

Übersicht

Agenda:

1. Modalitäten Oberseminar und Projekte
2. Themenvorstellung

	Oberseminar Messsystemtechnik	Projekt „Optische Prozessmess- technik“	Projekt „Photonische Messsystem- technik“
Studiengänge	ET, MT, RES, Physik	MT	ET
Modul	Oberseminar Messsystemtechnik	Modul Sensoren und Messsysteme Vertiefung	Modul Photonische Messsystemtechnik
Umfang	2 SWS	2 SWS	1 SWS
Leistung	Vortrag (+ Beleg)	Vortrag + Beleg	Vortrag

→ Ansprechpartner zur Organisation Oberseminar und Projekte:
Dr. Martin Kroll, martin.kroll2@tu-dresden.de

Modul „Oberseminar Messsystemtechnik“ (2 SWS, 4 bzw. 2 LP)

Teil A: Wöchentliches Seminar

→ Anwesenheitsliste

Teil B: Seminararbeit

- betreute Gruppenarbeit à 2-4 Studenten (mind. einmal Konsultation)
- Umfang: je 120 Stunden (Elektrotechnik) bzw. 60 Stunden (Mechatronik)

→ Benotung:

- ☑ Referat: 20 min Vortrag + 10 min Diskussion, jeweils pro Student
- ☑ Beleg (nur ET): 6 Seiten
Vorlage auf Webseite
(Studium → Lehrveranstaltungen → OS Messsystemtechnik)

SG Elektrotechnik (4 LP):

Modulnote = Note des Referats * 1/3 + Belegnote * 2/3

SG Mechatronik bzw. SG Regenerative Energiesysteme (2 LP):

Modulnote = Note des Referats

SG Physik:

Leistungsschein (Ausarbeiten und Halten eines Seminarvortrags)

→ Ihre Anmeldung im HISQIS ist erforderlich (zwecks Notenmeldung)!

Projekt „Optische Prozessmesstechnik“

Projektarbeit:

- betreute Gruppenarbeit à 2-4 Studenten (mind. einmal Konsultation)
- Umfang: je ca. 3 Tage pro Student + Selbststudium

Benotung:

- ☑ Referat: 15 min Vortrag (5 min pro Student) + 10 min Diskussion
- ☑ Beleg: 6 Seiten
Vorlage auf Webseite
(Studium → Lehrveranstaltungen → Projekt Optische Prozessmesstechnik)

SG Mechatronik (2 SWS):

Note Projektarbeit = $1/2 * \text{Vortrag} + 1/2 * \text{Beleg}$

Note der Projektarbeit geht mit 40 % in die Modulnote ein (Modul: Sensoren u. Messsysteme-Vertiefung)

➔ Ihre Anmeldung im HISQIS ist erforderlich (zwecks Notenmeldung)!

Projekt „Photonische Messsystemtechnik“

Projektarbeit:

- betreute Gruppenarbeit à 2-4 Studenten (mind. einmal Konsultation)
- Umfang: je ca. 3 Tage pro Student + Selbststudium

Benotung:

- ☑ Referat: 15 min Vortrag (5 min pro Student) + 10 min Diskussion
- ☑ Beleg: kein Beleg

SG Elektrotechnik (1 SWS):

Note Projektarbeit = Note Vortrag

Note der Projektarbeit geht mit 1/7 in die Modulnote ein (Modul „Photonische Messsystemtechnik“)

➔ Ihre Anmeldung im HISQIS ist erforderlich (zwecks Notenmeldung)!

