IMAGE PROCESSING TECHNIQUE FOR WIRELESS CAPSULE ENDOSCOPE DETECTION

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Abstract

We propose a multiscale elastic image registration incorporating an affine pre-registration for wireless capsule endoscope (WCE) imaging motion. It includes registrations that capture both rigid-like and non-rigid deformations, due respectively to the rigid-like WCE movement and the elastic deformation of the small intestine originated by the gastrointestinal peristaltic movement. Under this approach a qualitative information about the WCE speed can be obtained. Moreover by using projective geometry, the scale and rotation parameters resulting from the registration scheme, can be related to the capsule orientation and displacement.

Introduction

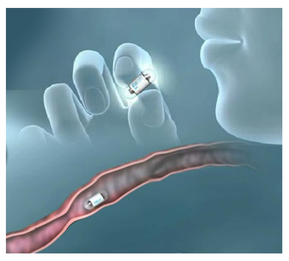

Fig. 1: The WCE procedure.

WCE is an imaging technique that permits physicians to examine all the areas of the gastrointestinal tract, and in particular the small intestine which is an organ that is not easily reached by conventional endoscopic techniques. However, the WCE precise location in the human body during its operating time is not know. Therefore, when an abnormality is detected, in the WCE images, medical doctors do not know precisely where this abnormality is located relative to the intestine and therefore they can not proceed efficiently with the appropriate therapy. As the WCE is propelled by peristalsis, the motion of the walls of the small intestine, in consecutive frames, is a consequence of a combination of two types of movements [2]: the WCE movement, which is rigid-like, and the non-rigid movement of the small intestine (that is an elastic organ that bends and deforms as a consequence of the peristaltic movement). We propose a new procedure [1], for measuring the motion of the walls of the small intestine between consecutive frames, that takes into account the combination of these movements.

Proposed Approach

In a first step a parametric pre-registration is performed at a coarse scale, and gives the motion that corresponds to an affine alignment of two consecutive images, thus matching the most prominent and large features, and correcting the main distortions, originated by the WCE movement. In the second step, and based on the result of the first step, a multiscale elastic registration is accomplished. This second step corrects the fine and local misalignments generated by the non-rigid movement of the gastrointestinal tract. Moreover we further enhance the quality of this approach by iterating it twice.

Results

The results of the tests and experiments evidence a better performance of the multiscale elastic image registration compared to the multiscale parametric image registration, to the real objective of WCE localization and orientation, when elastic deformations are involved (which is the realistic scenario since the capsule motion is driven by peristalsis). The multiscale parametric image registration is similar to other existing approaches [3], that essentially rely on affine correspondences between consecutive frames, and consequently are only capable of capturing rigid-like movements.

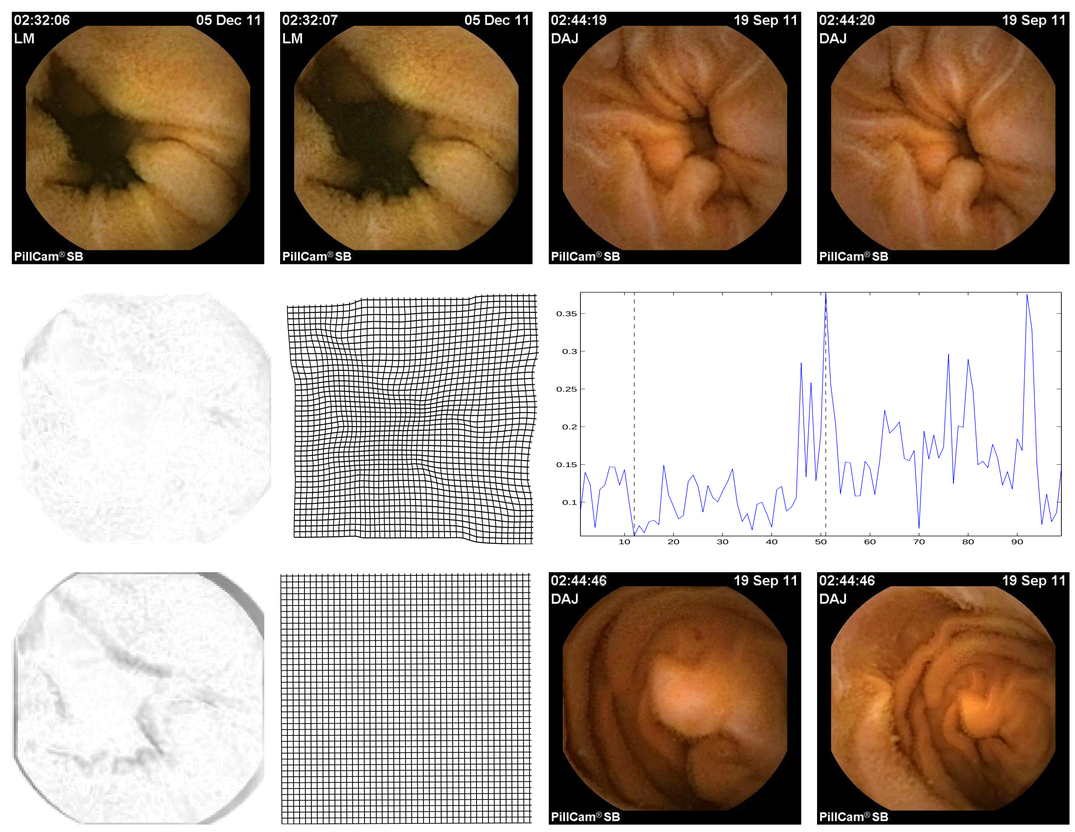

Fig. 2: From left to right, up to down: (first two columns) original template T and original reference R; difference between registered T and R, and deformed grid obtained with the proposed approach and with the multiscale parametric image registration; (last two columns) pair T and R with the biggest similarity in a WCE video with 100 frames; qualitative speed estimation of the capsule during the WCE video; pair T and R with the lowest similarity.

References

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[2] H. Liu, N. Pan, H. Lu, E. Song, Q. Wang, and C.-C. Hung, Wireless capsule endoscopy video reduction based on camera motion estimation, *Journal of digital imaging*, vol. 26, pp. 740-741, 2013.

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