Comparative study of cost effective laser and DLP projectors for fringe projection

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Abstract

Commercially available projectors are subject to gamma non-linearity, lack of depth-of-focus (DOF), system vibration and noise which distort the fringe patterns and introduce significant errors in the phase measurement. In this work, we will compare a low-cost DLP and a laser projector in terms of gamma performance and DOF, and assess which projector type performs better for fringe projection applications. Our study finds that the focus-free eye-safe laser projector provides more consistent high-quality sinusoidal patterns and has a much longer DOF and is, therefore, recommended for practical implementation in fringe projection systems.

Methodology

Gamma-correction:

- Laser (Laser Beam Pro, C-200) projector
- DLP (ICODIS-G1 Mini) projector
- Raspberry-Pi camera
- Software for data acquisition

DOF:

- A camera-projector assembly
- Checkerboard pattern
- Rail
- Software for image processing

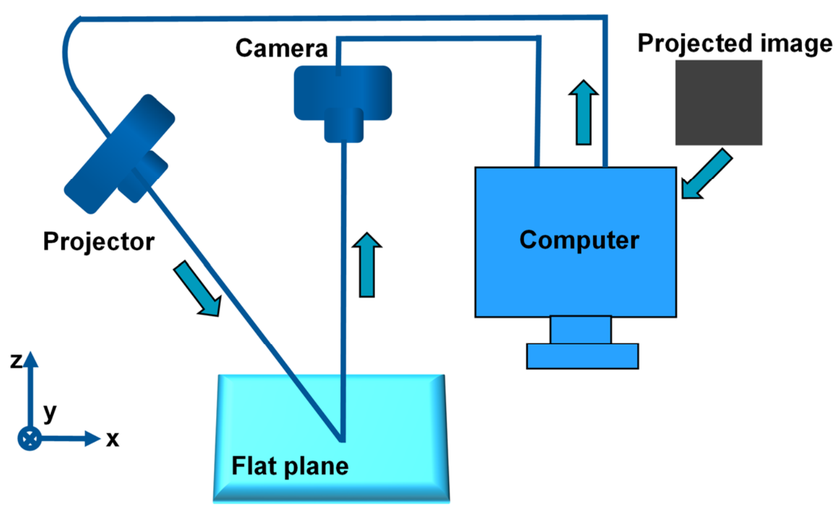

Fig. 1 Schematic diagram of the gamma-correction

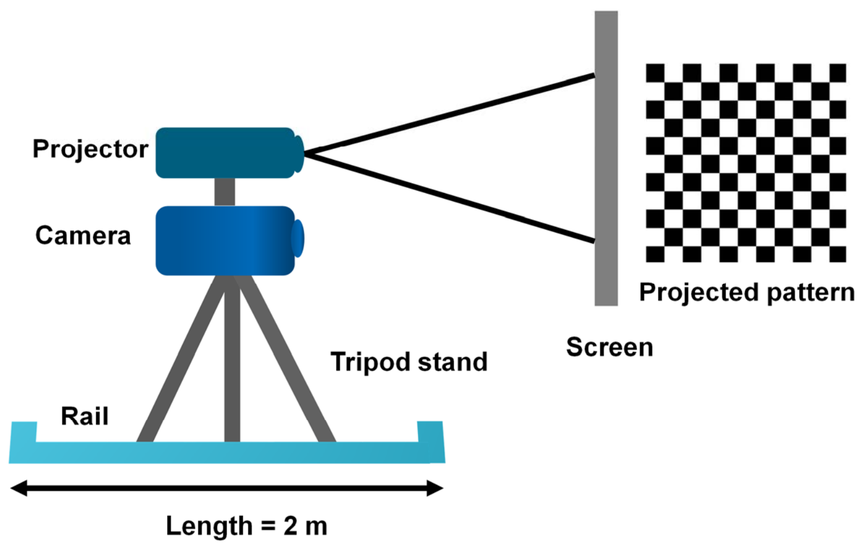

Fig. 2 Schematic illustration of DOF

Results

A lookup table is used to compensate for the non-linear sinusoidal behaviour of the fringes. The gamma curve is acquired by projecting multiple grayscale values on an imaging target and capturing by a camera. The DOF is measured by determining the maximum of the Fourier transform of the region-of-interest.