Zeitplan

- 1. Woche Themenvorstellung
- Bis 2. Woche Einschreibung für die Bearbeitung der Themen (Einschreibung während des Oberseminars oder im Bar 25, jedes Thema kann nur durch eine Gruppe bearbeitet werden → „First Come, First Serve“-Prinzip)
- ab 2. Woche Bearbeitung der Projekte
- ab Januar Präsentation der Projektergebnisse und ggf. Abgabe der Belege (in Rücksprache mit dem Betreuer)

→ Themenvorstellung

Themen für das Oberseminar & Projekte

Coherence Factor Beamforming to Enable Novel Ultrasound Imaging Techniques

Keywords

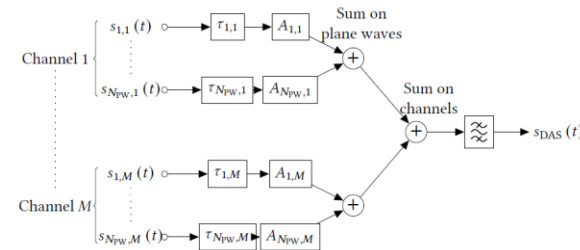
Ultrasound, medical imaging, adaptive beamforming, python Inf, ET, MT, RES, Physics, PoL

Motivation

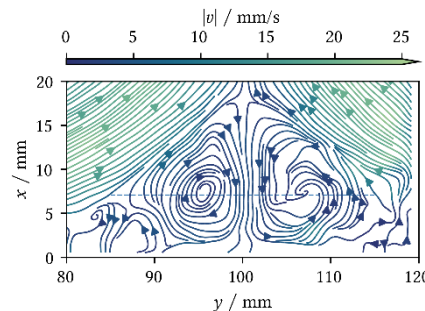
In this project, novel processing algorithms that involve the signal coherence shall be investigated. With that, the image resolution and reliability of ultrasound b-mode images can be extensively increased. This is relevant in challenging domains such as super-resolution in deep penetration depths or ultralow-channel imaging. The spatial and angular coherence factor needs to be introduced as a weight to process the image data. Finally, the properties of this beamformer need to be evaluated.

Tasks

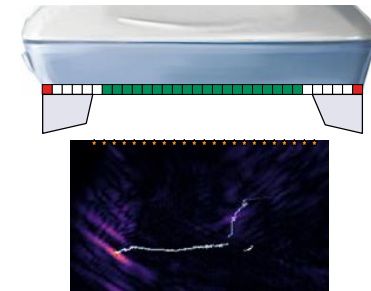
- Implementation in Python with GPU-support for online processing
- Test and characterization with simulation and physical data



Deep Super-Resolution Flow Imaging



Dual-Channel Ultrasound Imaging



Contact

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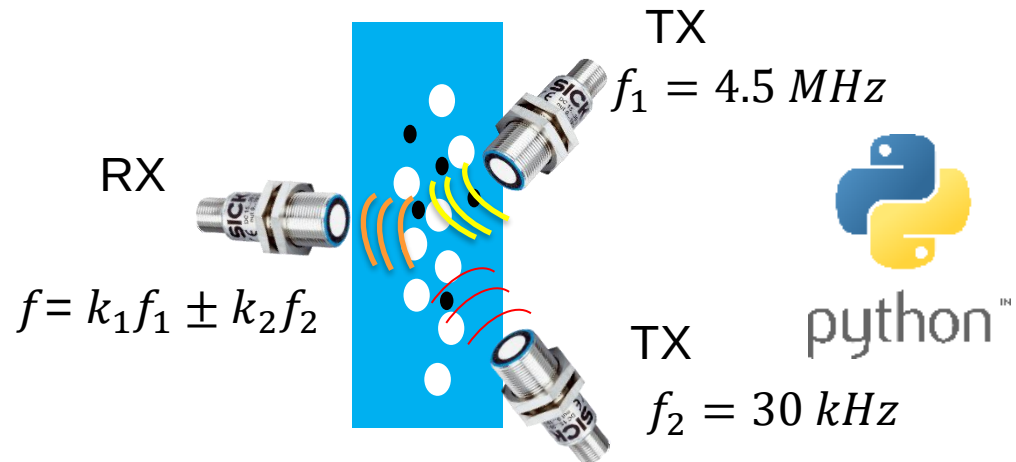
Exploration of multiple evaluation techniques for intermodulated bubble oscillation scattering

Motivation

Measuring the parameters of three phase flows is an ongoing hurdle. In froth flotation processes, bubbly liquids contain particles as well. When determining the three phases (water, air, particles) it is hard to distinguish the impact of the phases on the ultrasound signal.

