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# Smart Solutions for Underwater 3D Exploration and SLAM – Possibilities and Limitations

Christian Bräuer-Burchardt, Martin Hubold, Matthias Heinze, Peter Kühmstedt, Gunther Notni  
Fraunhofer Institute for Applied Optics and Precision Engineering Jena, Germany  
3D Underwater Mapping from Above and Below, 9th July 2025, Vienna

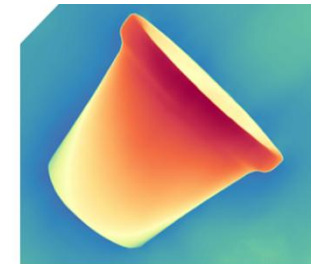
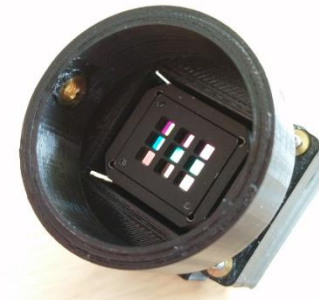
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# Smart Solutions for Underwater 3D Exploration

## Outline

- Motivation
- New approaches in underwater environments
  - Monocular 3D reconstruction
  - Multi-aperture camera technique
  - Monocular depth estimation by AI
- Experimental evaluation
- Summary, discussion and outlook



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# Smart Solutions for Underwater 3D Exploration

## Motivation

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- Goal (of our research): development of a
  - user-friendly,
  - lightweight,
  - high accuracy, and
  - low-budgetsystem for optical underwater 3D measurements for a wide range of applications (including SLAM)
- Offer suggestions for innovative new solutions as a discussion inspiration

# Smart Solutions for Underwater 3D Exploration

## Monocular 3D reconstruction

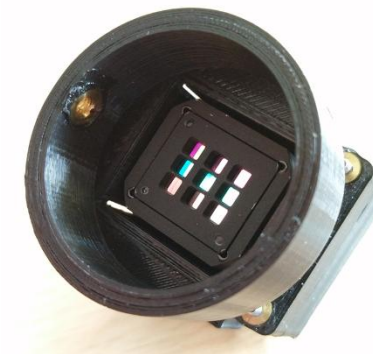
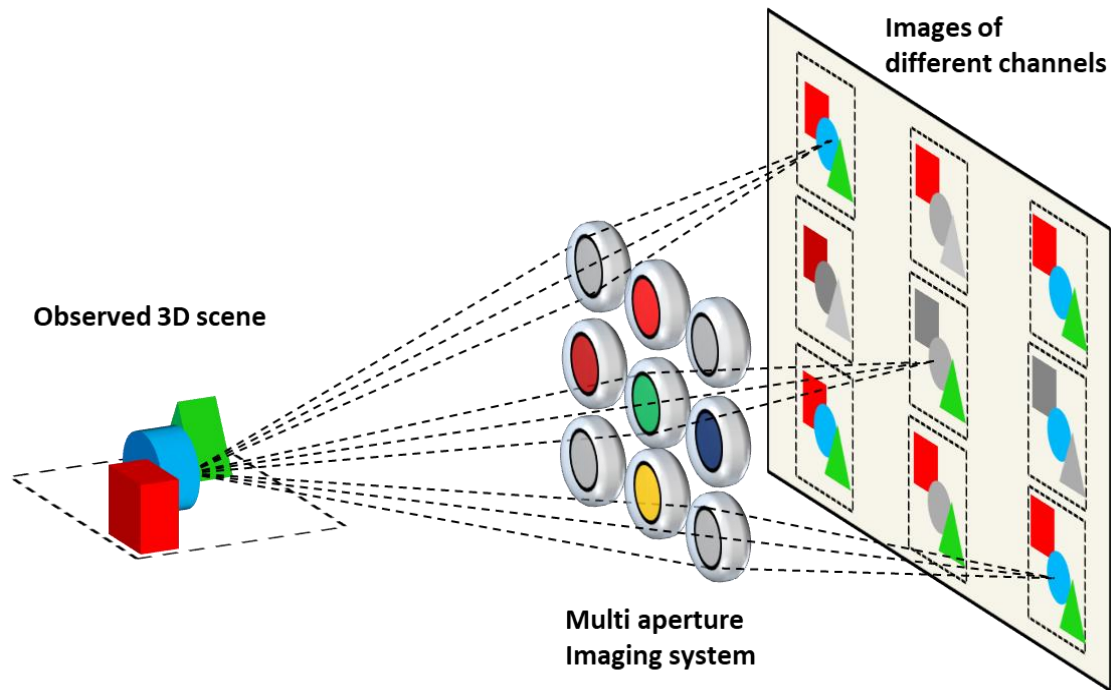
- Principle
  - Input: video streams and tracking camera (IMU) data
  - Offline 3D reconstruction process
  - Pairwise photogrammetric reconstruction using estimated camera positions (using image processing and IMU data)
  - Successfully established in air applications
- First solution for underwater applications, e.g. → [goSEA3D scanner](#)



# Smart Solutions for Underwater 3D Exploration

## Multiaperture camera technique

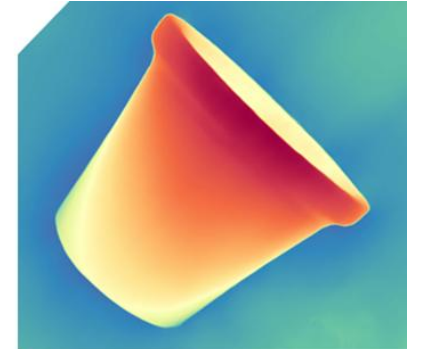
- Principle



# Smart Solutions for Underwater 3D Exploration

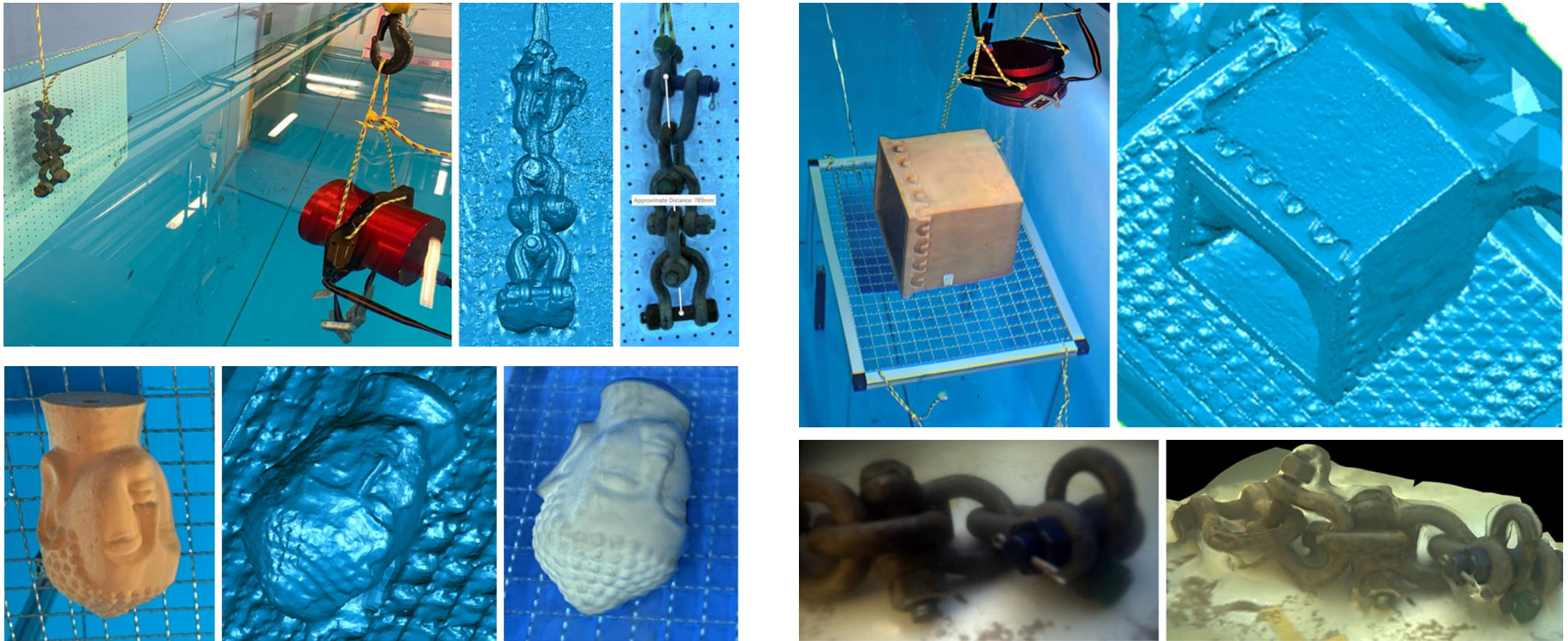
Monocular depth estimation by AI

- Advancing new research topic
- Many commercially available solutions (mainly for air applications)
- First experiments with underwater images



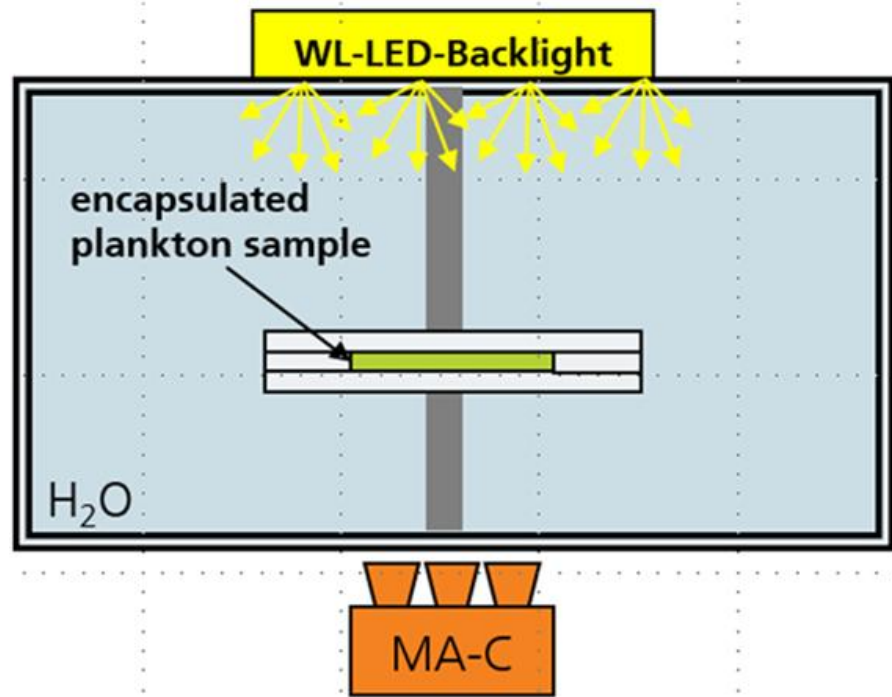
# Experimental Evaluation

Monocular 3D reconstruction – clearwater examples and application in a lake

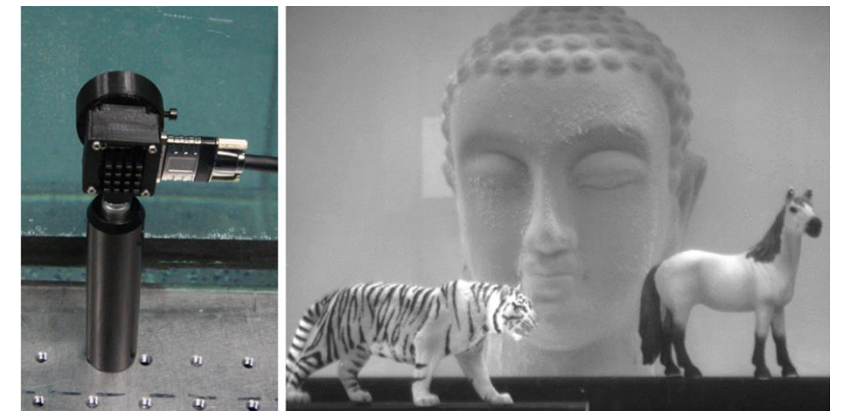
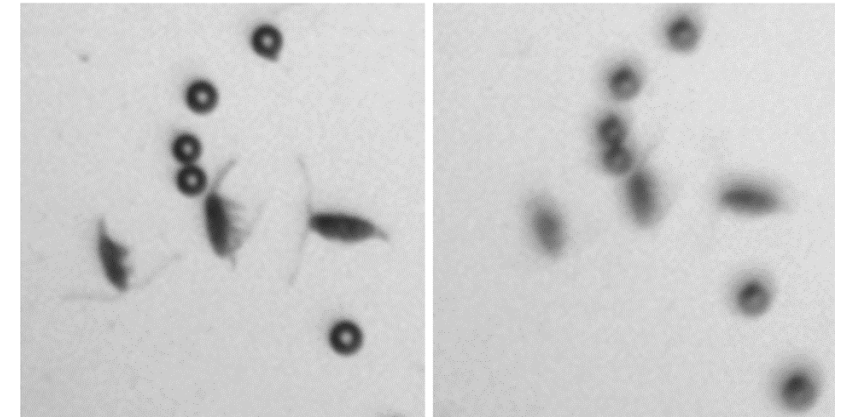


# Experimental Evaluation

3D reconstruction examples taken by a multi-aperture camera in an aquarium

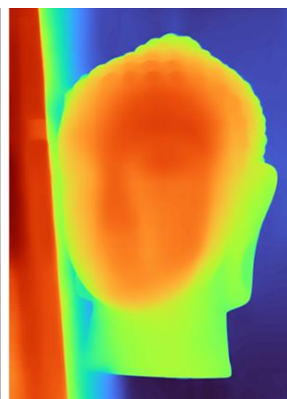
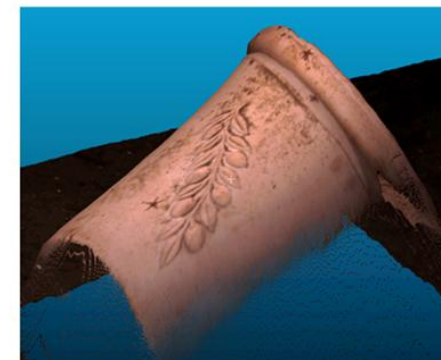
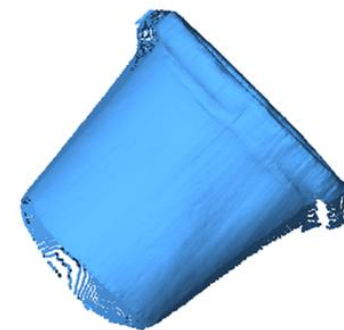
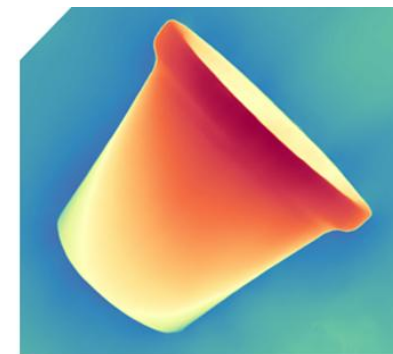


Sketch of the experimental setup with aquarium (left) and photograph of the setup, view through the side windows of the aquarium (right)



# Experimental Evaluation

3D reconstruction trials obtained with monocular depth estimation using AI



Original underwater recordings, monocular depth estimation and 3D reconstruction results

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# Summary, Discussion, and Outlook

Smart solutions for underwater 3D exploration

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- New ideas for possible applications for 3D underwater measurements presented
  - Monocular 3D reconstruction
  - Multi-aperture camera technique
  - Monocular depth estimation using AI
- First experimental results obtained
- Improvements necessary for practical application
- Further research planned in current and future projects

# Thank you for your kind attention!

Questions?

