Countering Anti-forensics of SIFT-based Copy-Move Detection

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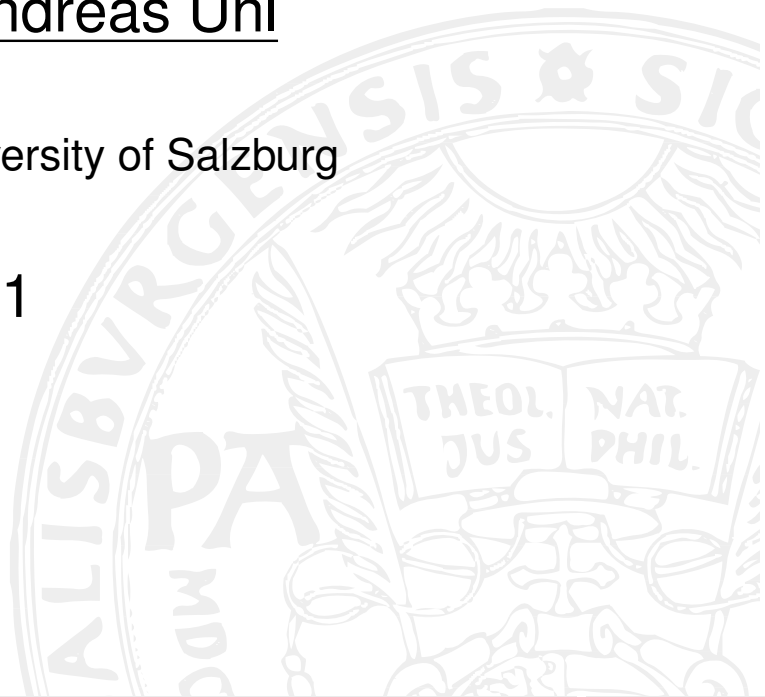


SIFT Keypoint Forensics

Backgound

- SIFT-based forensic analysis is used to detect image forgeries e.g. the copy move forgery
- Counter forensic techniques (aka anti-forensic methods) to fool the forensic analyst by concealing traces of manipulation have been developed
- For SIFT-based forensic analysis, various keypoint removal techniques have been introduced to counter copy move forgery detection techniques
- Keypoint removal approaches include global and local smoothing, collage attacks, and removal with minimal distortion (and combinations of these)

This paper introduces a technique to counter anti-forensic SIFT keypoint removal approaches.

