



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Multispectral interest points for RGB-NIR image registration

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Overview

Improvement of RGB and near-infrared (NIR) feature detection.



Multispectral



Single band

Multispectral generalisation of Harris, Difference of Gaussians (DoG) and SIFT

Outline

Introduction

- Near-infrared

- Image registration

Extended methods

- Multispectral feature detection

- Gradient reversal

Results

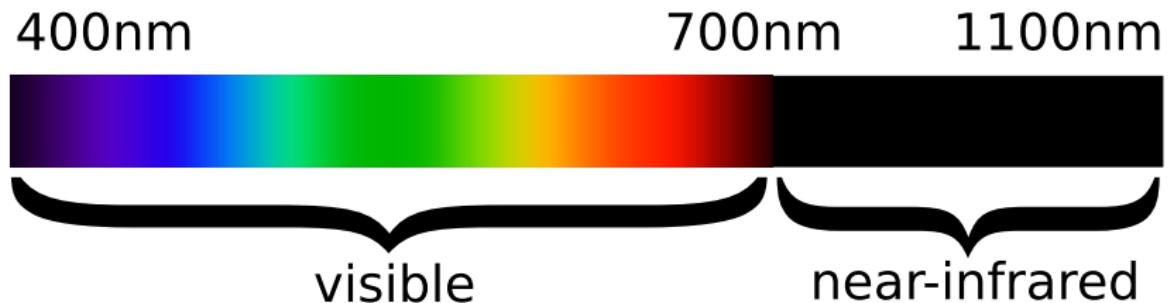
- Evaluation method

- Multispectral detection

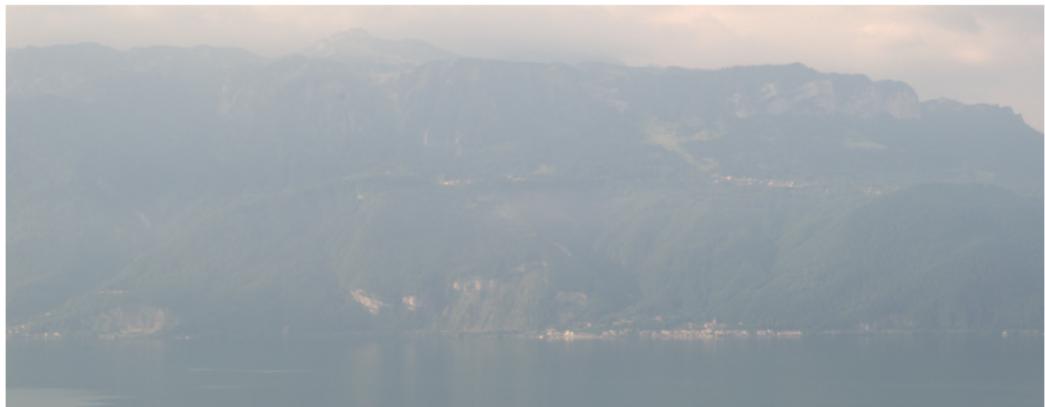
- Gradient direction invariant SIFT

Conclusion

NIR - Near-infrared



NIR - Differences with RGB



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Gradient direction invariant SIFT

