CSF Project:
Robust Structured Light Coding for 3D Imaging in Difficult Conditions

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Acknowledgment

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- Webpage: https://www.fer.unizg.hr/3dcoding/en

Project team

- Tomislav Petković

- Tomislav Pribanić

- Antonio Vasilijević (Norwegian University of Science and Technology, AURLab)

- Simone Gasparini (INP ENSEEIHT)

- Josep Forest Collado (Universitat de Girona, ViCOROB)

- Joaquim Salvi Mas (Universitat de Girona)

- Domagoj Zoraja

- doctoral student

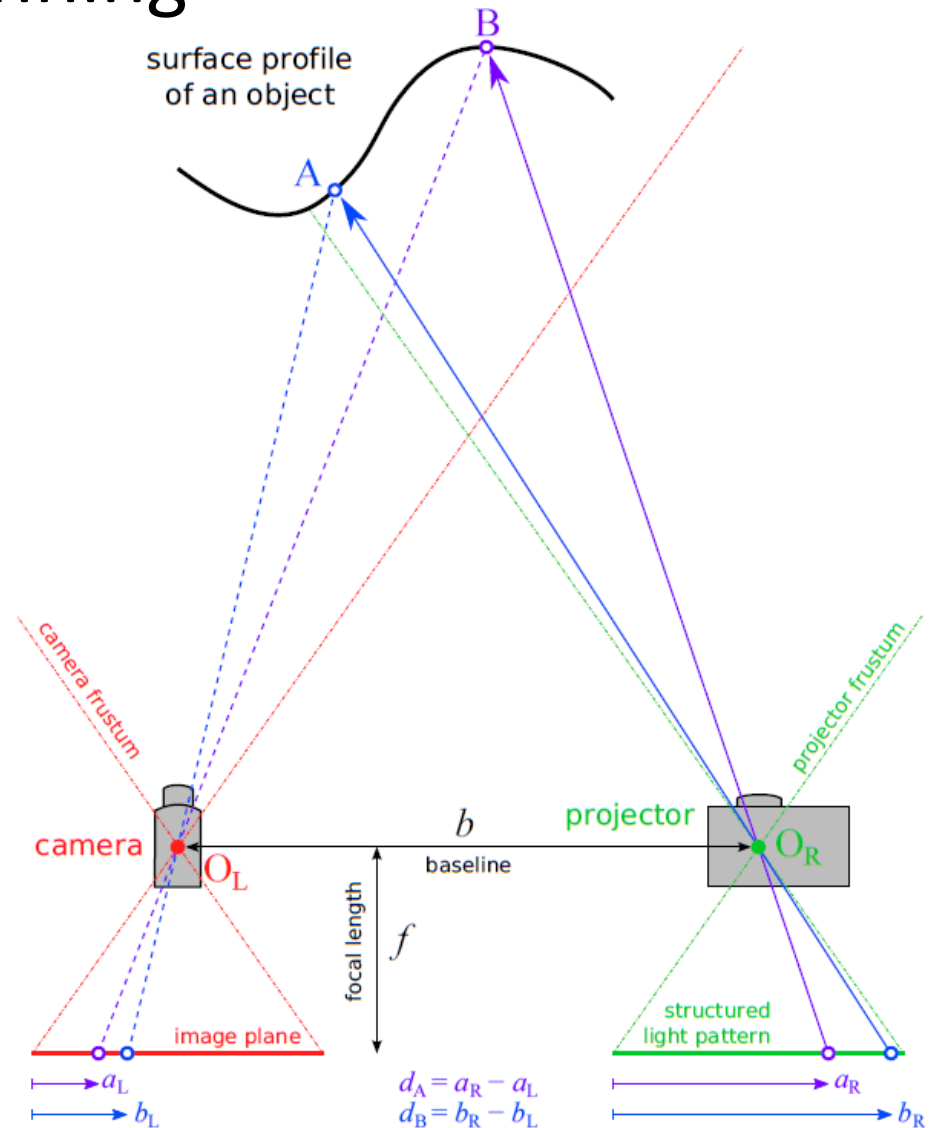- postdoctoral researcher

Open positions

- Doctoral student
  - job notice posted on October 22nd, application deadline this Friday
  - https://www.fer.unizg.hr/novosti/natjecaji/radna_mjesta?@=2udki#news_95608
- Postdoctoral researcher

- Contact e-mail: tomislav.petkovic.jr@fer.hr

Project Aim

- Practical aim:
  develop an **underwater structured light scanner**

- Many practical problems
  - water gets everywhere
  - some parts of hardware are not readily available
  - have to develop and test first in a laboratory, and then move to the field