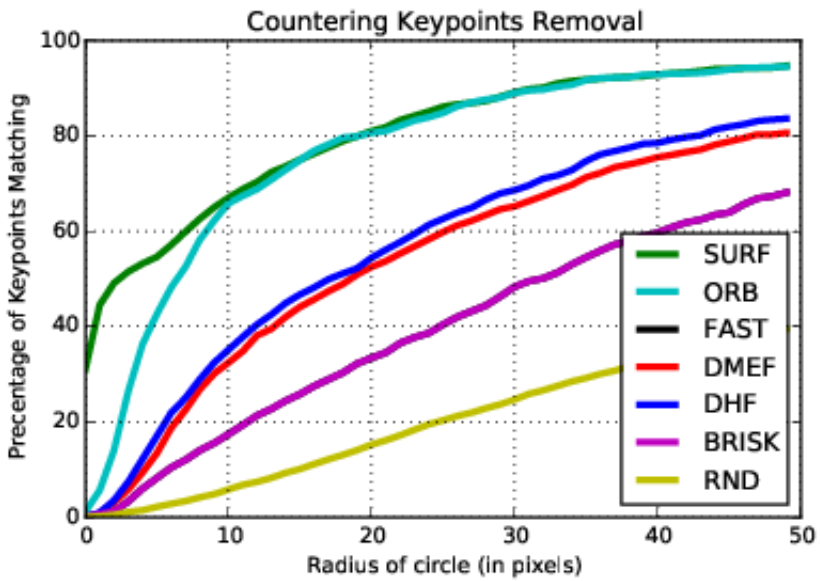
Key Idea

Changing Key Point Types

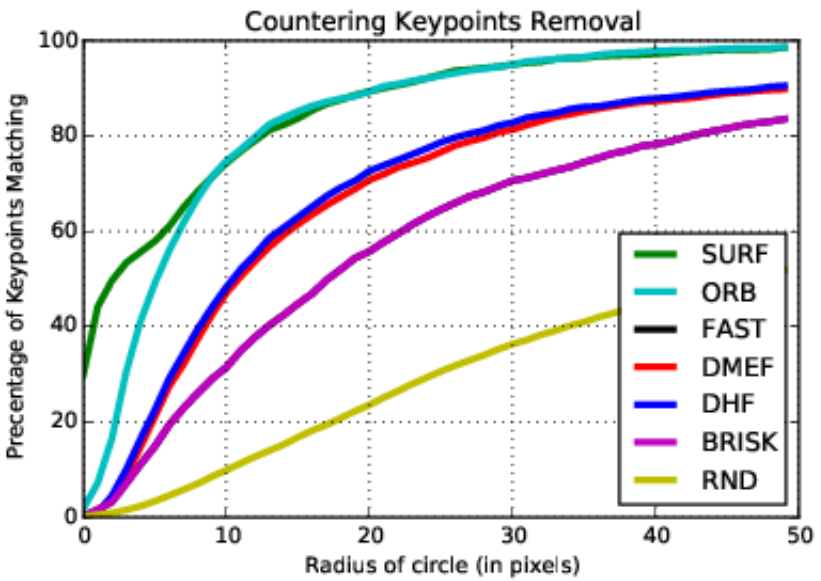
- The attacker removes SIFT keypoints to disguise the copy-move forgery
- In doing so, she/he assumes that the foresnic analyst uses SIFT keypoint in her/his analysis
- However, this is not necessarily the case !!
- $\longrightarrow$ The forensic analyst can resort to a different type of keypoints in her/his analysis.

$\longrightarrow$ Intuitively, those alternative keypoints should be situated far away from the SIFT keypoints to avoid their erosion during the attackers keypoint removal process. Which ones to choose ?

Experimental Motivation



(a) 50 keypoints each



(b) 100 keypoints each

Figure: Draw circle around each SIFT keypoint and measure the share of other keypoints contained in these circles.

$\longrightarrow$ Using BRISK keypoints for forensic analysis after SIFT keypoint removal is a natural choice !

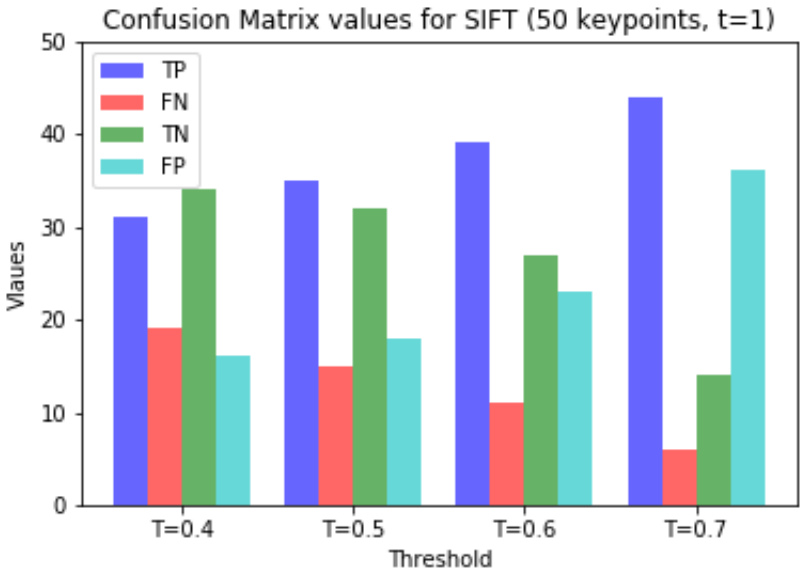
Datasets used

(a) 50 Forged Images

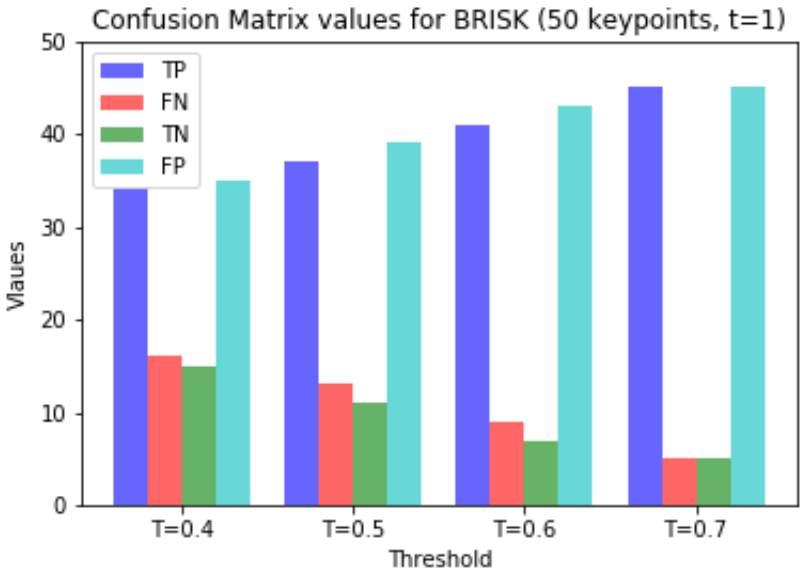
(b) 50 Original Images

Figure: Forged images to estimate TP and FN, original images with repeated structures to estimate FP and TN.

