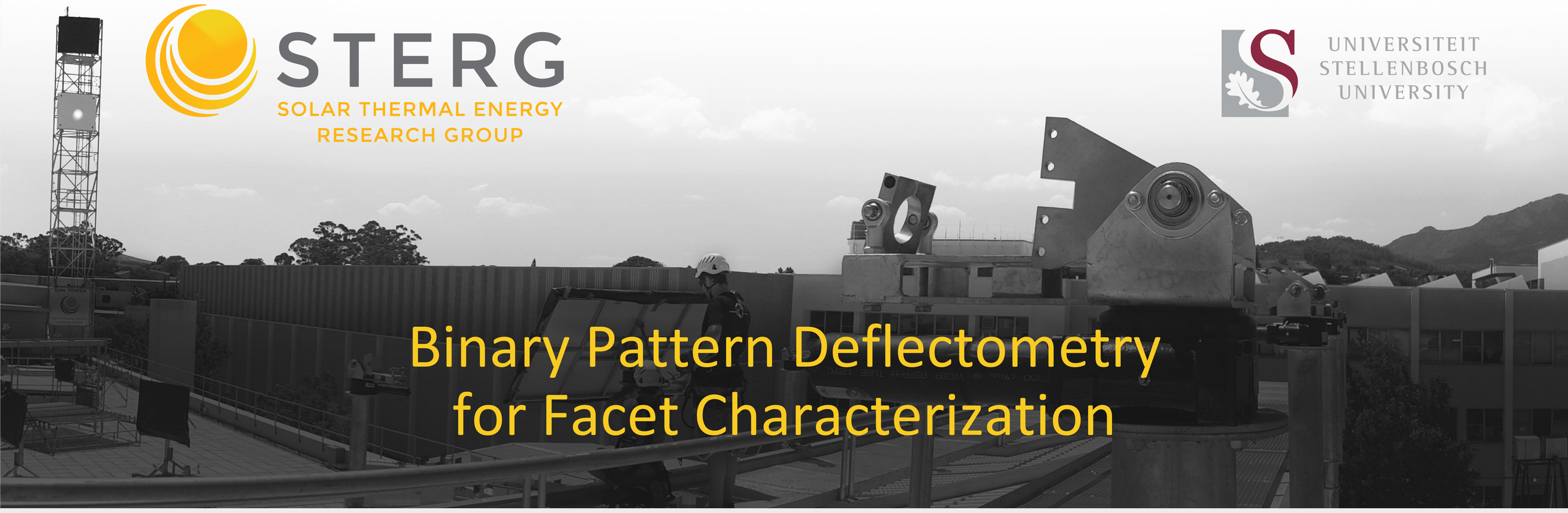

Binary Pattern Deflectometry for Facet Characterization

JANTO DREIJER, WILLEM A. LANDMAN, KAREL MALAN, PAUL GAUCHÉ

SOLAR THERMAL ENERGY RESEARCH GROUP (STERG), STELLENBOSCH UNIVERSITY, SOUTH AFRICA

INTRODUCTION

A deflectometry system has been built in a shared workshop environment to characterize small heliostat facets. The system can function in a room with multiple light sources, including a large roller door which allows light from outside. To solve the problem of multiple light sources, instead of fringe patterns, we implement a varying binary pattern to determine the mapping between pixels on the screen and the camera image.

BACKGROUND

- Deflectometry uses Snell's law of reflectivity to derive normal directions on a facet from the path a ray of light travelling from a screen to a camera via reflection of the facet.
- Varying sinusoidal fringe patterns are commonly used to determine mapping between the projected screen image and received camera image. The mapping is then combined with knowledge of the position and orientation of the camera, facet and screen to determine local normal directions on the facet.
- Fringe patterns are robust against linear changes in grayscale intensity. There are, however, non-linear effects on the pixel intensity, e.g. due to limited dynamic ranges of the projector and camera, and non-linear interactions from the propagation from the projector to the camera. A radiometric calibration stage is usually necessary where a viable grayscale range is determined and a simplified transformation is estimated to compensate for any non-linear effects.
- Due to the radiometric calibration, these fringe patterns are sensitive to environmental changes and typically require a dark room or night-time operation.

