bias

Bremer Institut für
angewandte Strahltechnik GmbH

Assessment of active pattern generation with displays of non-ideal physical properties

IUP seminar 11. January 2019

Johann Rasmus Nüß
Supervisor: Jonas Bartsch

Outline

- Visual perception of non-specular and specular surfaces
- Shape measurements of specular surfaces → Deflectometry
- Active patterns
- Considered properties of LCDs
  - Shape deviations
  - Cover glass
  - Pixelation and finite color depth
  - Intensity characteristics

Perception of non-specular surfaces

- Compression of texture → Slope → Shape

blog.fotolia.com, 16.11.2017

Perception of specular surfaces

- Quasi-invisible
- Compression of image of surroundings → Curvature → Shape
- Surroundings unknown, still obviously sphere

tagesschau.de, 16.11.2017

Shape measurement of specular surfaces

- Assumption: known surroundings (pattern)
- Calculate Shape from distortion of image

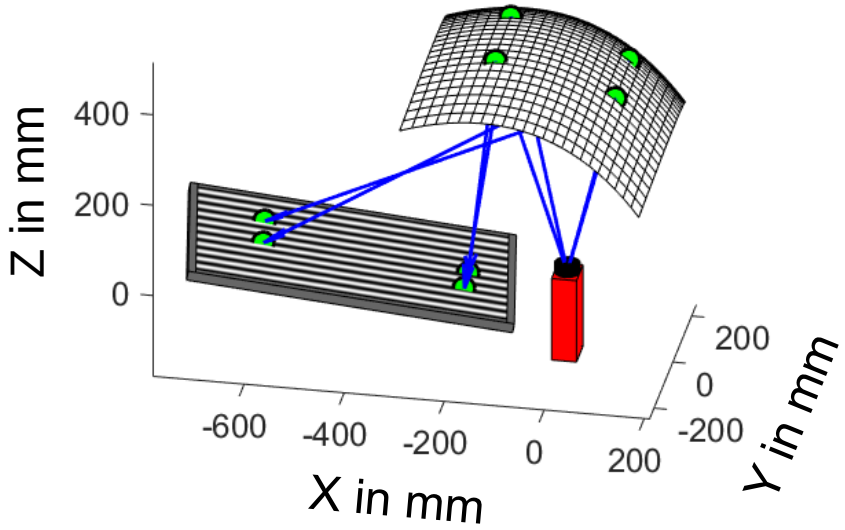
  → Requires high computational cost

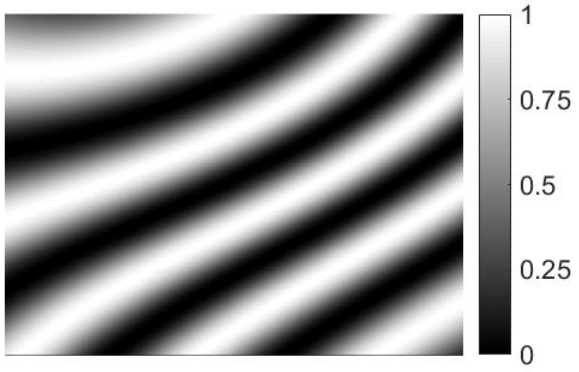
  → Offers high precision
- Technique: “Deflectometry”

Deflectometry

- Approach:
  - Generate specific pattern with structured light source
  - Observe distorted reflection of pattern via measuring object

  ➔ Shape of object defines type of distortion
- Based purely on geometric optics
- Very scalable (microchip to airplane hull)





Active Patterns

- Generated with structured light source (i.e. LCD)
- “Active”: Displaying multiple, adapted patterns allows for elaborated sampling strategies
- Used to map positions on the source

→ Change texture of surrounding without changing the surrounding

- Advantages of LCDs as structured light sources
  - Cheap, flexible, high production accuracy

