

Title: Combined Feature Ensemble Based Mutual Information (COFEMI) for Robust Multimodal Medical Image Registration (Technology 07-039)

Benefits

Clinical deployment of the COFEMI registration technique will provide a powerful tool for alignment of medical imagery from multiple sources. The implications of a robust multimodality medical image registration technique are significant in the following applications:

- Accurate image guided therapy for improved accuracy of cancer therapy and reduced side effects associated with invasive treatment options
- Validation of cancer drug efficacy and other treatment efficacy in terms of volume change following treatment and during treatment
- Highly informative image-based treatment planning systems by simultaneously visualizing multiple 3D diagnostic images
- Improved capabilities of computer assisted diagnosis systems by evaluation of cancer detection performance

Potential commercial use

Only a handful of companies claim to offer generalizable multimodal image registration software solutions for medical imagery. Although the offerings of multimodal registration solutions are limited and generally task specific, there are a myriad of clinical applications requiring robust and generalizable image registration solutions that are under development by major corporations. The applications include:

- Quantitative validation of diagnostic imaging systems via registration of histology (gold standard) with diagnostic imagery (e.g. MRI, CT). Computer aided detection applications will be in active development as the savings associated with fewer and more accurate biopsies will be in the thousands of dollars per patient screened for cancer.
- High resolution therapy guidance systems via online registration of high resolution diagnostic MRI with faster, low resolution interactive MRI typically used during therapy for guidance.
- Quantitative validation of drug and therapy efficacy via registration of images taken pre- and post-therapy or during the course of therapy. Development of cancer therapy drugs and other treatment systems represent an enormous research effort.
- Enhanced tumor/lesion visualization for treatment planning via registration of functional imagery (e.g. SPECT, PET, MRSI) for tumor distribution with high resolution structural imagery (MRI) for localization and visualization for tumor extent.

The technology

The simultaneous use of multiple diagnostic imaging modalities greatly assists the tasks of cancer therapy, treatment planning, and visualization. Combining information from different imaging modalities or protocols requires aligning, or registering, the images so that corresponding

tissue are in spatial alignment. In a clinical environment, multimodal image registration is both a more ubiquitous and complicated task than registration of images from the same modality. However, multimodal registration has not been sufficiently addressed, due in part to the variety of functional and structural imaging techniques (MRI, CT, US, histology, SPECT, PET, MRSI), but mainly because of the inherent difficulty in establishing correspondence on very different images. The COFEMI registration technique we developed provides the unique ability to robustly register images from very different modalities. In a clinical setting there is great need for the COFEMI method, which provides the following important and previously unfulfilled abilities:

- Alignment of images from different imaging modalities (e.g. MRI & SPECT)
- Ability to operate on images with severe artifacts
- Alignment of images acquired at different times (e.g. over the course of therapy)
- Fusion of multiple sources of image information (e.g. enhanced visualization of tumor)
- Applicable to any types of images
- Extensible to any image warping techniques

Preliminary Results:

We have developed novel methods to robustly register images from very different modalities and images affected by severe artifacts. The method has been demonstrated to outperform conventional registration techniques for prostate histology and MRI, as well as for brain T1 MRI and T2 MRI. Few methods have successfully addressed alignment of histology and MRI because of vast modality differences as can be seen between Figure 1 (a) and (b), as well as tissue inhomogeneity as can be seen in the top of Figure (b). Successful alignment will yield an alignment of the histology and MRI boundaries, outlined by the green and red contours respectively, however conventional techniques have been unable to to achieve correct alignment for this kind of task (Fig. 1(c)). Our COFEMI registration technique utilizes high-level texture feature representations of the images as in Fig 1(d) and (e) to provide correct alignment (Fig. 1(f)). The COFEMI technique has also been demonstrated to provide improved registration of brain images (Fig. 1(l)) for T1 MRI and T2 MRI (Fig. (g) and (h)) over conventional methods (Fig. 1(i)).