Luckily bubbles show a non-linear behaviour when oscillating, due to an excitement through ultrasound (f_2). The non-linearity leads to a mix of the measurement frequency (f_1) and the excitement frequency. The scattered wave can then be recorded by an RX-transducer. We can thus distinguish between bubbles and particles and even measure a bubble size distribution.

Unfortunately the amplitude of the received frequency is comparably small but we do know the signal we are expecting. Therefore we want to investigate different analysing methods (i.e. convolution, Lock-In amplifier, ..) and compare them with one another.



Tasks

- Familiarization with Intermodulation in Bubble Oscillation Behaviour
- Implementation of multiple concepts of data analyzing for known, expected signals
- Comparison of different concepts

Keywords

Ultrasound, Python, Bubbly Liquid, Oscillation, Data Processing

Contact

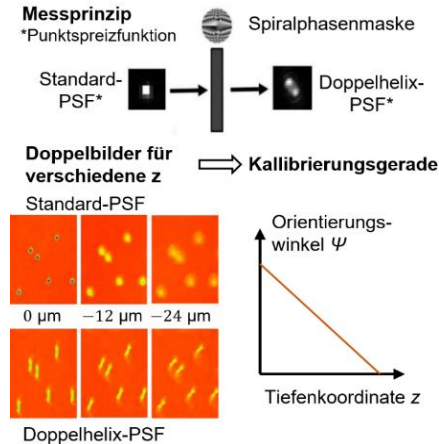
- Hannes Emmerich, BAR I56E, Tel. +49 351 463-35282
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Adaptive 3D-Mikroskopie in kleinskaligen Strömungen

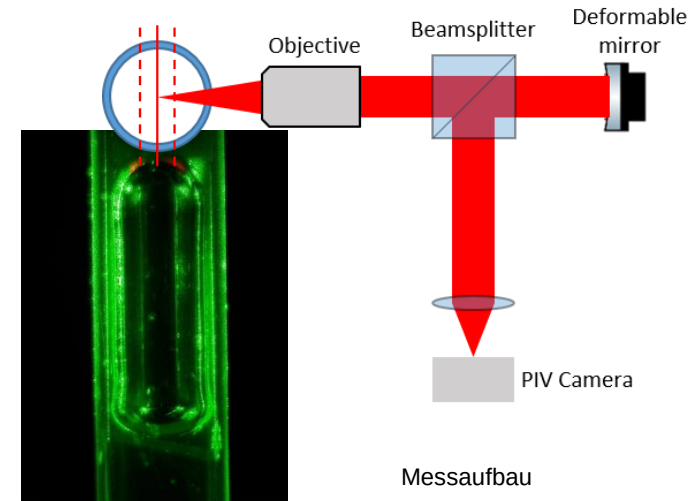
Motivation

Zur Untersuchung von kleinskaligen Strömungen werden unter anderem Mikroskope eingesetzt. Diese sind allerdings auf 2D-Messungen beschränkt, wodurch interessante dreidimensionale Phänomene nicht gemessen werden können. Für volumetrische Messungen wird die Tiefeninformation benötigt, welche auf verschiedene Arten gewonnen werden kann.

Ziel dieser Arbeit ist es, ein Messsystem aufzubauen, welches zur 3D-Vermessung von Strömungen geeignet ist. Eine Phasenmaske erzeugt hierzu helikale Wellenfronten, welche punktförmige Objekte als Doppelbild darstellt. Je nach Abstand zur Brennebene dreht sich das Doppelbild und lässt so die Tiefenmessung zu. Eine besondere Herausforderung ergibt sich durch die Messung durch gekrümmte Oberflächen, welche für Messabweichungen sorgen. Diese Messabweichungen sollen in dieser Arbeit ebenfalls reduziert werden.



