Vision-based Automated Visual Inspection of Large-scale Bridges

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Motivation

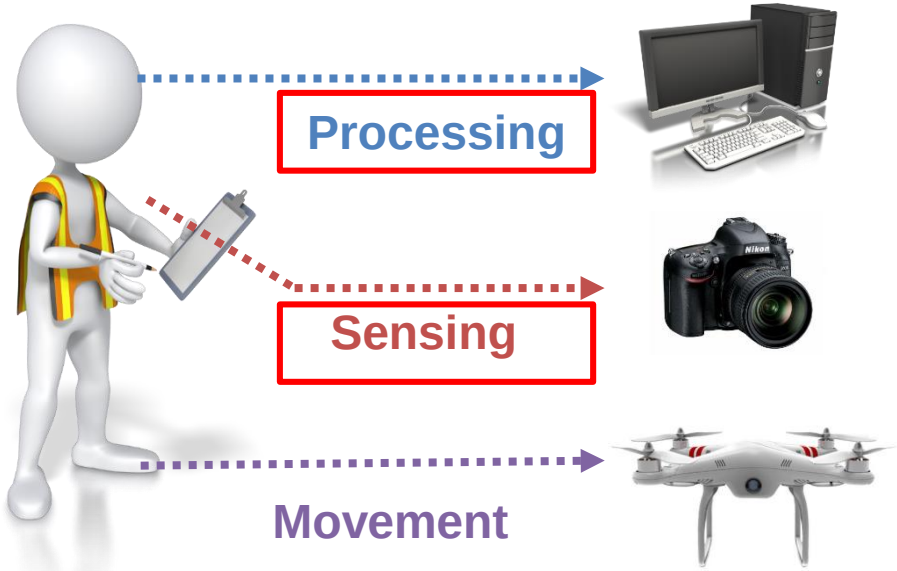
Dangerous works

Low accessibility

Traffic block

- Large scale
- Subjective interpretation
- Accessibility
- Periodic inspection
- Time consuming

Proposed Approach



Objective

Development of a vision-based visual inspection technique using a large volume of images collected by aerial cameras

Advantage

- **Fully automated visual inspection**
- **Use of images taken under uncontrolled circumstance**
- **Robust detection and minimizing false-positive detection and misdetection**

Problems of Current Vision based Damage Detection

Non-crack area

Images of a fatigue crack from different view points

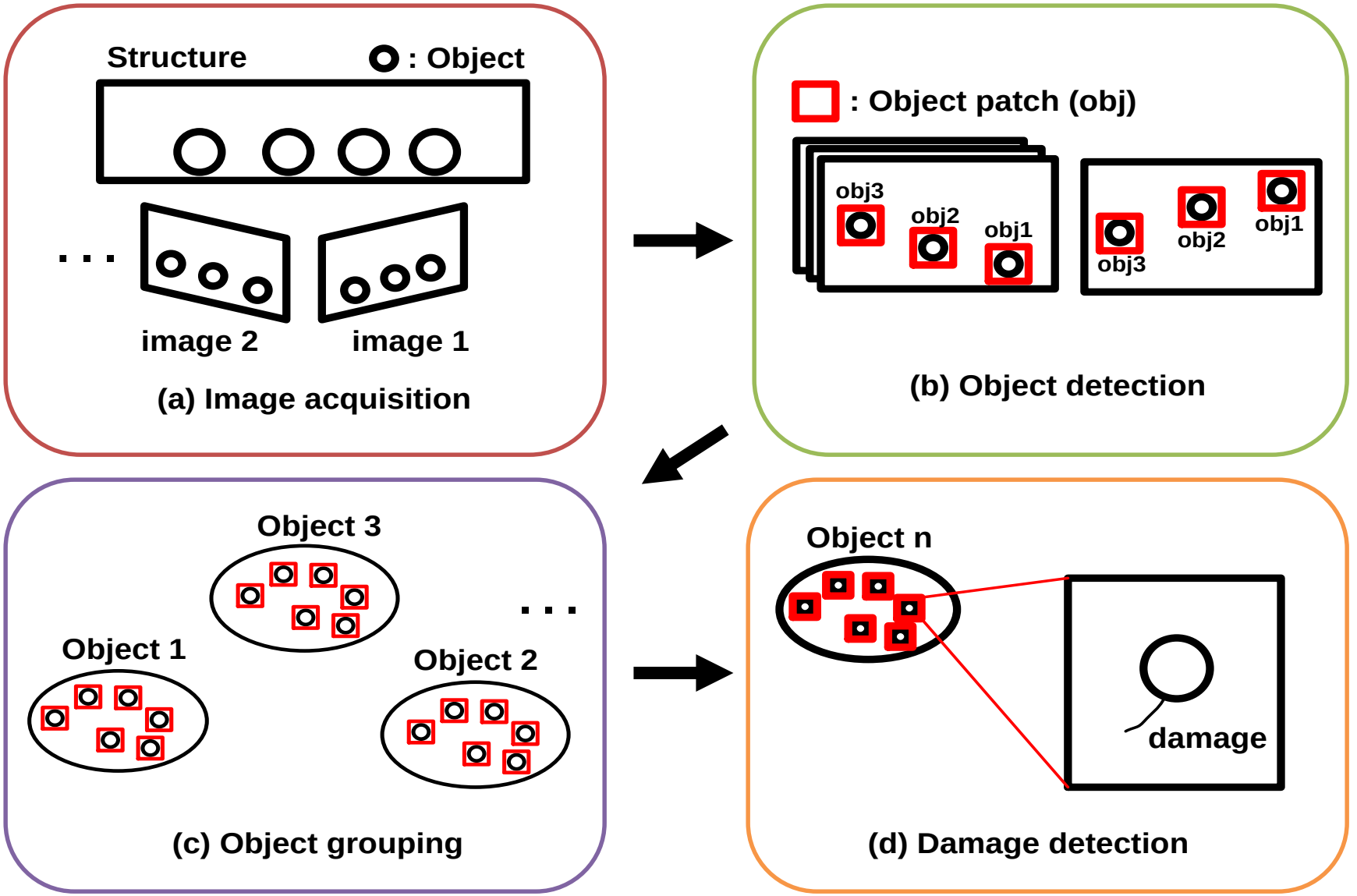
- Many false-positive alarms and misdetections

