MOSAICING OF CONFOCAL MICROSCOPIC VIDEO SEQUENCES: LARGER FIELD OF VIEW AND STILL HIGHER RESOLUTION

Tom Vercauteren[1,2], Anne Osdoit[1], Aymeric Perchant[1] and Sacha Loiseau[1]

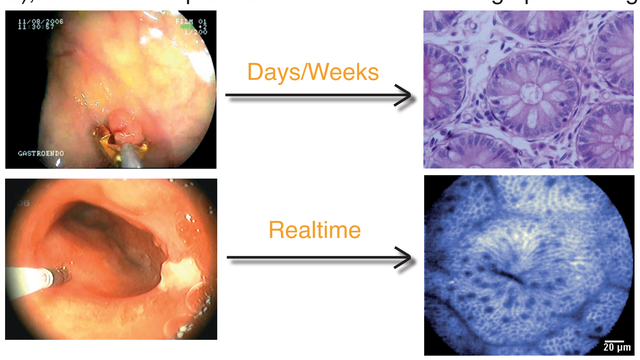
[1] Mauna Kea Technologies, 9 rue d'Enghien, Paris, France
[2] Asclepios research group, INRIA, 2004 Route des Lucioles, 06902 Sophia-Antipolis, France

Abstract

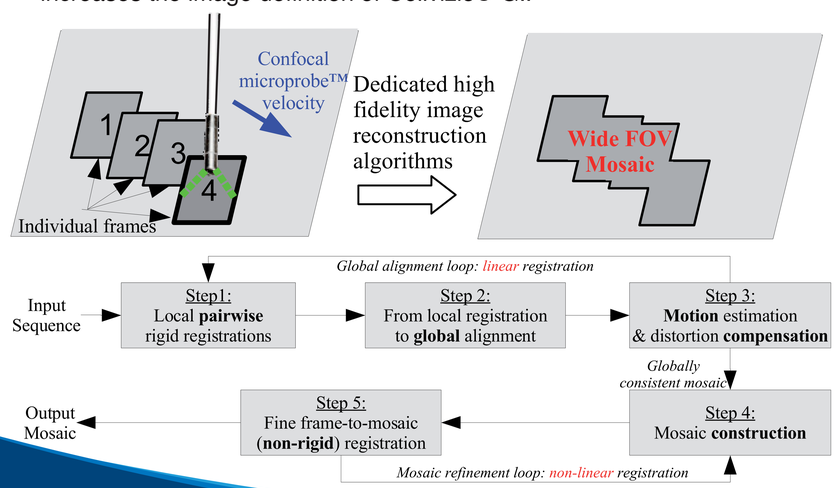
The development of Cellvizio®-GI (Mauna Kea Technologies, Paris, France), a "through the scope" confocal fluorescence microscope, makes it possible to obtain microscopic *in vivo* dynamic sequences during endoscopy procedures. Recent improvements allow the stitching of successive video frames to reconstruct images with a larger field of view and higher resolution.

Material and Methods

Cellvizio®-GI is the result of technological breakthroughs in different fields and is composed of 3 main elements: a Laser Scanning Unit (LSU), Confocal Miniprobes™ and a real-time image processing software.



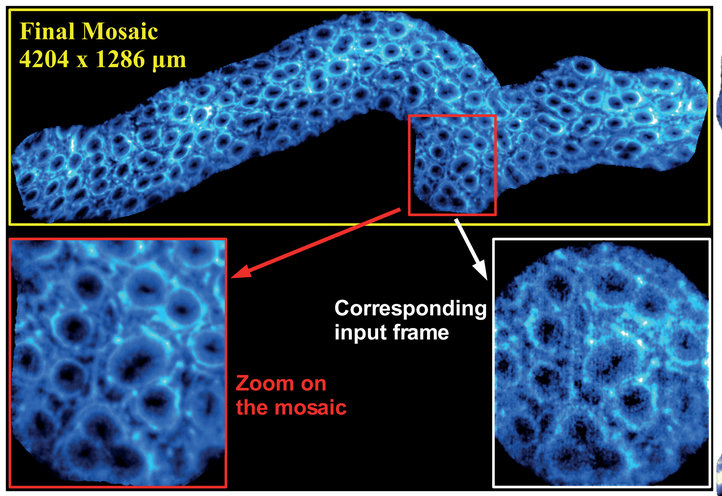
Cellvizio®-GI provides the clinician with a smooth dynamic microscopic view of the tissue in its natural surroundings. However the miniaturization of the device imposes a trade-off between the field of view (several hundreds of micrometers) and the scanning frame rate. In order to go beyond this trade-off, we have developed mathematical image processing algorithms which can automatically combine together successive moving images, cancel motion artifacts, and reconstitute wide FOV images of the tissues. To image and explore a region of interest, the confocal miniprobe is simply glided along the tissue. Our post acquisition algorithm does not only bring a fantastic increase of the field of view but can also boost the detectivity and eventually increases the image definition of Cellvizio®-GI.



