6 DoF Pose Estimation for Wide baseline Stereo Camera

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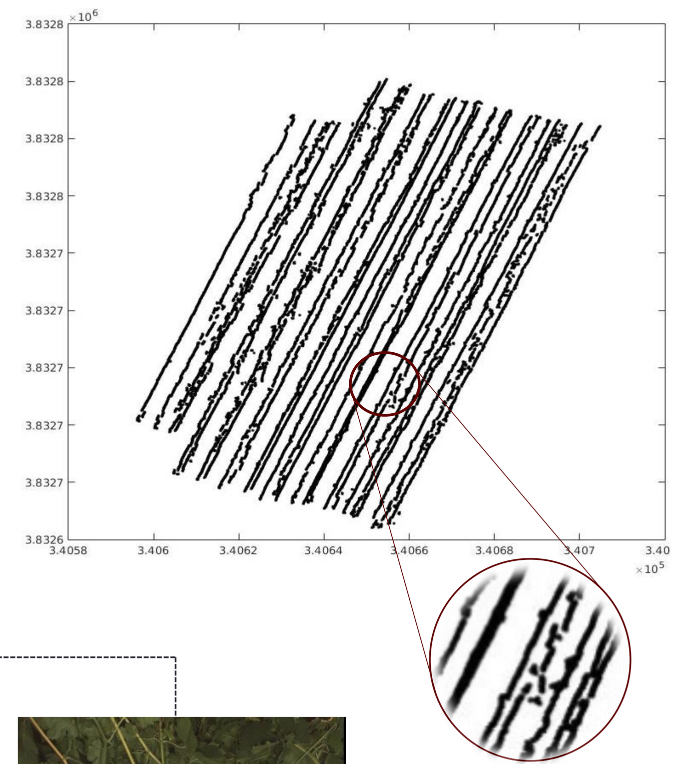
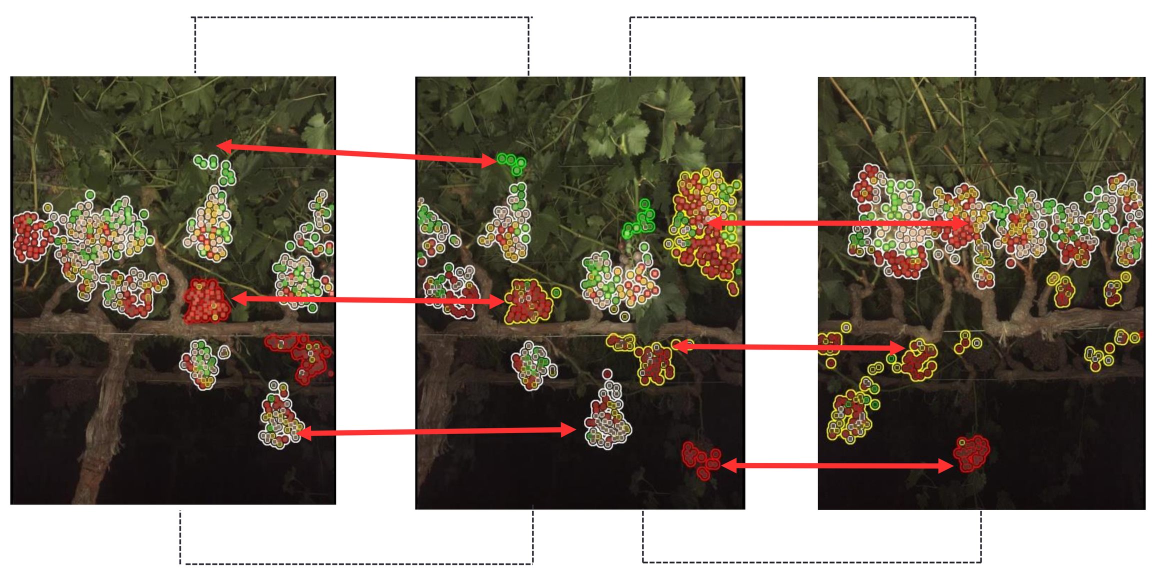
MOTIVATION AND OBJECTIVE

- We use robots for automated visual yield mapping.
- Current system utilizes an expensive GPS to geotag raw stereo images. Accuracy is within a meter range.



- Overlaps between consecutive frames can lead to lead to inaccurate output yield estimates or over counting.

Overlaps



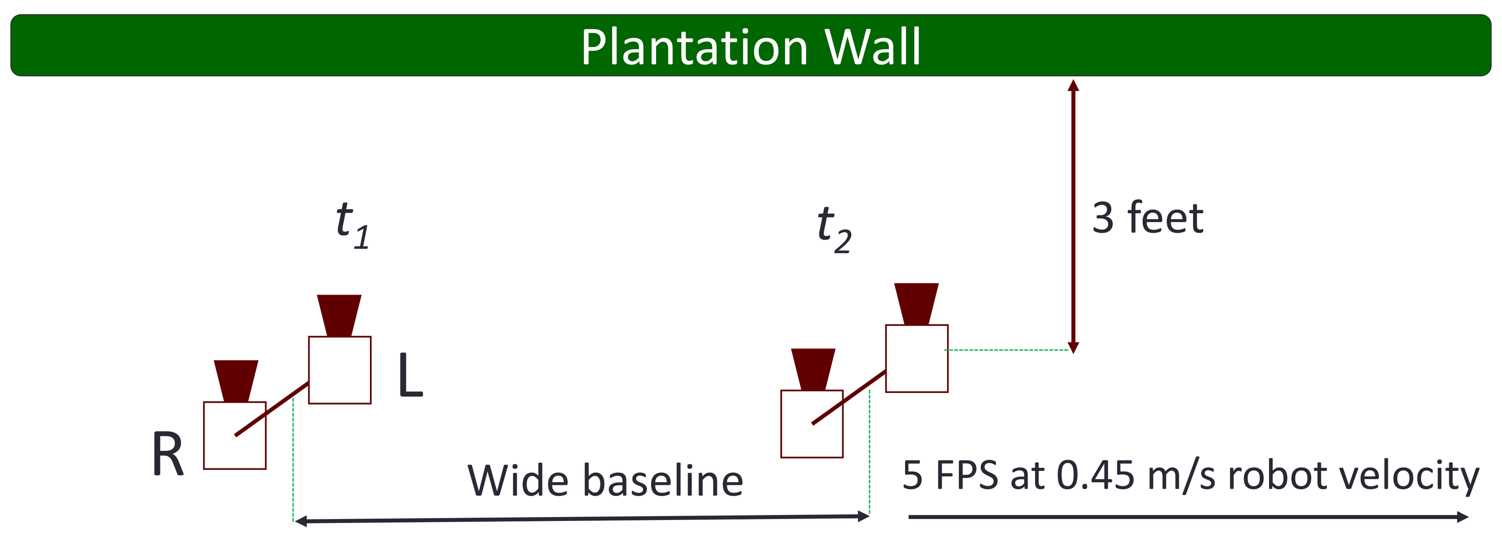
- Develop a new visual odometry pipeline to robustly estimate the 6 DoF camera pose for a wide baseline stereo camera that logs high resolution images at low frame rates.
- Improve the accuracy of yield estimates by establishing a pose relation between individual image frames

