BUNRAKU

Perception, decision and action of real and virtual humans in virtual environments and impact on real environments

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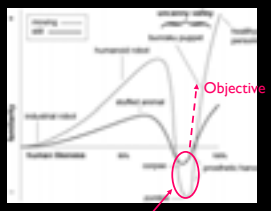
Why Bunraku ?



Form of traditional Japanese anthropomorphic puppet theatre

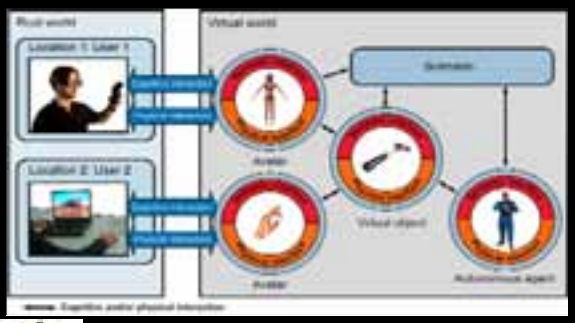
Actual situation of real-time virtual humans

Team Composition in october 2008

- 3 Professors : B. Arnaldi, K. Bouatouch, Y. Beckers
- 3 Researchers : S. Donikian, A. Lécuyer, J. Pettré
- 6 Assistant Professors : R. Cozot, T. Duval, G. Dumont, V. Gouranton, F. Lamarche, M. Marchal
- 2 Visiting Researchers : S. Gibet, M. Christie
- 2 Collaborators: F. Multon, R. Kulpa
- 2 Research Engineers : A. Chauffaut, C. Bouville
- 2 Post-doc: N. Ouarti, Z. Gao
- 18 PhD students: …
- 13 Technical staff: …

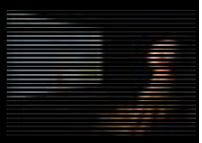
- Total : 51

Overall Objective of our Research Team



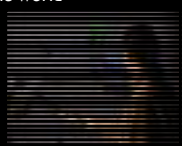
Our challenges

- Increase cross fertilization between two complementary research thematics
  - Virtual Reality and Virtual Humans
- Allow Real and Virtual Humans to naturally interact in a shared virtual world
- Combine two kinds of interaction of different nature: cognitive and physical

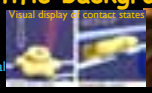


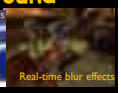
Complementary Research Thematics

- Multimodal Interaction with objects within the world
  - A generic multilevel model of an object
  - Multimodal rendering
    - visual, haptic, audio, cognitive
  - Acting on the objects of the world
    - language, gesture, mind
- Expressive Autonomous Characters
  - Complex and believable movements for human-like characters
  - Unified architecture to model individual and collective human behaviors
- Interactive scenario languages

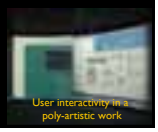


A pluridisciplinary scientific background

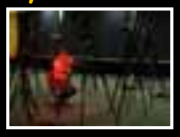




- Object modelling
  - Physics: B. Arnaldi, G. Dumont, M. Marchal
- Rendering
  - Visual (Computer Graphics and Optic): K. Bouatouch, R. Cozot
  - Haptic (robotic, cognitive sciences): G. Dumont, A. Lécuyer, M. Marchal
- Interaction
  - 3D Interaction (Man-Machine Interface): T. Duval, A. Lécuyer
  - Collaboration (distributed architecture): T. Duval, V. Gouranton
- Virtual human
  - Motion control (biomechanics): F. Multon, R. Kulpa
  - Behaviour (artificial intelligence, behavioural and cognitive sciences): S. Donikian, F. Lamarche, J. Pettré
- Scenario
  - Languages (Computer science): Y. Bekkers, S. Donikian
  - Interactive drama (literature, cinema, theatre): S. Donikian



Hardware and software platform for Virtual Reality

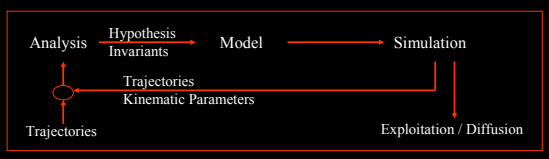


OpenMASK: an open source VR middleware

http://www.openmask.org

Analysis and Synthesis Approach for Virtual Humans

- Use an Analysis/Synthesis approach to model human characteristics:
  - Locomotion, reactive navigation, path planning, …

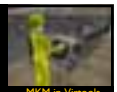


Different application areas



- Industry
  - Simulation
  - Training
  - Collaborative work
- Sport
  - Sport Performance Analysis
  - Sport Training
- Narrative & interactive Arts Works
  - Video Games
  - Interactive Drama
  - Interactive Choreography

On-going Collaborative Projects


MKM in Virtools

- Open-Vibe: open-source software architecture for Brain-Computer Interfaces [2006-2009]
- PERF-RV2: french platform (21 academic and industrial partners) about VR Technology to study the human activity inside a digital factory [2006-2009]
- Simulem: microscopic simulation including user activity in train stations [2006-2008]
- System@TIC Competitiveness Cluster: use of VR for the Digital Factory
  - Integration of human motion control and behaviour inside Virtools [2005-2009]
- Part@ge: Leader of the french Platform on Collaborative interaction in VR. [2007-2009]
- GVT: Generic Virtual Training for maintenance activities [2002-2010]

New Projects [2008-2010]