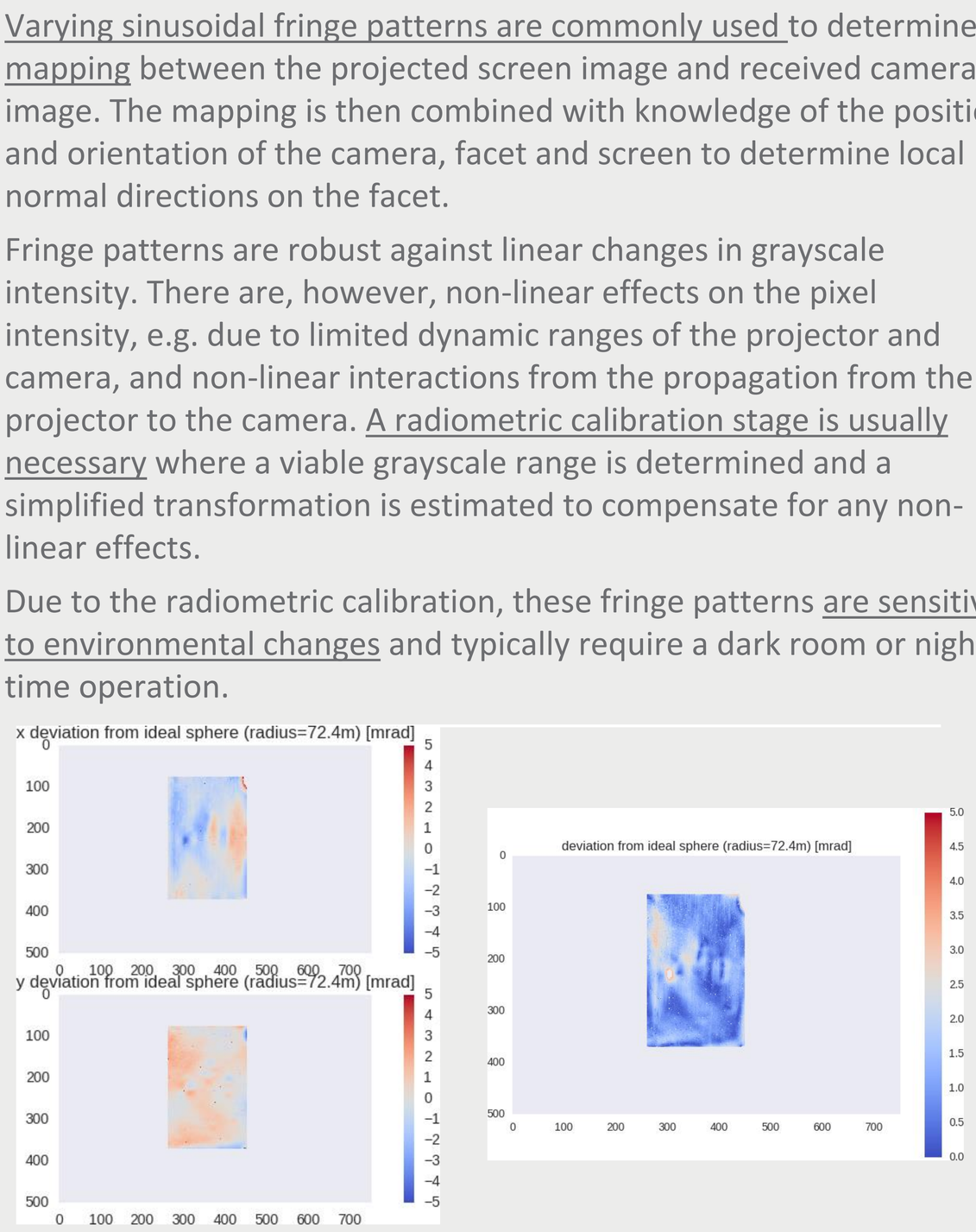

Fig. 1. Example system output: x and y surface normal deviation from ideal

PROJECTED BINARY PATTERN

- We constructed a deflectometry system where, instead of grayscale fringe patterns, only black and white pixels are projected onto a screen.
- Pixel indices are binary encoded. E.g. pixel with horizontal index 123 is encoded as 01111011 base 2.
- Successive images are projected with each pixel value representing a bit in the pixel's encoding. E.g. pixel with horizontal index 123 has value 0 (black) in first image, 1 (white in second), 1 in third, etc.
- Process is repeated for vertical component. A threshold is applied on the grayscale image to convert back to binary. Indices are decoded back from the received binary sequences. Transmitted and received indices are used for pixel mapping in typical way to determine surface normals.
- Requires log(M)+log(N) projected encoded images and two images to determine threshold (a fully black and a fully white image).

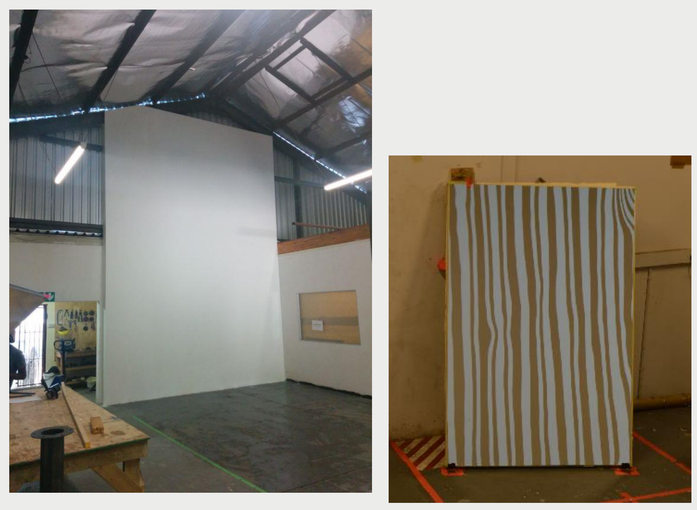

Fig. 2. Projector screen in workshop and facet with reflected binary pattern

CONCLUSION

Binary patterns require slightly more images, but does not require a complex calibration stage. These binary patterns are more robust against non-linear local and global lighting changes. The resulting deflectometry system therefore allows a more flexible installation environment. Our system is constructed in a workshop with a shared floorspace.

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CONTACT

concentrating.sun.ac.za

janto@sun.ac.za | Tel: +27 (0)21 808 4016

Solar Thermal Energy Research Group • Department of Mechanical and Mechatronic Engineering • Stellenbosch University • Private Bag X1, Matieland 7602, South Africa