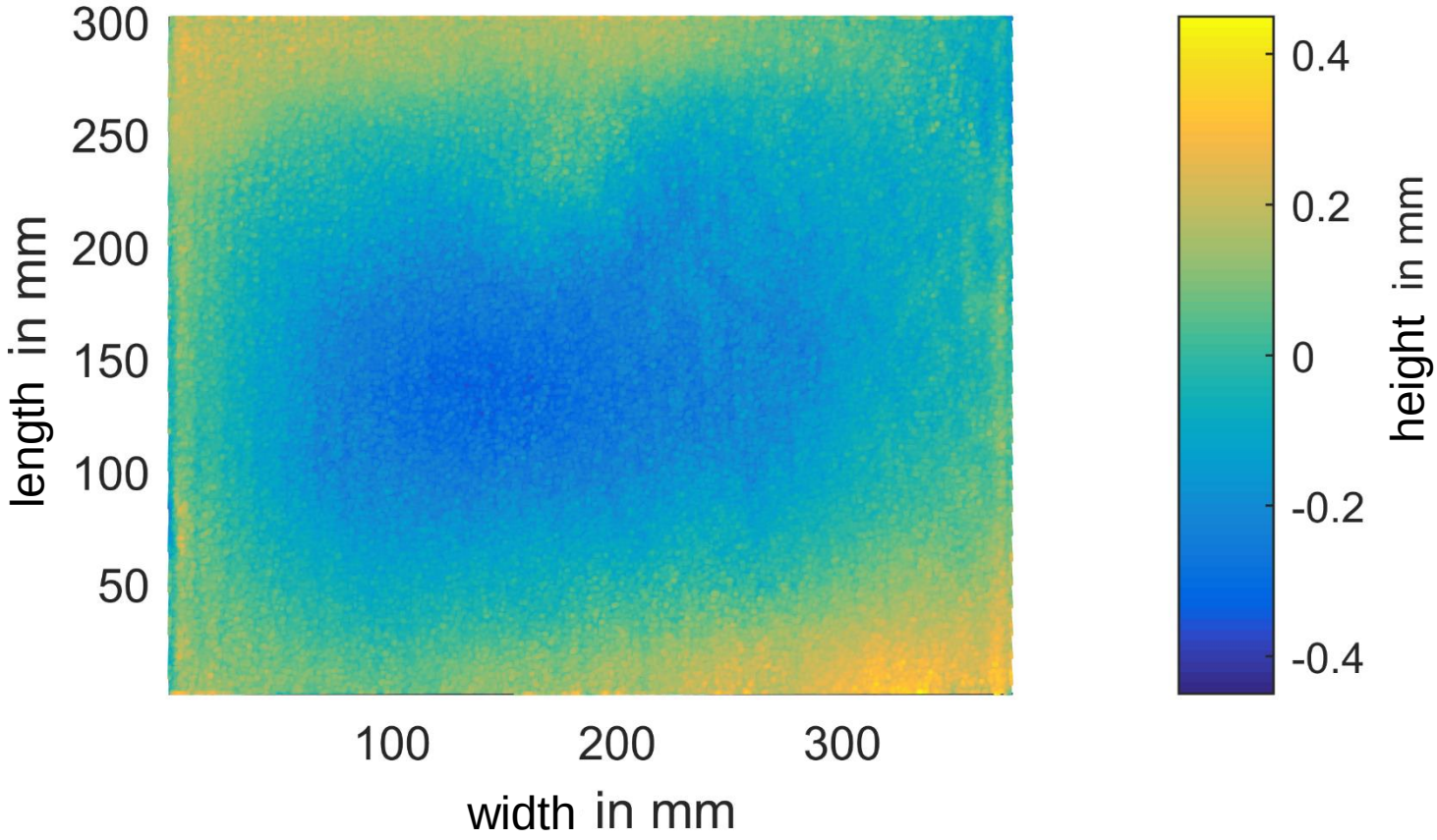
Aim of Thesis

- Aim: Identify errors introduced by displays
  - Consider non-ideal properties

Scope of thesis:

Consolidate results of previous works and create simulation tool to assess the relevance of each property

