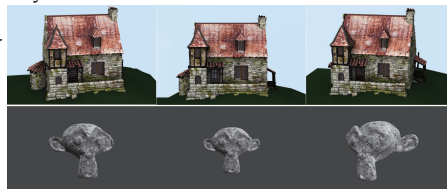


CONTRIBUTIONS

An SfM pipeline built on AC-RANSAC:

- AC-RANSAC estimation of E, F, H, Pose,
- Experimental validation showing the benefit of adaptive automatic threshold.
- **openMVG open source library**
A multiple-view geometry library,
A collection of 2-view solvers,
Generic robust estimators: RANSAC, AC-RANSAC.

Synthetic datasets with GT calibration:



REFERENCES

- [1] N. Snavely et al. Photo tourism: exploring photo collections in 3D. In *SIGGRAPH 2006*.
- [2] C. Strecha et al. On benchmarking camera calibration and multi-view stereo for high resolution imagery. In *CVPR 2008*.
- [3] L. Moisan et al. Automatic homographic registration of a pair of images, with a contrario elimination of outliers. In *IPOL 2012*, <http://dx.doi.org/10.5201/ipol.2012.mmm-oh>.