

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

In a previous project, a prototype of a Human-Machine Interface (HMI) was developed to support the use of image-to-image translation models for medical Digital Twin applications. The prototype demonstrated the potential of combining image translation technologies with an intuitive interface, enabling end-users such as clinicians to access and interact with AI-generated virtual images. However, the current prototype is limited in functionality and robustness. It requires further development to improve user interaction, visualization capabilities, system performance, and integration with different models, and data modalities. To bring this technology closer to practical use, it is essential to evolve the prototype into a more mature, stable, and feature-rich system that can later be evaluated in clinical context.

Aim of the project

The aim of this thesis is to further develop and refine the Human-Machine Interface (HMI). The focus will be on creating a more robust, flexible, and technically advanced interface that supports integration with different image-to-image translation models and offers improved usability. This includes extending visualization and interaction features, enhancing performance, and ensuring the system is adaptable to different data modalities and translation frameworks.

Work description

The project will involve systematic development tasks aimed at maturing the HMI into a more advanced system:

1. **Requirements Analysis and Prototype Review:** Evaluate the current prototype, identify limitations, and define new functional requirements.
2. **Framework and Model Integration:** Extend support for multiple image-to-image translation models and modalities. Develop flexible back-end structures for model management and scalability.
3. **HMI Design and Development:** Improve visualization features (e.g., multi-view image display, 3D rendering, overlay comparisons), design intuitive interaction elements (dashboards, adjustable parameters, dynamic controls).
4. **Testing and Iterative Refinement** Conduct systematic technical testing of usability, stability, and responsiveness, iterate design based on feedback from engineering peers and selected test users.
5. **Documentation and Reporting:** Produce technical documentation covering architecture, design choices, and development steps and deliver a final report with results, and discussion.

Prerequisites: good programming skills including knowledge of Kotlin for GUI/front-end development, experience with Flask and Python for back-end and AI integration, principles of modular design.

Supervisor at MT-FoU

Paolo Soda, Francesco Di Feola

CIMT, Medicinsk teknik – FoU

Region Västerbotten

E-post: paolo.soda@umu.se, francesco.feola@umu.se

Web: <https://www.regionvasterbotten.se/medicinsk-teknik-forskning-och-utveckling>