Augmented reality and 3D measurement for monocular laparoscopic abdominal wall hernia repair

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Background:
Let be a hand-held monocular camera ---or endoscope--- observing an unknown rigid cavity. It is a classical result in computer vision that, up to a scale factor, both a 3D cavity model (map) and the camera location with respect to the map can be computed solely from the gathered image sequence. Only recently are there available algorithms to routinely perform this computation robustly and in real time. These algorithms collectively referred as SLAM (Simultaneous camera Location And Mapping).
The research is focused in exploit monocular SLAM in hernia repair surgery. On one hand the defect size and hence mesh patch size is computed solely from the endoscope images. On the other hand augmented reality procedures to help the mesh alignment with respect to the defect are researched.

Material/Methods:
Translating endoscope observing the defect and a known size tool image sequence is gathered. 2 points over the known size tools and 5 points over the hernia defect boundary are clicked. The defect is modelled as an ellipse defined by two axes. The computer estimates two axes modelling the defect and also the two axes defining the mesh patch. In an additional screen the endoscope image sequence is augmented with a superimposed defect location and also the computed mesh so that the surgeon can anticipate the region where the mesh will be located. The estimated defect size is compared with respect the classical measurement methods both in terms of accuracy and surgical time. The utility of the augmented reality is qualitatively assessed by the surgeons.

Results:
We have performed seven procedures which show the feasibility of the proposed method.

Conclusions:
SLAM makes the surgery easier, because it does precise measurements, lets the surgeon check the wall defect and allows treatment by covering it completely with the mesh.