Conclusion

Image registration - Extract features



Image registration - Find matches

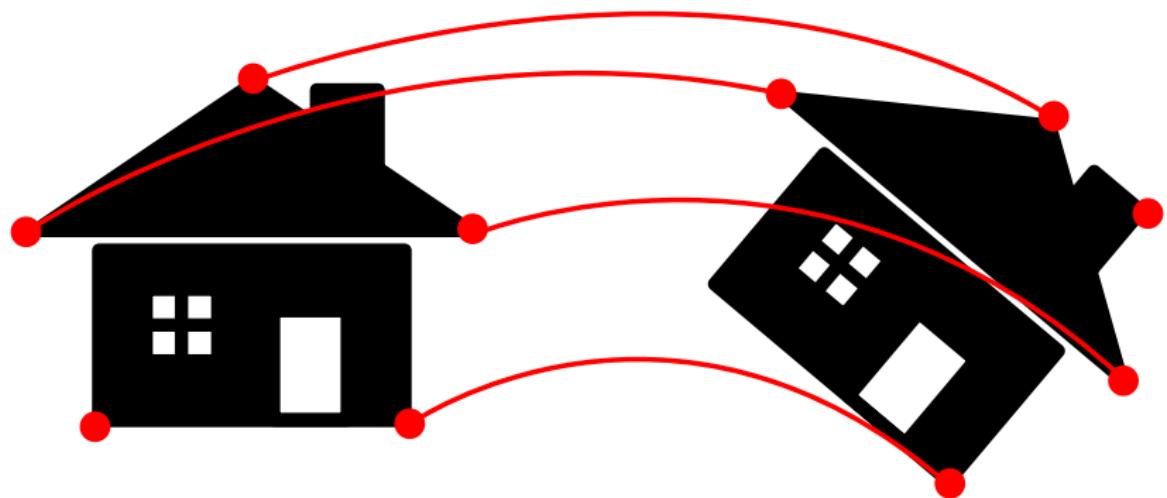
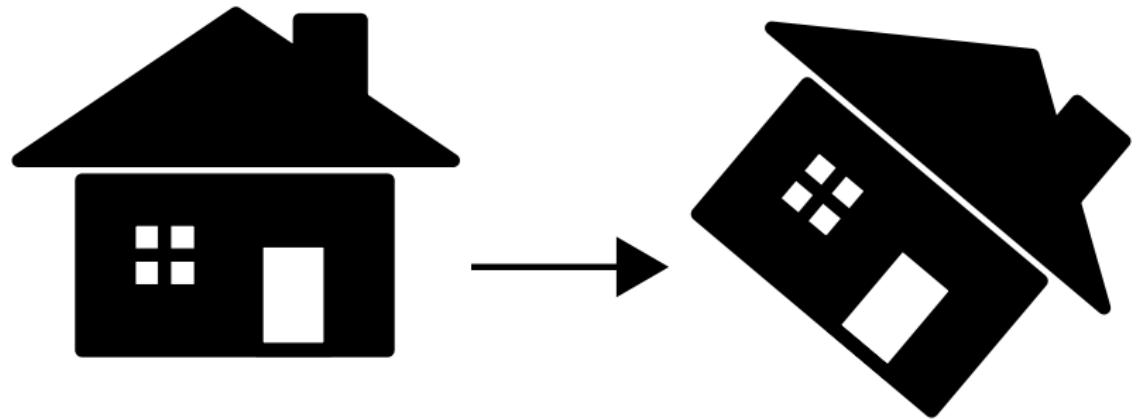


Image registration - Compute transformation



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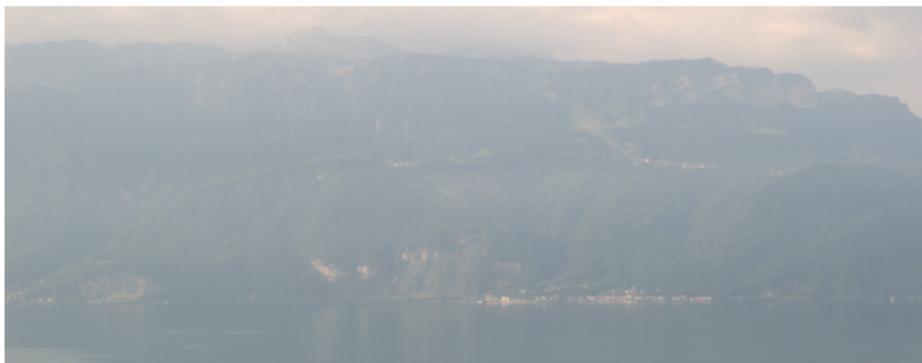
Multispectral detection

