Enhanced Simulation for the daVinci System

Group 6

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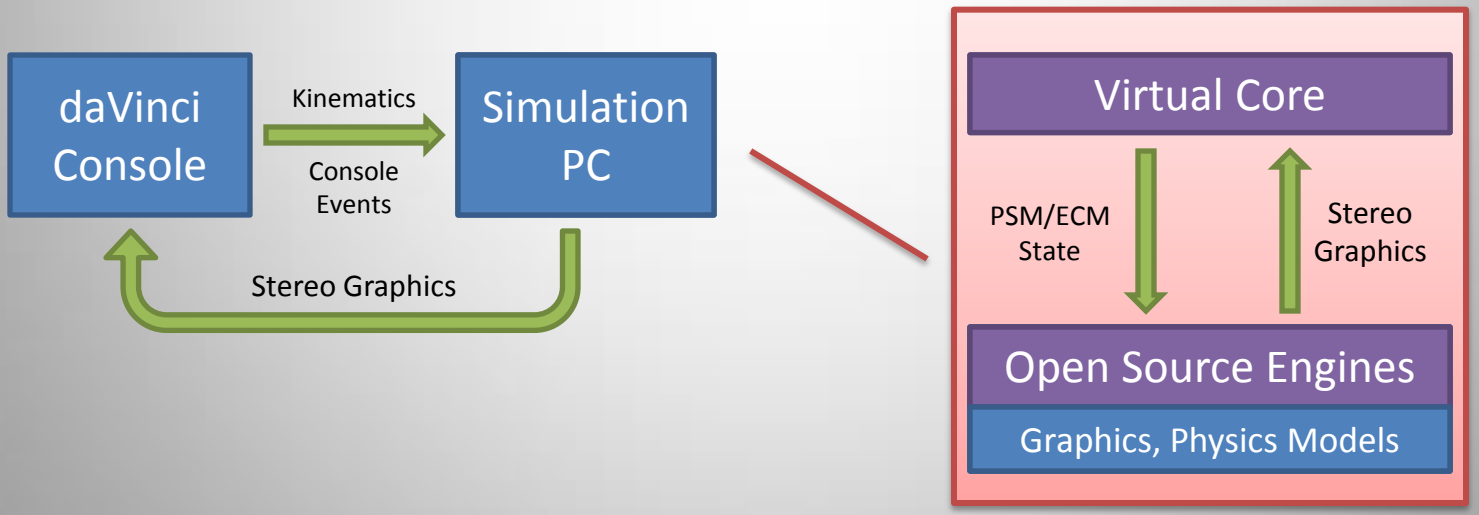
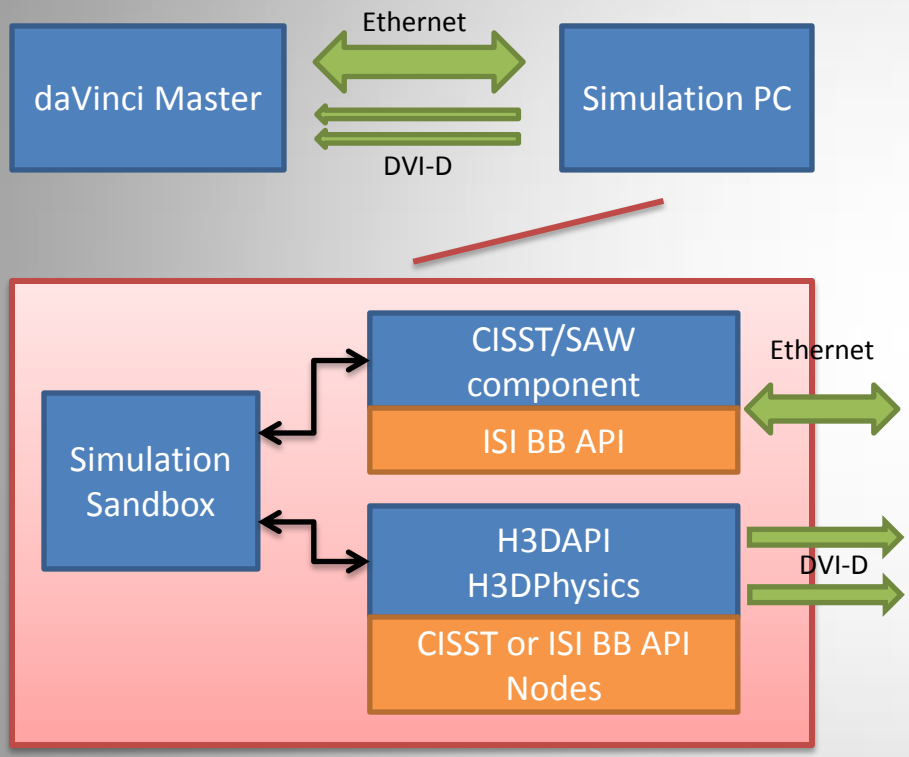
Recap Slide!

- Develop a simulation framework for the daVinci System using Open Source dependencies (except ISI API)
  - CISST-SAW [5,6] (developed at ERC-CISST, JHU)
  - H3DAPI [7]



Recap (cont'd)



Significance:

- Develop new object models and newer applications
- Generate ground truth easily
- Patient specific simulation for procedural planning

Papers

[1] Robotic Surgery Training with Commercially Available Simulation Systems in 2011: A Current Review and Practice Pattern Survey from the Society of Urologic Robotic Surgeons

Costas

Journa

Reviews the existing (2011) robotic surgical simulators!

