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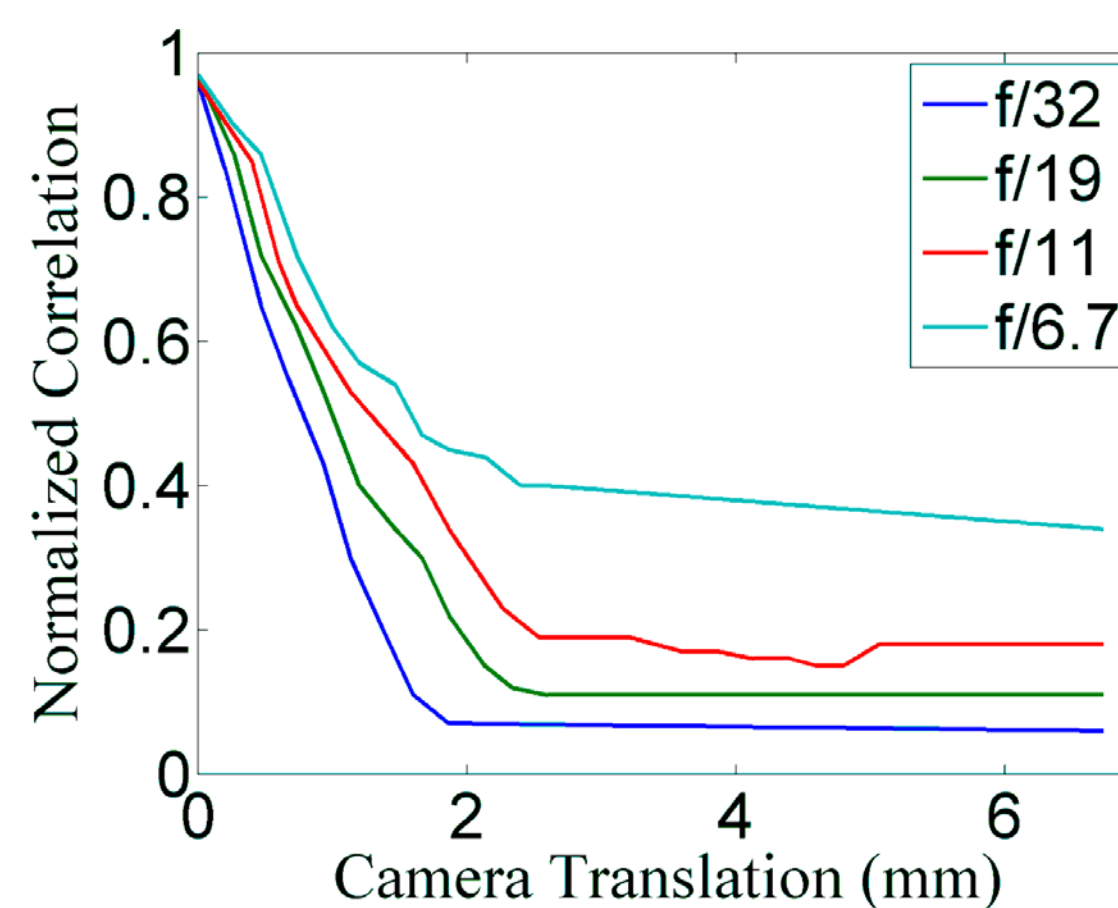