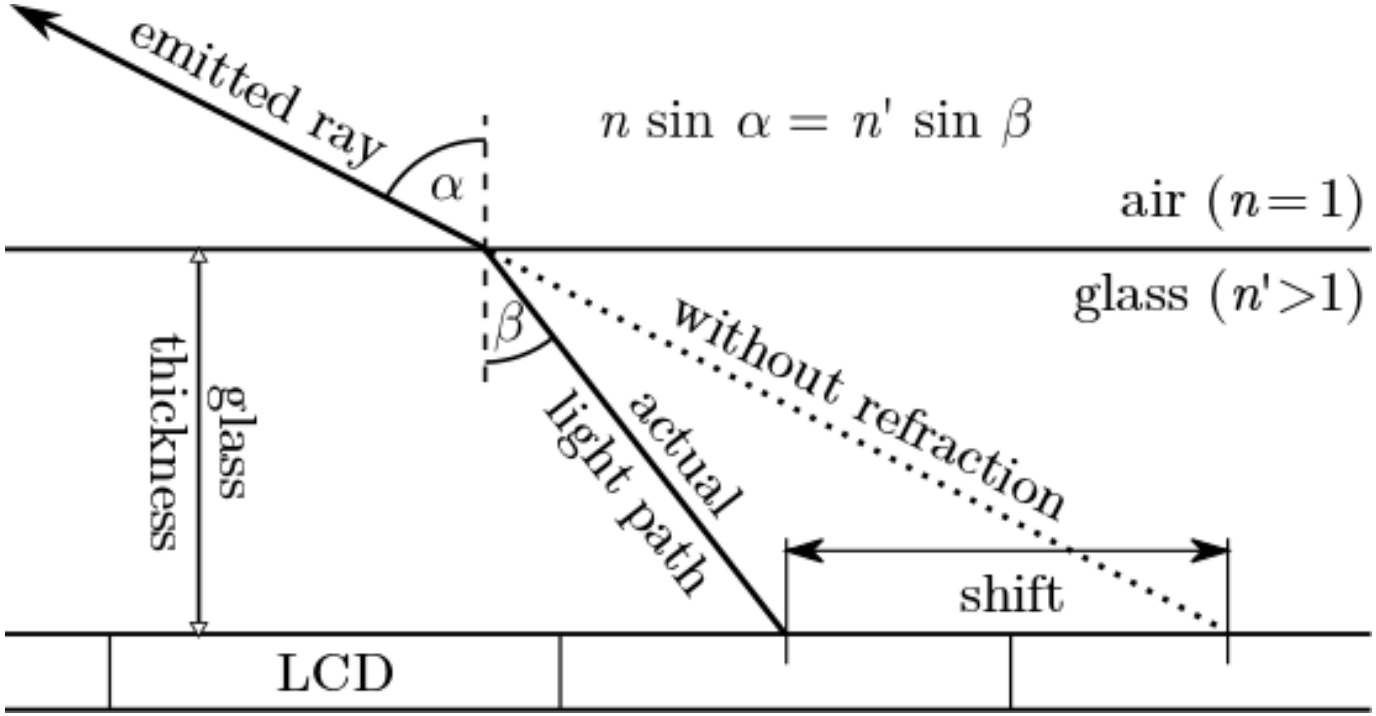
Error 1: Shape deviations



- Shape deviates in 100 µm range with low spatial frequencies

→ Measurement errors in 10-100 µm range for deflectometry

Error 2: Cover Glass



- Refraction in cover glass
- Thickness around 1 mm, refractive index around 1.5

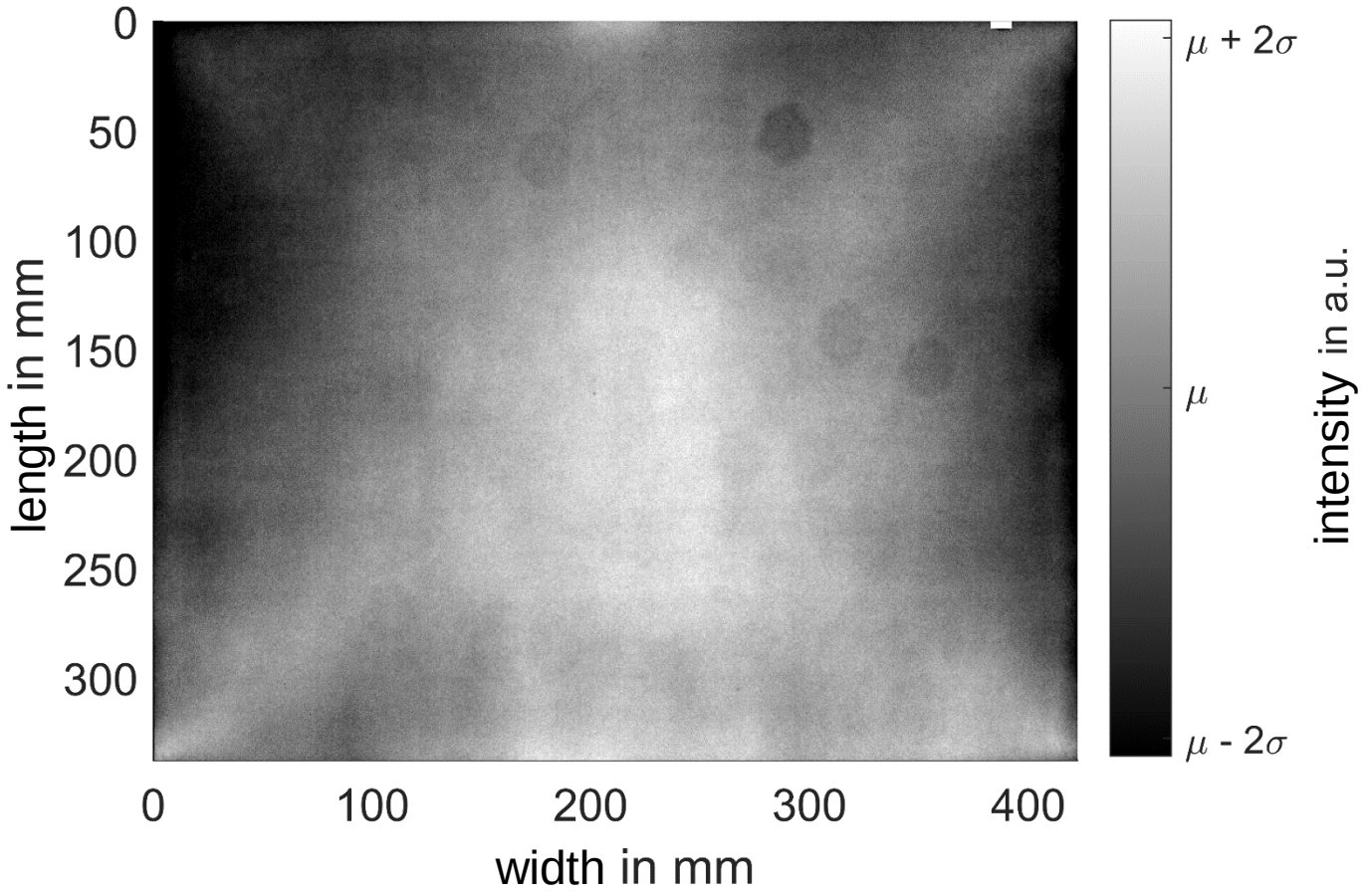
→ Measurement errors in 1-10 µm range for deflectometry