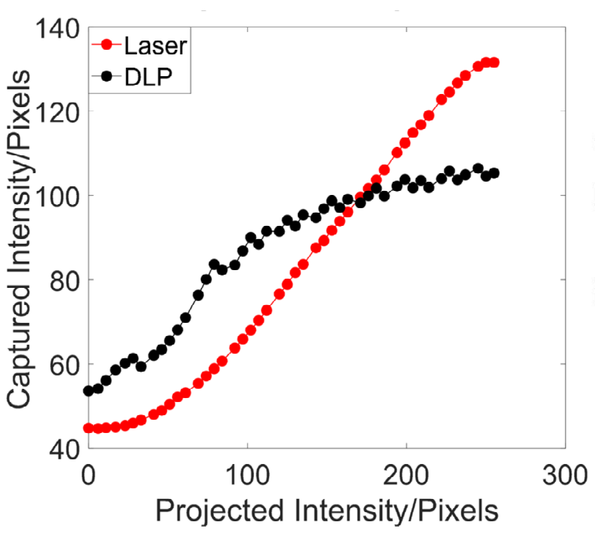

Fig. 3 Comparison of gamma curves

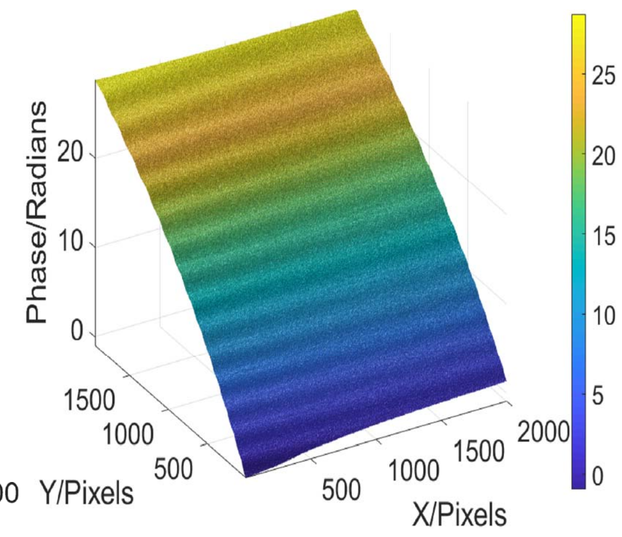

Fig. 4 Phase image of a flat plane before gamma-correction (laser)

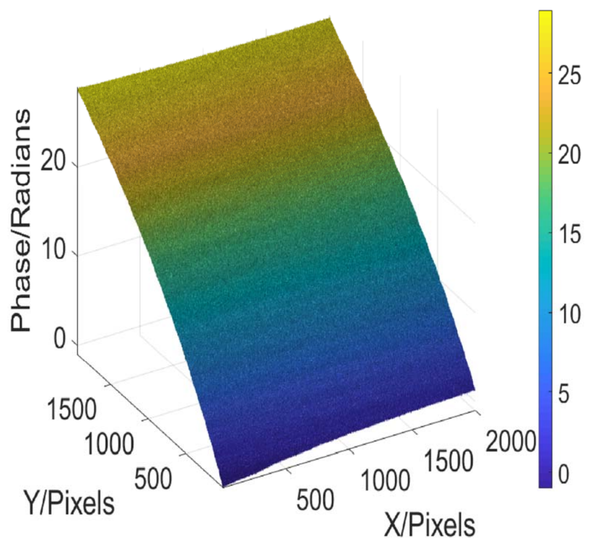

Fig. 5 After gamma-correction (laser)

