3D image reconstruction with Fourier transform

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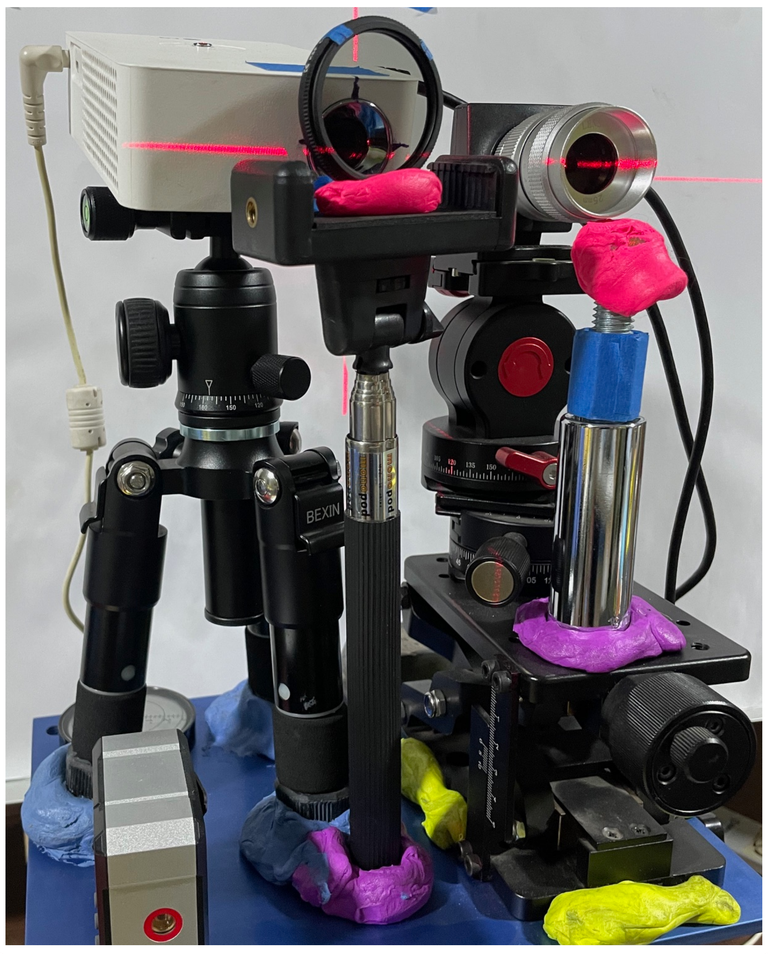
Problem

The Fourier transform is a fundamental tool in image analysis and processing, particularly when dealing with projected stripe patterns on three-dimensional objects. When a stripe pattern is projected onto an object's surface, the deformation of these stripes directly encodes the object's topography. However, the image captured by a camera contains complex information, where the stripes are mixed with lighting variations and noise.

By applying the Fourier transform to this image, it becomes possible to separate the frequency components corresponding to the projected stripes from the rest of the information. This allows the isolation of the signal that encodes stripe deformation, which is directly related to the height and relief of the object. Subsequently, through filtering and phase analysis techniques, one can accurately calculate the lateral displacement of each stripe, converting the two-dimensional camera information into a three-dimensional depth map of the object.

This approach is particularly valuable in applications where precision and non-invasiveness are critical, such as industrial inspection, biomedical modeling, or complex surface reconstruction. While the technique requires careful handling of artifacts and noise, the ability to transform a simple 2D image into a detailed 3D model makes it a powerful and widely used tool in modern computer vision and pertfilometry.