Gradient direction invariant SIFT

Conclusion

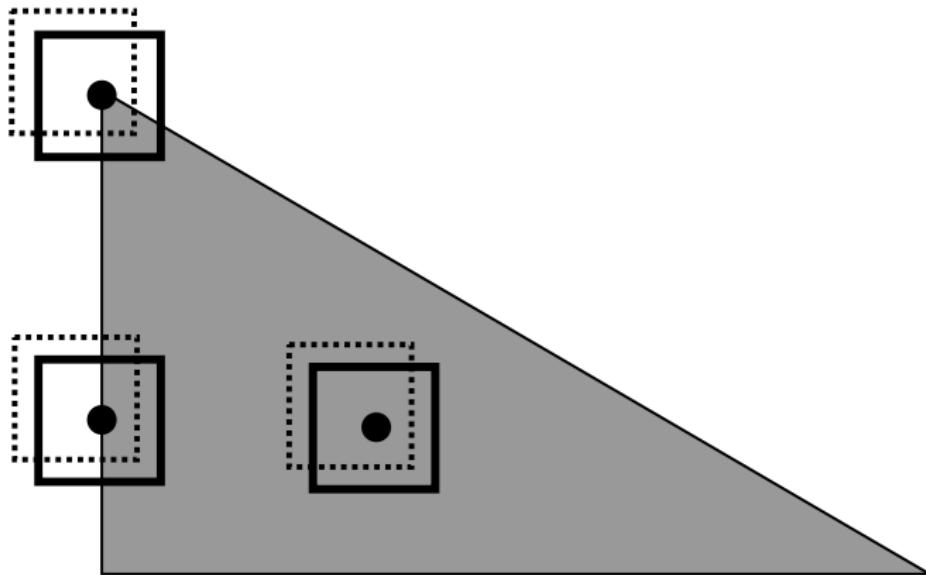
Single band detection

Image registration fails when features aren't good enough



Combine the RGB and NIR images for feature extraction

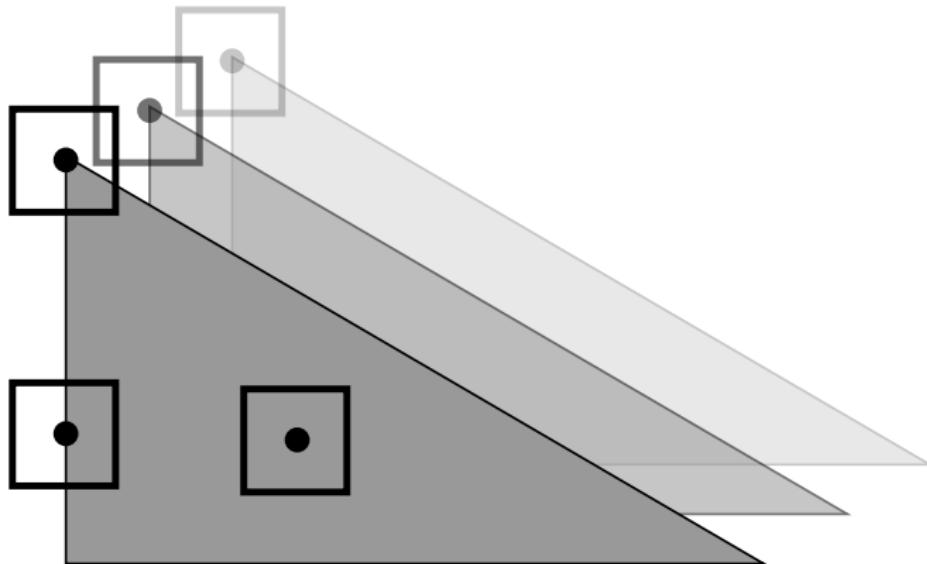
Harris corner detector - standard method



Harris, 1988

Modeled by the autocorrelation matrix

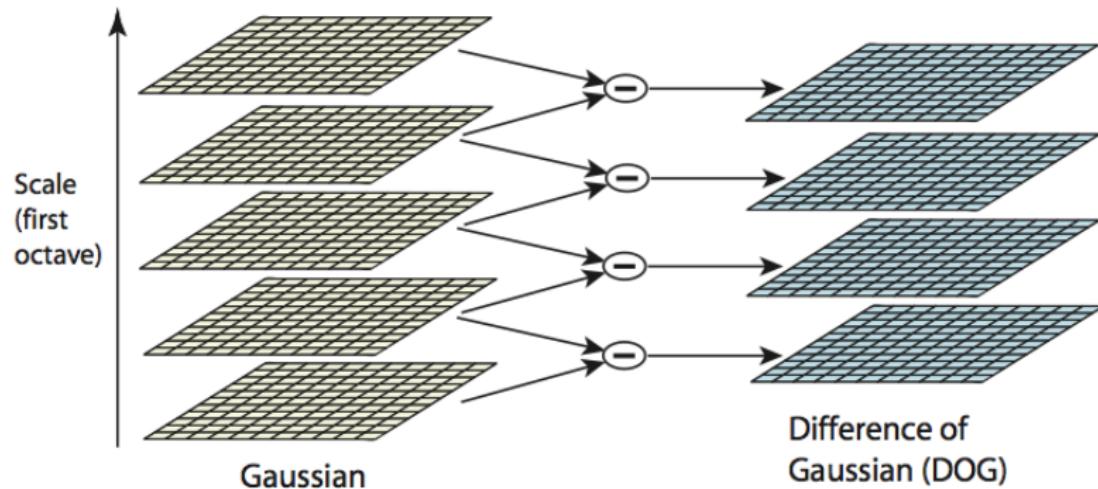
Harris corner detector - extended method