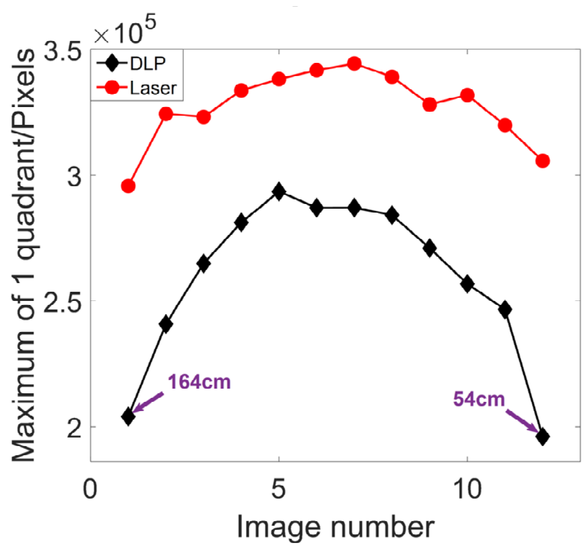

Fig. 6 Comparison of DOF

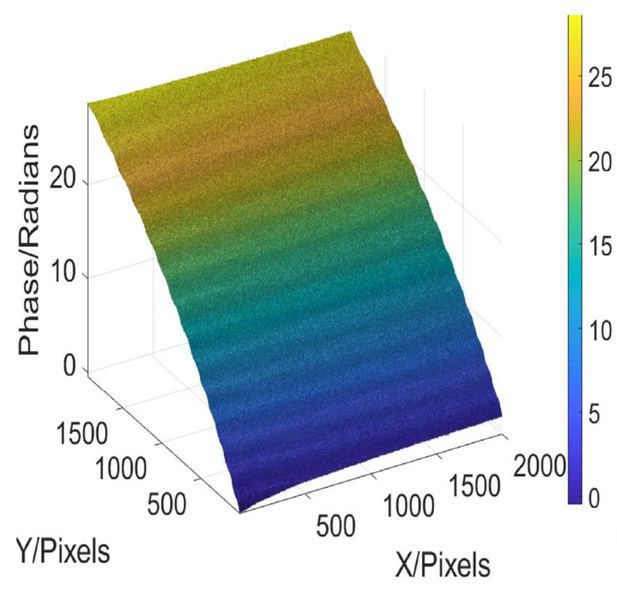

Fig. 7 Phase image before gamma-correction (DLP)

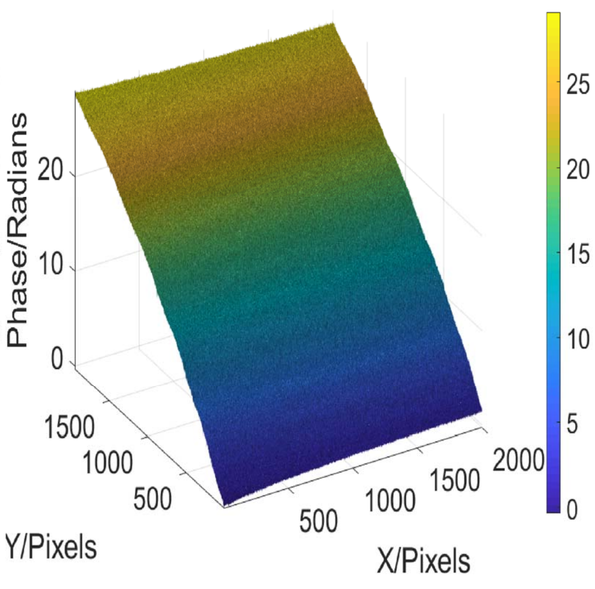

Fig. 8 After gamma-correction (DLP)

Conclusions

The laser projector has the following upsides,

- Eye-safe class-1 laser
- Focus free
- Longer DOF
- Requires less gamma correction
- Outperforms a DLP projector
- Recommended in high-speed 3D applications

Future work

- Integrating the a-priori information and fusion of different optical techniques
- Sources of error
- Calibration
- Traceability
- Ultimately, designing a high-speed 3D optical imaging system

Acknowledgements

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