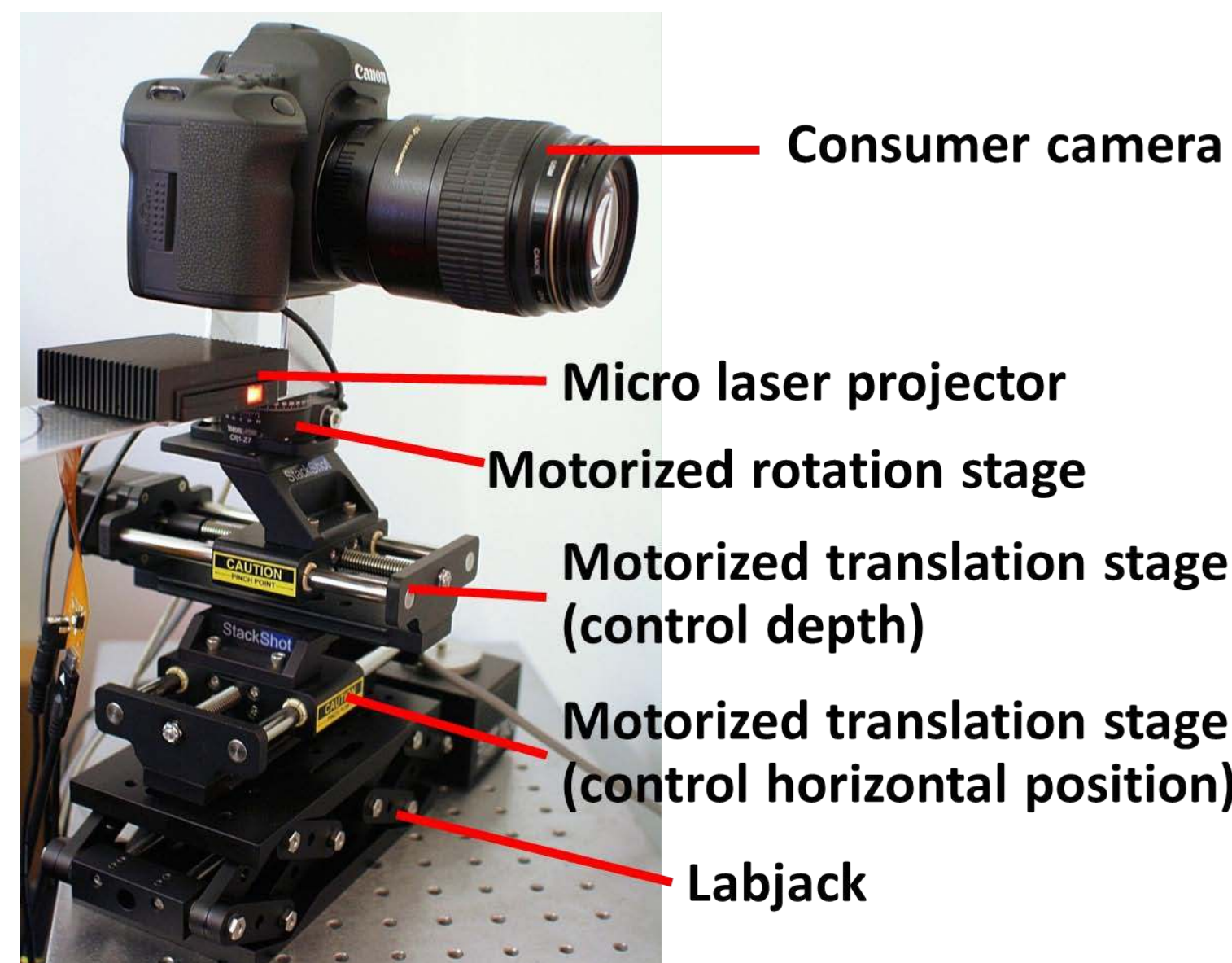
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## Abstract

