



GBT

# ENDOSCOPIC VIDEO ANALYSIS FOR SURGICAL TRAINING, OBJECTIVE EVALUATION AND IMAGE-GUIDED SURGERY

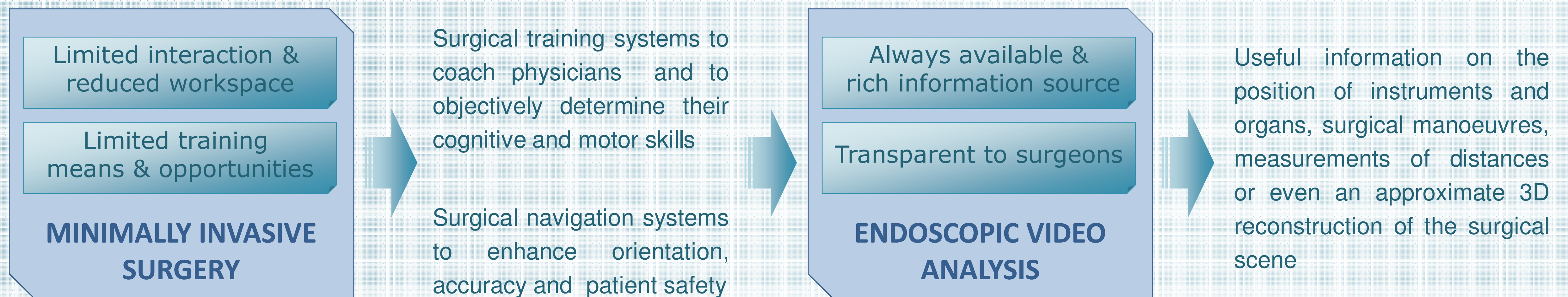
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## Abstract

Automatic analysis of Minimally Invasive Surgical videos has the potential to drive new solutions to develop safe and reproducible training and assessment programs and provide new tools for surgical navigation, thus improving patient safety. Surgical video is an always available source of information, which can be used without any additional intrusive hardware in the operating room. Our research efforts are focused on two key aspects, the 3D reconstruction of the surgical field and the segmentation and tracking of tools and organs based on video analysis.

## Rationale



## Methodology

### NON-INTRUSIVE OBJECTS' TRACKING

- ✓ Traditionally, object tracking is achieved by devices based on mechanical, optical, acoustic or electromagnetic technologies.

#### ORGANS' TRACKING

- Automatic segmentation process quite challenging: interreflections, specularities, lack of sharp borders.
- Shading as an additional segmentation criterion.
- Simplified illumination model: light source and camera located in the same spatial point.
- A split and merge technique is chosen as the evolution strategy.

#### TOOLS' TRACKING

- Endoscopic images affected by vignetting and barrel distortion.
- Correction method to define a rectification mapping function.
- Tools' segmentation algorithm:
  - ROIs detection: analysis of both colour and geometrical properties.
  - Edges detection: laplacian and Hough/Radon transforms.

- ✓ They disturb surgical workflow and ergonomics, which may compromise patient safety.
- ✓ Surgical video analysis: non-intrusive alternative for tracking.

## Results

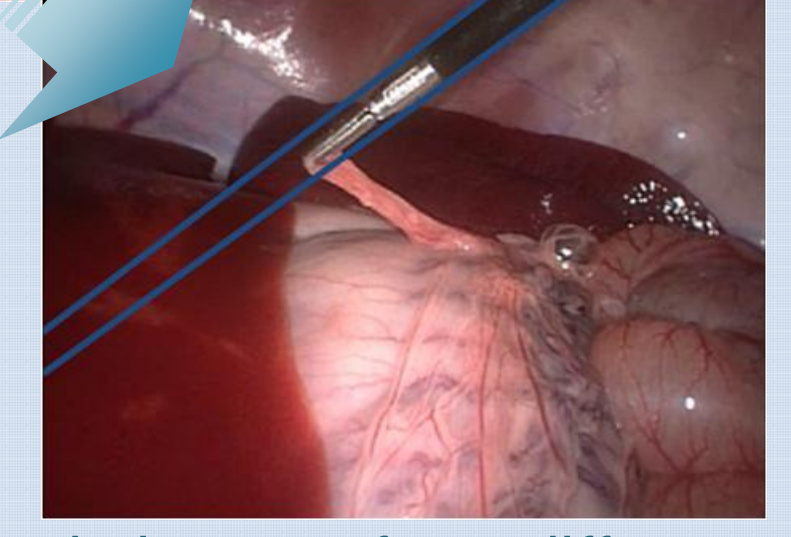
### NON-INTRUSIVE OBJECTS' TRACKING

#### ORGANS' TRACKING



- The method is able to segment both large organs, i.e. liver or spleen, and anatomic details such as vessels.

#### TOOLS' TRACKING



- Laparoscopic images from different scenes as validation setting.
- Good accuracy valid for non-real time applications, i.e. skills' evaluation.