Messprinzip 3D-PTV



Aufgaben

- Aufbau und Charakterisierung eines 3D-Messsystems für die adaptive Strömungsmessung
- Messung verschiedener Strömungen und Untersuchung unterschiedlicher Einflüsse

Stichworte

3D-Mikroskopie, Punktspreizfunktion, Bildverarbeitung, Strömungsmechanik

Kontakt

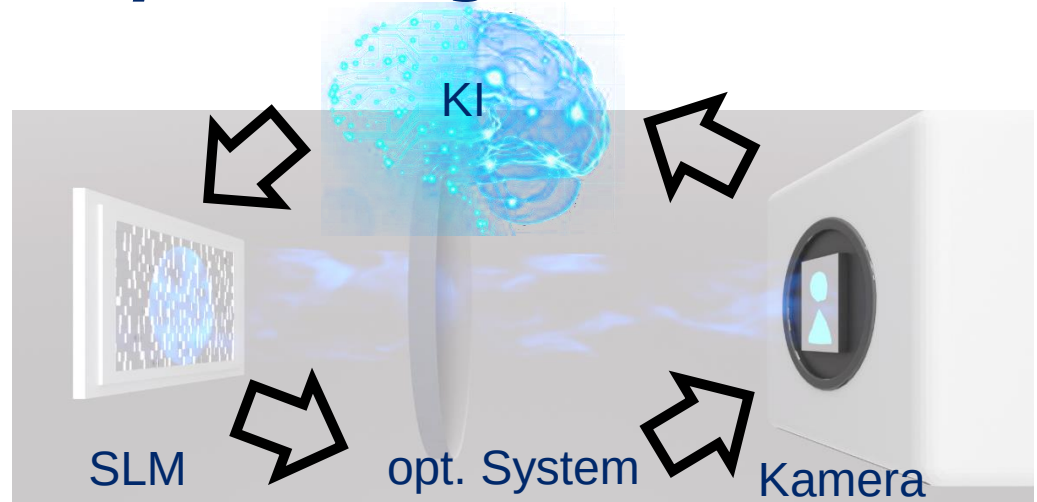
- Dr.-Ing. Florian Bürkle, E-Mail: florian.buerkle@tu-dresden.de
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Fast generation of binary holograms with deep learning

Motivation

Together with computer-generated holograms, modern pixelated spatial light modulators open up new possibilities in many applications, namely aberration correction in measurement systems, structured illumination in information technology or biomedical research or for the development of holographical displays. Many of these applications benefit from high frame rates, e.g. for real time control. However, light modulators with accordingly high refresh rates often only allow a binary modulation and sufficiently quick calculation of binary holograms. Established algorithms for hologram calculation are often of iterative nature and therefore inherently slow. In contrast, deep learning with neuronal networks promises fixed execution times once properly trained.

Therefore, the use of binary holograms for the fast generation of binary holograms shall be explored in this project using different approaches depending on experience and student group size, ranging from the use of physical models to different means of ground truth data generation.



Range of tasks

- Extension of existing neuronal network/ Design of new neuronal network + training
- Generation of applicable ground truth data with different methods.
- Evaluation of quality metrics and speed

Subjects

Computer generated holograms, artificial neural networks, deep learning, physical modelling