It is often desirable to detect whether a surface has been touched, even when the changes made to that surface are too subtle to see in a pair of before and after images. To address this challenge, we introduce a new imaging technique that combines computational photography and laser speckle imaging.

## Rephotography

- ❖ Our system is portable, out-of-lab setting, and can be removed during the two speckle images.

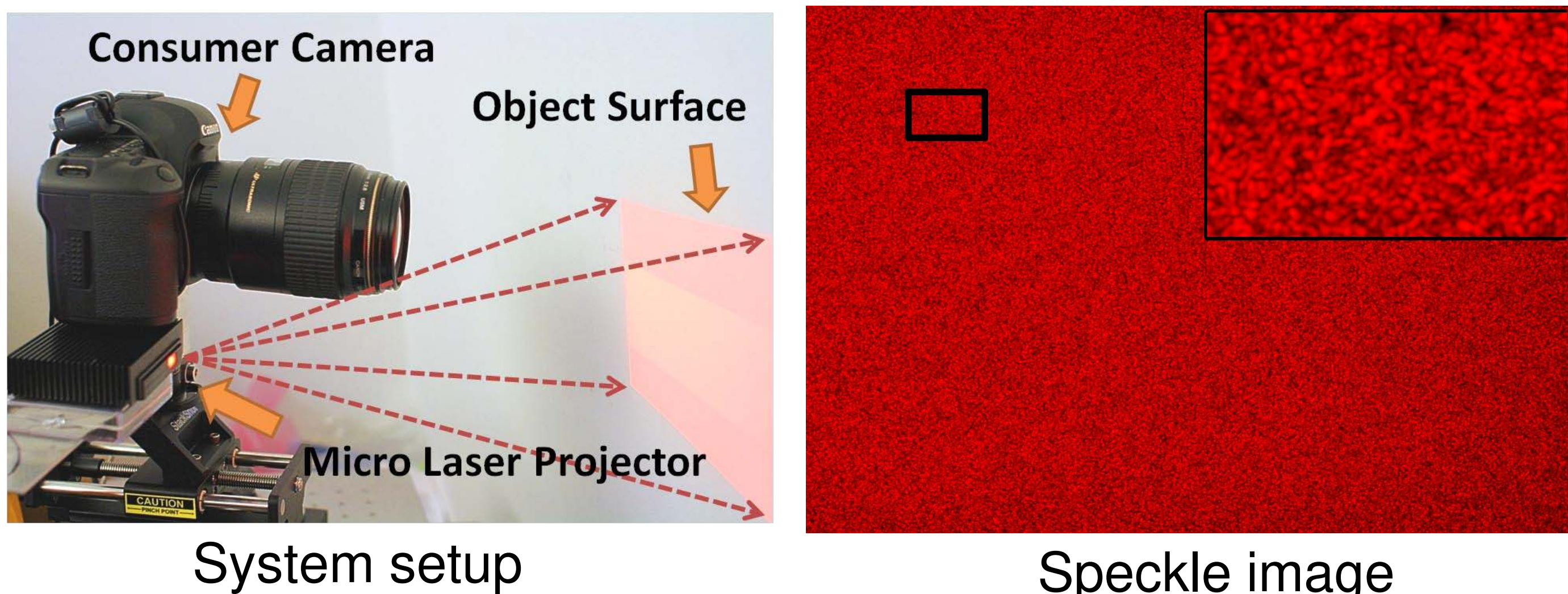


- ❖ Speckle is very sensitive to camera viewpoint, so the alignment need to be very precise (about 1 mm)

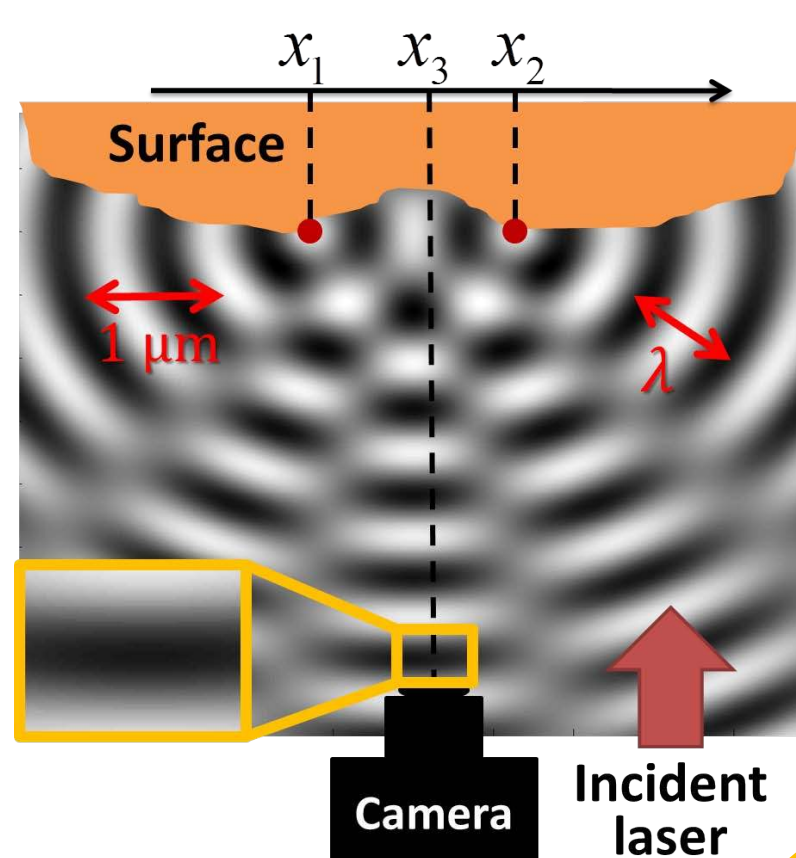
- ❖ Our solution takes two stages,  
**Feature-based localization by PTAM**
  - Accuracy about 2-3mm
  - Not enough meet the requirement**Speckle-based finer alignment**
  - Utilize the speckle sensitivity to viewpoint

