Surgical Robotics : 2nd Summer European University, Montpellier, France

September 7th-14th 2005.

Performance Evaluation of a CRS Robot Manipulator Applied to 3D-Ultrasound Imaging

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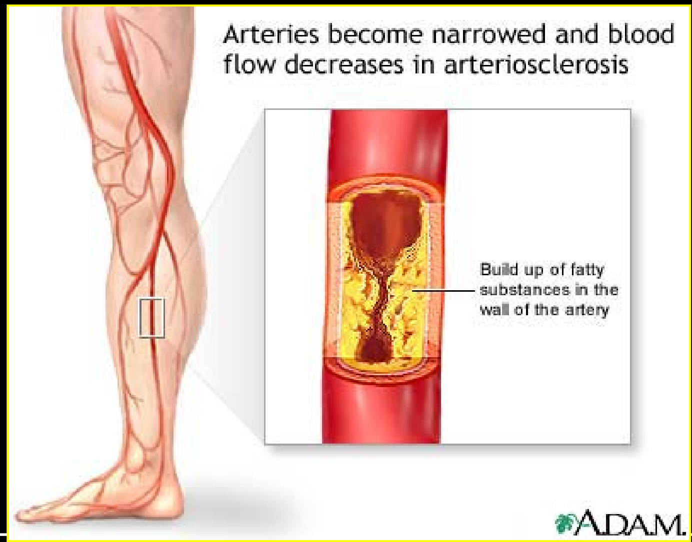
Clinical application

- Cardiovascular diseases are the leading cause of death for over 1/3 of Canadians.
- Degree of stenosis is the mostly used criterion to assess atherosclerosis.
- Appropriate therapy planning requires a complete 3D representation of the lower limb vessels.



http://adam.about.com/encyclopedia/18077.htm (29/08/225)

3D-US Systems

- US offers many advantages :
  - Low cost, non invasive, non-ionic, less traumatic, safe, painless, real-time, convenient, multiple analysis option.
- 2D-US does not provide an accurate evaluation of the 3D geometry !!!

http://www.phlebologia.com/en/anatomie_classique_04.asp (29/08/2005)

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Problem

- Most 3D-US freehand tracking devices are not optimally adapted for quantifying a stenosis in lower limbs.
  - To identify tight stenoses in lower limbs, a scanning of high precision is required over a long segment.

Objectives

- Evaluate the performance of a new medical prototype robot in terms of accuracy and repeatability.
- Evaluate the feasibility of accurate stenoses quantification with the robotic system.

