Said Harb

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Education

- **Technische Universität Braunschweig** — Brunswick, Germany
  Master of Science - Computational Science in Engineering; current GPA: 1.2/1.0 — *Okt 2022 - today*
  Courses: *Deep Learning, Pattern Recognition, Continuum Mechanics, Software Engineering, Numerics, FEM, Parallel Computing*
- **University of Rhode Island** — Kingston, RI, USA
  International Student - Computer Science; GPA: 1.0/1.0 — *Aug 2023 - Jan 2024*
  Courses: *Algorithms for Big Data, Numerical Methods for Partial Differential Equations, Ecological Statistics*
- **Technische Universität Ilmenau** — Ilmenau, Germany
  Bachelor of Science - Mechanical Engineering; GPA: 1.4/1.0 — *Okt 2018 - Sep 2022*
  Courses: *Machine Elements, Electrical Engineering, Materials Science, Production Engineering*
- **Pestalozzi-Gymnasium** — Dresden, Germany
  Abitur; Top of the year, GPA: 1.1/1.0 — *Aug 2009 - Juli 2017*

Skills Summary

- **Programming Languages**: Python (Advanced), Matlab (Intermediate), Julia (Intermediate), C++ (Beginner)
- **Programming Frameworks**: PyTorch, TensorFlow, Keras, Cuda, OpenCV, Pandas, NumPy, Matplotlib
- **Technologies**: Git, Docker, Weights and Biases, GPU Clusters, Linux
- **Languages**: German (Native), English (Full Professional Proficiency), Spanish (Conversational), Arabic (Conversational)

Experience

- **Technische Universität Braunschweig** — Brunswick, Lower Saxony, Germany
  Master Thesis (Work in progress) — Institute of Geodesy and Photogrammetry — *Nov 2024 - today*
  - **Topic: Deep Learning for Point Cloud Reconstruction**: Currently reviewing research on deep learning techniques for reconstructing point clouds into mesh, wireframe, and implicit representations.

  Student Assistant — Institute of Geodesy and Photogrammetry — *Okt 2024 - today*
  - **LiDAR Simulation**: Resarched methods for simulating LiDAR scanners. Used Helios++ software to simulate TLS scanning of concrete structures and extracted point clouds.
  - **Curriculum Development**: Assessed international students curricula at TU Braunschweig and developed strategies to improve them with digital tools and better module structures.

  Student Assistant — Institute of Applied Mechanics — *Apr 2023 - Sep 2024*
  - **Software Developement**: Developed an importable module in Julia for using the tesselation software Neper for creating, meshing and visualizing polycrystal tesselations (GitHub: NeperStructureGenerator.jl).
  - **Teaching Assistance**: Conducted 14 seminars on advanced engineering mathematics, preparing civil engineering undergraduates for their final technical mechanics exams.
  - **Educational Tool Development**: Designed interactive Pluto notebooks in Julia to visualize, teach and explore various topics in continuum mechanics (e.g. deformation gradient, linear elasticity, stress-strain relationship).
- **Schaeffler Technologies AG & Co. KG** — Herzogenaurach, Bavaria, Germany
  Bachelor Thesis — GPA: 1.3/1.0 — *Apr 2022 - Sep 2022*
  - **Title: "NVH-Analysis of the Interface Stiffness of Attachment Parts of Electric Drive Units"**: Developed an analytical three-mass oscillator model in MATLAB and a numerical NVH model of an electric drive in Abaqus CAE to study the impact of attachment part interface stiffness on vibration and sound radiation. Formulated strategies to optimize interface stiffness, reducing vibration transmission and sound radiation, and successfully validated these strategies using Abaqus CAE simulations.

  Internship — Simulation department — *Okt 2021 - Mar 2022*
  - **Structural Dynamics Analysis**: Conducted literature research on structural dynamics and vibration transmission. Developed analytical two-mass oscillator models in MATLAB and performed modal and harmonic analysis on FEM models using Abaqus CAE.
- **Technische Universität Ilmenau** — Ilmenau, Thuringia, Germany
  Student Assistant — Machine Elements Group — *Apr 2021 - Aug 2021*
  - **Surface Analysis**: Conducted roughness measurements on spring wires using a laser scanning microscope to assess and improve manufacturing processes.

Honors and Awards

- Ranked among the top 7 graduates in the Mechanical Engineering Bachelor's program at TU Ilmenau since 2019.
- Chosen for the highly competitive cooperation program between TU Braunschweig and the URI (USA).
- Graduated as top of the year in high school.