Contact

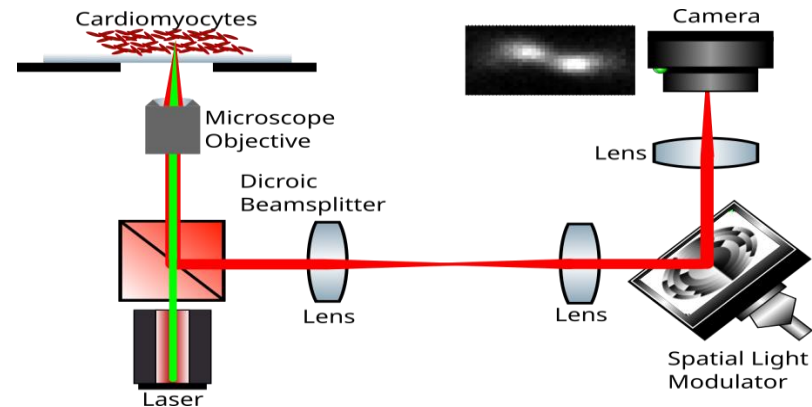
- Felix Schmieder, BAR 25, Tel. 463-33894, E-Mail: felix.schmieder@tu-dresden.de
- Internet: <http://tu-dresden.de/et/mst>

Single-Shot 3D Cell Imaging for Optogenetically Stimulated Cardiomyocytes

Motivation

Sudden cardiac death is one of the leading causes of death globally, with the majority caused by arrhythmias. By combining optogenetics and single-shot 3D-imaging, we want to study the underlying mechanisms with high temporal and spatial resolutions. Optogenetics allows the precise spatial stimulation of cardiomyocytes. By spatially imprinting a double helix on the phase profile via a spatial light modulator, the point spread function is converted into two separated points, and the orientation angle corresponding to depth as third coordinate. This allows to obtain a single-shot 3D image of the calcium fluorescence signal.

The aim of the project is to extend the existing DH-PSF measurement system to calcium imaging of cardiomyocyte networks. Furthermore, the connection between stimulation, contractility, and calcium fluorescence signal should be investigated.



Tasks

- Design of optical setup
- Fabrication and measurement of cell phantoms
- In-vitro measurements of cardiomyocytes
- Image processing and data analysis

Keywords

Optics, Optogenetics, 3D-Imaging, Microscopy, Fluorescence

Contact

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Image Processing based Biomedical Study: Virtual Staining

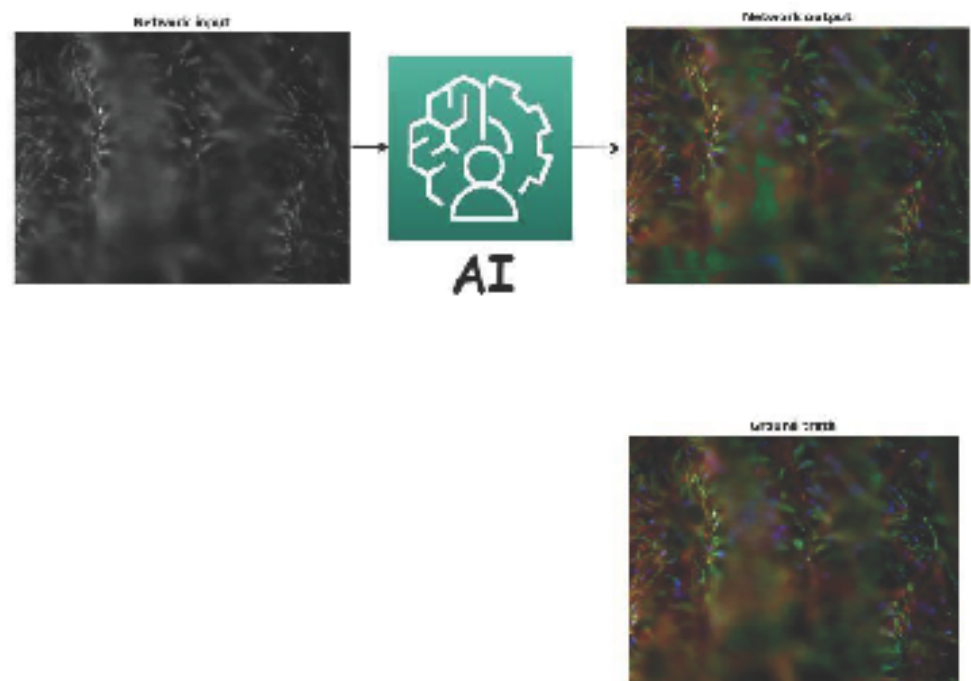
Motivation

With the increasing demand for AI technology in various industries, the implementation of image processing in biomedicine is also a new land eager for more pioneers.