Copy Move Forgery Detection: Baseline



(a) SIFT keypoints

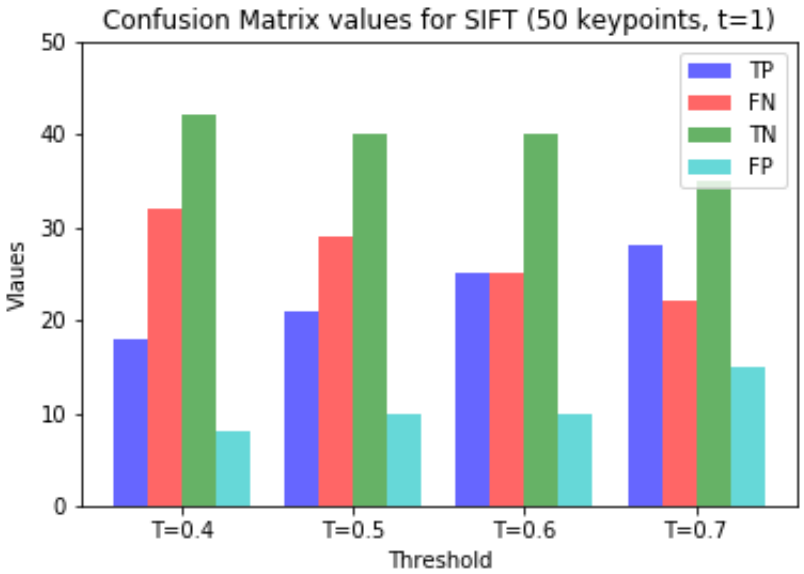


(b) BRISK keypoints

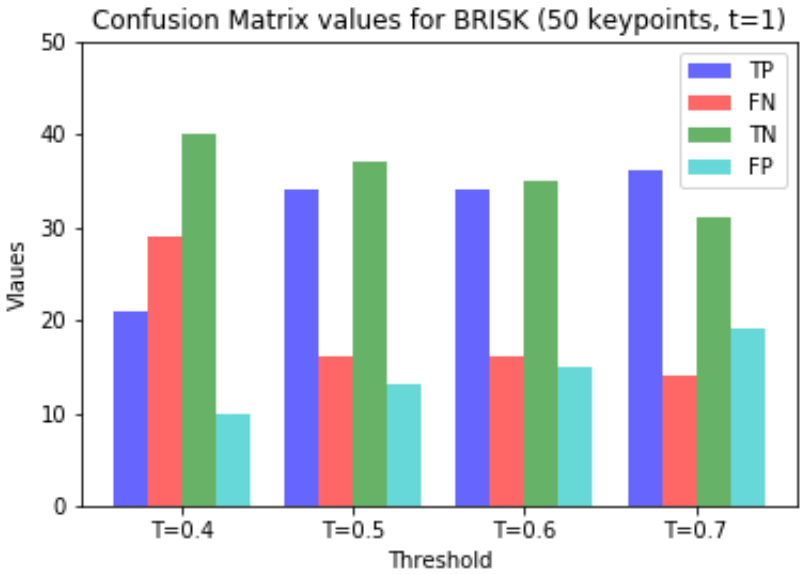
Figure: Confusion matrices for copy move forgery detection WITHOUT keypoint removal.

$\longrightarrow$ BRISK results in slightly higher TP rates at the cost of significantly higher FP rates for the (challenging) original images.