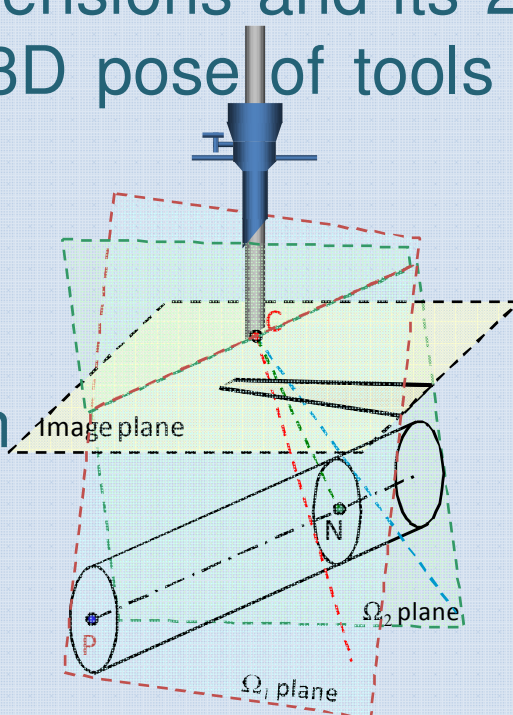
### 3D RECONSTRUCTION OF SURGICAL SCENE

#### SCENE RECONSTRUCTION

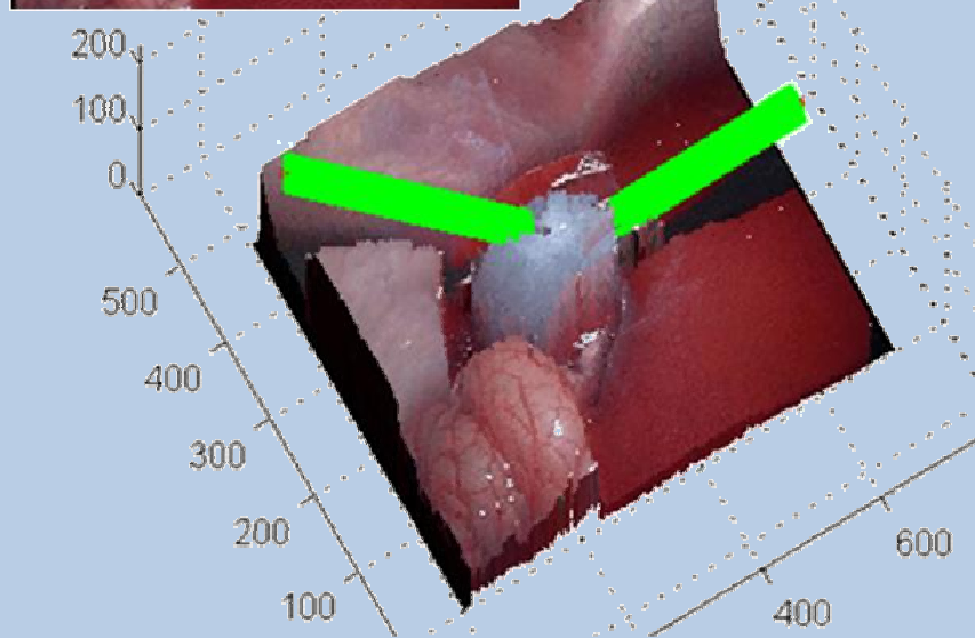
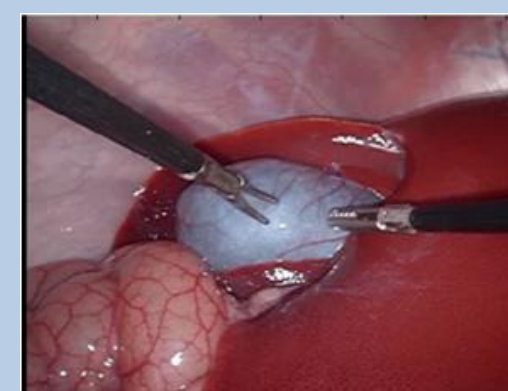
- Reconstruction problem using shading information.
- Aim: to achieve the relative depth map associated to the laparoscopic image.
- Depth information is contained in the shading, that is, in the gradient of the image intensity.
- Integration of differential increments from adjacent pixels.

#### TOOLS' 3D LOCALIZATION

- Knowing tool cylindrical geometrical dimensions and its 2D projection real 3D pose of tools is calculated.
- Description of the geometrical relation between tools and the optical centre of the camera.



### 3D RECONSTRUCTION OF SURGICAL SCENE



- ✓ With shading information it is not possible to determine absolute depth of the whole surgical scene.
- ✓ Influence of reflections and specularities.
- ✓ Necessity of combination of shading, motion and texture cues.
- ✓ Medium-term vision : to achieve robust and instantaneous automatic video analysis algorithms.

## Conclusions

- ✓ MIS video analysis can be improve surgical training by including overlays with tools' movements information, positions of anatomical structures and directions to follow in the surgical scenario.
- ✓ MIS video analysis is essential for extraction of relevant information of the intervention and for creating real-time image guided surgery systems without adding extra technology components in the OR.

## Contact

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