  → Detection of damage-sensitive areas (object)

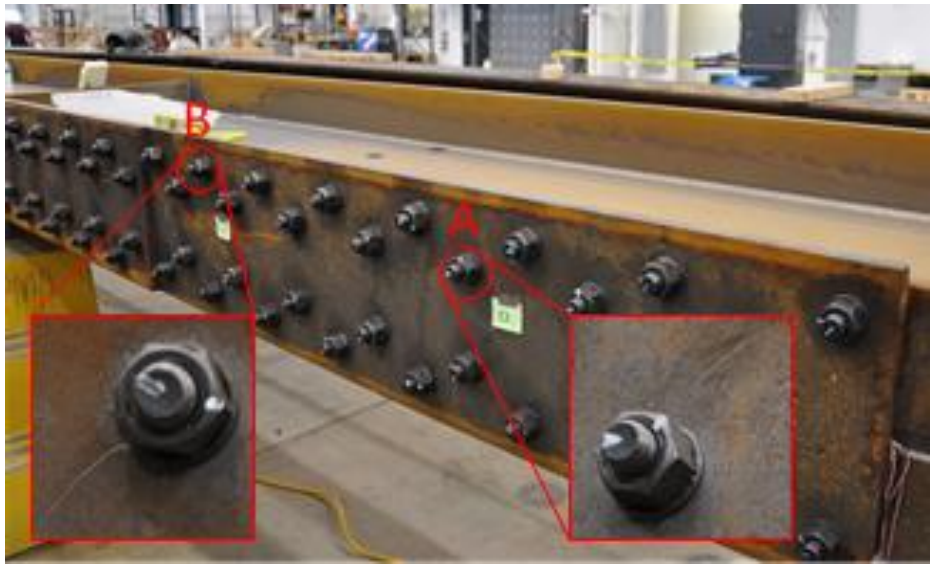
- Visibility depending on viewpoints

  → Use of many different viewpoints of object images

Overview of the Proposed Technique



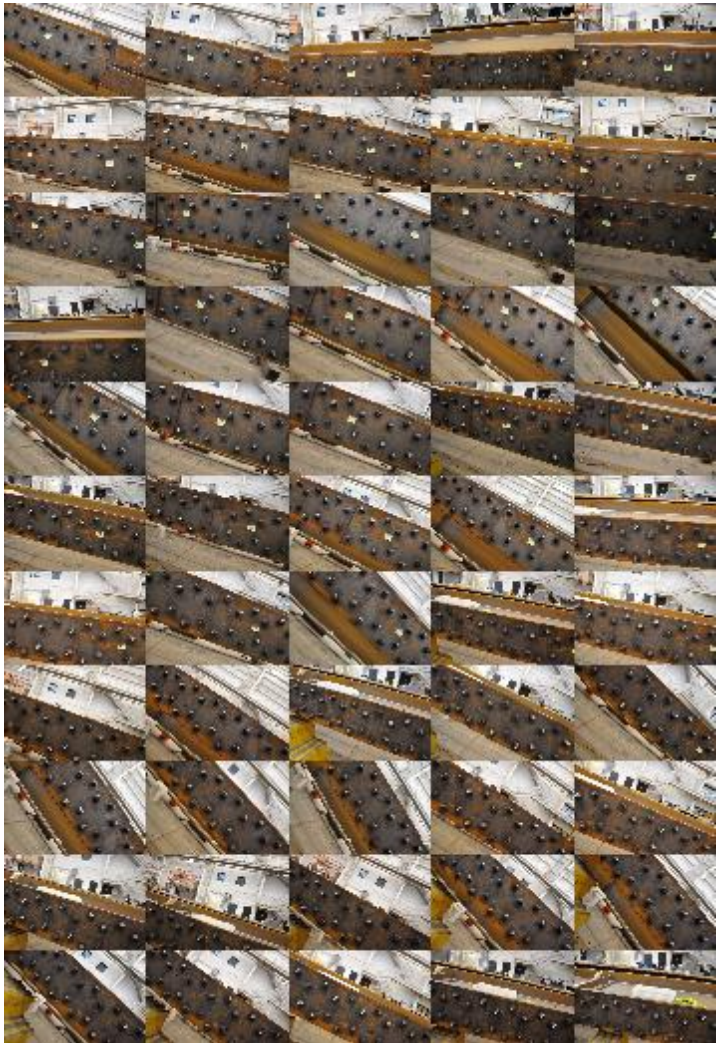
Experimental Setup



- # of images : 72 (Nikon D90)
- Image resolution : 4288 x 2848
- # of object (bolts) : 68
- # of artificial cracks : 2 (A and B)
- Working distance : 2~3 m
- # of training images : 5 (68 positive and 204 negative image patches)

Location B

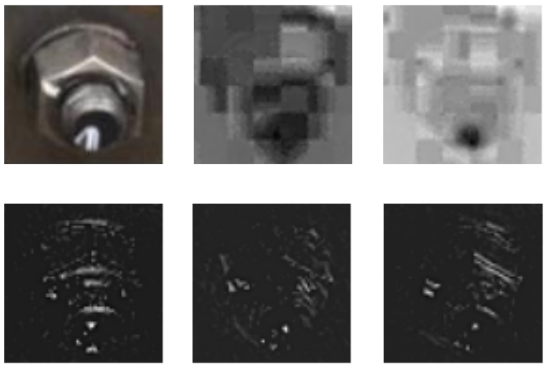
