Degree project 30 credits in Biomedical Engineering

Human-Machine Interface for Digital Twins in Medicine

Biomedical Engineering R&D (MT-FoU) is a research and development department at the Center for Information Technology and Biomedical Engineering at Norrland University Hospital, Region Västerbotten. The department conducts international research, development and education in the field of biomedical engineering, with expertise in, for example, sensors and measurement systems, image and signal analysis and biomechanical models. MT-FoU is also a part of the competence center AI for Medicine in Northern Sweden, AIM North, which supports clinical research projects with technical method expertise in machine learning and AI.

Background

Image-to-image translation is a technique that transforms images from one domain to another, offering significant potential in the medical field for creating a Digital Twin—a virtual replica of a patient. This approach aims to generate accurate images across multiple modalities, thereby reducing the need for multiple scans and minimizing radiation exposure. To translate these advanced models into practical medical applications effectively, it is crucial to develop a Human-Machine Interface (HMI): a well-designed, intuitive, and user-friendly interface is essential for enabling clinicians and medical practitioners to easily access and operate with these models. This HMI will bridge the gap between sophisticated image translation technologies and their practical use in clinical settings, facilitating seamless integration into everyday medical practices and enhancing overall patient care.

Aim of the project

This project aims to develop a Human-Machine Interface for Digital Twins in medicine, designed to enhance the practical use of advanced image-to-image translation models for whole-body virtual scanner applications. The goal is to create and implement an intuitive HMI that allows clinicians and medical practitioners to easily access and operate these sophisticated AI models. By integrating user-friendly interfaces with cutting-edge algorithms, the project seeks to simplify the process of generating accurate virtual images. This integration will not only improve diagnostic accuracy and reduce the necessity for multiple scans but also contribute to enhanced patient safety by minimizing radiation exposure.

Work description

The project will involve systematic tasks aimed at developing a Human-Machine Interface (HMI) for Digital Twins in medicine to facilitate the use of advanced image-to-image translation models for whole-body virtual scanners. The key objectives and tasks for this project include:

1. **Literature Review**: Analyze current HMI solutions and identify key requirements for integrating advanced translation models into a user-friendly interface.
2. **Clinical Interviews:** Engage with clinicians and medical practitioners to understand their needs and preferences for an effective HMI.
3. **Requirements definition:** define requirements of the HMI, based on clinical interviews and AI solutions for image-to-image translation in digital twins available in the lab.
4. **Model selection and Integration:** integrate existing image-to-image translation models into a cohesive framework that supports full-body image translation across various modalities.
5. **HMI Design and Development:** design and develop an intuitive HMI that facilitates easy interaction with the translation models (e.g., user-friendly controls, dashboards, and visualization tools).
6. **Implementation and Testing: i)** implement the HMI and integrate it with the chosen translation models. **ii)** conduct rigorous testing to ensure functionality, usability, and performance. **iii)** gather feedback from clinical users to refine and improve the HMI based on real-world usage and needs.
7. **Reporting and Documentation:** document all stages of the project, including methods, results, and insights gained, producing a final report.

If your program has 15 credits rather than 30, we will adapt the scope of the thesis to fit within the credits.

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