# BAFT: Binary Affine Feature Transform

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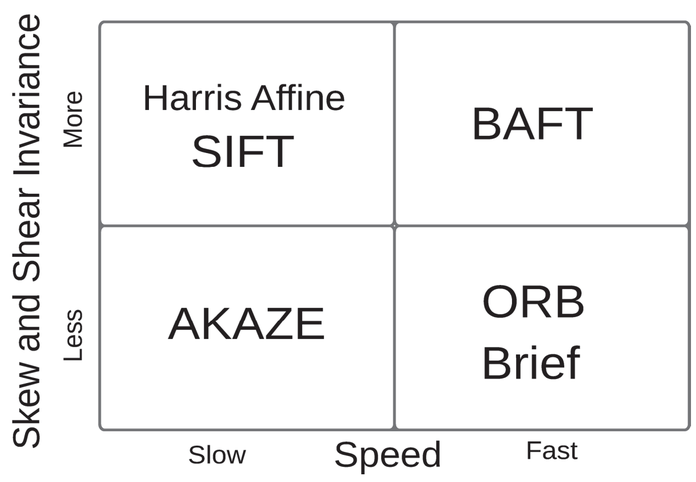
## Motivation & Contribution

- Real-time matching, mobile devices require efficient descriptors.
- Many existing fast descriptors sacrifice invariance for speed.
- BAFT is a fast, binary, quasi affine-invariant local image feature
- Based on ideas from ORB descriptor [6], Harris/Hessian Affine detectors [10]; adapt sampling pattern to normalization matrix.
- Higher degree of invariance to skew vs. rotation
- Higher AUC; works well especially for large perspective changes




## BAFT Algorithm

### 1. Detecting Keypoints

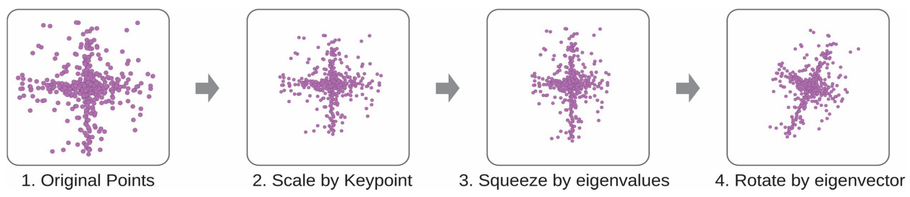
- Detect keypoints using FAST, compute second moment matrix

$$\mathbf{M}(\mathbf{x_r}) = \sum_{p,q} w(p,q) \begin{bmatrix} I_x^2(\mathbf{x_r}) & I_x I_y(\mathbf{x_r}) \\ I_x I_y(\mathbf{x_r}) & I_y^2(\mathbf{x_r}) \end{bmatrix}$$

- Eigenvalues of **M** measure 'cornerness', pick *N* best keypoints
- Matrix stored in memory with keypoint

### 2. Building the Descriptor

- Sample image around keypoint, adjusted for affine transformations




- Winner-take-all hashing from samples (16-128 bytes descriptors)

