Comparing Random Sample Consensus Algorithms for Unmanned Aerial Vehicles Using Structure From Motion

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I. Introduction

- Unmanned Aerial Vehicles (UAVs) are used in diverse ways: inspection, surveillance, detection, reconnaissance, and making deliveries, for example.
- The focus of our work is the application of Structure From Motion (SFM) for surface identification, an important task of sense-and-decide for UAVs.

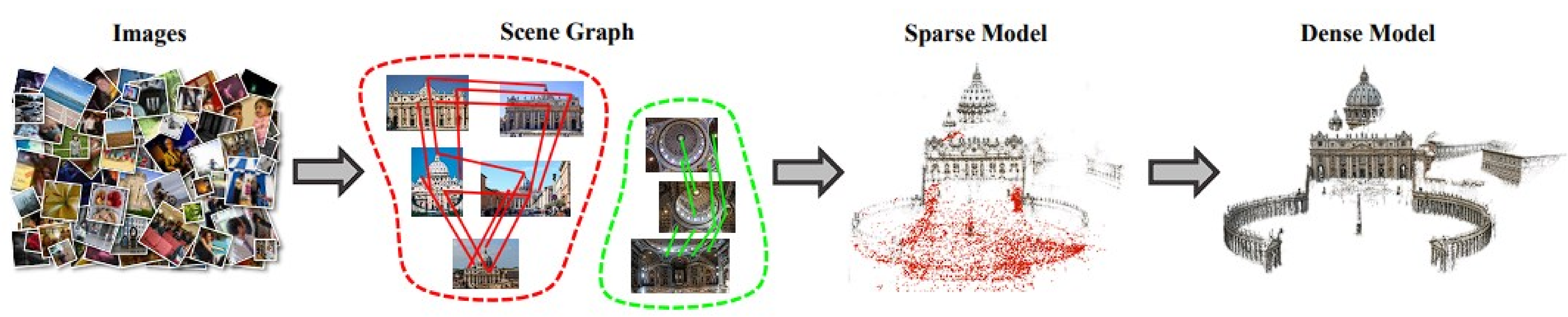


Figure 1. SFM consists of multiple steps from image acquisition to outputting a 3D model.

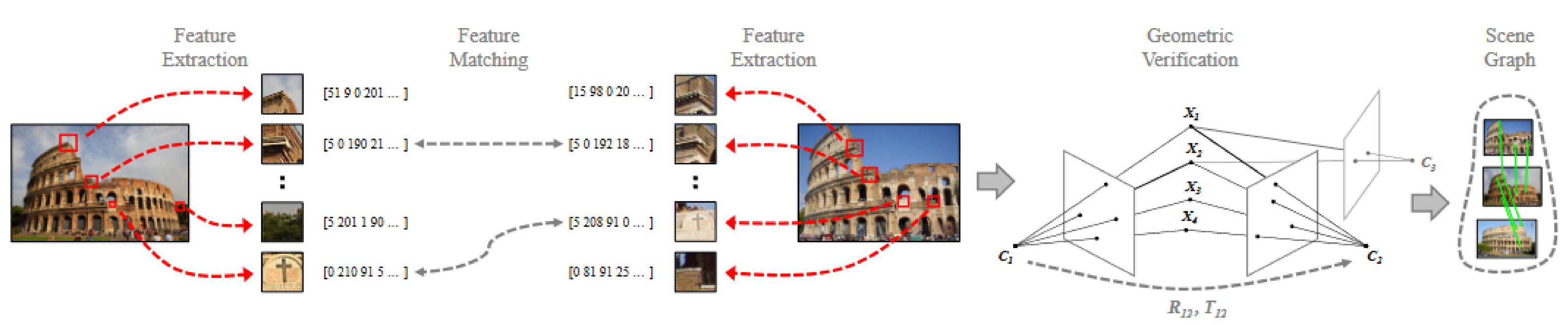
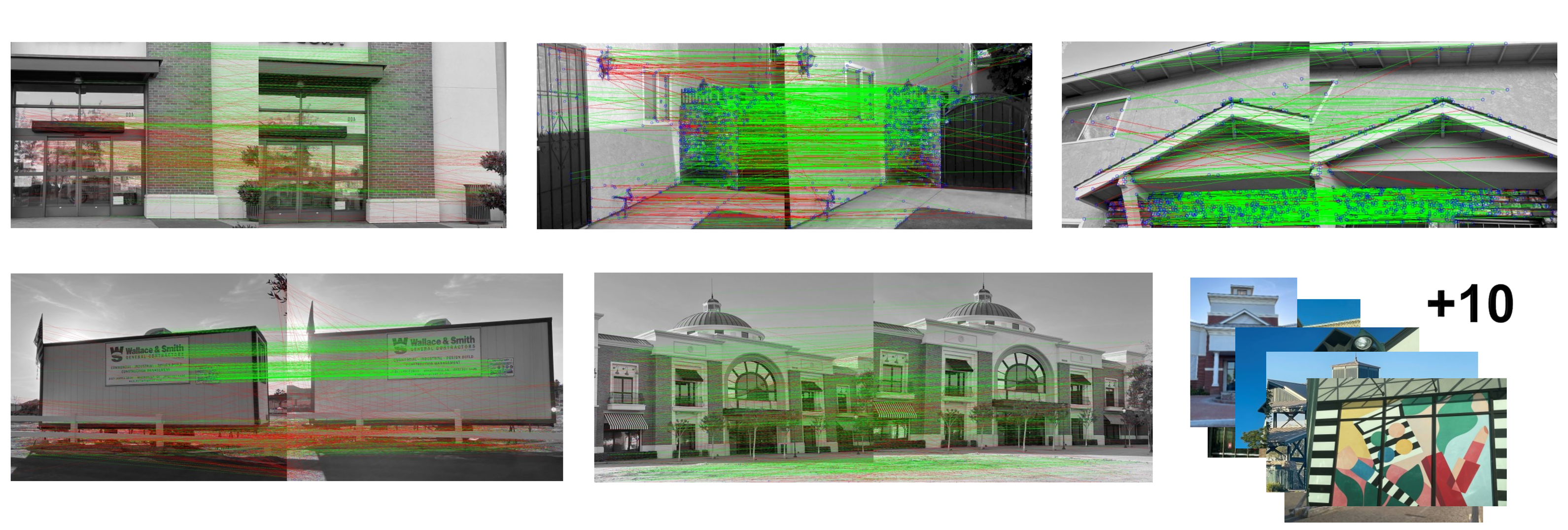