In the conventional chemical staining, different chemical dyes are used as 'labels' to stain organoids/tissues in order to observe different cellular components. But the structure of the organoids/tissues will quickly be damaged with a long-time light illumination which is used as the main observing method. Now we need a non-invasive label-free method to get rid of the chemical staining.

To achieve this aim, several image processing approaches should be tested and compared, for example image segmentation and image classification.

Basic knowledge about neural network is desirable but not mandatory. Basic MATLAB/ Python experience is needed .



Tasks

- Literature research
- Implementation of different neural network architectures in several sub-tasks
- Investigation on the results of different neural networks for the corresponding tasks

Keywords

Bio-medicine, Deep Learning, Neural Network, Image Processing, Virtual staining

Contact

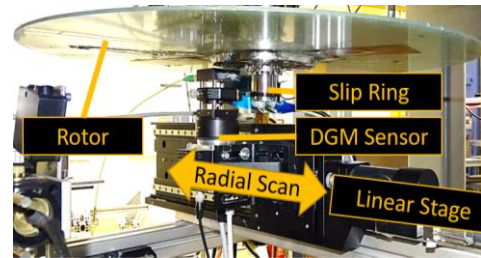
Dipl.-Ing. Ning Guo, BAR I56D, E-Mail: ning.guo@tu-dresden.de

Strain Sensor for Structural Health Monitoring

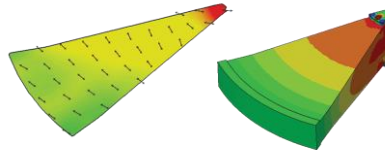
Motivation

Due to their lightweight properties, fiber reinforced polymers (FRP) are predestined for the development of high-speed rotors, such as electrical machines and flywheels. To validate and calibrate numerical models, in-situ deformation measurements during rotation are necessary. The challenge is to enable full-field measurement with low uncertainty at surface velocities up to 1 km/s.

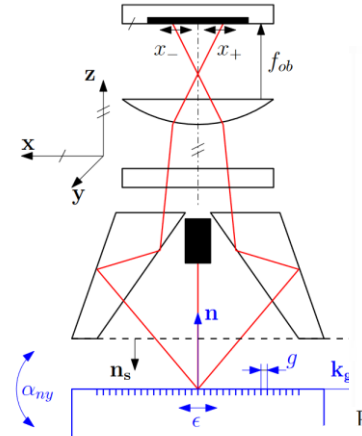
We developed an optical diffraction grating sensor which measures deformations with high spatiotemporal resolution and precision at arbitrarily high surface velocities. Currently, line-scan cameras are used for the readout process. To enable lower measurement uncertainties and Structural Health Monitoring, Position Sensitive Detectors (PSD) can be used.



Test Rig



Strain Field



DGM Sensor



Tasks

- Development and installation of a PSD-based strain monitoring unit
- Characterization of the measurement uncertainty

Key words

Laser Metrology, Strain sensor, Position Sensitive Detector

Kontakt

- M.Sc. Julian Lich, E-Mail: julian.lich@tu-dresden.de
- Internet: tu-dresden.de/et/mst