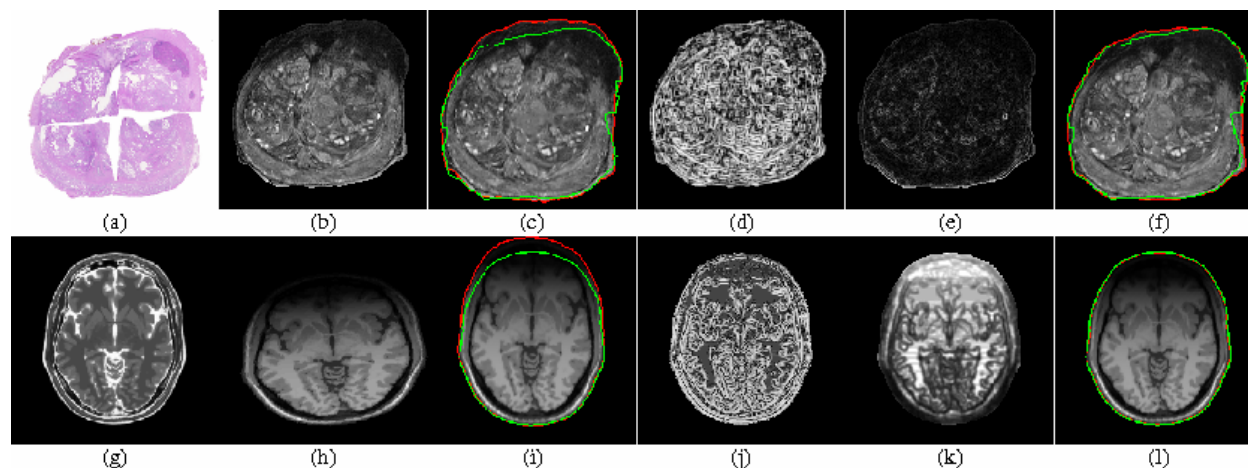


Figure 1: Multimodality image registration results.

We have successfully applied the above methods to determination of cancer location on prostate MRI from histology. This is an important task for evaluation of systems for computer assisted diagnosis of cancer from medical imagery. Figure 2(a) shows cancer location on histology. Prostate MRI (Fig. 2(b)) is registered to histology

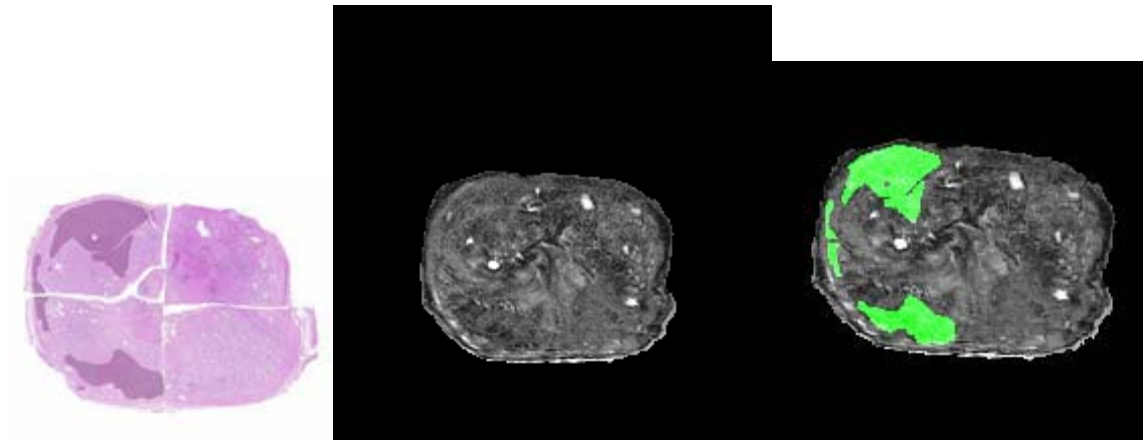


Figure 2: Evaluating MRI diagnostic systems using histology.

Research and Licensing

The intellectual property associated with the technology is available for licensing. Further details about Dr. Madabhushi's research are available on his homepage <http://coewww.rutgers.edu/~anantm/>.

Patent Information

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