A Game-Theoretic Approach to the Enforcement of Global Consistency in Multi-View Feature Matching

Emanuele Rodolà, Andrea Albarelli, and Andrea Torsello

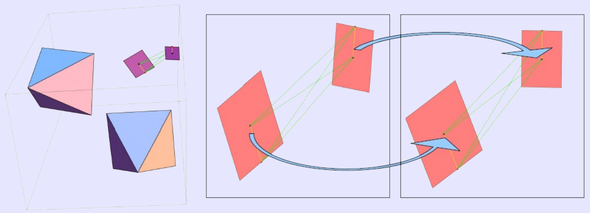
UNIVERSITÀ CA' FOSCARI VENEZIA

Research Goal

We introduce a robust matching technique that allows to operate a very accurate selection of multiple corresponding feature points. Robustness is achieved by enforcing global geometric consistency at an early stage of the matching process, without the need of ex-post verification through reprojection.

Pairwise Geometric Consistency

Two geometric consistency models are presented.



Scale and orientation offer depth information and a second virtual point. The conservation of the distances in green enforces consistency with a 3D rigid transformation.

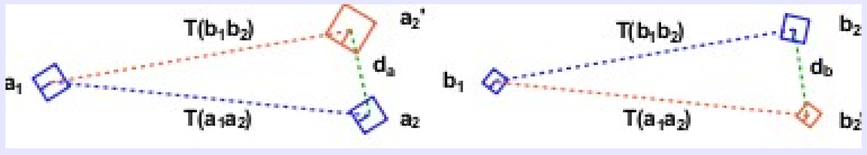
The first approach tries to impose that the points be consistent with a common 3D rigid transformation.

We define a measure of compatibility between correspondences as:

$$C(m1,m2) = \max_a e^{-\gamma d(m1,m2,a)}$$

where a is maximized over a reasonable range of ratio of scales of local 3D patches.

The second geometric consistency constraint assumes a weak perspective camera: we can expect the transformation to be a similarity at least locally.



This means that we aim to extract clusters of feature matches that belong to the same region of the object and that tend to lie in the same level of depth.

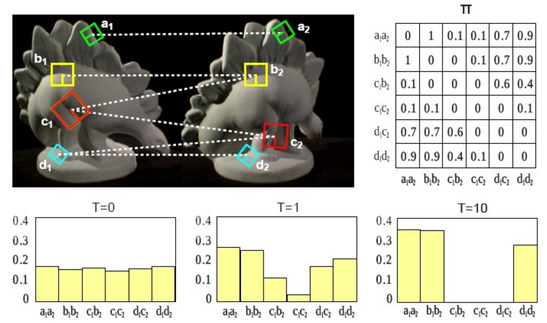
The payoff between (a1,a2) and (b1,b2) is defined as:

FORMULA (1)

Feature Matching

We model the matching process in a game-theoretic framework, where two players extracted from a large population select a pair of matching points from two images. The player then receives a payoff from the other players proportional to how compatible his match is with respect to the other player's choice.

The search for a stable state is performed by simulating the evolution of a selection process.

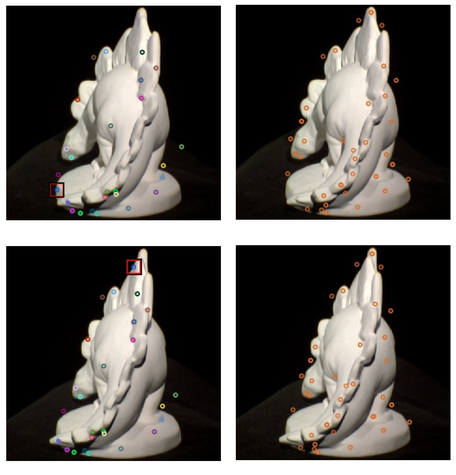


Π

	a_1a_2	b_1b_2	c_1b_2	c_1c_2	d_1c_2	d_1d_2
a_1a_2	0	1	0.1	0.1	0.7	0.9
b_1b_2	1	0	0	0.1	0.7	0.9
c_1b_2	0.1	0	0	0	0.6	0.4
c_1c_2	0.1	0.1	0	0	0	0.1
d_1c_2	0.7	0.7	0.6	0	0	0
d_1d_2	0.9	0.9	0.4	0.1	0	0

Experimental Results

We compared the results with those obtained using the Bundler keymatcher.

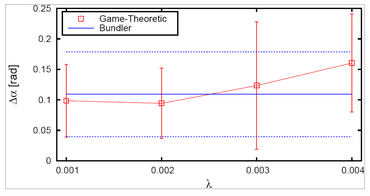


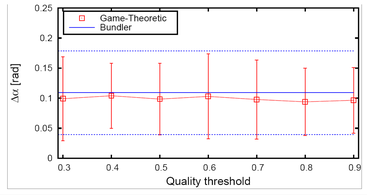
Dino sequence

	GT-3Drigid	*GT-2Daffine*	*Bundler*
Matches	262.5±61.4	271.1±64.2	172.4±79.5
Δα	0.0668±0.0777	0.0497±0.0810	0.0767±0.1172
Δγ	0.4393±0.4963	0.3184±0.3247	0.6912±0.8793

Temple sequence

	GT-3Drigid	*GT-2Daffine*	*Bundler*
Matches	535.7±38.7	564.3±37.2	349.3±36.2
Δα	0.1326±0.0399	0.0989±0.0224	0.1414±0.0215
Δγ	0.0809±0.0144	0.0792±0.0091	0.0850±0.0065





Conclusions

- Robustness is achieved by enforcing global geometric consistency in a pairwise setting, according to two separate models.
- Only highly compatible matches are enforced while incompatible correspondences are driven to extinction.
- Experimental comparisons show the ability of our approach to obtain very accurate estimates in an efficient way.