Experimental arrange



Affiliations

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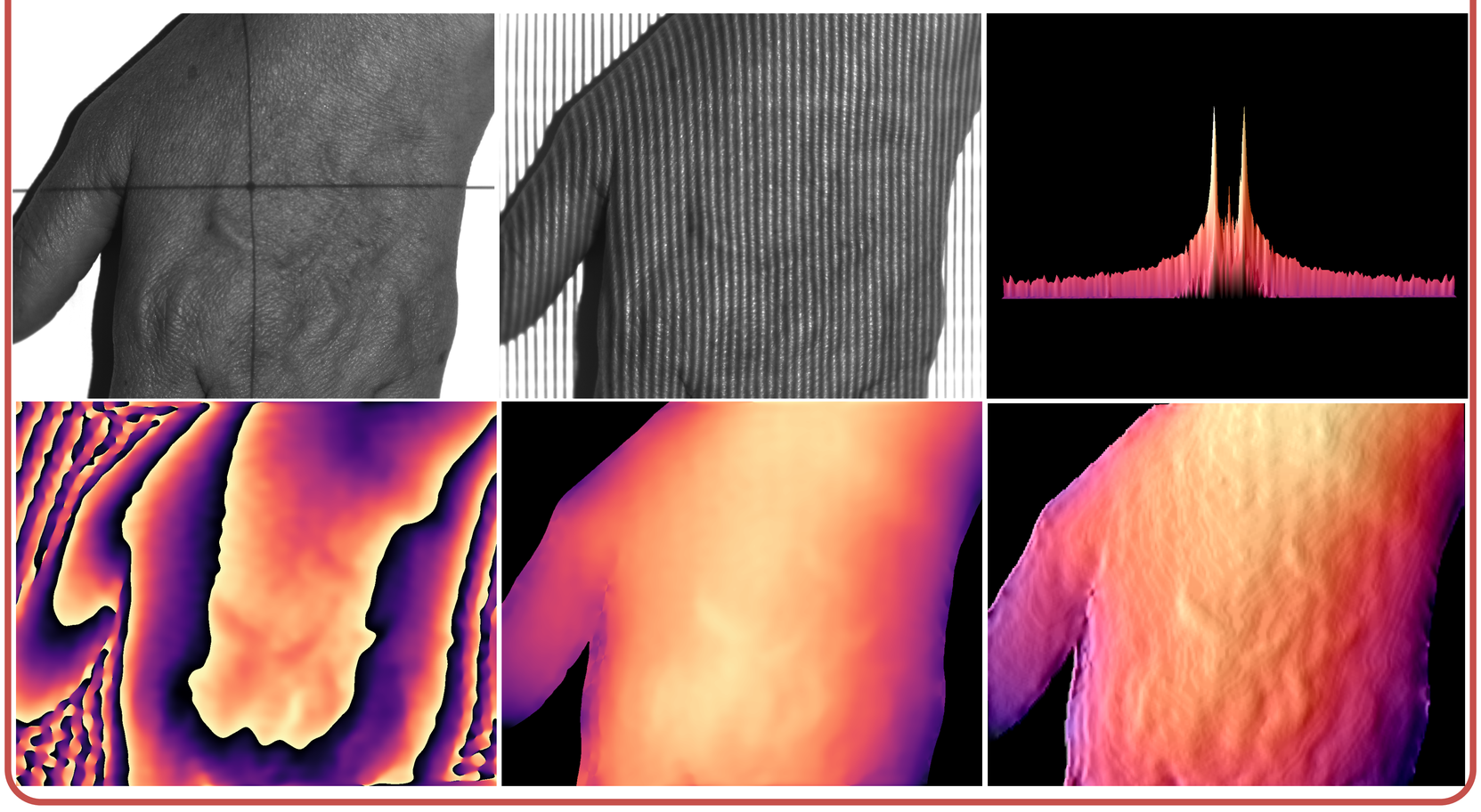
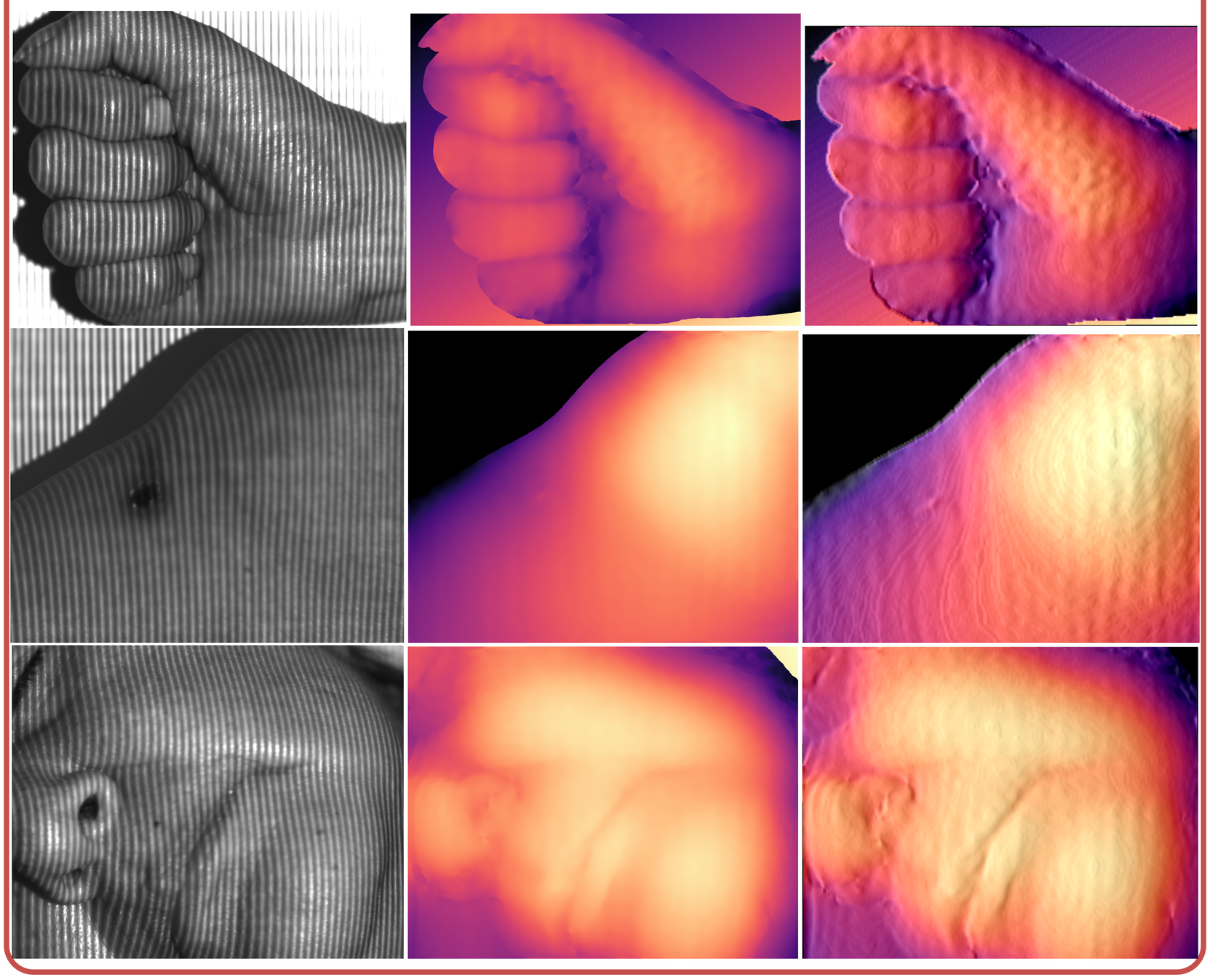
Method



Fourier processing



Conclusions

This approach is particularly valuable in applications where precision and non-invasiveness are critical, such as industrial inspection, biomedical modeling, or complex surface reconstruction. While the technique requires careful handling of artifacts and noise, the ability to transform a simple 2D image into a detailed 3D model makes it a powerful and widely used tool in modern computer vision and perfilometry.

References

[1] Mitsuo Takeda, Hideki Ina and Seiji Kobayashi, *Fourier-transform method of fringe-pattern analysis for computer-based topography and interferometry*, J. Opt. Soc. Am. **72**, 156, (1982).

[2] Dennis C. Ghiglia and Mark D. Pritt, *Two-Dimensional Phase Unwrapping: Theory, Algorithms, and Software*, 1st Edition, Wiley-Interscience, New York (1998).