- Also many scientific challenges
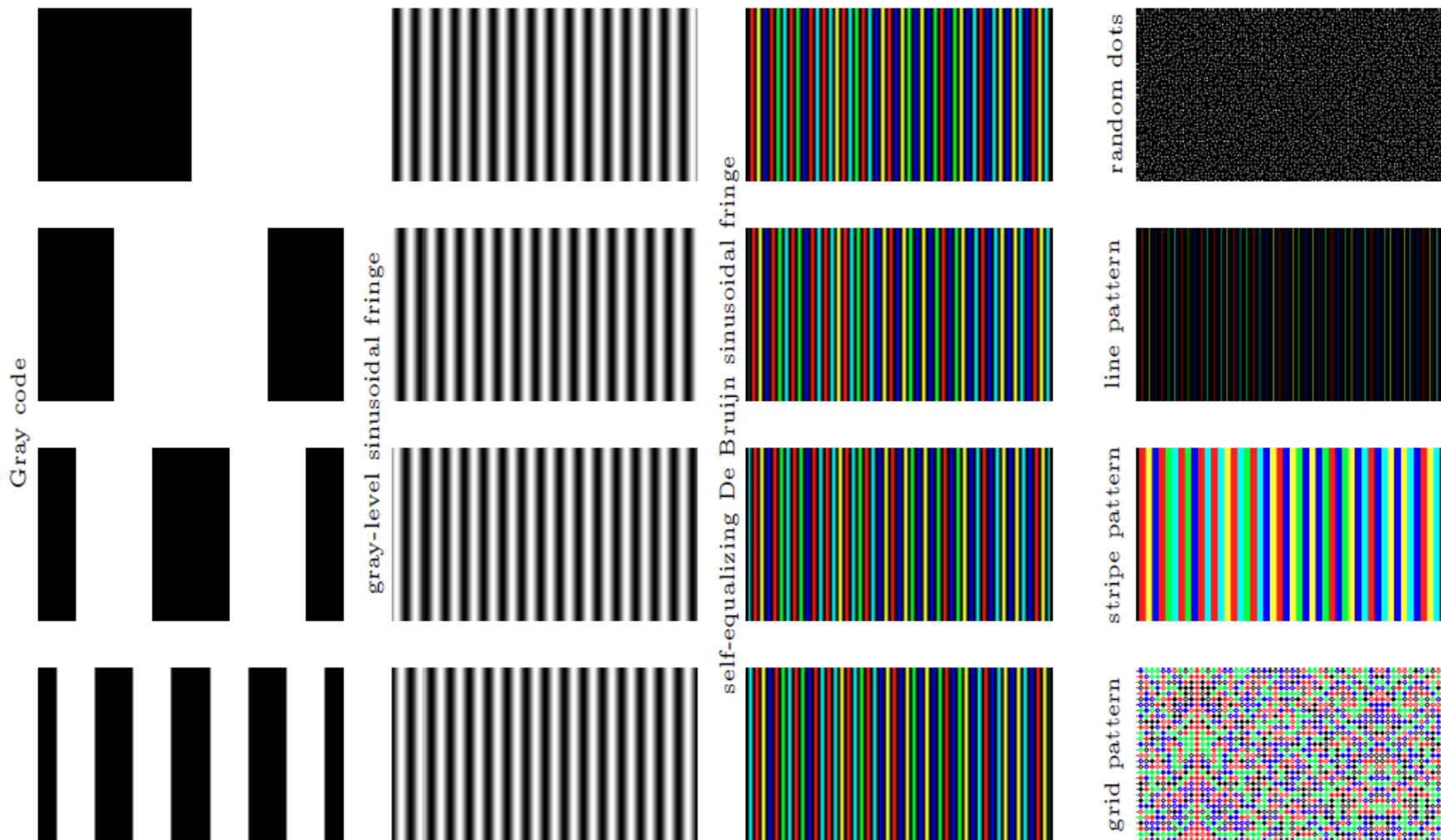 - a plus for research, a minus for project planning

Structured Light 3D Scanning

- Similar in principle to stereo vision
- One camera is replaced by a projector
  - finding corresponding points is simplified
  - can image textureless objects
  - calibration is more difficult

- What are difficult conditions?
  - outdoor imaging gives unpredictable ambient illumination
  - underwater imaging adds additional complexity