Materials & Method

Prototype Medical Robot System

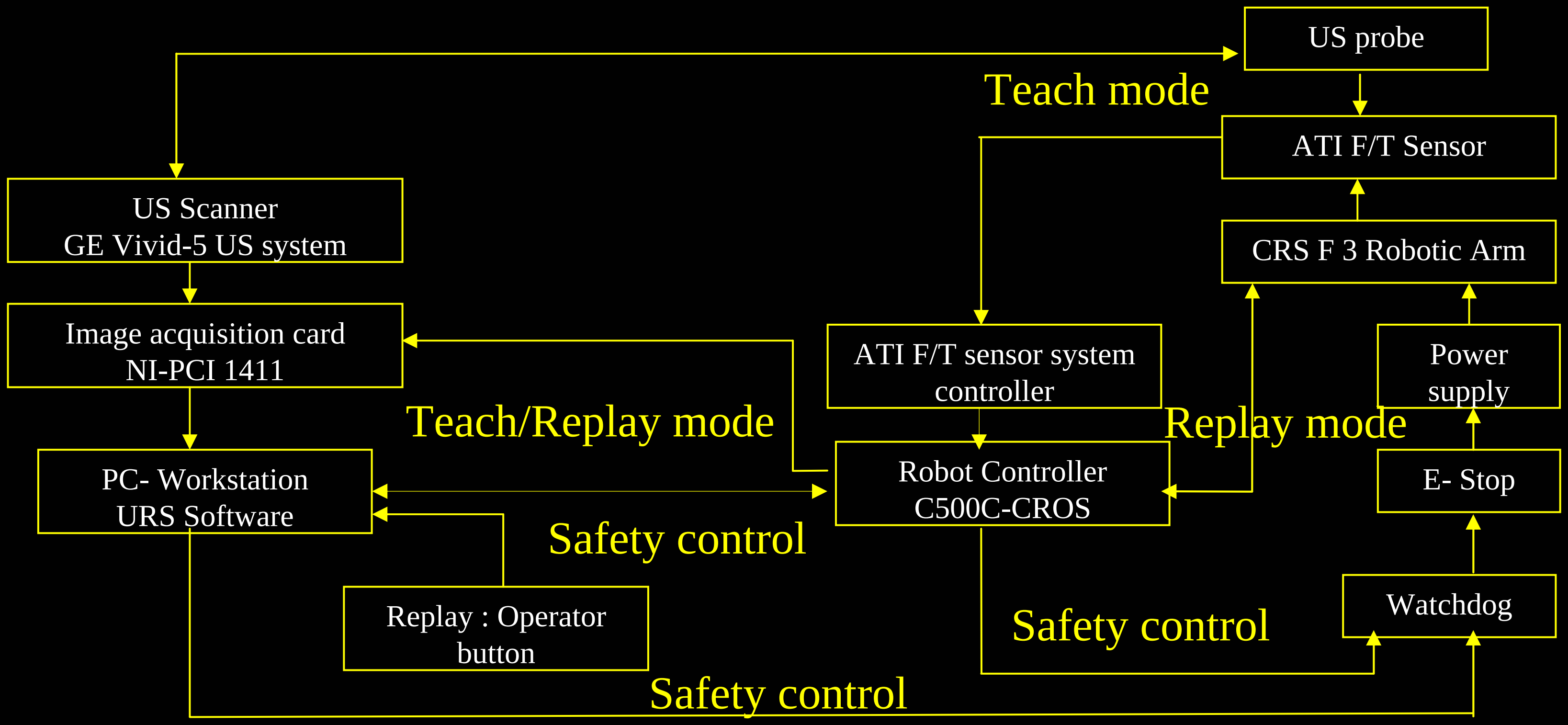
US Scanner

Robotic Arm

PC Workstation

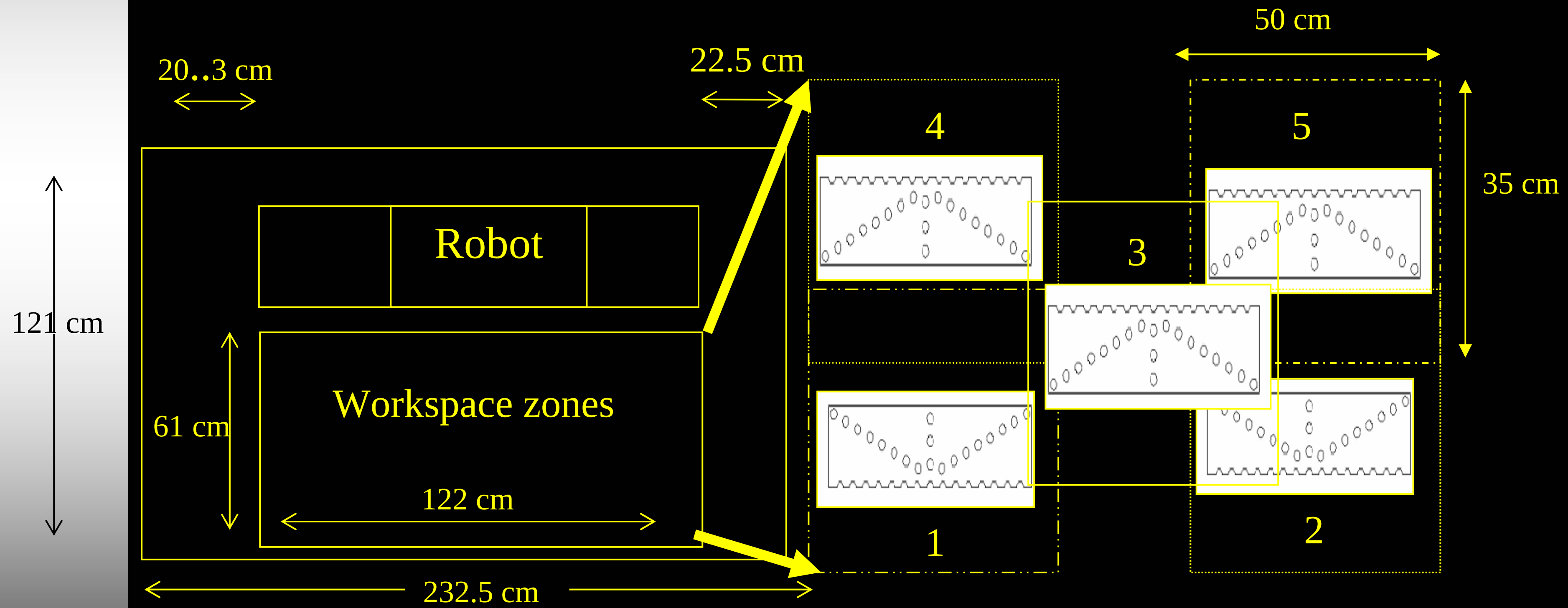
Materials & Method

Prototype medical robot architecture



Materials & Method

Designated experimental zones

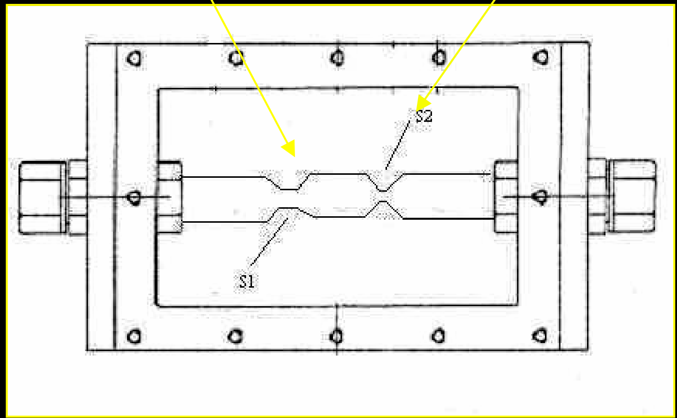


Materials & Method

Preliminary 3D-reconstruction with a vascular phantom.

1st stenosis 79.5%

2nd stenosis 69.9%



Vascular phantom (Cloutier et al., Med. Phys., 2004)

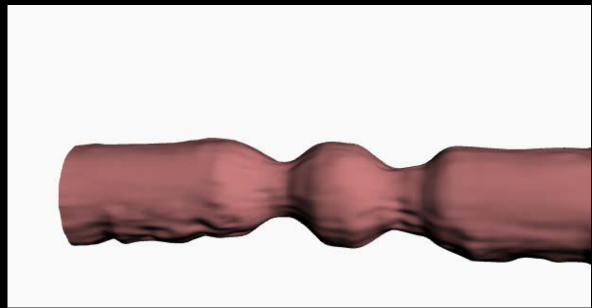
Results/Discussion

Performance evaluation

Zones	Mean repeatability	Replay mode accuracy	
		Mean positioning	Mean inter-distance
1	0.0091±0.13	0.72±0.30	0.0036±0.53
2	0.12±0.26	0.56±0.27	0.0033±0.44
3	0.086±0.18	0.61±0.29	0.0027±0.54
4	0.14±0.30	0.63±0.34	0.0024±0.69
5	0.081±0.16	0.58±0.22	0.0035±0.50
Mean	0.10±0.22	0.62±0.29	0.003±0.54

Results/Discussion

Preliminary 3D-reconstruction



Area ratio reduction of the lumen vessel	Phantom model	3D-Reconstruction	Ratio Error
Stenosis 1	79.5 %	76.03 %	3.47 %
Stenosis 2	69.9 %	70.77 %	0.87 %

Acknowledgments

- This work was supported in part by Canadian Institutes of Health Research (CIHR).
- This project was produced with the collaboration of an industrial partner : Integral Technologies Inc. , Laval, Québec, Canada (www. Integraltek.com).