Deep Learning-based Image Analysis for ECG Paper Digitization

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Project description:
This project will involve the research and deployment of deep learning models (with an emphasis on computer vision and generative models) that aim to solve the segmentation and digitization of signal traces from medical images (ECGs).
Join us in transforming the way heart health is monitored and understood. Our project focuses on the Electrocardiogram (ECG), a crucial yet often underutilized tool in cardiac care. With your help, we aim to bring ECG into the digital age, overcoming traditional limitations and unlocking its full potential. Many hospitals still rely on paper-based ECG records, which are difficult to access, share, and analyse. These scanned images often suffer from noise and distortion, making them challenging for clinicians to use effectively.
Our goal? To convert these images into pristine digital signals using the latest AI technology.
As part of our team, you'll dive into a range of computer vision tasks, including image augmentation, segmentation, and signal denoising. You'll get hands-on experience with advanced neural networks and explore different architectures (e.g., CNNs, GANs or Diffusion Models). Such architectures are key in detecting and reconstructing high-fidelity signals from noisy ECG paper images, which often include text, grids, geometric distortions, missing traces, and signal interference. Digitizing ECGs isn't just a technical challenge; it's a chance to make a lasting impact on heart health research. By converting historical data into digital format, you'll enable long-term studies and facilitate easier data storage and sharing. It will also enable the application of established AI methods for digital ECGs, which have shown their potential to transform healthcare.

Timeline (tentative):
Oct 2024: Literature review and Methods Plan (1-page Plan)
Dec/Jan 2024: Method Development and Preliminary Results (Simulated R&D reports)
June 2025: Final Results and Model Evaluation (Poster Presentation)
Aug 2025: Writing and Review (Final Thesis Submission)

Minimum viable thesis:
A minimum viable thesis could rely on the development and extension of an existing implementation for ECG digitization, by gradually working on steps of the analysis pipeline that can be automated (e.g., segmentation analyses that are currently missing).

Required background & skills:
Programming (Python) Deep Learning (Tensorflow/Pytorch) Data Science and Statistics Linear Algebra Signal Processing (Optional) Computer Vision (Optional)

Representative References:
H. Wu et al., ‘A fully-automated paper ECG digitisation algorithm using deep learning’, Sci Rep, vol. 12, no. 1, p. 20963, Dec. 2022, doi: 10.1038/s41598-022-25284-1.
S. Mishra et al., ‘ECG Paper Record Digitization and Diagnosis Using Deep Learning’, J. Med. Biol. Eng., vol. 41, no. 4, pp. 422–432, Aug. 2021, doi: 10.1007/s40846-021-00632-0.
Y. Li et al., ‘Deep learning for digitizing highly noisy paper-based ECG records’, Computers in Biology and Medicine, vol. 127, p. 104077, Dec. 2020, doi: 10.1016/j.compbiomed.2020.104077.
S. Kiranyaz et al., ‘Blind ECG Restoration by Operational Cycle-GANs’, IEEE Trans. Biomed. Eng., vol. 69, no. 12, pp. 3572–3581, Dec. 2022, doi: 10.1109/TBME.2022.3172125.