surface profile of an object

B

A

camera frustum

projector frustum

camera O_L

projector O_R

b

baseline

focal length f

image plane

structured light pattern

a_L
b_L

$d_A = a_R - a_L$
$d_B = b_R - b_L$

a_R
b_R

Structured light patterns

Multi-shot SL patterns

Single-shot SL patterns

Gray code

gray-level sinusoidal fringe

self-equalizing De Bruijn sinusoidal fringe

random dots
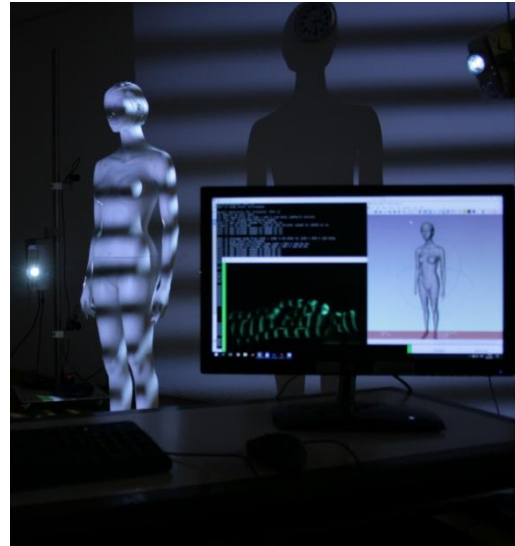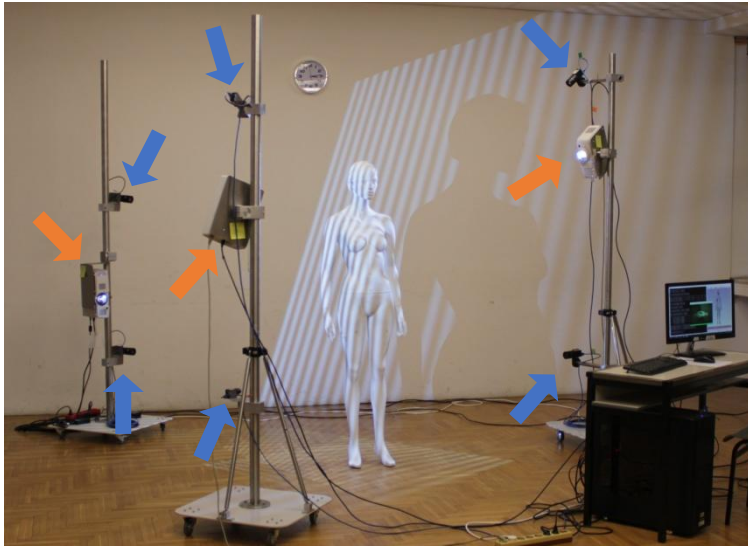
line pattern

stripe pattern

grid pattern

Research question:
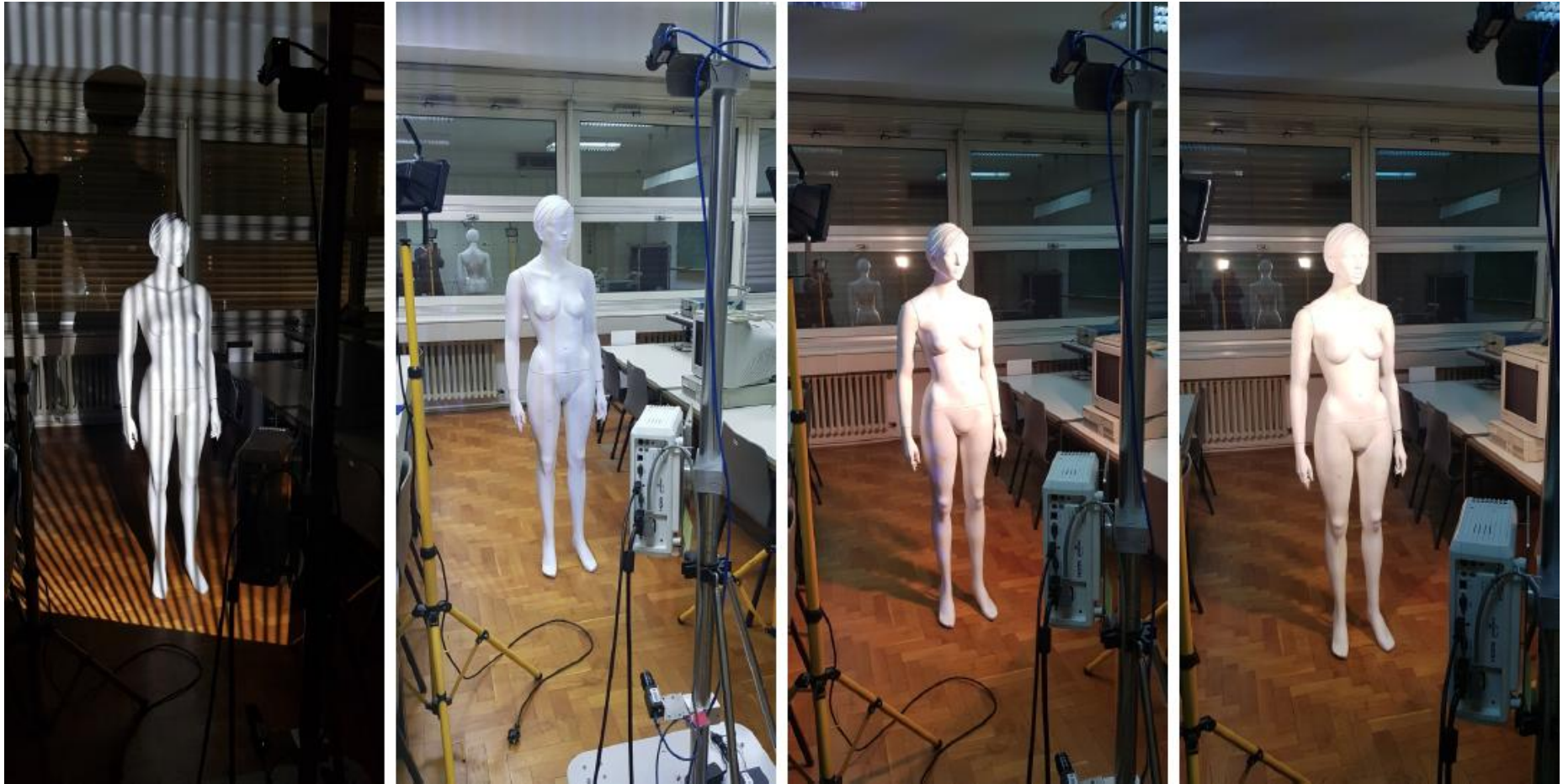# What are the optimal coding functions?