DATASET COLLECTION AND HARDWARE SETUP

Hardware: Pointgrey Flea3 Stereo Camera | Trimble GPS

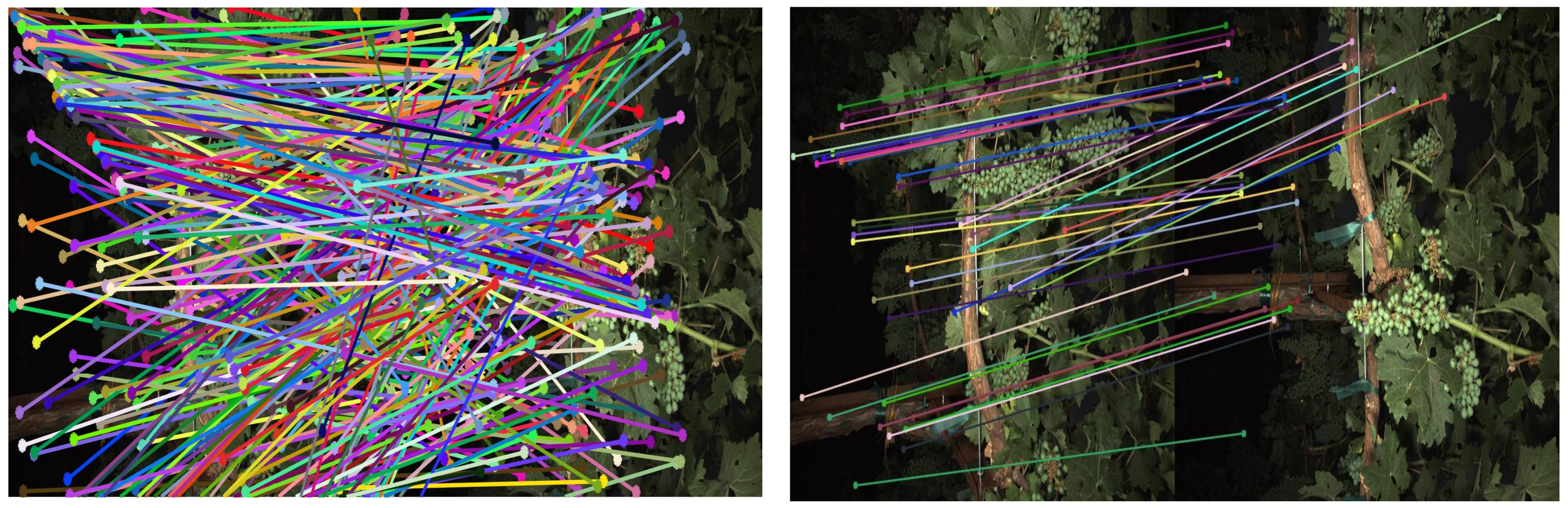
- Sorghum Fields, SC

- Grape Vineyards, CA



NOVEL SAMPLING SCHEME: UNISAC

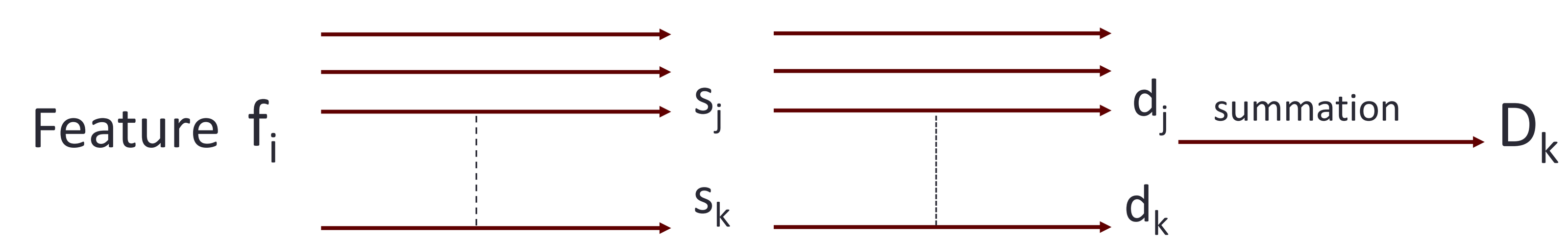
- We observe that the fraction of inliers from a set of matched correspondence is very small (~10%). Many false matches can pass the inlier test causing bad solutions to appear as good solutions.



- **Uni**queness **S**ampling and **C**onsensus (UniSAC) utilizes the feature quality to evaluate geometry solutions.