Publications

- **Multi-temporal Crack Segmentation in Concrete Structures using Deep Learning Approaches:** Submitted to ISPRS Conference, 2025. **Harb, S.**, Achanccaray, P., Maboudi, M., Gerke, M. (arXiv-link): This paper addresses the critical importance of maintaining concrete structures, which are vital to modern society for safety, ecological, and economic reasons. Cracks are one of the earliest indicators of structural decay, therefore detecting them early on is important. Utilizing deep learning techniques, the study focuses on pixel-level image classification to identify cracks. Current approaches overlook the temporal domain of crack progression, which holds valuable information for deep learning models and is addressed in this work. I manually created and annotated a multi-temporal crack propagation dataset for semantic segmentation, consisting of 1356 samples, each illustrating crack growth over a series of 32 sequential images. After a thorough literature review on state of the art multi-temporal segmentation models a Swin Transformer adapted for three-dimensional input (Swin UNETR) was trained on the multi-temporal dataset using a GPU-cluster. Then the performance of this model was compared to a mono-temporal model (U-Net) which was trained on exactly the same deserialized data. Results demonstrate that the multi-temporal approach surpasses the mono-temporal model in terms of IoU (7.8% higher) and F1-score (5.1% higher), alongside superior visual predictions, all while using half the parameters of the mono-temporal model. The multi-temporal approach holds potential for long-term structural health monitoring of concrete structures, even with limited sequential data. This paper was crafted by me and my co-authors from my student project which received the highest grade of 1.0.

Projects

- **Computer Vision and Remote Sensing — Improving Object Detection Performance on Hard to Detect Instances in DOTA** (Homepage portfolio link): This project aimed to enhance the mean Average Precision (mAP) for deep learning object detection models specifically targeting "hard-to-detect" instances within the DOTA dataset. A comprehensive literature review was conducted to explore methods for improving small object detection and identifying suitable models. We selected the Yolov5 model and implemented dataset augmentation strategies such as oversampling and copy-pasting hard-to-detect instances to address the research question. For this I implemented state of the art research, dataset preprocessing pipelines, object detection evaluation algorithms, and post-processing techniques from scratch using PyTorch. The results demonstrate a significant improvement, with the mAP for hard-to-detect instances in DOTA increasing by up to 42.2%. This project was a collaborative effort completed with a co-author during a Deep Learning course, receiving the highest grade of 1.0.
- **Computer Vision and Autonomous Driving — Entropy Maximization for Anomaly Detection in Complex Driving Scenes Using a UNet Architecture** (Homepage portfolio link): The objective of this project was to train deep learning segmentation models to detect out-of-distribution objects in complex driving scenes through entropy maximization. Semantic segmentation models are typically trained on a fixed set of classes, yet real-world scenarios often feature classes not included in many training datasets, such as Cityscapes. A thorough literature review of state-of-the-art anomaly detection methods was performed, leading to the selection of entropy maximization. This approach modifies the standard cross-entropy loss function to boost the model's prediction entropy for out-of-distribution objects. A standard U-Net model was trained using this modified loss function and its performance was compared to the DeepLabV3+ model used by the original authors. The results indicate a substantial improvement in the anomaly detection capability of the U-Net model compared to the DeepLabV3+, with an AUROC increase of 12.0%, a 61.5% decrease in FPR95, and a 379.9% increase in AUPRC. This project was completed during my exchange semester in the US for the Algorithms for Big Data course and received the top grade of 4.0.
- **Natural Language Processing — Song Generator** (Homepage portfolio link, Work in progress): To gain a deeper understanding of modern chat tools like ChatGPT, I implemented a decoder-only transformer model from scratch using PyTorch. Additionally, I developed a pipeline to extract song lyrics of any given artist from the web, enabling the transformer model to be trained on these lyrics for the creation of new songs. For further comprehension, I also implemented backpropagation, Multi-Layer-Perceptron (MLP) and Batch Normalization from scratch.

Extraculicular Work

- **Work & Travel** — New Zealand
  Personal development, Language skills, Agricultural work — *Sep 2017 - June 2018*
- **Hobbies & Interests**
  Personal Finance, Brazilian Jiu Jitzu, Scuba Diving, Hiking, Crypto Currency
- **Current Research Interests**
  Speech Processing, Computer Vision, Natural Language Processing, Machine Learning for CFD