Figure 2. To chain the verified matches using two-view geometries and produce the scene graph, the estimation of the homography between two views is a key step involving multiple view geometry.

- Homography transfers points from one view to the other, and computing it between the two views is important for reconstruction in SFM. The SFM technique can employ Random Sample Consensus (RANSAC) (See *Algorithm 1*).

II. Dataset



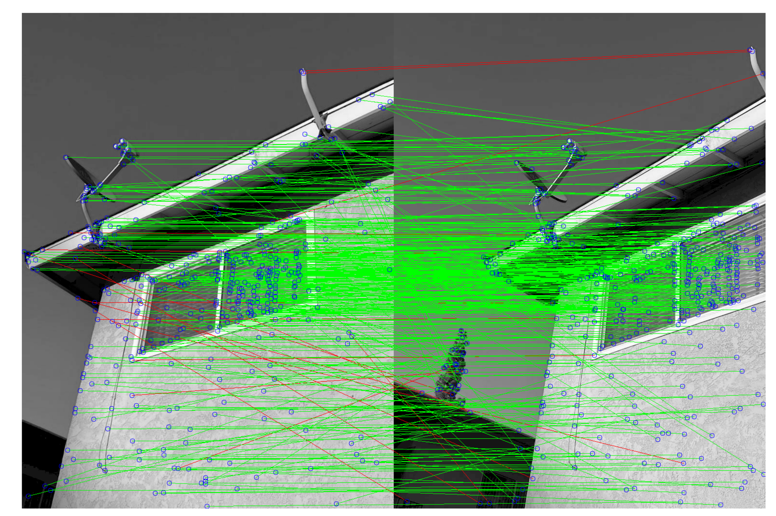
III. Resources

OpenCV

IEEE Access

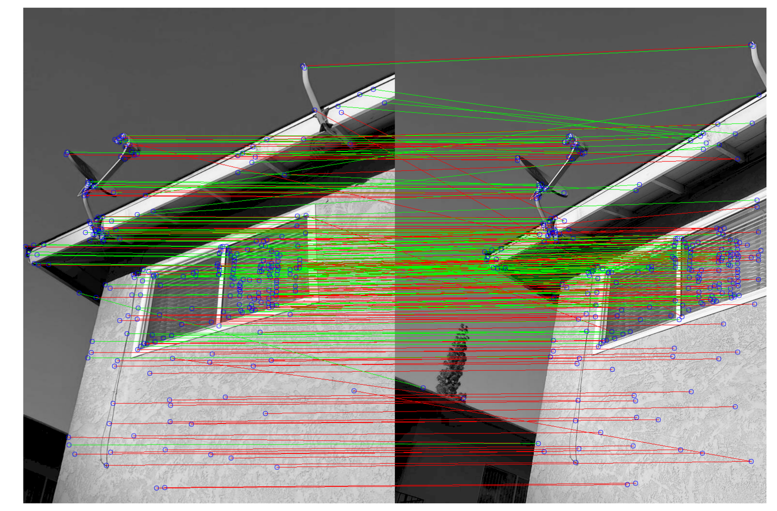
IV. Implementation

Algorithm 1. Random Sample Consensus (RANSAC)