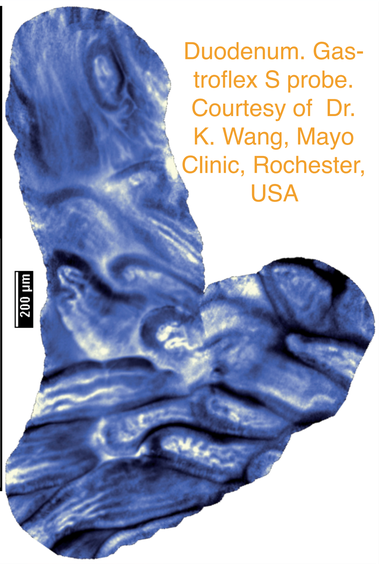
Overview of our mosaicing framework

Validation of our method was first performed by using a computer numerical control milling machine to glide the miniprobe over a known object with a prescribed micron-precision trajectory. We have compared the trajectory that our algorithm recovers with the one imposed by the milling machine. The accuracy of our method is of the order of the resolution of Cellvizio®-GI. Our mosaicing algorithm has further been extensively evaluated *in vivo* in the clinical setting.

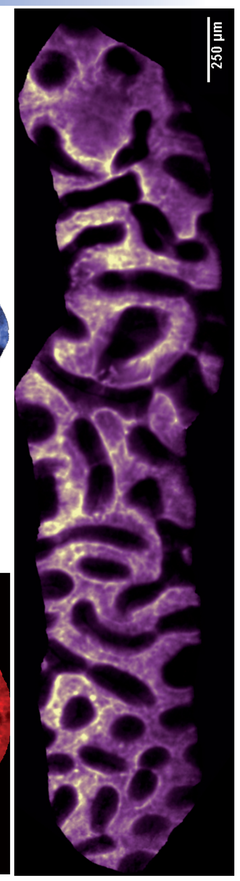
Results

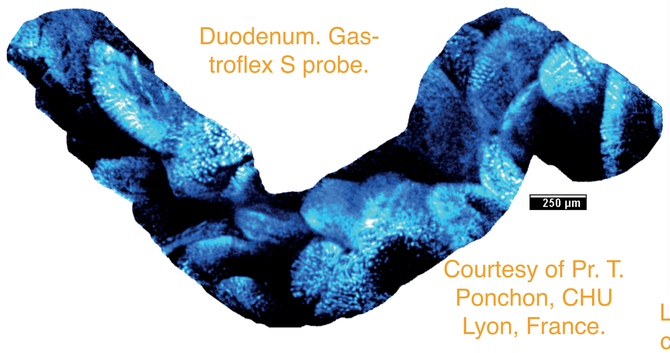


Lymphocytic colitis. Coloflex Z probe. Courtesy of PD. Dr A. Meining, Klinikum rechts der Isar, Munich, Germany.



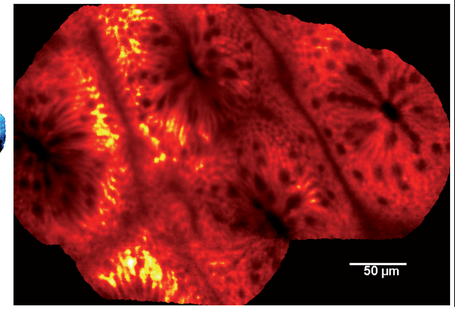
Duodenum. Gastroflex S probe. Courtesy of Dr. K. Wang, Mayo Clinic, Rochester, USA





Duodenum. Gastroflex S probe.

Courtesy of Pr. T. Ponchon, CHU Lyon, France.



Left: Normal colonic mucosa, Coloflex MiniO probe. Right: From colon to ileum. Coloflex Z probe. Courtesy of PD. Dr A. Meining.

Contributions and Conclusions

Used in combination with any video endoscope, Cellvizio®-GI provides dynamic sequences with a cellular resolution. The extended field of view obtained with the mosaicing algorithm fills the gap between the macroscopic scale of the video sequence and the micro-architectural features of the examined mucosa, resulting in more accurate interpretation. Further work is being performed to integrate this algorithm during examinations.

References

- T. Vercauteren, A. Perchant, G. Malandain, X. Pennec, and N. Ayache. "*Robust mosaicing with correction of motion distortions and tissue deformation for in vivo fibered microscopy.*" Medical Image Analysis, vol.10, no.5, Octobre 2006.
- L. Thiberville, S. Moreno-Swirc, T. Vercauteren, E. Peltier, C. Cavé, and G. Bourg Heckly. "*In Vivo Imaging of the Bronchial Wall Microstructure Using Fibered Confocal Fluorescence Microscopy.*" Am. J. Respir. Crit. Care Med., Vol. 175, No. 1, January 2007.
- A. Meining, S. Schwendy, V. Becker, R.M. Schmid and C. Prinz. "*In vivo histopathology of lymphocytic colitis.*" Gastrointestinal endoscopy, in press.
- A. Meining, D. Saur, A. Osdoit and R. M.Schmid. "*Real-time endomicroscopy of the upper GI-tract using a portable confocal miniprobe – a feasability study.*" United European Gastroenterology Week 2006.
- T. Kikuchi, Y. Saito, H. Shoda, T. Matsuda, T. Gotoda and D. Saito. "*Diagnostic possibility of confocal microscopy with the Cellvizio-GI system.*" United European Gastroenterology Week 2006.
- S. Friedland, R. Soetikno, J. Liu,P. Sahbaie, M. Singh, J. Crawford, C. Contag and T. Wang. "*Novel Fiberoptic Confocal Fluorescence Microendoscope.*" Digestive Disease Week 2006.