- Structured light is an active vision approach
- We have to design the pattern which is projected
- Design must be application specific
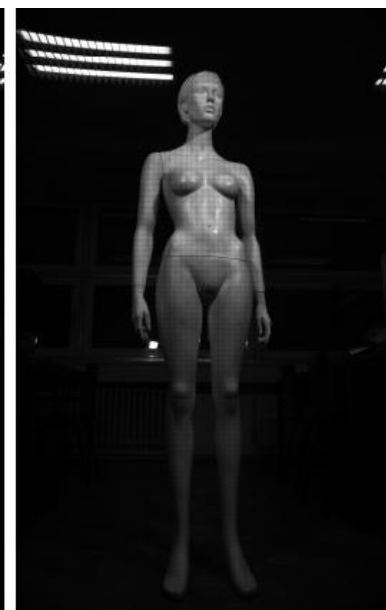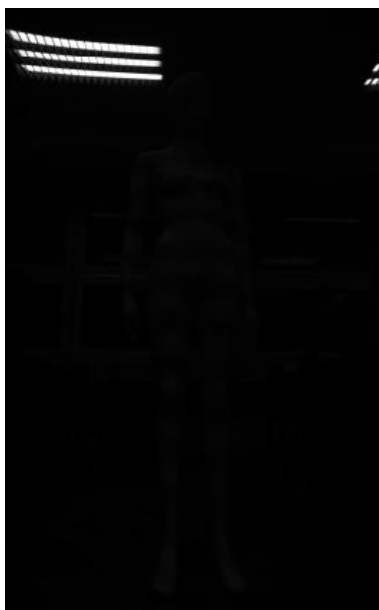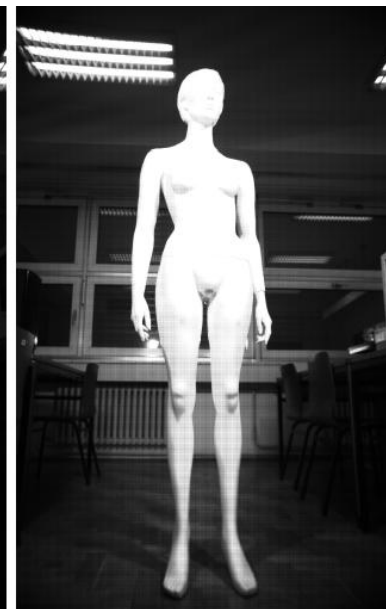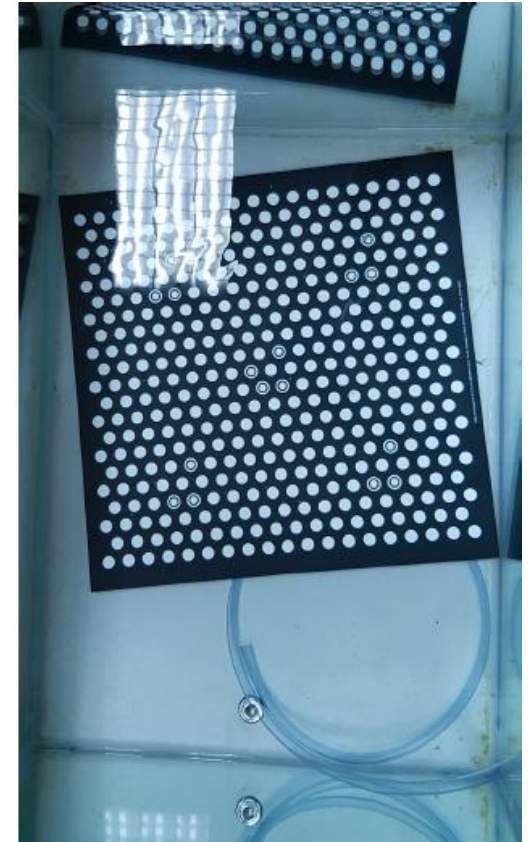- Pattern must provide for a robust scanning