Step 1: Image Acquisition



Suggestion for the best performance

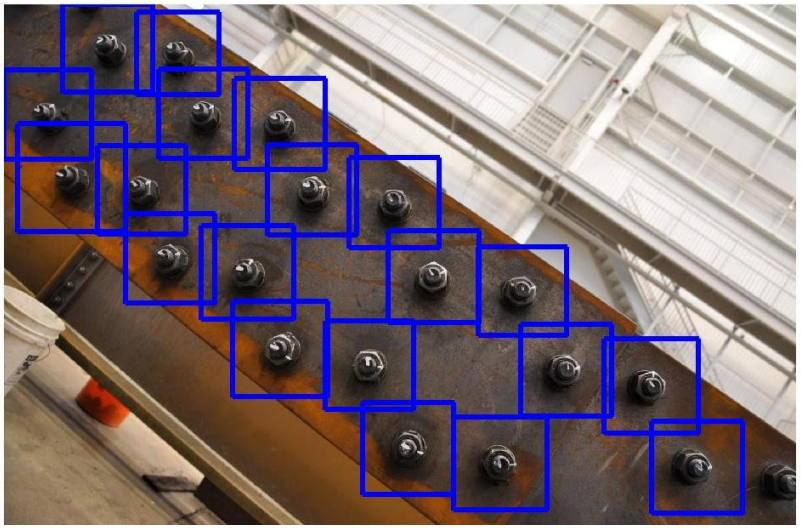
- **High focused and resolution images**
- **Small tilt angles but many angle variations**
- **Constant distance between the UAV and a test bridge**
- **GPS data for roughly estimating damage locations**

Step 2: Object Detection



Feature : Integral channel image with Haar-like feature (HSV, LUV, and histogram of gradient)

Classifier: Gentle boost algorithm

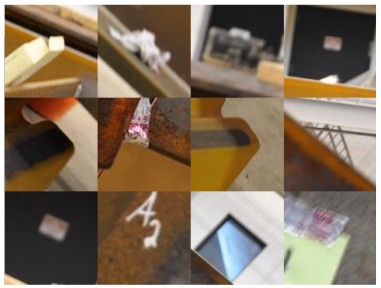


Object detection

98.7 % true detection (1294 / 1310)