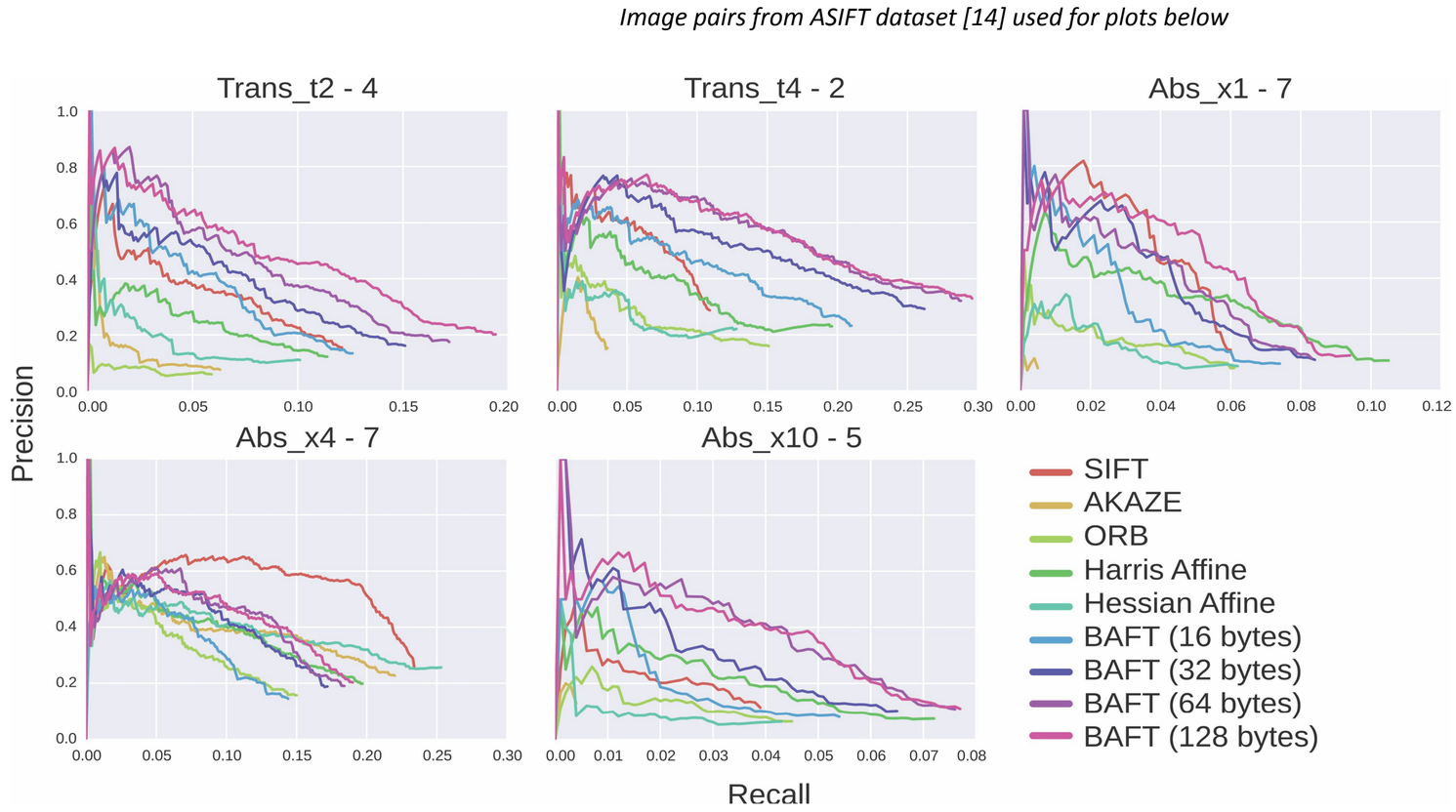
**Source code available at**
**github.com/arnfred/BAFT**