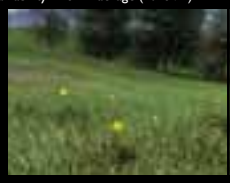
- LOCANTHROPE [2008-2010]
  - Computational foundations of human locomotion
  - Multidisciplinary research project (Robotics, Neurosciences, Biomechanics, VR)
  - Partners: LAAS, LPPA (Collège de France), M2S
- SIGNCOM [2008-2010]
  - Sign-based Communication between real and virtual agent
  - Partners: Valoria, FT R&D Rennes et Lannion, M2S, IRIT, Polymorph
- FET Open NIW [2008-2010]
  - Natural Interactive Walking
  - Partners: Univ. McGill (Canada), Université Paris 6 (France), University of Verona (Italy, leader), University AAU (Denmark)

New Projects [2009-2011]

- FP7 European Network of Excellence IRIS [2009-2011]
  - 10 Academic partners working on Interactive Storytelling
  - Leader of the Hybrid Intelligent Virtual Actors Work Package
  - Partner of the Cinematography Work Package
- PEDIGREE [2009-2011]
  - 4 Academic partners working on Crowd Simulation
  - Calibration of macroscopic and microscopic models
  - Comparison of different models & Micro-macro combination
- Coll@viz [2009-2011]
  - 18 Academic and Industrial Partners
  - Open Source Platform for remote collaborative multi-domain pre/post-processing

International Collaborations

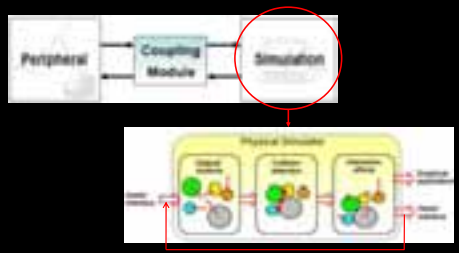
- Member of the core group of the FP6 European Network of Excellence INTUITION [2004-2008]
  - 60 industrial and academic partners
  - Leader of the Haptic Working Group and Sustainability Work Package (EuroVR)
- Associate team on Real-Time Rendering and Augmented Reality
  - University Central Florida (S. Pattanaik)
- Associate team on Virtual Humans and Augmented Reality
  - State Key Lab CAD & CG (Q. Peng)
- JST/CNRS on Virtual Reality
  - The University of Tokyo (M. Hirose),
  - Keio University (M. Inami, P. Codognet)
- PHC on the use of dynamics for athletic movements
  - University of Edinburgh (T. Komura)



Focus on research activities

Multimodal Interaction with objects within the world

Haptic interaction



Contact forces computation

- Differential equation of dynamics: Newton's laws

$$M(q)\ddot{q} = Q(q,\dot{q},t) + R$$

q: configuration parameter
M: matrix of mass
Q: external forces
R: sum of contact forces

- No contact
  → classical temporal integration (R = 0)
- R is unknown: associated by duality, to the contact geometry equation
- ➔Problem: how to solve the system?

Contact
Insures the non penetration

$$\rightarrow \begin{cases} v_{n,at} \geq 0 \\ r_{n,at} \geq 0 \\ r_{n,at} \bullet v_{n,at} = 0 \end{cases}$$

Friction
Force in the friction cone

$$\rightarrow \|r_{t,at}\| \leq \mu r_{n,at}$$

For relative motion

$$\rightarrow r_{t,at} = -\mu \left(v_{t,at} / \|v_{t,at}\| \right)$$

Impact
Normal restitution

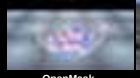
$$\rightarrow v^{+}_{n,at} \geq -e\, v^{-}_{n,at}$$

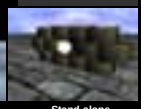
Tangential restitution

$$\rightarrow v^{+}_{t,at} \geq -e\, v^{-}_{t,at}$$

Experimental Platform: ConF&TiS

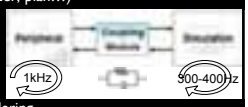
- Collaboration – Bunraku and Siconons teams (INRIA)
- Multibody and Multicontact [Renouf, 05]





OpenMask Stand-alone

- Prototype:
  - Dynamics: non smooth
  - Approache: time stepping
  - Objects: basic ones (cube, sphere, cylinder, plan…)
  - Collision Detection: primitive-primitive
  - Numerical Solver: Lemke, NLGS, QP



- Framework:
  - Haptic interface
  - Experiments on stability and haptic rendering

Integration of Vision and Touch in Virtual Reality Setups

[Congedo, Lécuyer and Gentaz, Presence, 2006]

- Influence of Spatial Collocation?

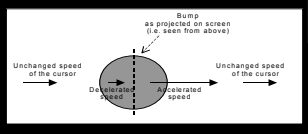
vs

- Perceptive weighting between visual and haptic information
  - Psychophysical experiment
  - Vision overweights haptics when delocated
  - Illustrations
    - Colocated
    - Delocated

Pseudo-haptic feedback

[Lécuyer et al., IEEE VR 2000], [Lécuyer et al., ACM CHI, 2004]

- Simulate haptic sensations without using a haptic device ?
- Use visuo-haptic integration
- Example : pseudo-haptic textures
- Change the Control/Display ratio

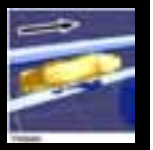


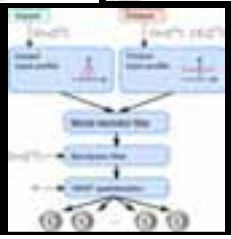
http://www.inria.fr/tactiles

Multimodal rendering techniques

- Visual Feedback of contact
- Audio feedback : spatialized feedback of impact and friction

Illustration



[Sreng et al., IEEE TVCG, 2006]
[Sreng et al., ACM VRST, 2007]