Prior work

Robust Structured Light Coding for 3D Imaging in Difficult Conditions
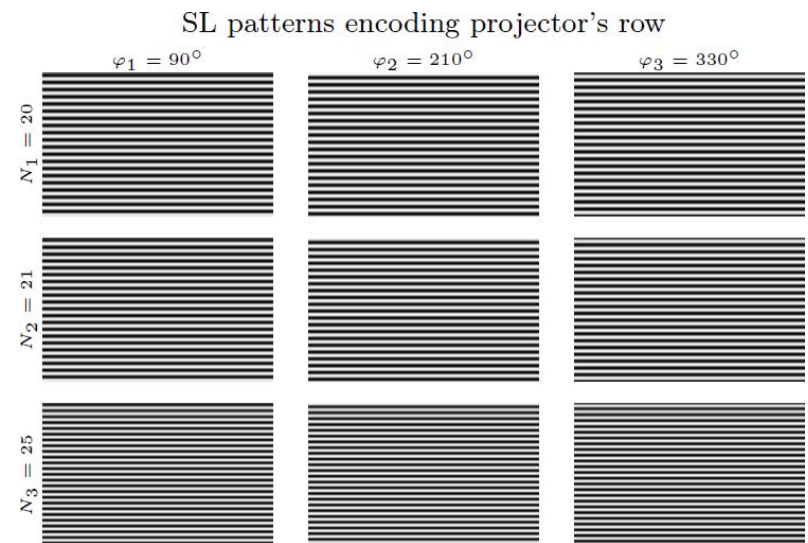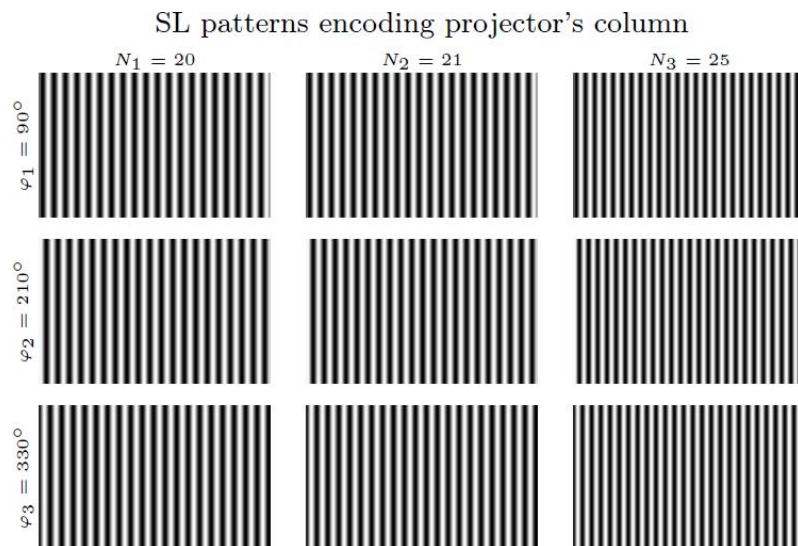
Outdoor scanning indoors?

What does the camera see?