Addition of the autocorrelation matrices

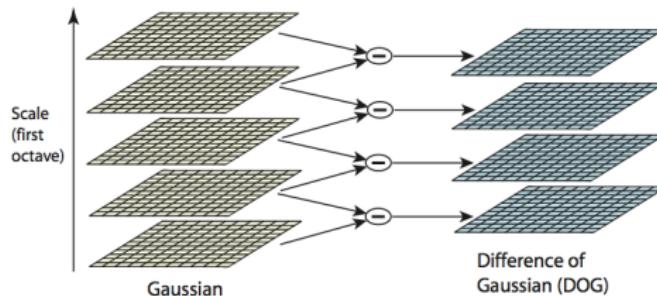
$$A = A_{RGB} + A_{NIR}$$

Difference of Gaussians - standard method



Lowe, 1999

Difference of Gaussians - extended method



Norm of vector of DoG responses

$$D(x, y, \sigma) = \begin{vmatrix} D_{RGB}(x, y, \sigma) \\ D_{NIR}(x, y, \sigma) \end{vmatrix}$$

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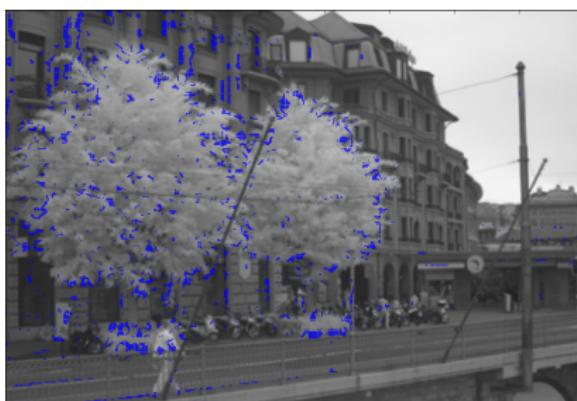
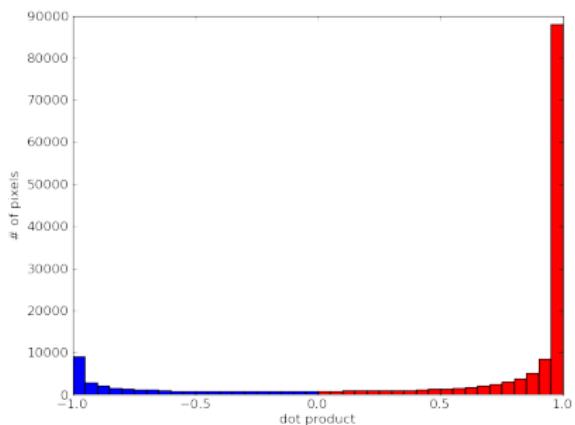
Gradient direction invariant SIFT

Conclusion

Gradient reversal problem

RGB to NIR registration

Inverted contrast reverses
gradient orientations



SIFT descriptor relies on image gradient orientations

SIFT descriptor - standard method

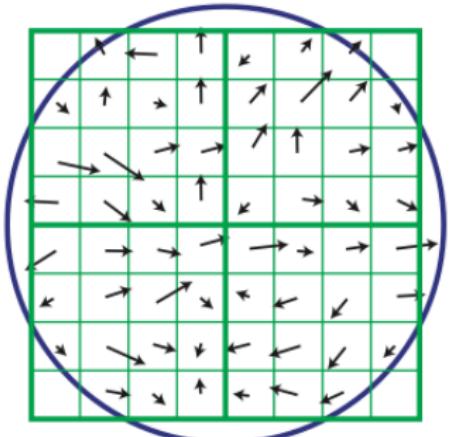
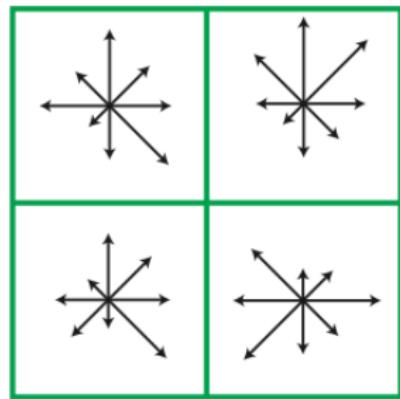