## Laser Speckle Photography

- ❖ When shine a coherent light (laser) on a surface, a camera will capture a granular pattern, which is called speckle.

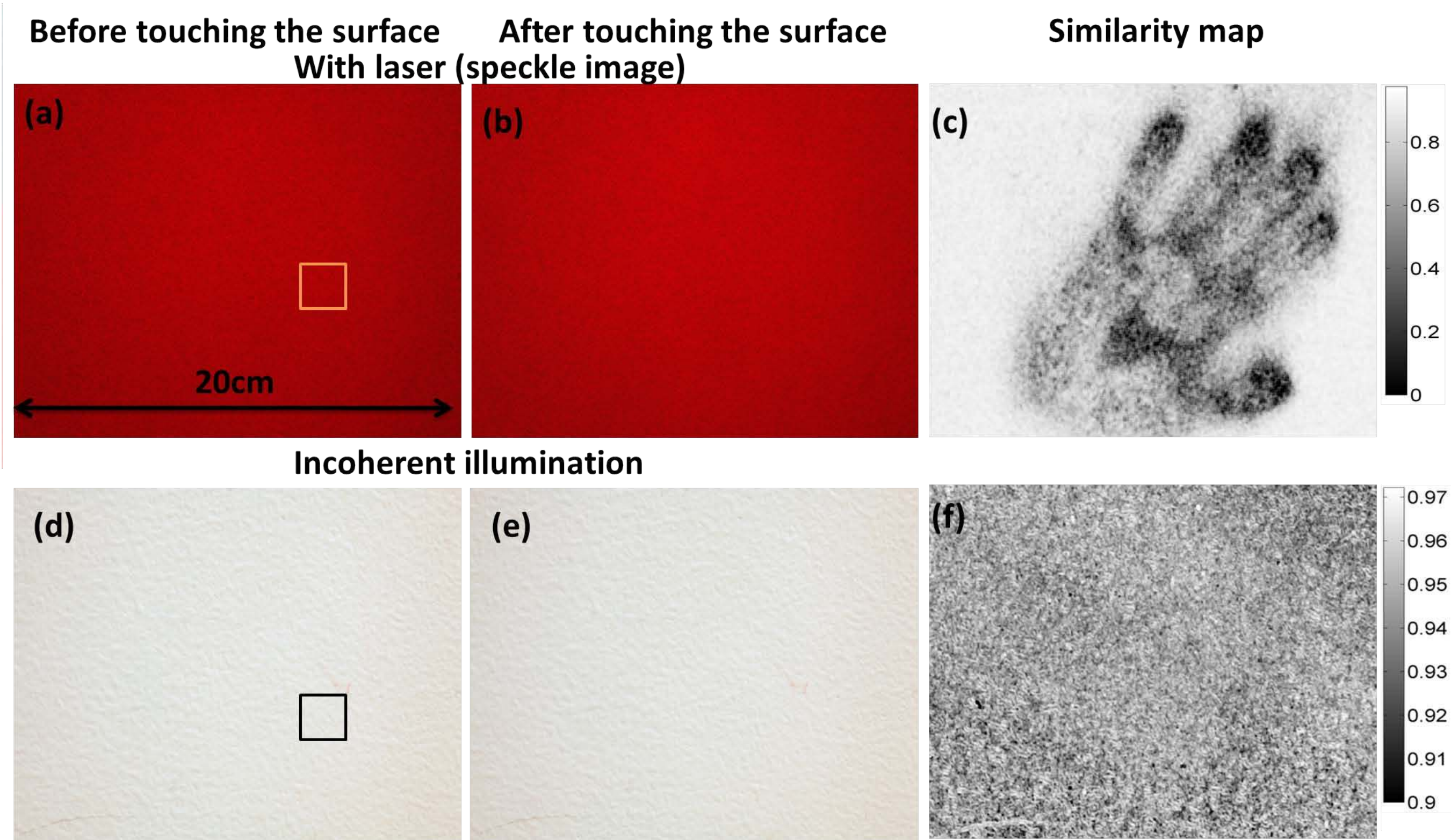
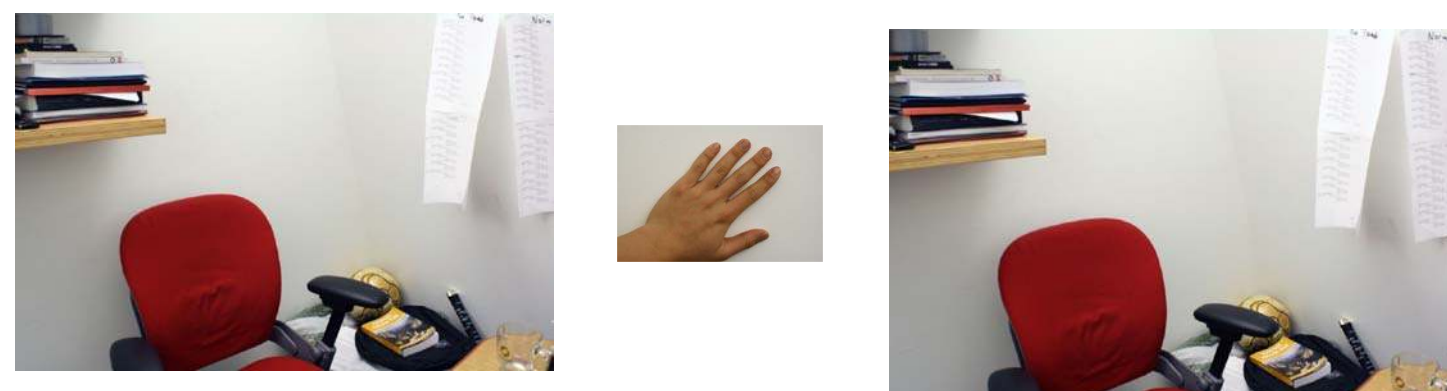
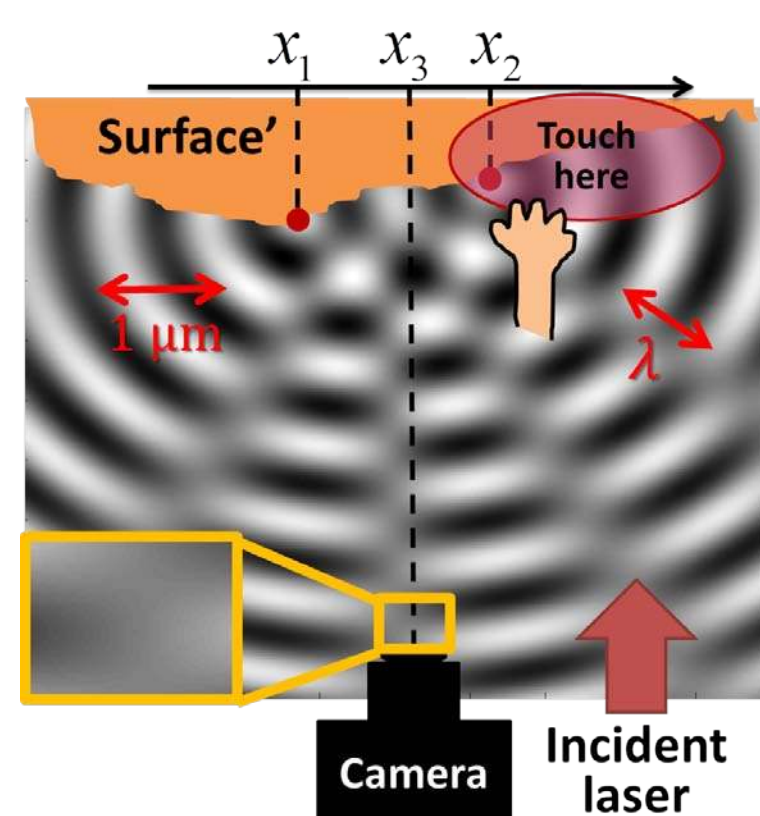