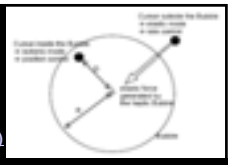
Haptic vibrations

- 6DOF Haptic rendering of complex industrial simulations
- Improvements of 6DOF impacts :
  - 6DOF High-Frequency force transient
  - Rendering techniques to convey the contact position information


$\Gamma_f(t) = \Gamma_{cf}(t) + \Gamma_v(t)$

[Sreng et al., EuroHaptics, 2008]

Haptic Hybrid Control



- Improve haptic interaction in large scale workspaces (Problem illustration)
  - Use hybrid Position/Rate control
  - Force feedback emulates elastic input device in rate control

Bubble Technique

Other Solutions
Task clutching
Hybrid Approach

[Dominjon et al., Visual Computer, 2008]
[Dominjon et al., IEEE VR, 2007]

Brain Computer Interaction

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General principal of BCI

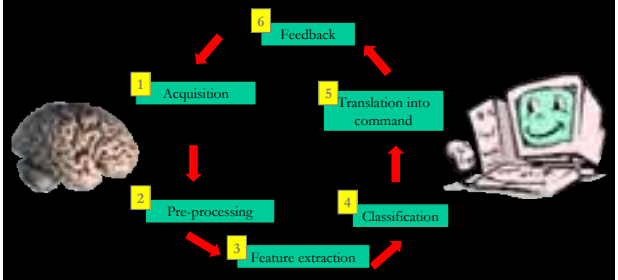
- How identifying the "brain pattern" ?
- Reconstruct, from EEG, the volume information

EEG → Preprocessing → Feature Extraction → Classification

- Preprocessing → Frequency and spatial filtering
- Feature Extraction → Activity in specific brain regions (using source localization)
- Classification → Linear classifier

ENS Cachan, october 2008

Brain-Computer Interface



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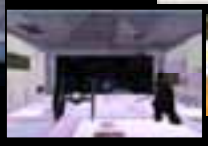
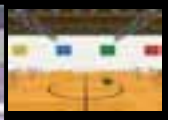
Virtual Reality and BCI

- Improve Learning and Neurofeedback with VR
- 3D Interactive visualization of brain activity
- 3D Interaction techniques for BCI-based VE



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ANR OpenViBE

- « Brain-Computer Interfaces » and Virtual Reality (2005-2009)
- Partners: INRIA, INSERM, CEA, GIPSA-LAB, AFM, FT
- Many Research results
  - Neurophysiology
  - Signal Processing
  - Interaction with a Virtual Environment
- Development of an integration platform for the results of the ANR OpenViBE project
  - A software platform to easily design, test and use BCI and Neurofeedback applications
  - A software platform for *real-time Neuroscience :*
    - *real-time and on-line* processing of cerebral data (EEG, ECoG, MEG, etc)

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Main Features of the Integration Platform

- A generic signal acquisition server (EEG, MEG)
- Various signal-processing algorithms
- Visualization tools
- A scenario designer
- Several existing scenarios
  - Neurofeedback
  - BCI based on motor activity (Graz-BCI)
  - BCI based on P300 (P300 speller - soon)
- VRPN plug-in

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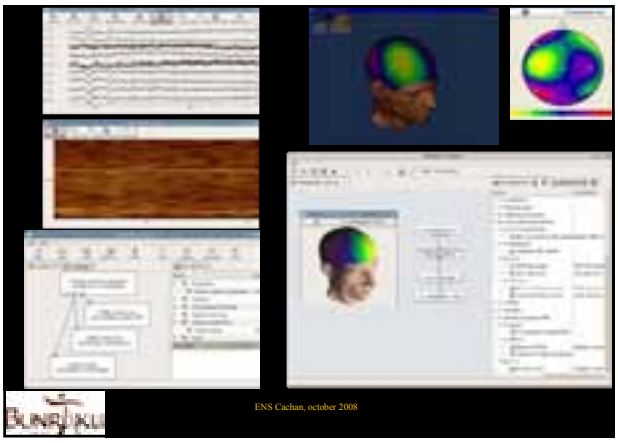

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Illustration

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Modelling Virtual Humans

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A big difference between real-time virtual humans and those used in movies and other precomputed image sequences

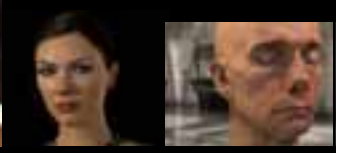
Kaya, 2001, brazilian artist

Kayahi.mov

Alone with wolf, June 2006, N+N Corsino

Differences are less and less important, but still there

- Manual Animation
  - Hand-made
  - Good control on the character expressivity
- Real-time Animation
  - Model based on real-data (3D scanner, motion capture)
  - Problems when the character is animated
  - Human behaviour is still missing

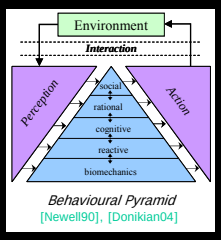


Real-Time Virtual Human

- Real-Time is an extremely high constraint in Virtual Reality
- Real-Time Virtual Human is:
  - either a fully or partial representation of the user in the virtual environment (the avatar)
  - or an autonomous character independant from the user but useful to simulate complex environments populated with several characters.
- Both can be of course combined together

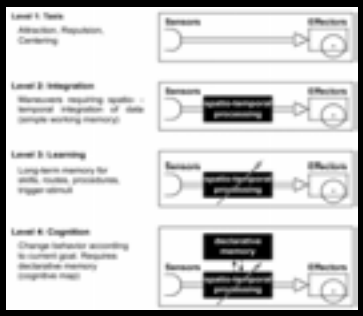
What is needed to model an autonomous virtual human?

- Individual Approach (autonomous agent)
- A Hierarchy of Perception – Decision – Action loops



Behavioural Pyramid
[Newell90], [Donikian04]

Kinds of Behaviour [Mallot99]



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Behavioural Psychology

- Theory of Control
  - Information feedback [Frese&Zapf 94]
  - Hierarchical nature of control systems [Lord &Levy 94]
  - Concurrency [Hoc 87]
- Memory Models [Atkinson & Shiffrin 68, Baddeley Hitch 74, Shallice 82]
- Theory of Activity and Attentive Coordination [Clancey02]
- Unified Theories of Cognition [Newell90, Anderson et al. 98 & 03]
- Embodied and Situated Cognition [Keijzer02, Ziemke02, Vogt02]
- Ecological Approach to Visual Perception [Gibson79, Warren95, Hirose02]
- Navigation and Spatial Cognition [Tversky 81 & 01, Tom & Denis 03, Wiener & Mallot03]

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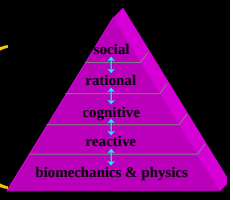
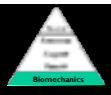
Modelling Virtual Humans

- Integrate the richness and complexity of human motions and behaviors
- Combine bottom-up and top-down controls
- Develop goal-oriented behavioral simulators

Team Research Activities



Move



- Direct and inverse kinematics [Tolani et al. 2000]
- Inverse Kinetics [Boulic97, Baerlocher et al. 2001]

- Replay of Motion Capture Data

MKM: Character Animation Engine

Joint work with M2S (Common Lab Univ. Rennes 2 & ENS Cachan)

Advantages

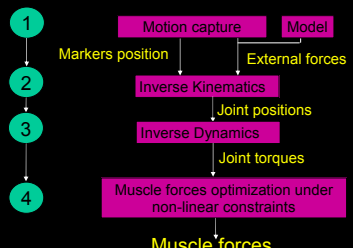
- Real-time animation of several hundreds of virtual humans
- Automatic motion blending & synchronization
- Adaptable to any kind of human skeleton
- Real time movement adaptation to
  - Different morphologies
  - External kinematic constraints (footprints…)
  - Kinetic constraints (center of mass)
- Locomotion and other models of movement
- Intuitive control

Live demo

Already used by Dassault Systèmes in real case studies

- Digital Factories

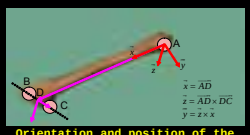
From Motion Capture to Muscles Forces in Human Elbow [Pontonnier08]



Motion Capture protocol

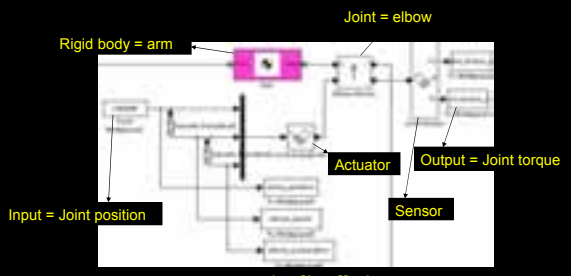
Motion capture situation

- Based on *H-anim* protocol (www.h-anim.org)
- The subject plays prescribed tasks, such as elbow extension



Orientation and position of the humerus from motion capture markers

Inverse Dynamics



Zoom on the elbow flexion implementation

Muscle forces optimization: elbow sample

For each frame :

$$\min f(F) = \sum_m \left(\frac{F_i}{(F_{\max})} \right)^2$$

$$F = (F_1, F_2, F_3, F_4)$$

Under Constraints :

$$h(F) = c - \sum_m F_i R_i = 0$$

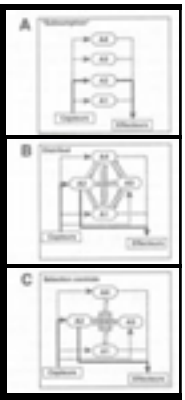
$$g_i(F_i) = F_i - (F_{\max})_i \le 0$$

- The cost function is the most efficient for a muscle force determination **[Challis 1997]**
- Use of the MATLAB fmincon() solver to perform the optimization
- Fmincon() is using Lagrangian formulation of the problem and Kühn-Tucker conditions

Attentive Coordination
[Clancey97, Berthoz03]

- An activity is not necessarily interrupted when requested
  - Hurried activity
  - External condition leading to interrupt what the person is currently doing.
- A Competitive Activation Mechanism is involved.
  - Termination and start of an activity are more subtle than just a goal oriented decision.
- There is no opposition between sequencing and parallelizing but a coupling.
  - Coupled sub-systems organize their activities together in real-time.
- Parallelism
  - Allow to combine several activities at the same time,
  - It is fundamental to couple behaviours and schedule their activities upon time,
- Serialism
  - Forces the treatment of orderly forms of sequences of action.

Action Selection [Berthoz 03]

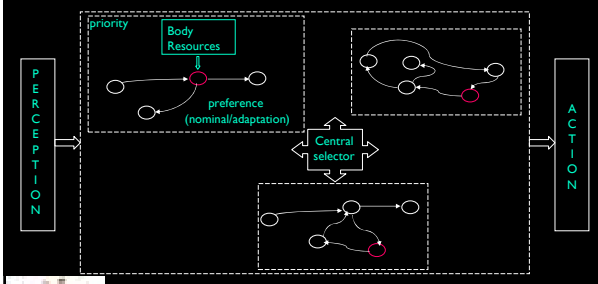


Three kinds of architectures have been proposed in the litterature for action selection:

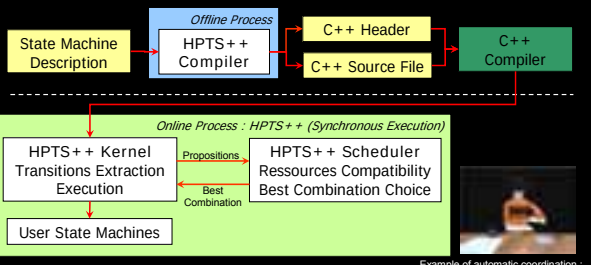
1. Subsumption : actions endowed with a hierarchical index allowing to select them automatically with respect to a fixed order.
2. Organization of actions in a network: reverse inhibitive connections.
3. Supervisor or central selector: selectively activate the circuits. Less connections, more flexibility.

Action Selection Mechanism
[Lamarche & Donikian 02]

- HPTS++ : modèle modulaire hiérarchique et parallèle



HPTS++: Action Selection Mechanism



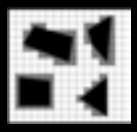
Example of automatic coordination : Reader, Smoker, Drinker

Advantages

- Independent behavior description
- No need of explicit communication between behaviors to handle adaptation
- Extensible and Hierarchical Library of Behaviors
- Automatic coordination of parallel behaviors
  - Based on resources, priorities and preferences
  - Allowing contextual adaptation of a behavior
  - Managing correct termination of a behavior upon request
- Dynamic activation/inactivation of behaviors

Represent the environment

- Discrete Approaches
  - Grid [Thrun96], Quadtree [Shao05]
    - Fast Access [Kuffner98] [Tecchia02]
    - Dependance of the discretisation precision [Andersen05]



- Exact Approaches
  - Delaunay Triangulation [Chew87], Filtered Delaunay Triangulation [Lamarche04]
    - Keep the original information

TopoPlan: Topological Planner for complex 3D Environments

3D Database
(Polygonal mesh)

Offline Process

TopoPlan
Spatial Subdivision

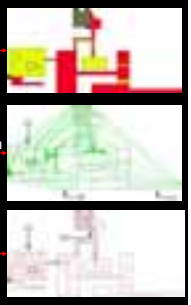
TopoPlan
Topology Extraction

Information on the mockup

Topology

Spatial subdivision

Roadmap



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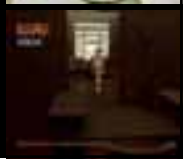
Advantages

- Fully Automatic 3D Spatial Subdivision (save time)
  - Exact subdivision (more precise)
  - Identifies floor and ceiling
- Topology Extraction (fully automatic)
  - Identifies homogeneous areas
  - Compute bottlenecks
  - Compact & optimal roadmaps
- Optimization of Trajectories in Real Time
- Efficient Spatial Queries



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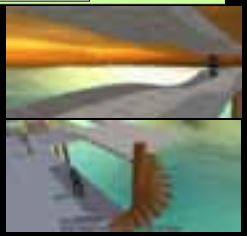
Joint use of the three components

Online Process

MKM
Characters Animation

HPTS++
Path Planning
Reactive Navigation
Posture Adaptation

TopoPlan
Kernel



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Advantages

- Real time path finding in complex environments
- Realistic footprints generation on the fly
  - Footprints computation depending on
    - the ground configuration
    - the morphology of the character
- Reactive control of beam avoidance
- Real-time adaptation to complex ceiling shape
- Automatic adaptation to virtual human morphology

Navigate

- Reactive Navigation
  - Local Adaptation
  - Rule based Models [Reynolds87]: *animation*
  - Particles Models [Helbing00]: *evacuation*
  - Predictive Geometric Model [Feurtey00]: *realism, complexity*
- Path Planning
  - Global Evaluation of the journey
  - Different criteria: *distance, deviation* [Hochmair05], *complexity* [Duckham03], *density* [Shao05], *stress* [Osaragi04]
    - No unified method

Reactive navigation: a predictive approach [Paris, Pettré, Donikian 07]

- Steering along the planned trajectory
  - Path smoothing through visual optimisation
- Parameterised Speed and direction optimisation to avoid collisions
  - Collision prediction thanks to linear trajectory extrapolation
  - Local adaptation to the environment topology
  - Local avoidance of dynamic obstacles
  - Proposes an ideal direction and speed
- Advantages
  - Generating a realistic trajectory along the planned path
  - Collision anticipation based on spatio-temporal prediction
    - Local adaptation to environment topology
  - Scalability: efficient data structures and low frequency computation

Path Planning: a Hierarchical Technique
[Paris & Donikian 06]

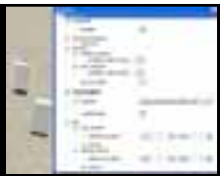
- Full path calculation in the more abstracted graph
- Local path refinement as the entity moves inside the environment
- 3 specializations for the full path calculation
  - Reach a unique identified target
  - Choose the best target between a set of identified ones
  - Explore to improve the knowledge of the environment
- Multicriteria Heuristic based on static data (path width & length, deviation angles, discovering potential) and dynamic data (densities and flows of people)
- On-going experiment to understand from real case studies how people plan their path in complex 3D buildings

Reasoning

- Long Term Goal Resolution
  - Situation Calculus [Funge99], STRIPS [Fikes71]
    - Combinatorial Complexity
  - Emotions and Motivations [deSevin06]
    - Physiological Needs
  - *Belief Desired Intention* (BDI) [Rao91]
    - Fixed know how

- Incarnation and situation of cognition are not treated (No link with the physical environment)
- Well known Symbol Grounding Problem [Harnad90]
  - An artificial system completely based on the manipulation of symbols cannot have access to their associated semantics.