Algorithm

N-dim feature descriptor —(sample K times)→ M-dim sub-features —(quantize)→ K integers

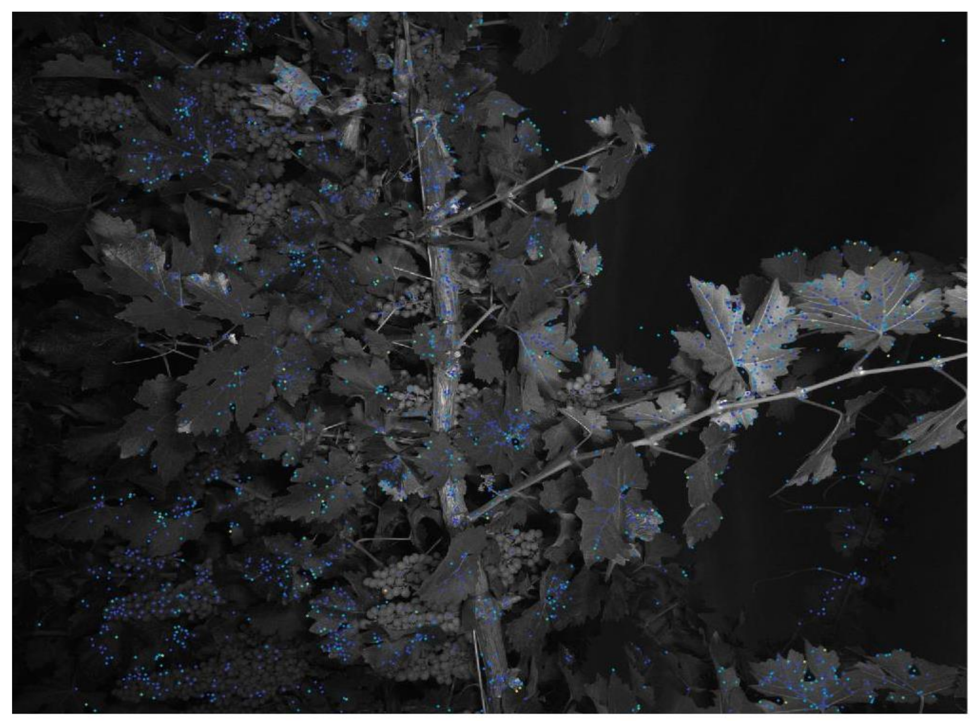


Feature quantization: $q(v,p,z) = [v^p z]$

- Feature Uniqueness score is used for sampling correspondences

$$U_f = \sum_{k=0}^{K} \frac{1 - C(D_k)}{C_{MAX}} \qquad p(C(i)) = w(\vec{f}_1(i))\, w(\vec{f}_2(i))$$

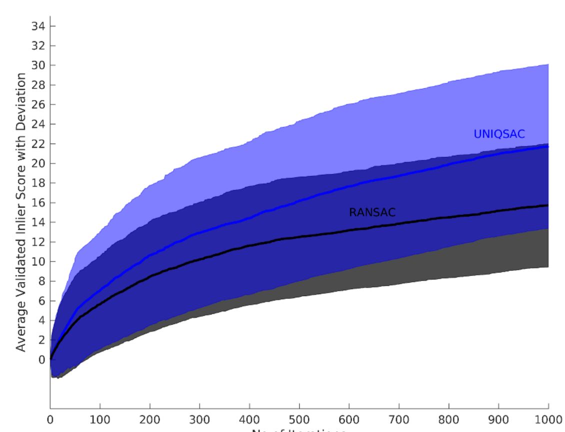
- Inliers plotted follow a heat-map color scheme, where red is a unique feature and blue is a frequently occurring feature.
- Lot of blue/green points indicate that the plant dataset consists of images that have repetitive features.