- ❖ The speckle is caused by the interference of the laser light reflected from the surface. The speckle pattern is determined by the surface micro-geometry



## Surface Tampering Detection

- ❖ When the surface is tampered (eg. touched), the surface micro-geometry is changed, and so the speckle image is changed, even the changes are very small.
- ❖ We take before and after speckle images of the surface to detect subtle change. Someone touched the surface between the two speckles.

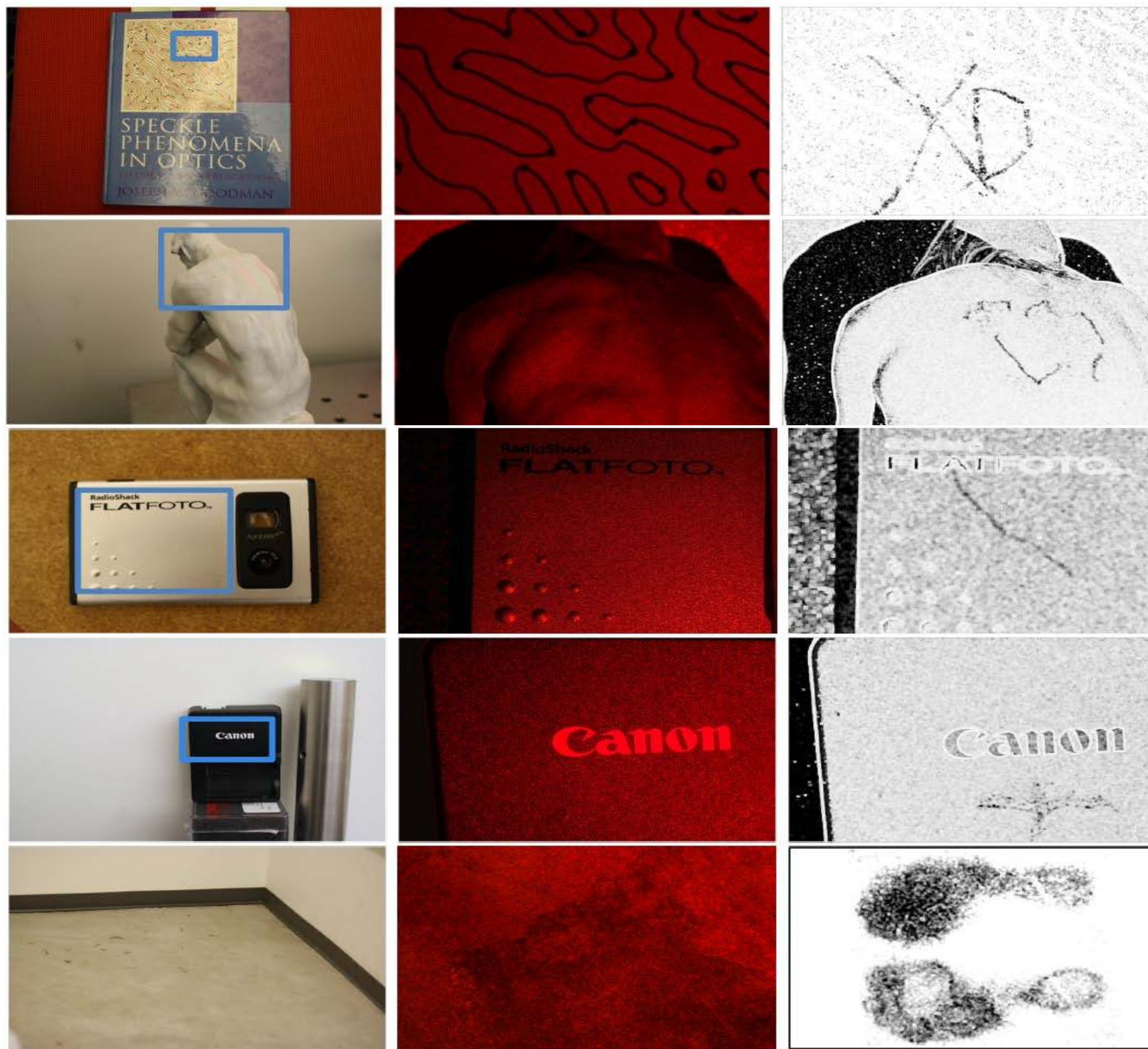


- ❖ We visualize the tampered region by correlating the two speckle images

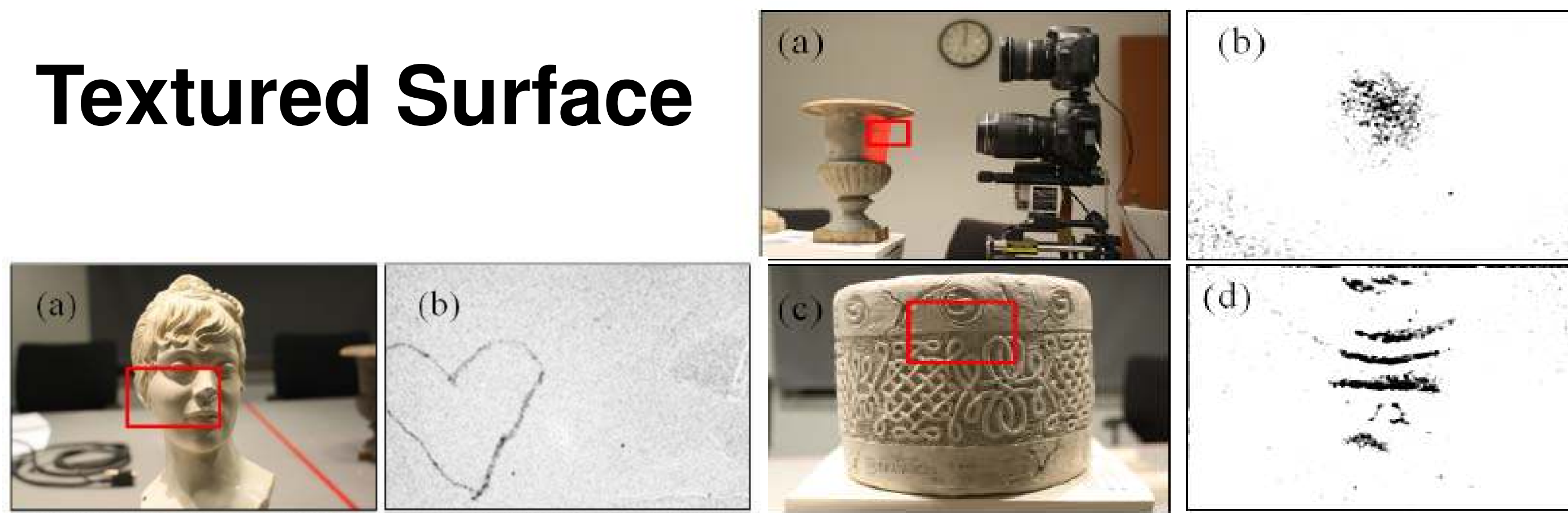
$$S(i, j) = NCC(W(i, j)I_{tar}, W(i, j)I_{ref, w})$$