BIIO [Paris PhD07]



- Behavioral Interactive and Introspective Objects
- Cognitive Tasks
  - Concurrent Atomic Processes (priorities)
    - Interact: complete management of an affordance
    - Move: management of default displacement
    - Observe: management of visual attention
- Goal Oriented Rational Model
  - manage all affordances
    - Rational Process classifying all interactions
    - Hierarchical Organization of affordances

Action on the environment

- Use motion capture data
  - Video games such as Sims2
- Specific Application Domain
  - Very specific and focused
  - Training:
    - STEVE Rickel et coll. 99]
    - GVT [Mollet et coll. 06]

Smart-Objects

- Objects contain all requested information for the interaction [Kallman 99, Kallmann 01, Abaci 06]
  - Information static and predefined before the simulation
  - Agent controlled by the object
  - Animations created in real-time

Our approach [Badawi04]

- Enable agents to interact with their environment
- The interactive object
  - Should inform the agent of the interactions it provides,
  - without taking the control on it.

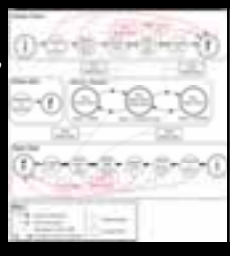
Geometric Environment
Action defined in the agent

Our Approach

Informed Environment
Action defined in the object

Our definition of « interaction »

- Which part of the object could be used ?
  → Interaction Surfaces
- Where should be located the agent during the interaction ?
  → Influence Surfaces
- How to use the object ?
  - What actions could be performed ?
    → Basic Actions
  - How to sequence actions ?
    → Complex Actions
  - inspired from the Schank's Theory of Conceptual Dependency



Architecture of our system called STARFISH [Badawi06]

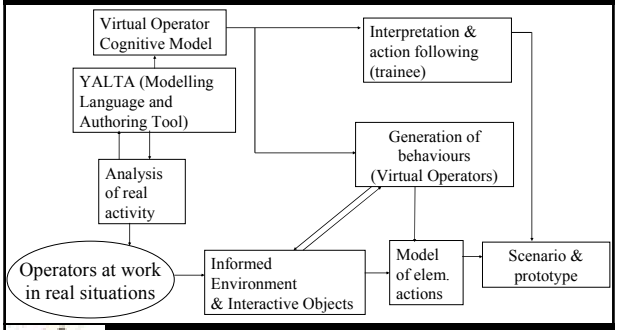
Model the Human Activity

- Objective
  - Model the cognitive activity of human beings working for an industrial process.
  - Develop and implement an internal model of this activity in the virtual environment
    - Program the behaviour of the virtual operator
    - Follow and help the trainee in a learning situation
  - Work on concrete cases coming from the industry

A new modelling language

- Development of a language called YALTA (Yet Another Language for Task Analysis) and its corresponding authoring tool
- Used to:
  - Describe individual and collective human activities
  - Describe functional objects
  - Describe the training scenario

Process Organization in YALTA



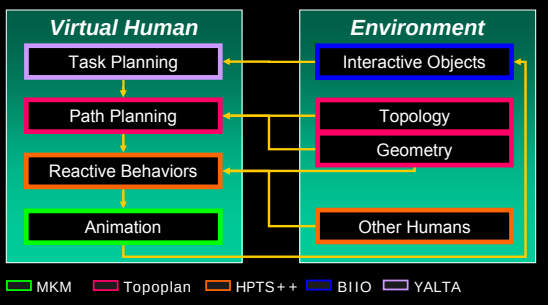
YALTA Objective

- Model the human cognitive activity
  - Situated in an industrial context
  - Studied by ergonoms and cognitive scientists
- Specification of a description language
  - Interface between models produced by ergonoms and C++ code generated for the behavioural simulation

Concepts of this new model

- Agents
- Roles
- Tasks
  - **Goal**: desired state of the environment
  - **Type**: category of task, such as mental, motor, pedagogical…
  - **Execution Conditions**: state of the world necessary to accomplish the task
  - **Initial Conditions**: state of the world wished before the task execution
  - **Stopping Conditions**: state of the world necessary to terminate the task
  - **Final Conditions**: state of the world wished after the task execution
  - **Duration**: duration of the task execution
  - **Priority**: dynamic priority function
- Events
- Relations

Behavioral Simulation Overview



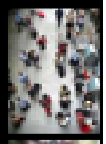
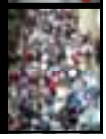
Multilayered Models

- Combine different layers of the behavioural pyramid in the same model [Goldenstein01]
- Evacuation [Pelechano03]
  - Behaviours:
    - High Level: *mental map, path planning*
    - Low Level: *reactive navigation*
  - ➢ Simple goals
- High scale [Moulin03]
  - Perception, knowledge and decision, navigation
  - ➢ Simplified Models
    - Thousands of virtual humans in real time
- ➢ No decisional aspectg linked with the interaction

A Goal Oriented Multi-layered Behavioral Simulator dedicated to Mobility Areas

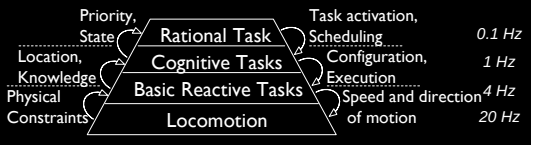
- Objective
  - Develop the first goal oriented simulation tool
    - dedicated to train station and more generally to transportation terminals
    - including all the human activity inside this restricted area