RESULTS

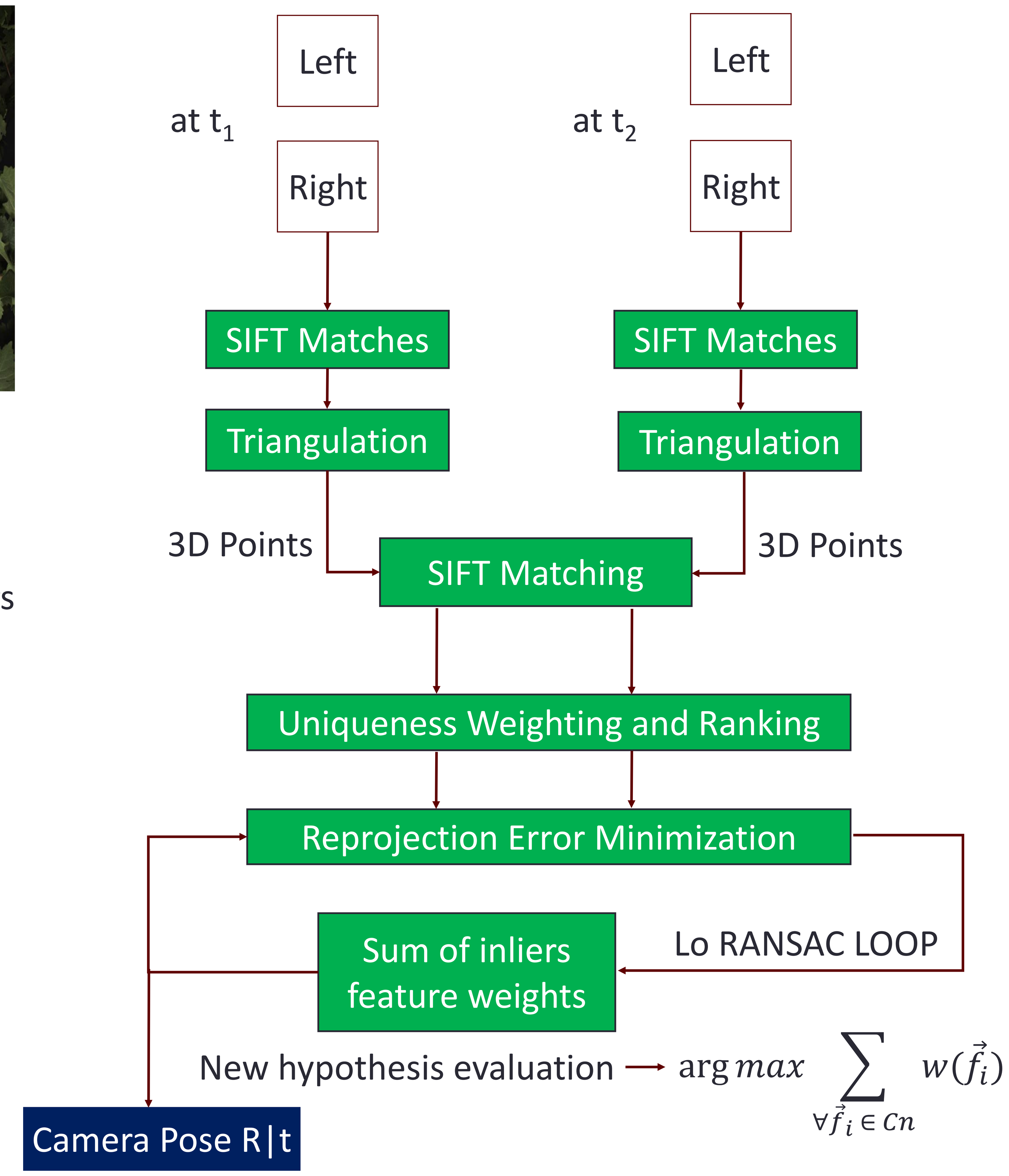
F-matrix estimation

Image Pair	Statistic	RANSAC	Lo RANSAC	BEEM	UniSAC
Vineyard Data	Correspondences	301	301	301	301
	Inliers	20	25	**34**	31
	Time (s)	**0.124**	0.68	0.61	.51
Office	Correspondences	306	306	306	306
	Inliers	56	78	86	**93**
	Time (s)	**0.129**	0.61	0.83	0.82



POSE ESTIMATION PIPELINE

- The proposed sampling scheme is wrapped into our pose estimation pipeline. Implemented visual odometry method similar to Libviso2 [1].



REFERENCES

[1] A. Geiger, et al. 2011.

FUTURE WORK

- ROS Package and systems integration for future field tests.
- Experiment with different feature descriptors to obtain best possible results.

ACKNOWLEDGEMENT

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