Robust Structured Light Coding for 3D Imaging in Difficult Conditions

Underwater scanning

Robust Structured Light Coding for 3D Imaging in Difficult Conditions
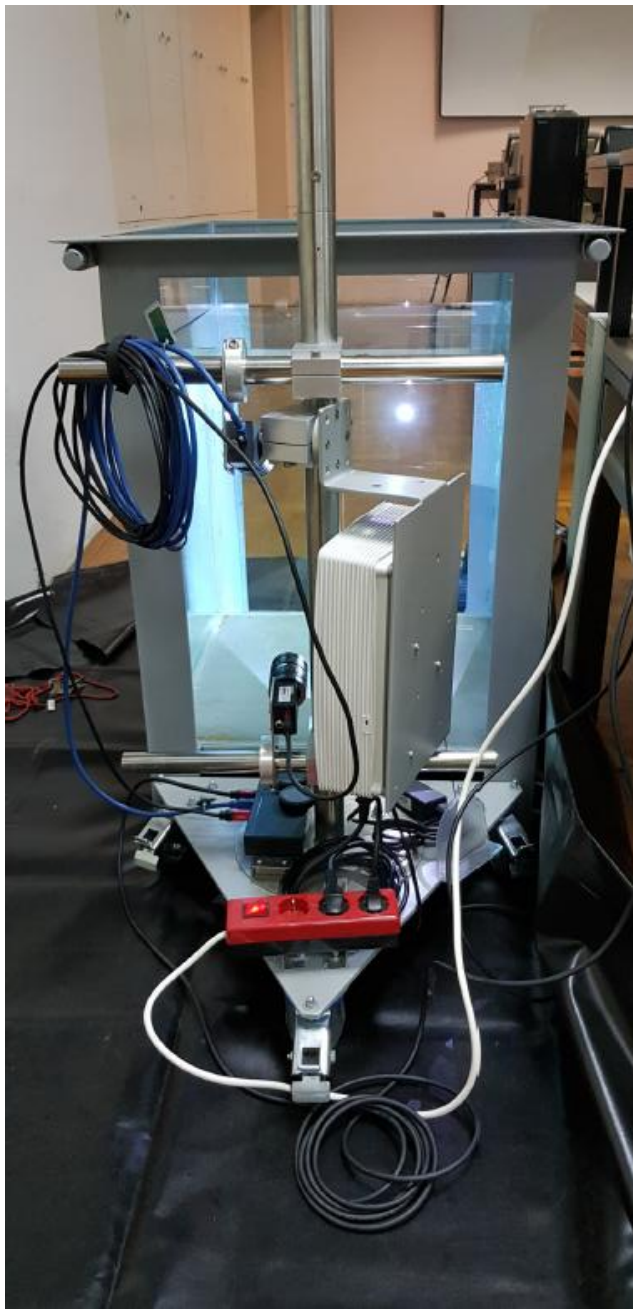
Normal conditions: cystal clear water
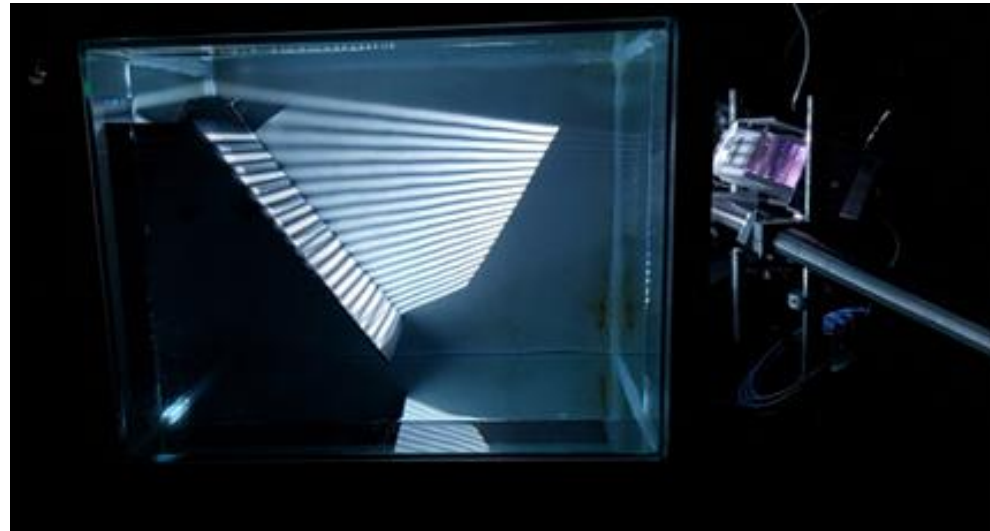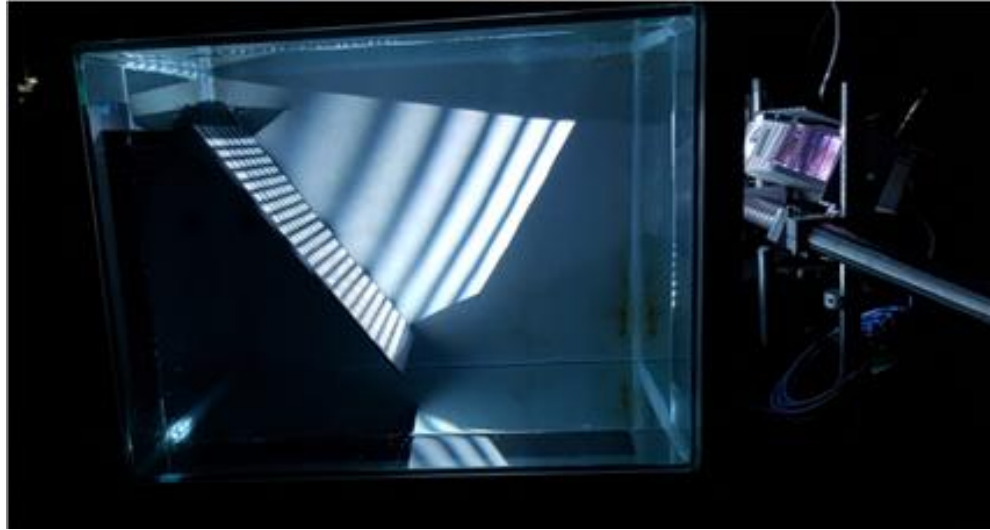
Decoding projected MPS code