An Embodied and Situated Virtual Human [Paris08]

- Based on the Behavioral Pyramid
  - All processes are independant and only connected to the connex layers



Configuration of a simulation

- Population generation based on exploitation data, distribution of delay before departure, Origin Destination Graph, …

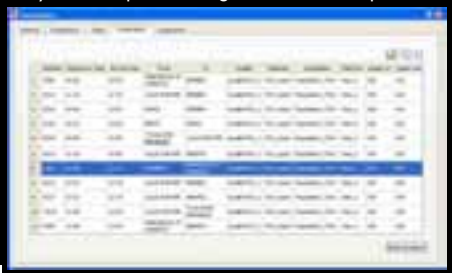
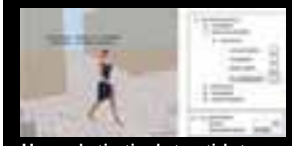


Illustration : the departure journey



Have a destination but no ticket

Go to a vending machine to buy it

Look at the timetable to find the lane, go to the lane, and validate her ticket.

ENS Cachan, october 2008

Running a simulation

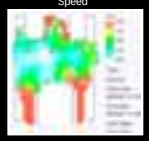
Queuing up to buy a ticket

Each virtual human interacts with others but behaves depending on its own goals

ENS Cachan, october 2008

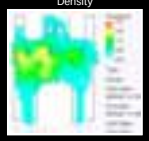
Exploitation of simulation results

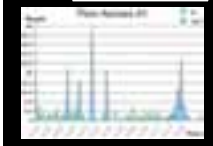
Speed

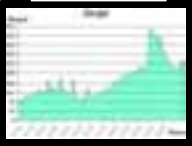


Jauge

Density







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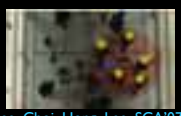
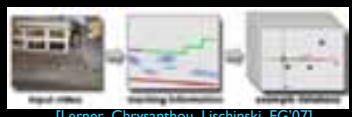
The Experimental Validation Problem

- Validate the proposed models
- Problem:
  - impossible to compare a virtual behaviour with a real one on complex examples
- Solution:
  - Statistical validation based on macroscopic data or mean data
  - Use real data to calibrate the model



[Lee, Choi, Hong, Lee, SCA'07]

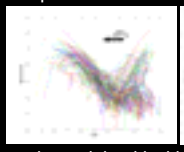


[Lerner, Chrysanthou, Lischinski, EG'07]

Experimental Studies

- Study interactions between two persons under different configurations

- Observation of micro-phenomena in micro-crowds



- Path-planning in complex multilevel buildings

Writing, Creating and Living Interactive Stories

Introduction

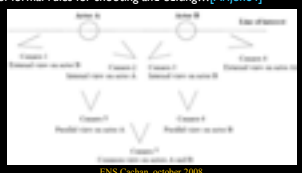
It turns out that it is at least as difficult to control an intelligent autonomous agent as it is to control a real actor. They don't necessarily do what you want them to do. So tools for choreography are just as important as anything else.

Jon Labrie, CTO at WETA
Lead animator
of the movie « Lord of the Ring »

Virtual Cinematography
[Courty et al. ICVS'03]

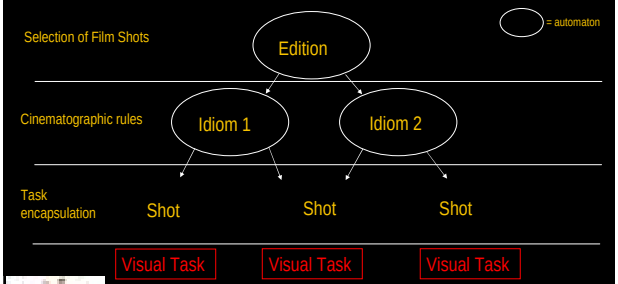
- Objective
  - Automatic screenshots of dynamic scenes
- State of the art
  - Non Real-Time Approaches [Christianson96]
  - Real-Time Approaches [He96, Funge99, Tomlisonn00]

⇨ Existence of formal rules for shooting and editing…[Arijon84]



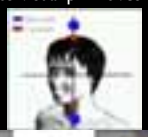
Hierarchical Structure

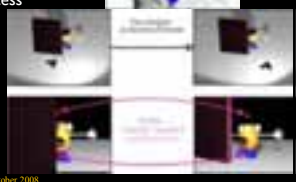
- Different Control Levels



Automatic shooting

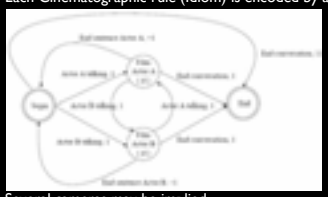
- Transcription of cinematographic rules into visual primitives
  - Selection of points of interest in the character depending on the chosen cutting height
    - From *extreme close-up* to *long view*
  - Occultation avoidance process



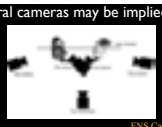


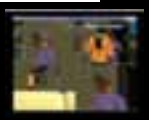
Film Idioms

- Each Cinematographic rule (Idiom) is encoded by an automaton



- Several cameras may be implied

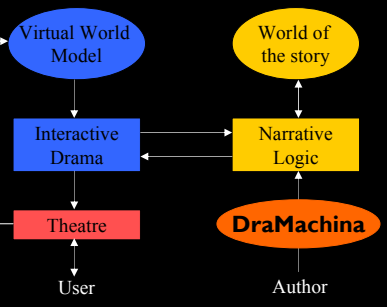




From Writing to Interactive Fiction: Simplification of the Adaptation Process

[Donikian & Portugal TIDSE04, Donikian 2006, Portugal 2006]