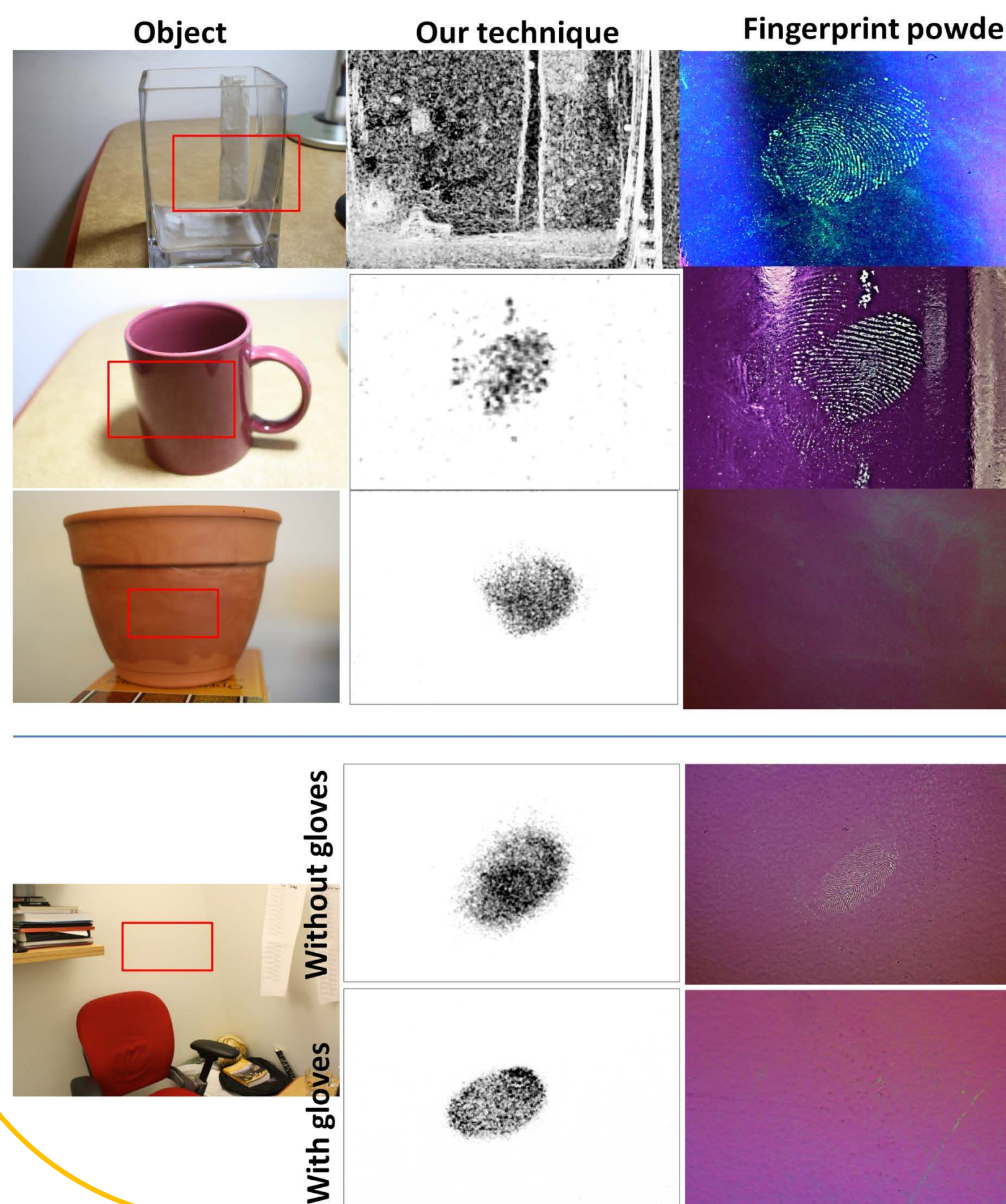
## Works on Various Kinds of Materials



## Textured Surface



## v.s. Forensic Technology



## Acknowledgement

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