Visual Servoing for Robotic Endoscopic Capsules

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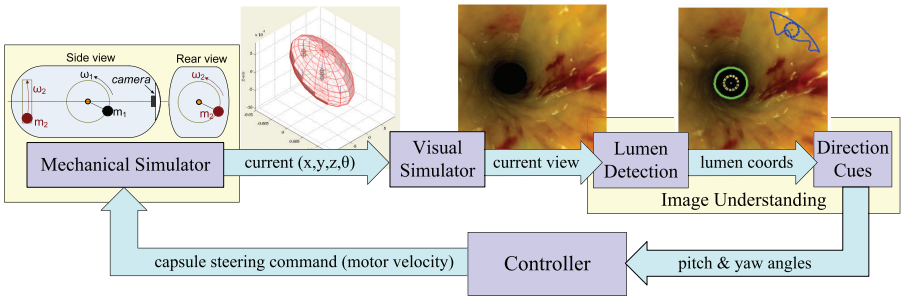

FIGURE – Simulation framework of the visual servoing scheme.

Abstract:
The clinical practice in capsule endoscopy is based on passive capsule propulsion inside the gastrointestinal tract (GIT) by peristalsis. Current research aims at endowing these devices with means of active locomotion, transforming them to full-fledged robotic systems, with locomotion, sensing, powering, control and data transmission capabilities. However, this necessitates the involvement of the medical personnel, performing the examination, also in the navigation of the capsule through the GIT. It becomes, therefore, desirable that certain, potentially cumbersome, aspects of this task, such as traversing long segments of the GIT, be automated, at least to some extent.
To this end, our group has been investigating the use of visual information, obtained by the real-time analysis of the images acquired from the capsule's on-board camera, for implementing capsule steering by appropriate visual servoing techniques [1-2]. Such image-based control strategies, for navigating the capsule by aligning its line-of-sight with the GIT, based on the detection of the intestinal lumen in the acquired images, have been developed and adapted to active locomotion of the capsule, either by on-board vibratory actuation or by external magnetic fields. Extensive modeling and simulation studies have been performed, focusing on the interaction of our devices with the GIT, the image acquisition and analysis process and the controller design [3]. The overall simulation framework is illustrated in the above Figure. The use of such strategies for robotic capsule devices is currently being investigated, also based on the findings of ex-vivo and in-vivo tests of related experimental prototypes [4-6].

References

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