## Experimental Validation & Results

### Database

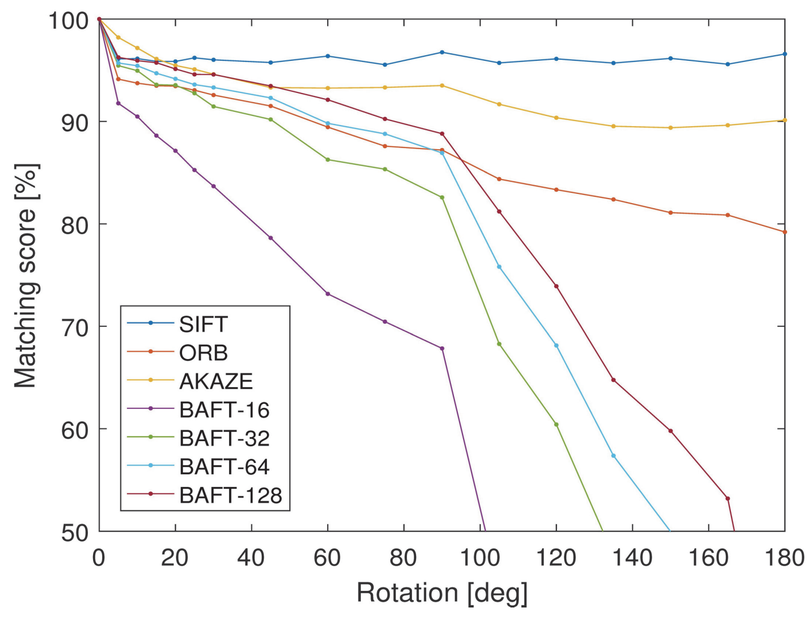
- ASIFT dataset [14]
- Perspective changes
- 5 sets of 10 images

*Image pairs from ASIFT dataset [14] used for plots below*

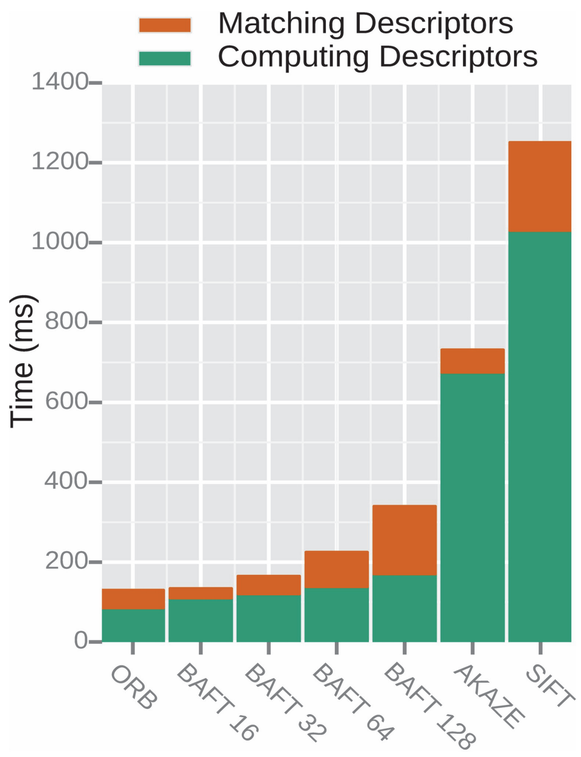



| Pair | SIFT | ORB | AKAZE | Harris-Affine | Hessian-Affine | BAFT-16 | BAFT-32 | BAFT-64 | BAFT-128 |
|---|---|---|---|---|---|---|---|---|---|
| All | 0.403 | 0.266 | 0.190 | 0.427 | 0.288 | 0.374 | **0.530** | **0.641** | **0.746** |

*Weighted average AUC over 40 image pairs*




*Quantifying rotation invariance*




*Feature computation and matching speeds*

## Conclusions

- BAFT: novel affine-invariant local image descriptor; computationally efficient (similar to ORB, much faster than SIFT).
- Achieves robustness to perspective changes without sacrificing speed (outperforms ORB, SIFT, AKAZE, and others).

## References

[6] E. Rublee, V. Rabaud, K. Konolige, G. Bradski, "ORB: An efficient alternative to SIFT or SURF." *Proc. IEEE International Conference Computer Vision (ICCV)*, 2011.
[10] K. Mikolajczyk, C. Schmid, "Scale & affine invariant interest point detectors." *International Journal of Computer Vision*, vol. 60, no. 1, pp. 63-86, 2004.
[14] J.-M. Morel and G. Yu, "ASIFT: A new framework for fully affine invariant image comparison." *SIAM Journal on Imaging Science*, vol. 2, no. 2, pp. 438-469, 2009.