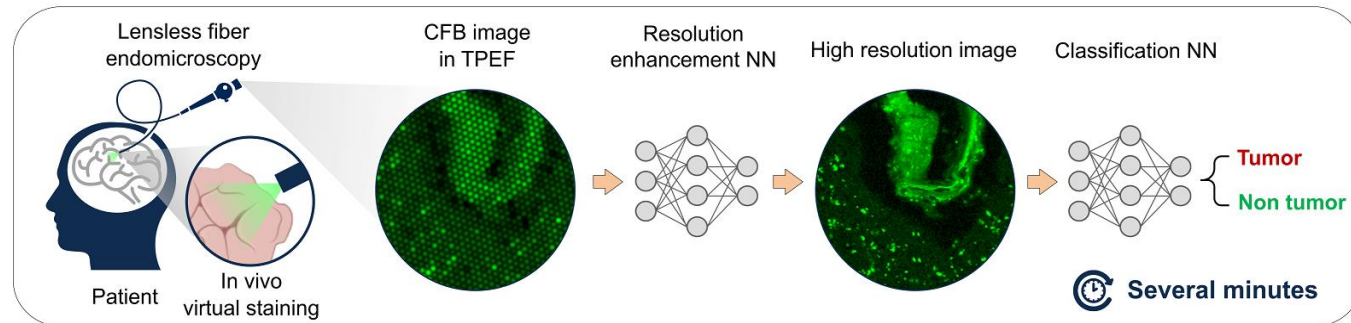
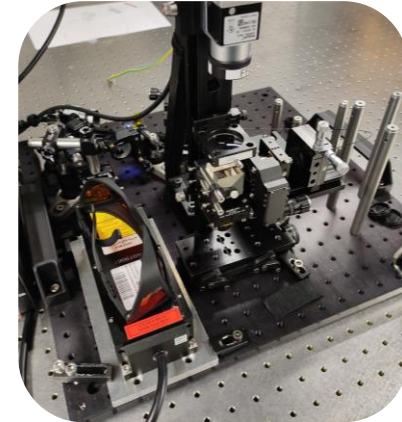
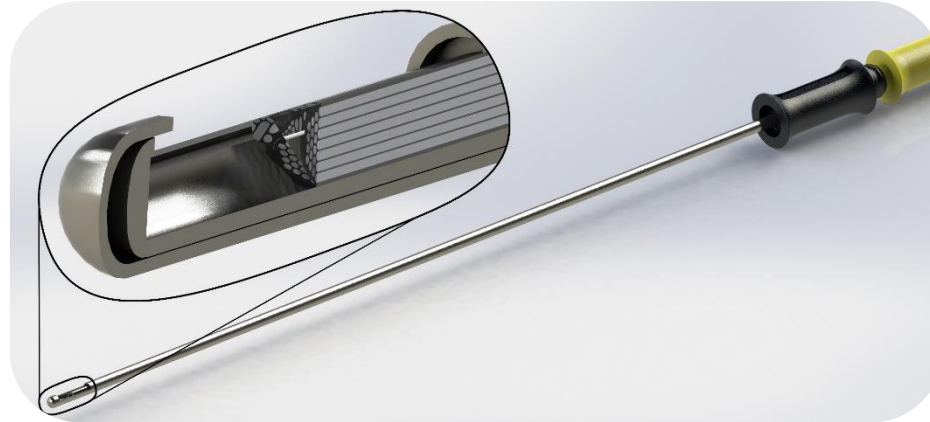
AI-assisted endoscopic tissue differentiation in neurosurgery

Keywords

endoscopy, cancer diagnostics, neural networks, lab work

Motivation

In this project, the spectral properties of the fluorescence of brain tumors are investigated and a miniaturised endoscope is developed to enable optical intraoperative biopsy. The development of a tissue characterization and an AI-supported diagnosis should enable a smooth integration into the clinical work routine in the future. The *in vivo* tumor diagnosis avoids the removal of brain tissue and its lengthy pathological examination, and would make it possible to start therapy for affected patients at an earlier stage.