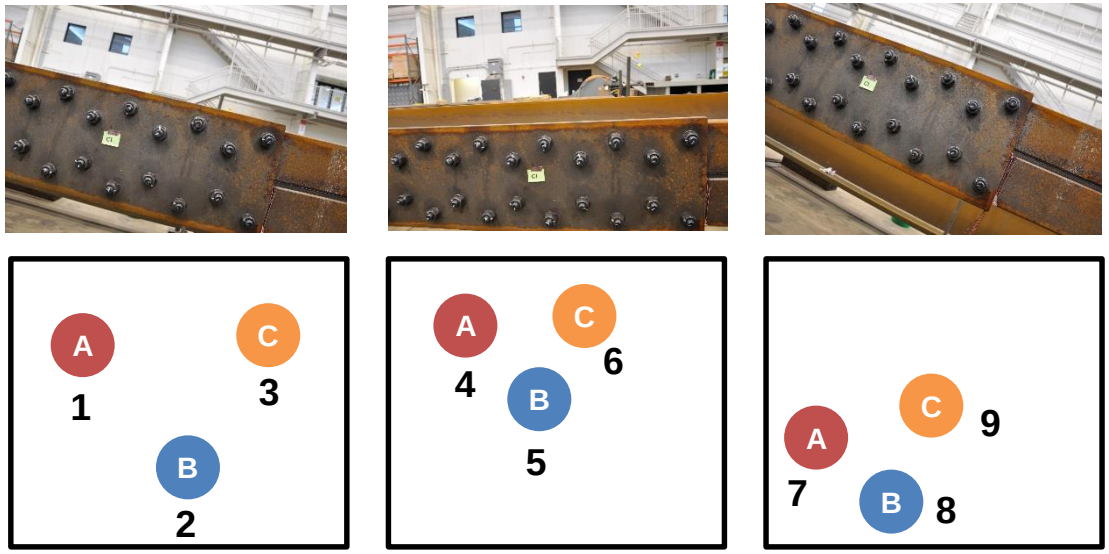
6.8 % false-positive detection (91/1310)

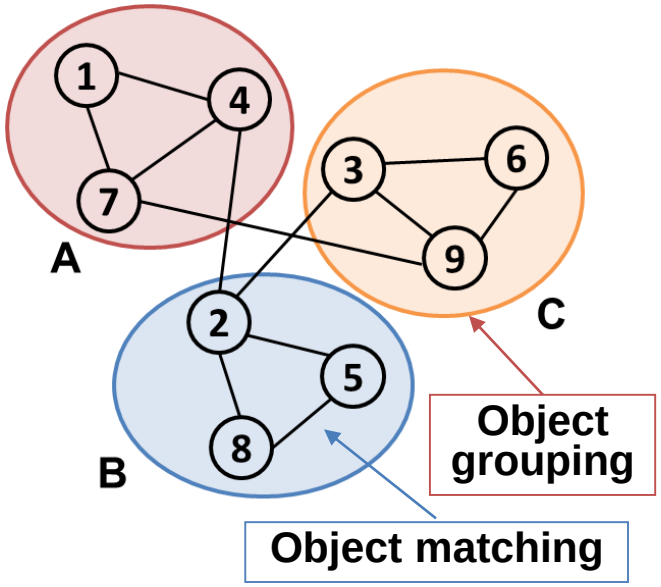
Detected object



False detection

Step 3: Object Grouping





Object matching: Integration of SIFT descriptor and epipolar constraint

Object grouping: Community detection technique (Modularity maximization technique)

2922 matching and 77 (= 1147) group detection

4 overlap groups and 5 non-object groups

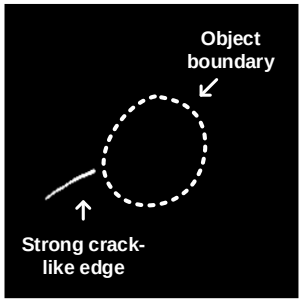
Step 4: Damage Detection

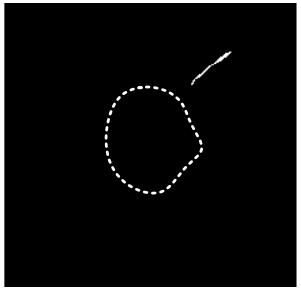
Grouping object patches at crack locations

1) Removing an object (Canny edge filter, morphological operation)

2) Crack-like edge detection (Frangi-edge filter)

3) Crack detection using object boundary (radon transformation)





Conclusion

- A vision based damage detection technique is developed for automated inspection of large scale bridge structures only using images.
- The effectiveness of the proposed technique is demonstrated using images collected from a steel beam with artificial crack damage
- Objects (= bolt) and cracks are successfully detected from images regardless of the small size or invisible depending on viewpoints
- Further investigation will be underway to extend the proposed concept to other structural components such as joints or welded areas

Acknowledgements

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