Forgery Detection after Keypoint Removal I



(a) SIFT keypoints

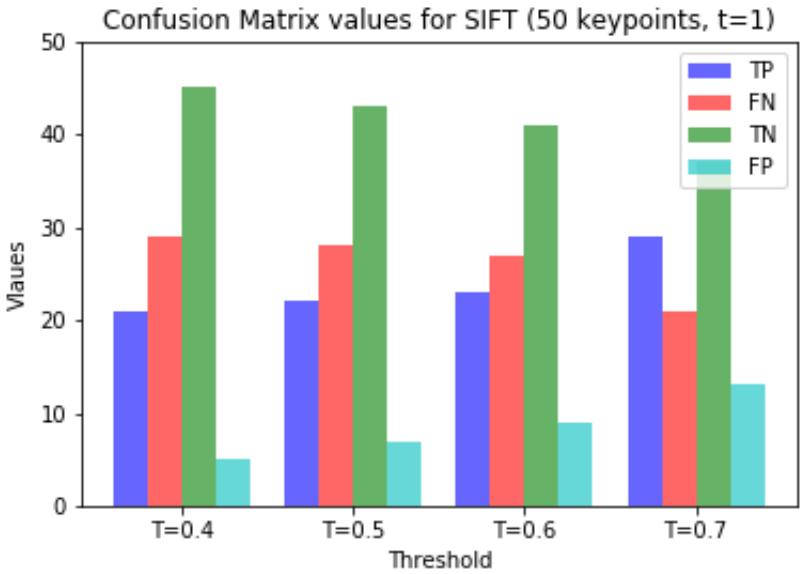


(b) BRISK keypoints

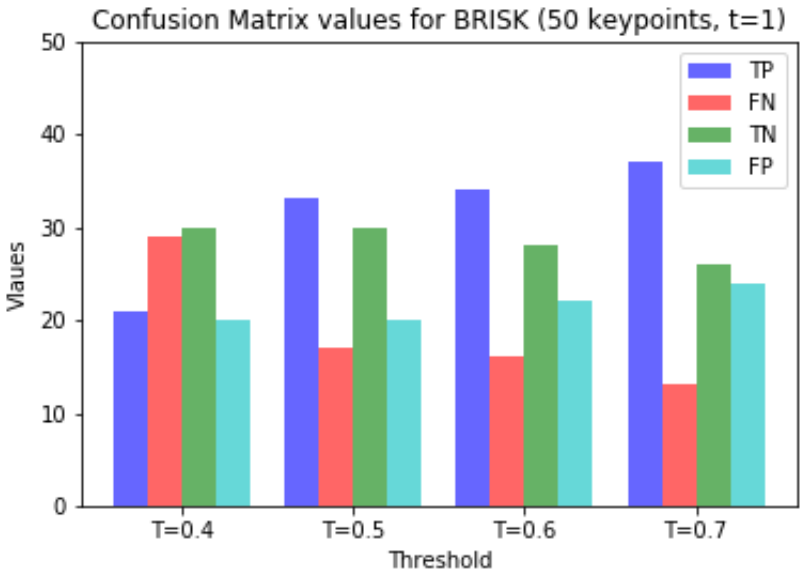
Figure: Confusion matrices for copy move forgery detection after *local smoothing* keypoint removal.

$\longrightarrow$ BRISK results in clearly higher TP rates at the cost of slightly higher FP rates for the (challenging) original images.

Forgery Detection after Keypoint Removal II



(a) SIFT keypoints



(b) BRISK keypoints

Figure: Confusion matrices for copy move forgery detection after *collage attack* keypoint removal.

$\longrightarrow$ BRISK results in clearly higher TP rates at the cost of (slightly) higher FP rates for the (challenging) original images.

Forgery Detection after Keypoint Removal III

So far, detailed results for selected settings suggest advantages for BRISK. What is the general trend ?

	CA			LS			GS+LS		
# Kp.	Prec.	Rec.	F1	Prec.	Rec.	F1	Prec.	Rec.	F1
50	0	9	9	3	4	4	4	9	7
100	0	6	5	12	8	9	12	3	9
200	1	9	7	8	10	10	12	4	8

Table: Comparison of keypoint removal techniques in terms of precision, recall, and F1-score: Number of settings (out of 12 in each category), where value(BRISK) $>$ value(SIFT).

$\longrightarrow$ we have 16/27 entries where BRISK is superior as compared to SIFT. In particular, F1(BRISK) $>$ F1(SIFT) in 7/9 cases.

Conclusion & Future Work

We have found BRISK-based forensic keypoint analysis to reveal copy-move attacks after the application of SIFT keypoint removal to be promising, however, success is dependent on parameter configurations.

Future Work

- Combine both SIFT and BRISK keypoint based forensic analysis in scenarios where a keypoint removal attack is suspected.
- Consider the the location of BRISK keypoints in forensic analysis after SIFT keypoint removal, but contrasting to the approach here SIFT descriptors will be analysed at these locations.

Thank you for your attention!

Questions?