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Calibration

Robust Structured Light Coding for 3D Imaging in Difficult Conditions
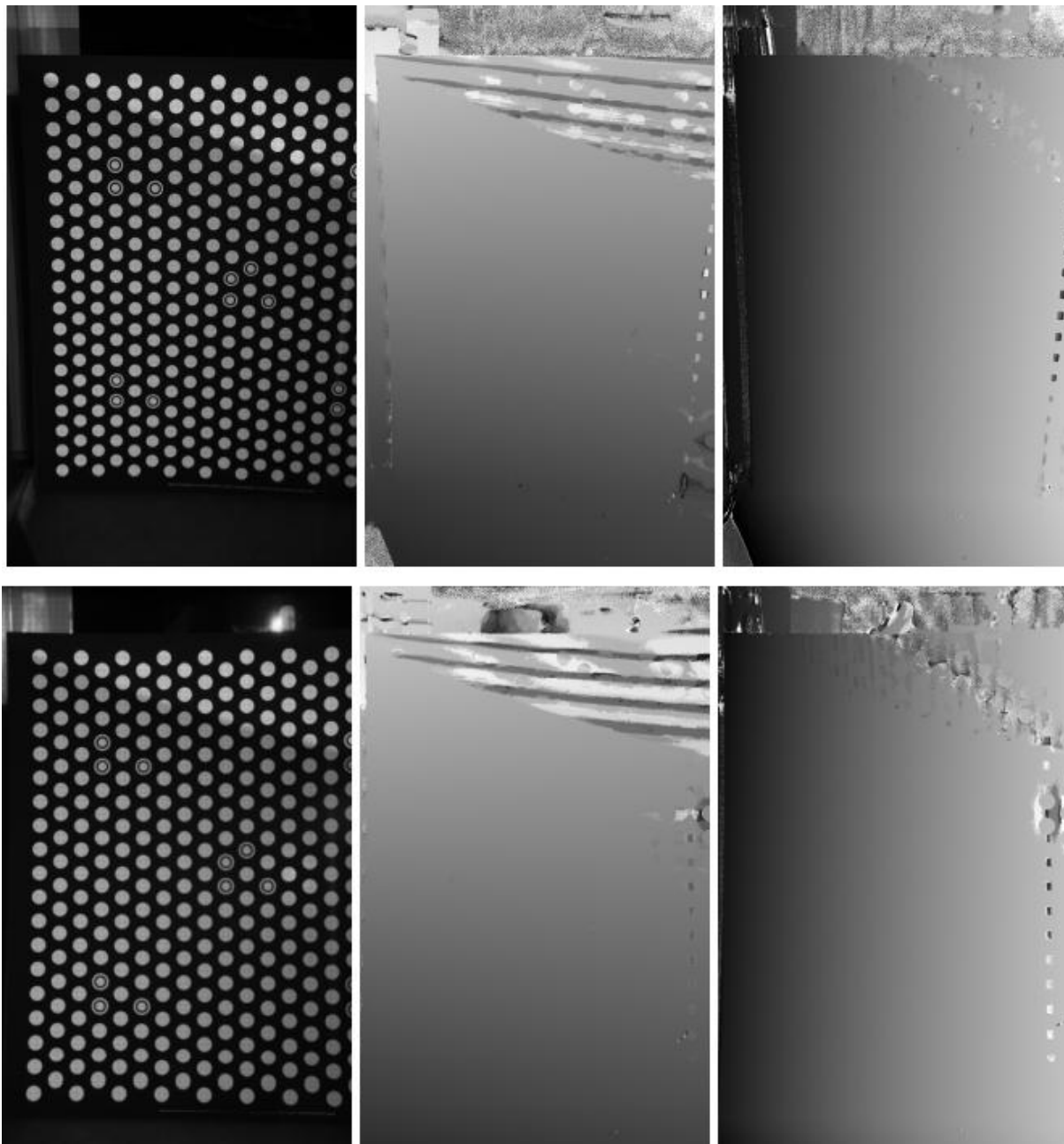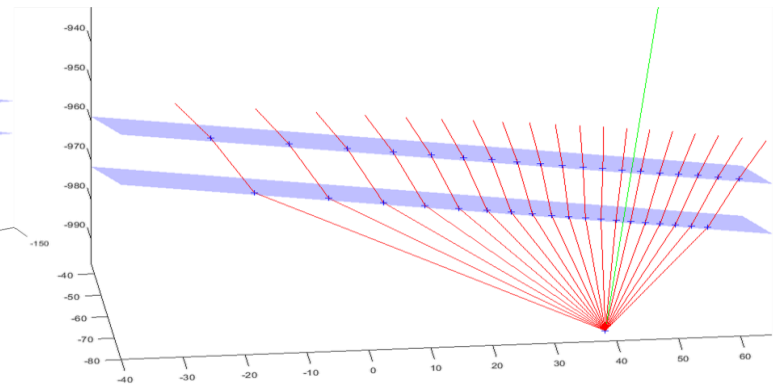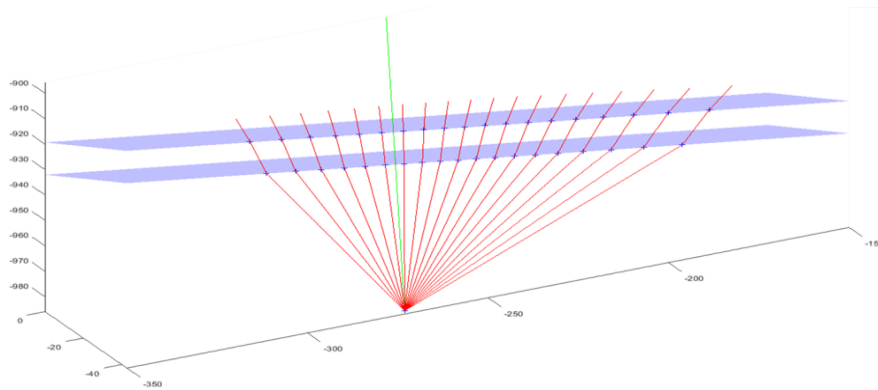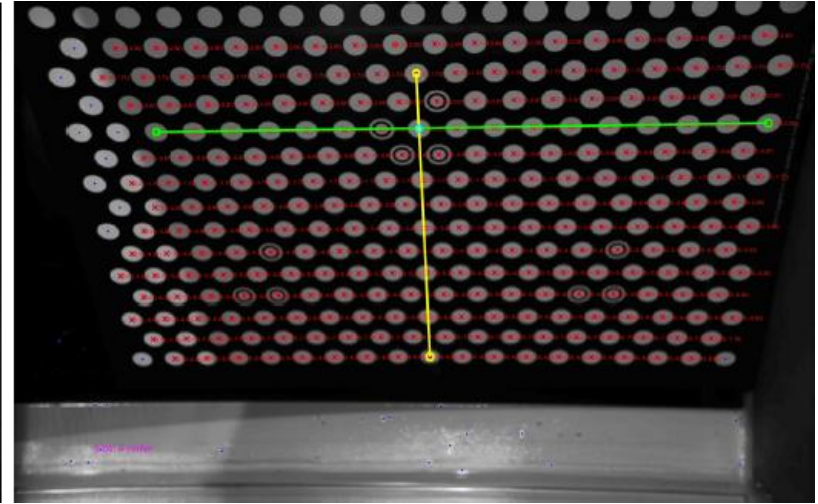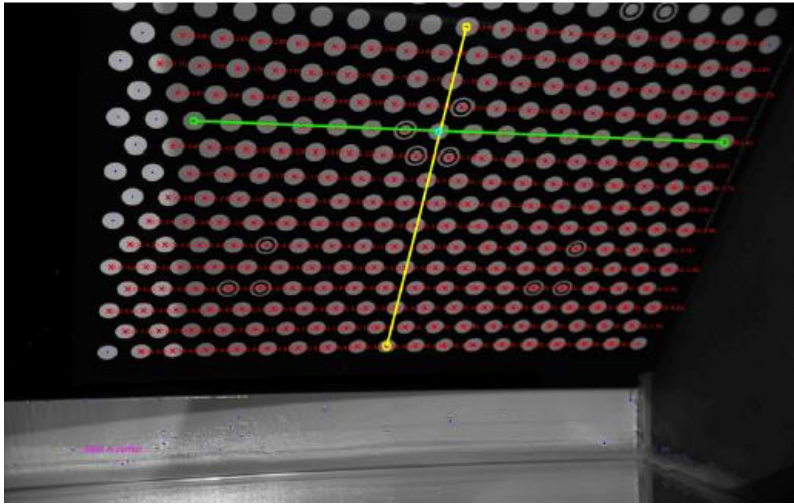
Difficult conditions? Turbid water (add milk)

Summary and future work

- First year of the project successfully completed
- Future work
  - development and manufacture of underwater enclosures
  - development of data processing software
  - design of optimal structured light patterns

- If you have an idea where such a scanner may be useful, we are open for cooperation