Error 3: Pixelation and finite color depth

- Limited color depth already negligible for 8-bit (256 gray values)
- Pixelation leads to moiré patterns

→ Measurement error already below 1 µm without optimization

Error 4: Intensity characteristics



- Lateral distribution and viewing-angle dependency

→ Both cause worse signal-to-noise ratio

→ Negligible if gray-value-depth of camera sufficiently high

Conclusion

- Perception of surfaces
- Shape measurements of specular surfaces with deflectometry
- Study of non-ideal properties of LCDs used as structured light sources
- Shape deviations and cover glass properties especially relevant
- Only minor influence of discrete pixels and intensity characteristics

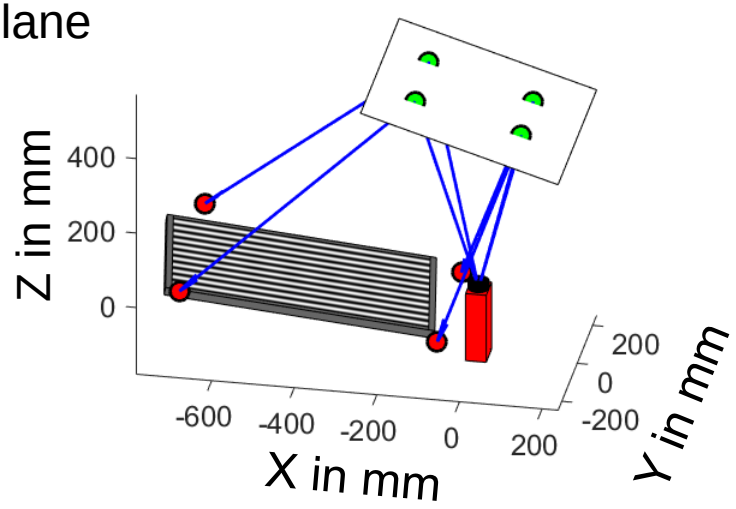
Acknowledgements

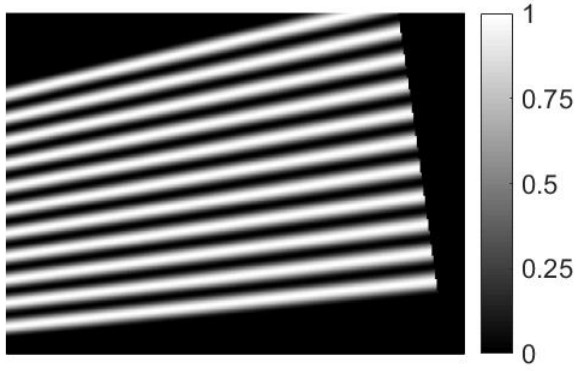
- The BIAS
- Supervisor: Jonas Bartsch, Michael Kalm
- Professor: Ralf B. Bergmann

Thank you for your attention

Examples for distortions (Simulation)

Plane





Sphere