Image Registration and Fusion for Biomedical Images

Author: Diletta Pennati
Department of Information Engineering
Laboratory: EidoLab

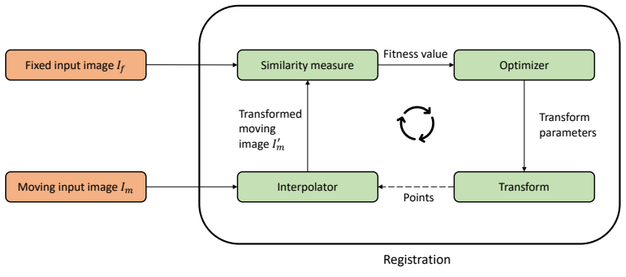
PhD program in Information Engineering

Introduction

In the medical field, the possibility of having an instrument for visualizing different information on a unique volumetric dataset has increasingly become a powerful tool for clinicians. Image fusion can satisfy this need, consisting in creating a single merged image synthesizing information extracted from one (*monomodal*) or more (*multimodal*) imaging modalities. Multimodality can be used for combining morphological and functional information and it's very useful for the operative planning and the evaluation of suspected pathologies. Instead, monomodality is useful for observing the same region of interest in different conditions and/or time instants and for consecutive volumes segments lining up when acquiring big region of interests.

Methods

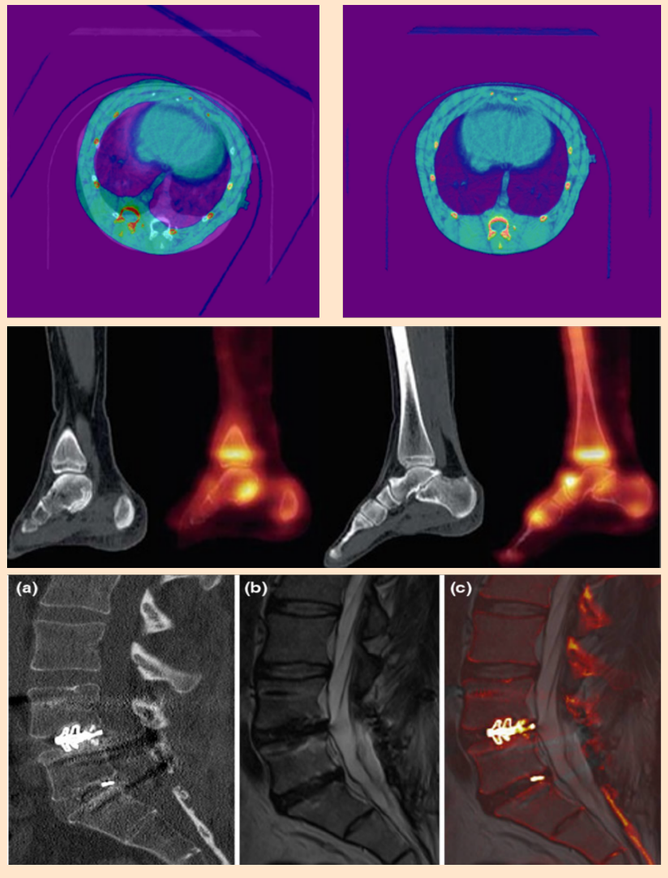
The first step of the research consisted in finding a registration algorithm that can be perform a fully automatic alignment. The image registration process can be seen as a cyclic optimization process, that ends when a cost function, called similarity measure, is minimized. Two different approaches where studied to find the transformation matrix that relates fixed and moving dataset: feature-based and intensity-based.



Intensity-based Image Registration

This method is based on matching the intensity patterns in each image using mathematical or statistical criteria. The sum of squared differences or cross-correlation between pixel intensity can be used as similarity metric if images have exactly the same gray levels. Instead, if a linear dependency can be assumed, entropy-based measures as Mutual Information are adopted.

A fully automated image registration and fusion tool for **Multimodal Biomedical Imaging Platform All-in-One**.

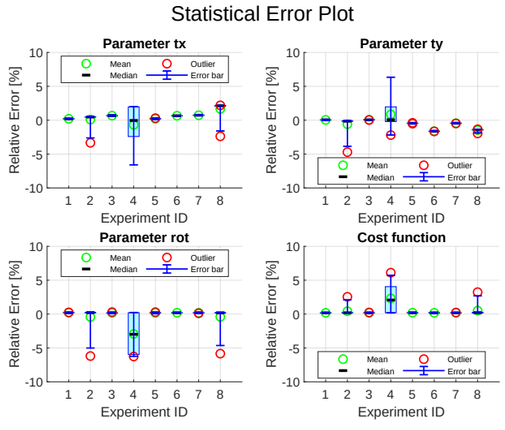


Feature-based Image Registration

This method is based on the keypoints matching between fixed and moving input image. A coarse-to-fine pyramidal framework has been adopted to identify features at different scale levels. In particular, the SIFT (Scale Invariant Feature Transform) has been used to detect keypoints that are invariant to different space orientation. Keypoints are than matched using a simple brute force matching, discarding all the outliers. The inverse of the transformation matrix that relates fixed and moving image is used to obtain the registration.

Results

Feature-based approach has revealed promising result in registering misaligned 2D CBCT slices with a known rigid transformation applied. A set of 8 experiments with different initial known misalignment has been performed. The same method is now going to be extended to 3D volumes.



This work will be integrated in a multimodal biomedical imaging platform all-in-one, designed for providing to physicians an easy and fast manipulation tool during surgery, pre-surgery planning, and post-surgery follow-up.

Vote here for this poster: