Master Thesis Proposal Nr:

Topic: Computer Vision Models for Chronic Wound Diagnosis

Chronic wounds and wound healing disorders pose a significant challenge to healthcare systems, often requiring extensive documentation and complex diagnostics [1]. As data-driven approaches continue to gain importance in medicine, the development of intelligent support systems becomes increasingly relevant [1].

One example is the work by Wang et al. [2], who developed a machine learning method for automatic wound segmentation. Similarly, UlcerGPT [3] provides an integrated solution for detecting, classifying, and localizing relevant regions in images of diabetic foot ulcers.

Sarp et al. [4] also contributed to the field by developing a classification algorithm for chronic wounds using transfer learning and fully connected layers. Their model classifies wounds into clinically distinct categories—such as surgical wounds, diabetic foot ulcers, venous/lymphatic leg wounds, and pressure ulcers.

These examples highlight the potential of machine learning to enhance diagnosis, documentation, and prognostic evaluation in wound care.
This master thesis will explore different machine learning models for accurate chronic wound classification based on collected data from the university hospital Erlangen.

The proposed work consists of the following parts:

- **Work Package 0 – Getting Started:**
  - Download Zotero (tool for literature research)
  - Understand the Prisma Method (used for literature research)
- **Work Package 1 - Literature review:**

  After completing the following steps, you should have selected the anonymization techniques you plan to apply to the non-anonymized images. Additionally, you should have chosen at least three models for chronic wound classification—one of which should be specifically designed for dermatology, and one that is a general computer vision model.

  - Read: A Survey of Wound Image Analysis Using Deep Learning: Classification, Detection, and Segmentation [6]
  - Literature review on: Wound Diagnosis with Deep Learning (create an overview of state of the art for (chronic) wound classification which you would like to test out)
  - Broad Literature review: Computer Vision Models for Medical Diagnosis (explore at least three in detail)
  - Research open-source models for image anonymization. Specialized models like *Deepskin* or *Detect-and-Segment* [5] may also support this process. For instance, *Deepskin* is an open-source Python package for wound image analysis that includes segmentation and wound area extraction.

  To do:

Develop a structured anonymization plan that outlines:

• The anonymization methods you plan to use

• Justifications for choosing each method

• A clear explanation of what surrounding context will be retained in the image and why

- Are there any publicly available datasets for chronic wounds that could be leveraged for comparison, testing, or additional training (find at least one if possible)?

- **Work Package 2: Anonymize the wound images at the university clinic Erlangen and remove images that contain identifying factors:**
  For this purpose, the data (wound images, tabular data) are stored on the computers of the university hospital Erlangen. Given the challenge of manually checking approximately 60,000 images for identifying features, a two-stage approach is proposed:
  a) Automatic filtering of images with chronic wounds: According to the anonymization process you outlined in work package 1 and which was validated with the doctor, the images should be anonymized
  b) Manual review of a randomly selected sample: After automatic filtering, a randomly selected sample of the data set (e.g. 200 images) can be reviewed manually to evaluate the effectiveness of the automatic filter and ensure that no identifying features have been overlooked.
- **Work Package 4: Develop, train and validate deep learning model to diagnose wound images and compare with state-of-the-art models**
  - Identify and evaluate appropriate preprocessing methods to prepare wound images for downstream analysis
  - Train/Finetune the computer vision models on the images of the university hospital Erlangen.
  - Test the three chosen models on known and unknown wound types.
  - Analyze the errors of the models (When is it difficult for the models to make predictions?)
  - Model Suitability: Assess whether the models that were used are sufficient to diagnosis the wound images. If they are not, identify what modifications or improvements are necessary. Implement and evaluate the proposed adaptations or add them to the outlook of the thesis.
- **Work Package 5: Explainability of Model Predictions**
  Apply methods to enhance the interpretability and explainability of model predictions medical image analysis (e.g. GradCAM [7]).

The thesis must contain a detailed description of all developed and used algorithms as well as a profound result evaluation and discussion. The implemented code has to be documented and provided. Extended research on literature, existing patents and related work in the corresponding areas has to be performed.

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References:

1 Augustin M, Hagenström K. Epidemiologie chronischer Wunden in Deutschland. In: Karl T, Storck M, eds. *Ärztliches Wundmanagement im interprofessionellen Team.* Berlin, Heidelberg: Springer Berlin Heidelberg 2023:5–15.

2 Wang C, Anisuzzaman DM, Williamson V, *et al.* Fully automatic wound segmentation with deep convolutional neural networks. *Sci Rep*. 2020;10:21897. doi: 10.1038/s41598-020-78799-w

3 Basiri R, Abedi A, Nguyen C, *et al*. UlcerGPT: A Multimodal Approach Leveraging Large Language and Vision Models for Diabetic Foot Ulcer Image Transcription. *arXiv Prepr arXiv241001989.* 2024.

4 Sarp S, Kuzlu M, Wilson E, *et al.* The enlightening role of explainable artificial intelligence in chronic wound classification. *Electron*. 2021;10. doi: 10.3390/electronics10121406

5 Scebba G, Zhang J, Catanzaro S, *et al.* Detect-and-segment: A deep learning approach to automate wound image segmentation. *Informatics Med Unlocked.* 2022;29:100884. doi: https://doi.org/10.1016/j.imu.2022.100884

6 Zhang, R., Tian, D., Xu, D., Qian, W. and Yao, Y., 2022. A survey of wound image analysis using deep learning: classification, detection, and segmentation. *IEEE Access*, *10*, pp.79502-79515.

7 Selvaraju, R.R., Cogswell, M., Das, A., Vedantam, R., Parikh, D. and Batra, D., 2017. Grad-cam: Visual explanations from deep networks via gradient-based localization. In *Proceedings of the IEEE international conference on computer vision* (pp. 618-626).