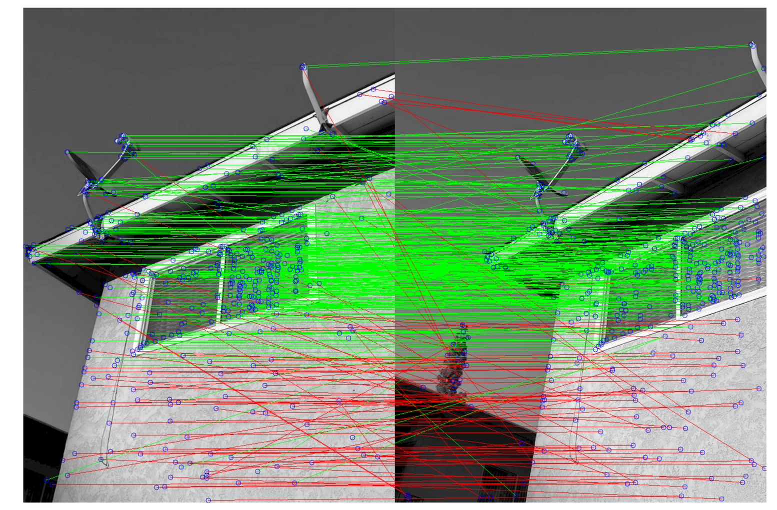
RANSAC can be used to estimate parameters of a model from a dataset which often includes outliers. They are mismatches between each image pair. RANSAC randomly samples the datapoints to fit a model while classifying outliers and inliers.

Algorithm 2. Progressive Sample Consensus (PROSAC)



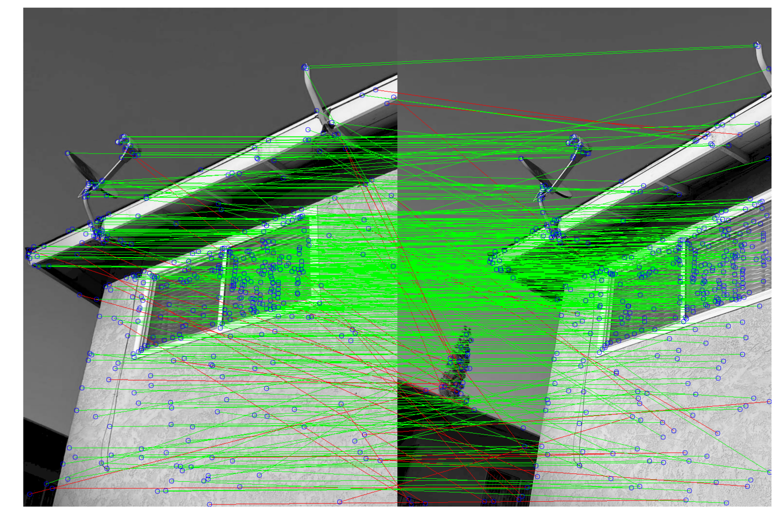
PROSAC is a ranking-based sampling method based on RANSAC. PROSAC assigns a quality value to each point. Points with greater quality scores are sampled first. PROSAC then *progressively* adds points with lower quality.

Algorithm 3. Prior Sampling & Sample Check RANSAC (PSSC-RANSAC)



PSSC-RANSAC address datasets with large outlier ratios and a concern for computational speed. It is a pre-sampling method that evaluates texture magnitude, spatial consistency, and feature similarity.

Algorithm 4. Blur & Contrast RANSAC (BC-RANSAC)



BC-RANSAC is an adaptation of PSSC-RANSAC that measures texture magnitude based on the blur and contrast of an image.

V. Experiment Results

Algorithm Name	Avg. Inlier Ratio	Avg. Wall Time
RANSAC (original)	64.17%	16.50s
PROSAC	44.69%	3.35s
PSSC-RANSAC	61.61%	139.07s
BC-RANSAC	61.18%	20.49s

Table 1. Each algorithm's average inlier ratios and computation times are compared to one another in homography with the twenty image pairs in the dataset. The feature matching algorithm used is Scale-Invariant Feature Transform. RANSAC has the highest inlier ratio while PROSAC is the fastest.

VI. Conclusion & Future Work

- Based on our literature survey on ten different RANSAC algorithms, improving accuracy has been a chief concern along with performance over the last two decades. Among them, we learn that the greatest number of RANSAC algorithms are tested in homography, and ranking-based sampling is the most popular approach.
- However, after comparing the four RANSAC algorithms on our own, we find that RANSAC still remains as a powerful and robust estimator.
- It came to our attention that there are several ways to assess image qualities. Further research can be conducted to evaluate the multitude of image qualities to discover which are the most consistent for containing inlier coordinate points.
- Therefore, we plan to research feature fusion as we see that BC-RANSAC might be a good alternative to RANSAC.

VII. References

- Y. L. Bond, E. Osornio, S. Ledwell, and A. C. Cruz. (March 2023). Comparing RANSAC Algorithms for Small Unmanned Aerial Vehicles Using Structure From Motion. Presented at Third Annual Computer Science Conference for California State University Undergraduates, [Online]. Available: https://www.researchgate.net/publication/369977413_Comparing_Strategies_of_Random_Sample_Consensus_Algorithms_for_Small_Unmanned_Aerial_Vehicles_Using_Structure_From_Motion
- J. L. Schönberger, "Robust Methods for Accurate and Efficient 3D Modeling from Unstructured Imagery," Ph.D. dissertation, Department of Computer Science, University of North Carolina, Chapel Hill, NC, 2018.

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