Image gradients

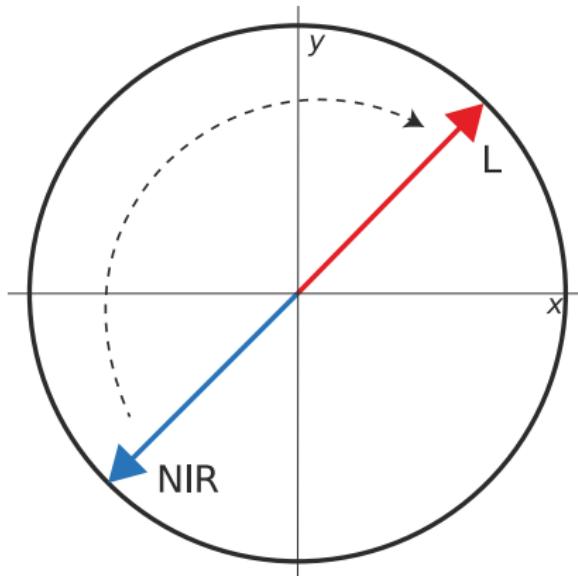


Keypoint descriptor

Lowe, 1999

Gradient Direction Invariant SIFT

Making the SIFT descriptor invariant to gradient reversal.



Feature description is more consistent between RGB and NIR.

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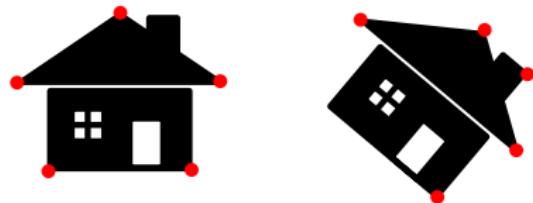
Multispectral detection

Gradient direction invariant SIFT

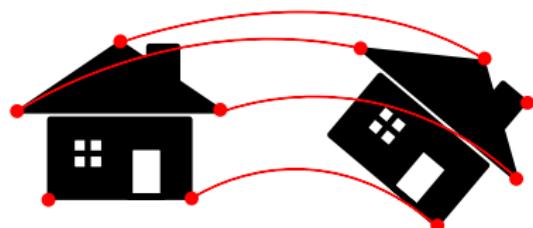
Conclusion

Evaluation method

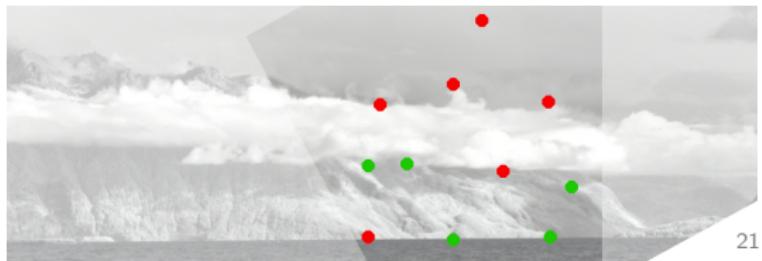
Extract features



Find the matches



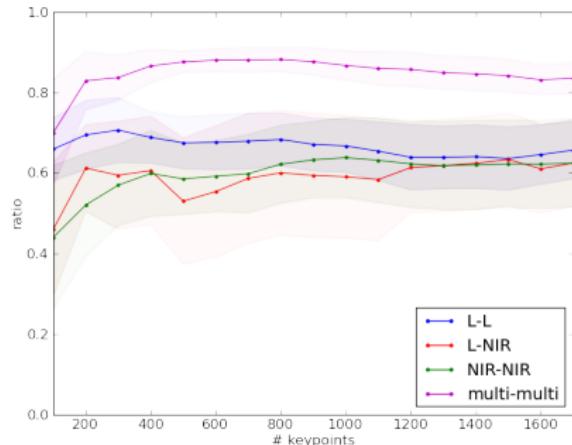
$$\% \text{ correct} = \frac{\# \text{ correct matches}}{\# \text{ matches in overlap area}}$$