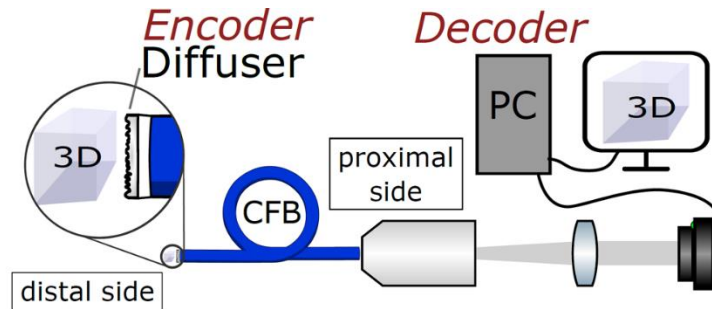
Tasks

- Characterization of different endoscopes (Lab work, Hardware side)
- Automation of a measurement process of real tissue samples for the training data of neural networks at the university hospital (Matlab, Software side)

Contact

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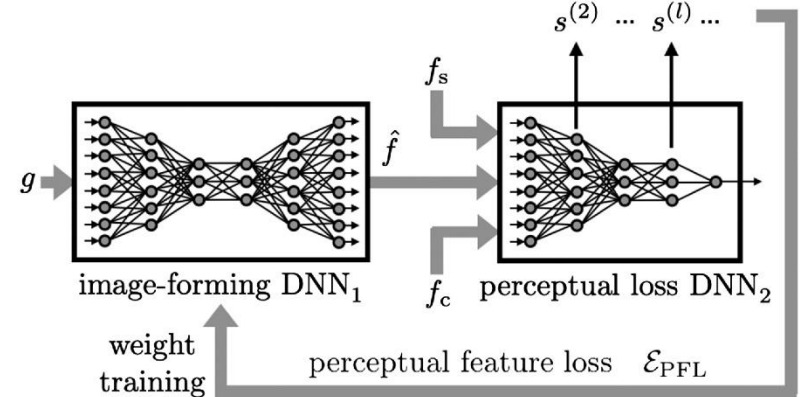
Perceptual loss for physics-informed neural network image reconstruction for diffuser endoscopy



Motivation

Diffuser based imaging is a recent topic in computational optics. The diffuser generates a unique pseudorandom speckle pattern for every point within a volumetric field-of-view on an image plane. By solving the inverse problem, the 3D scene can be reconstructed fast computationally by using neural networks. In conjunction with imaging waveguides, this enables the realization of single shot 3D microendoscopes.

For the training of image-reconstructing networks, choosing a fitting loss function is crucial. In generative adversarial networks (GAN), two neural networks are trained to contest with each other where one (Generator) is generating images from noise while the other one (Discriminator) tries to discriminate these images from real ones. This concept can also be adapted for an image reconstruction task where the discriminator network acts as a perceptual loss function for the reconstruction network, which generates images from measurements instead of noise.



Tasks

- Implementation of a Wiener-filter-based physics-informed neural network for image reconstruction in Python
- Realization of a GAN structure for perceptual loss function
- Comparison to conventional loss function

Key words

Endoscopy, Neural Network, Computational Imaging, Python

Contact

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E-Mail: tom.glosemeyer@tu-dresden.de

Themenübersicht

Thema	Kürzel	Projektart	Betreuer
Coherence Factor Beamforming to Enable Novel Ultrasound Imaging Techniques	CoherentBeam	OS	David Weik
Exploration of multiple evaluation techniques for intermodulated bubble oscillation scattering	BubbleScattering	OS	Hannes Emmerich
Adaptive 3D-Mikroskopie in kleinskaligen Strömungen	AdaptivMikro	OS	Florian Bürkele / Clemens Bilsing
Fast generation of binary holograms with deep learning	FastHolo	OS	Felix Schmieder
Image Processing based Biomedical Study: Virtual Staining	ImageStain	OS	Ning Guo
Strain Sensor for Structural Health Monitoring	StrainStructur	OS	Julian Lich
AI-assisted endoscopic tissue differentiation in neurosurgery	AI-Endoscope	OS, PMST, OPMT	Jakob Dremel
Perceptual loss for physics-informed neural network image reconstruction for diffuser endoscopy	DiffScope	OS, PMST, OPMT	Thomas Glosemeyer