ObjectMinutiae: Fingerprinting for Object Authentication

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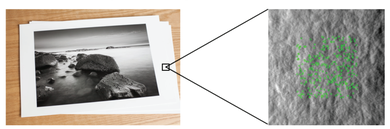
Motivation

- Artwork market has plenty of unauthorized reproduction of original products.
- Inspired by biometrics, a desirable solution is to extract unique object fingerprints for authentication.

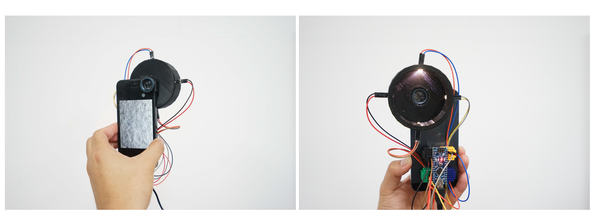


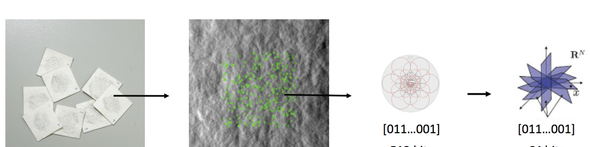
Highlights

- By photometric stereo technique, we capture images from a particular region of interest (ROI).
- We extract the minutiae from each image for matching purposes.
- The size of the fingerprints is less than 25K bits

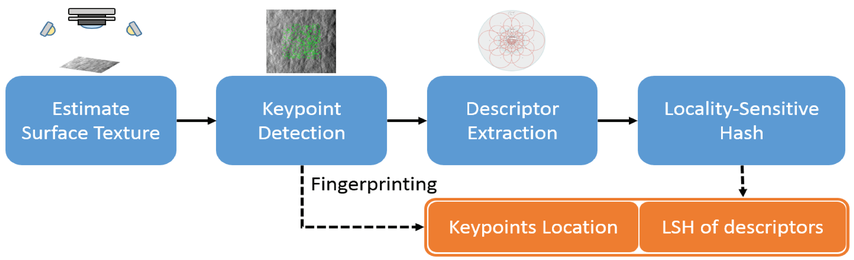
Device

- Apple iPhone5 with Olloclip 21X macro lens and a 3D-printed photometric stereo mask.
- The photometric stereo mask contains LEDs, which can be controlled independently.





Framework Overview



How to Fingerprint The Objects

- Extraction
  - Keypoints are detected and described by FAST [1] and FREAK [2], respectively.
  - < 300 keypoints for a 512 x 512 pixel region.
  - Each keypoint is a 512-bit binary code.
  - Random projection for dimension reduction.
- Matching
  - With geometric correction and RANSAC [3]
  - Similarity Metric:

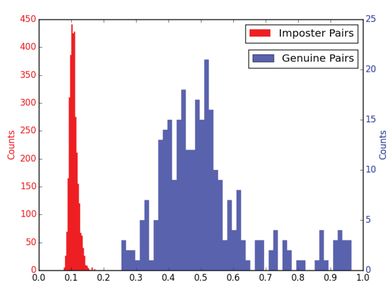
$$score = \frac{\#\ of\ Inliers}{\min(\#\ des\ after\ geometric\ correction)}$$

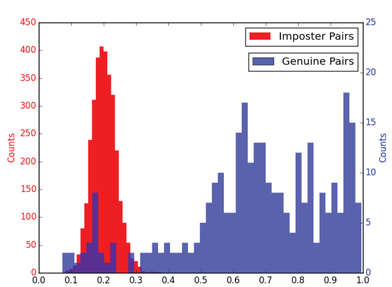
Experiment Setting

- 10 different art paper samples of the same material.
- 2 types of tampering processes: rubbing and soaking before acquiring a gradient image.
- For each condition (untampered, rubbed, and soaked) of each paper sample, we capture 2 gradient images separated by a time interval.
- Totally, a total of 60 samples are available.

Experim ent Results

- 360 genuine and 3240 imposter pairs are available.
- Matching results with/without using images produced by photometric stereo technique are shown below.





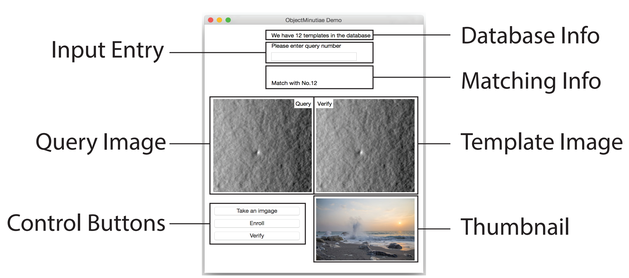
Comparison

- W. Clarkson et al. [4]: scan the entire document with a commodity scanner for fingerprinting.
- T. Takahashi et al. [5]: a keypoint extraction method without extracting fingerprints for matching purposes.
- A. Sharma et al. (PaperSpeckle) [6]: extract fingerprints of paper with additional efforts.

Demo

Enroll:

Verify:



References

[1] E. Rosten et al. Faster and better: A machine learning approach to corner detection. PAMI'10.
[2] A. Alahi et al. Freak: Fast retina keypoint. In CVPR' 12.
[3] M. A. Fischler et al. "Random sample consensus: a paradigm for model fitting with applications to image analysis and automated cartography." Communications of the ACM 24.6 (1981)
[4] W. Clarkson et al. Fingerprinting blank paper using commodity scanners. In SP' 09.
[5] T. Takahashi et al. Fibar: Fingerprint imaging by binary angular reflection for individual identification of metal parts. In EST' 14.
[6] A. Sharma et al. Paperspeckle: microscopic fingerprinting of paper. In ACM CCS'11, 2011.