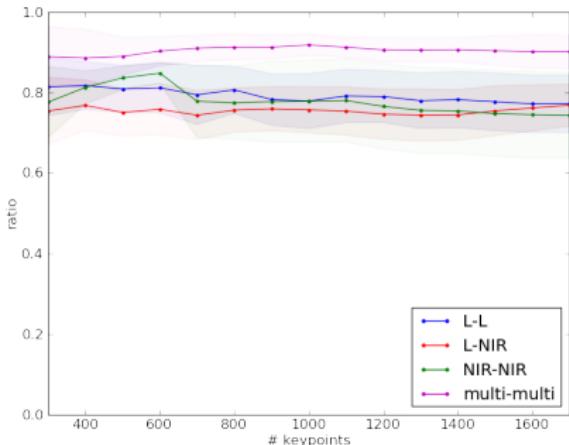
Evaluation dataset



Multispectral detection - Results

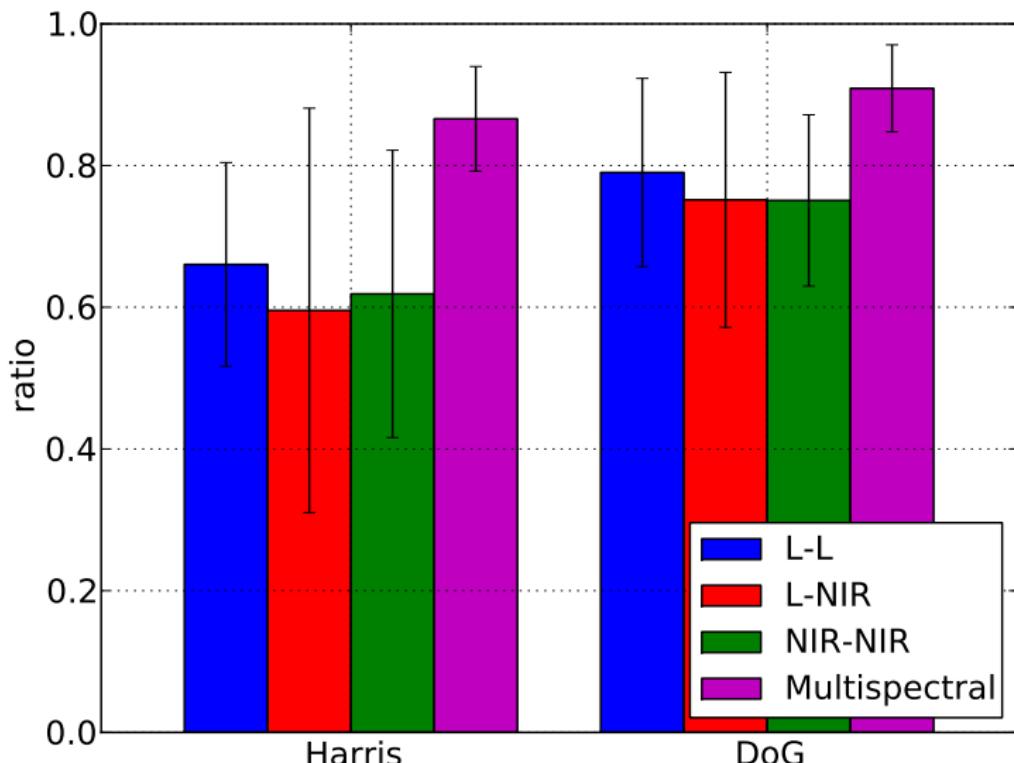


(a) Harris

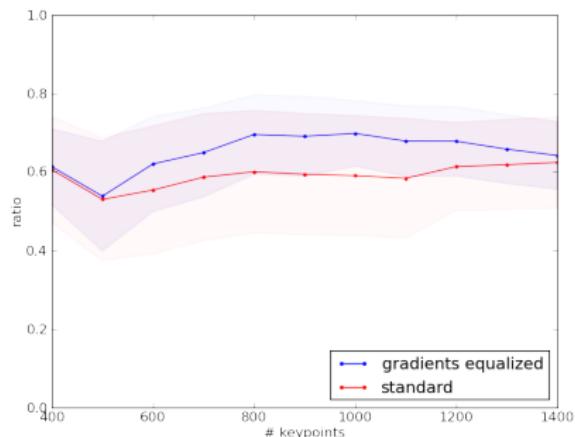


(b) Difference of Gaussians

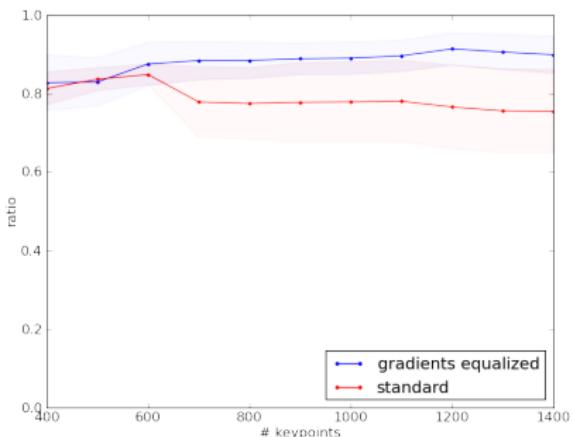
Multispectral detection - Comparison



Gradient Direction Invariant SIFT - Results

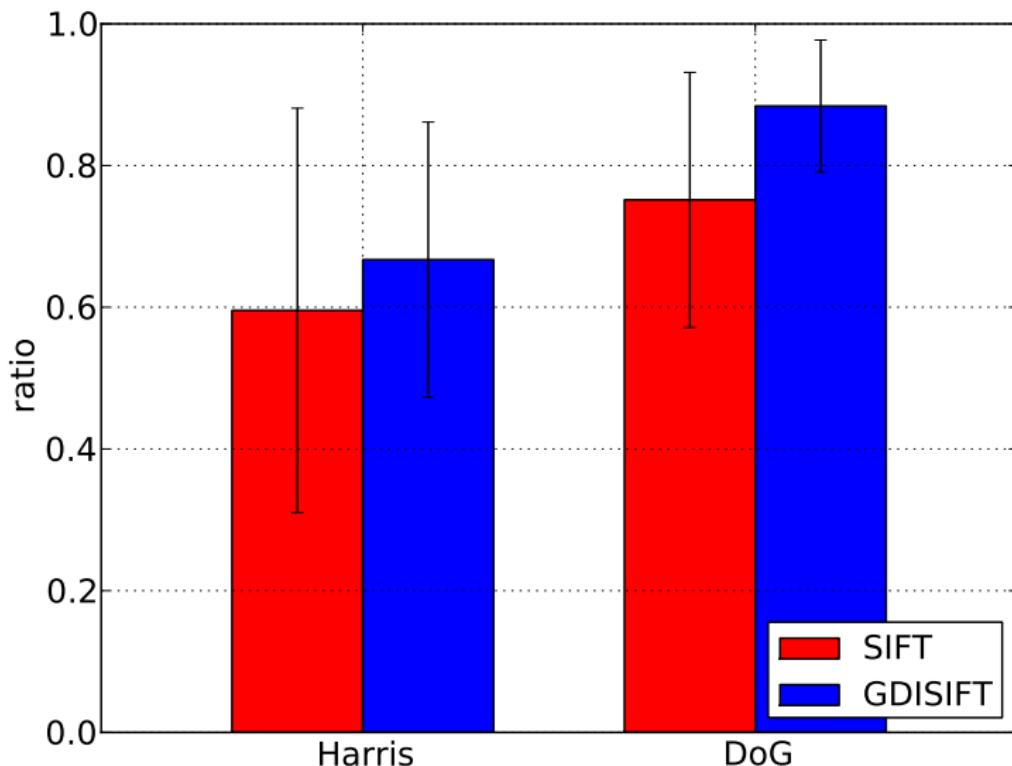


(a) Harris



(b) Difference of Gaussians

Gradient Direction Invariant SIFT - Comparison



Conclusion

Multispectral detection

- ▶ Multispectral detection methods using NIR lead to higher performance

RGB to NIR registration

- ▶ Loss of performance when registering RGB to NIR images
- ▶ Gradient direction invariant descriptor to improve performance

Future Work

- ▶ Look into other detectors (MSERs, ...)
- ▶ Use a multi-sensor camera to capture RGB/NIR images