Thesis Project Portfolio

Deep Learning-Based Motion Correction for Cardiovascular Magnetic Resonance Imaging

(Technical Report)

Bridging the Gap between Medical Imaging and Artificial Intelligence

(STS Research Paper)

An Undergraduate Thesis

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Table of Contents

Sociotechnical Synthesis

Artificial intelligence (AI) is transforming the ways that medical images are processed and analyzed. Tasks such as segmentation of anatomical structures in images and quantification of clinical functional parameters are being automated by AI-based models to assist in the clinical decision-masking process. However, these techniques have a black box nature and are not clear to physicians on how they function. This can lead to physicians questioning AI-based medical imaging analyses and makes it difficult for them to trust these new methods. The STS research paper works to answer the question, "How do we bridge the gap between the research of AI-based techniques in medical imaging and its implementation in healthcare?" Using Actor-Network Theory (ANT) as an STS framework, the STS research paper analyzes the interactions between actors in medical imaging and how the network is to change in order to incorporate AI in a transparent manner. This analysis will assist in creating a more interpretable pipeline for using AI in medical imaging that demystifies the black box nature of AI for physicians.

The capstone uses deep learning, a method in AI, to correct motion-based artifacts in Cardiovascular Magnetic Resonance first-pass contrast-enhanced myocardial perfusion (CMR perfusion) imaging. CMR perfusion imaging provides important diagnostic information in coronary artery disease. The process uses a breath-hold approach which can be difficult for patients with arrhythmias or limited breath-hold capacity, leading to inter-frame motion artifacts that make quantitative analysis for cardiac function evaluation difficult. In the technical paper, a deep learning-based model for rapid motion correction of CMR perfusion imaging is proposed. This is an important processing step before the robust quantification of myocardial perfusion analysis that assists physicians in their clinical duties.

Overall, the technical and STS research papers aim to use AI in the radiology field so that the clinical workflow of evaluating medical images is efficient and transparent for physicians. In the STS perspective, a modified actor-network map was created that displays increased interconnections between AI, physicians and scientists. This will allow for a better understanding on how the design of AI-based analysis in healthcare can be user-centered and more interpretable. In the technical paper, deep learning using the architecture of a U-Net was implemented to efficiently reduce motion-based artifacts in CMR perfusion imaging. This is essential for immediate clinical interpretation of medical images.