[2] Current Status of Validation for Robotic Surgery Simulators – A Systematic Review

Hamid , Ben Challa

Journa 194-205, February 2013

Reviews the validation studies (Sept. 2011) for robotic surgical simulators!

Relevance

- Good to have knowledge of the competitive technology in surgical simulation (robotic)
- Surveys involved provide insight on needs of the surgical society
- In final form, this project would need a validation study too!

Terminology

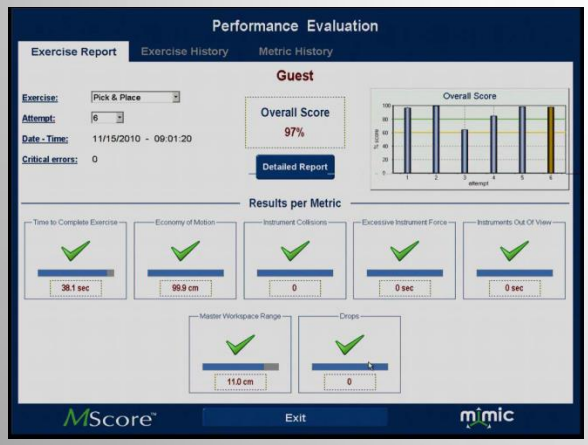
- Face Validation
  - Extent to which examination resembles the situation in real world
- Content Validation
  - Extent to which intended content domain is being measured by the assessment exercise
- Construct Validation
  - Extent to which a test measures the trait it purports to measure

daVinci Surgical System: Anastomosis task[3]

daVinci Skills Simulator: Anastomosis Task (Tubes)

Terminology (cont'd)

- Concurrent Validation
  - Extent to which results of a test correlate with the gold standard
- Predictive Validation
  - Extent to which an assessment will predict future performance



Mscore – automated skill assessment[4]

- OSATS (Likert scale 1-5)
  - Respect for Tissue
  - Time and Motion
  - Instrument Handling
  - Flow of Operation
  - Knowledge of Procedure
  - …

OSATS – subjective skill assessment

Robotic Surgical Simulator (RoSS)[5]

Simsurgery Educational Platform (SEP)[6,7]

LapVR [8]

dV-Trainer [9]

daVinci Skills Simulator (dVSS) [4]

Materials and Methods

- Both papers performed a MEDLINE literature search with keywords:
  - Robotic surgery
  - Simulation
  - Virtual Reality
  - Validation Studies
- [1], also sent out a blinded survey to members of the Endourological Society regarding training and VR simulation
- [2], additionally searched in EMBASE, PsychINFO, EAU, AUA databases

Comparison of Simulators [1,2]

Simulator	RoSS	SEP	dV-Trainer	dVSS
Hardware	Comparable to actual console	No console, monitor, arm board, CPU	Desktop w/ simulated pedals on floor	Actual Si console with backpack
Face Validation	✓	✓	✓	✓
Content Validation	✓	✓	✓	✓
Construct Validation		✓	✓	✓
Procedural Modules	HOST (Hands-On Surgical Training)	(Laproscopic Simulator)		
Cost (additional annual service)	$120,000	$62,000	$158,000	$89,000 (without console)

Properties of Simulators [1,2]

- All contain certain attributes:
  - Stand-alone simulator independent of vision cart and robot
  - Vision monitor for user/tutor to critique
  - Minimal cost of operation (no consumables required)
  - Relative freedom from operating room
- Some exceptions
  - Utilization of the daVinci Si console in case of dVSS
  - HOST technology of RoSS
  - Absence of camera, clutching, fourth arm, needle control, energy dissection in SEP

VR Simulation Survey [1]

- Sex, Age, Surgical discipline, Experience
- Awareness/access – robotic surgery simulation
- If access:
  - Type of simulator
  - Education Program Curriculum
  - Source of funding for purchase
- Reasonable Cost?
- Role in Training
- Largest obstacle

Responses [1]

- Only 65 out of the ~ 1200 recipients responded
- Demographics (fairly representative):
  - Majority males
  - > 40% in practice over 15 years
  - ~ 75% were involved in training
- Simulator:
  - ~ 25% have access to simulator at their institute
  - Majority have dVSS (released in 2011!)
  - > 90% believed in an expanding/advanced role in training
  - > 80% consider current pricing unreasonable

Discussion on Validation Studies [2]

- Lack of standardization of metrics to measure simulator quality
  - scale for face validation, definition of expertise
- Scale of the studies remains small (max 46 subjects)
- Variability and inconsistency in statistical methods
- Parameters like concurrent validity, predictive validity, feasibility, reliability have not been evaluated

Issues with Robotic VR Simulators [1,2]

- Absence of Procedural components
  - HOST, only such application on RoSS that takes the trainee through a virtual procedure while keeping them engaged on the console
  - No evidence of improving performance in real-setting!
- High Cost
  - Concerns magnified with the annual maintenance fee
  - Departmental funding limited
  - Surgeons are happy with current training curricula
  - Not incorporated at large scale at institutions

Limitations of the Reviews [1,2]

- May have missed some relevant validation studies
- Paucity of reports related to:
  - Head-to-head comparison of VR simulators
  - Several components of simulator like cost effectiveness
- Formal analytical results not possible due to different measurements for studies
- VR simulation as part of surgical training – still to be determined!

Critique

- Extensive search of literature
- [2], first of a kind review
- Excellent job of explaining the existing simulators
- Both papers conclude with the need for
  - Procedure based simulation
  - Complex skill evaluations
  - Large scale validations
  - Low cost simulations

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Thank you!

Questions?