An authoring tool to help writing

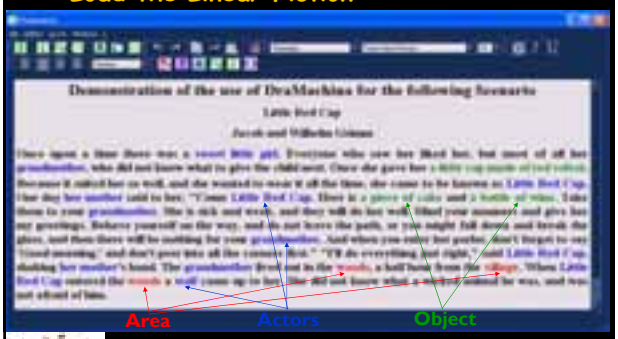


DraMachina: an Authoring Tool

- Dedicated to authors of Interactive Drama
- Let them manipulate the tale's key elements
- Assumptions:
  - Dialogs and the Granularity of Dramatic Actions are under the responsibility of the author.
  - The story generation is under the common responsibility of the author and the user.
  - To write an Interactive Story: start from the analysis of its linear version, what we call a protostory.

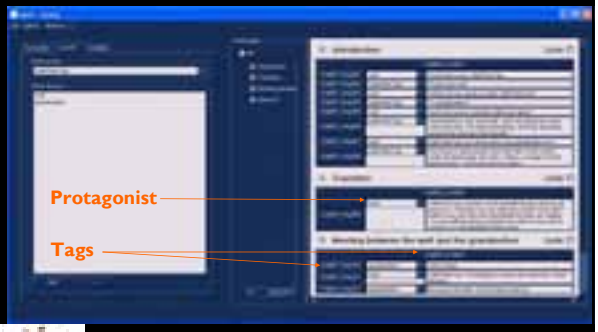
Overall Structure

Load the Linear Fiction



Specifiy the dialog structure

Fill the dialog boxes

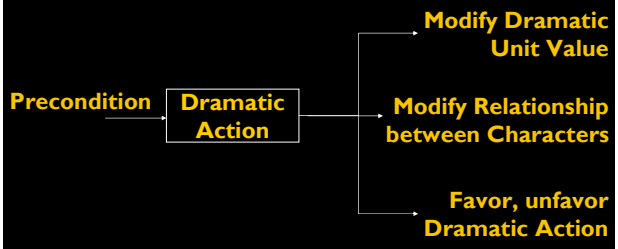


Dramatic Structure

- Vertical Structure:
  - Periods, Acts, Scenes
- Horizontal Structure:
  - Relations between:
    - Dramatic Actions
    - Dramatic Units
    - Character Relationships
    - Dialogs

Example of a DraMatic Action

- Atomic Element of the Narrative structure



DraMachina Output: XML file

- Internal and Export File Format
- In the french version:
  - syntaxic and semantic analysis

```
<proposition>
<sources>
<entity>jean</entity>
</sources>
<verbs>
<verb>
<word>ouvrir</word>
<category>physical activity</category>
</verb>
</verbs>
<targets>
<entity>la porte du château</entity>
</targets>
</proposition>
```

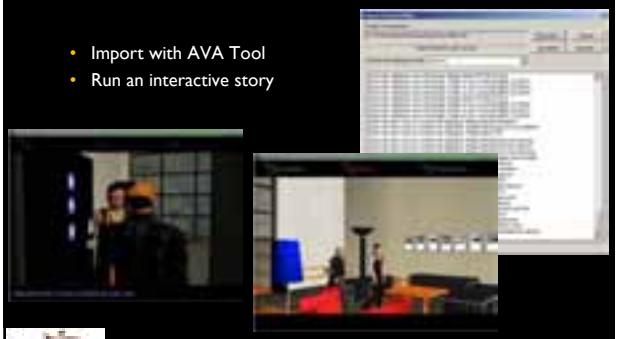
Character's Name

Open

the castle door

Use it in the AVA Environment

- Import with AVA Tool
- Run an interactive story



Creating interactive poly-artistic works: the ConceptMove project [Donikian et al. 07]

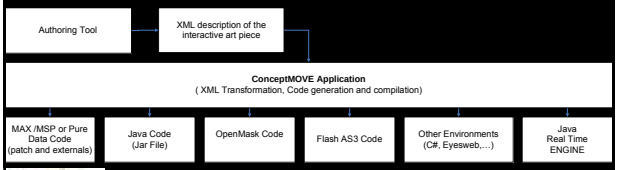
- Collaborative work with
  - IRCAM : Institut de Recherche pour la Coordination Acoustique et Musique
  - Olivier Delerue, Hugues Vinet
- Danse 34 Productions
  - Danse company of Nicole and Norbert Corsino

State of the art in the creation of interactive poly-artistic work

- Many realizations
  - Seule avec loup, Phase, Schlag!, Waves, Listen project, Secret Lisboa, Contemporary photography Virtual Museum…
- Wide number of artistic areas
  - Concerts, live music, audio installations, poly-artistic interactive pieces, live performances, choreography, music education, video games…
- Use of many software environment
  - MaxMSP, PureData, OpenMask, Spat, OpenMusic, Jitter, EyesWeb, Isadora, AudioMulch, AudioSculpt, SuperCollider, Logic, SoftVNS, ProTools, Cave, WFS,…
- For each creation the communication process and the language between software components has to be redesigned from scratch !

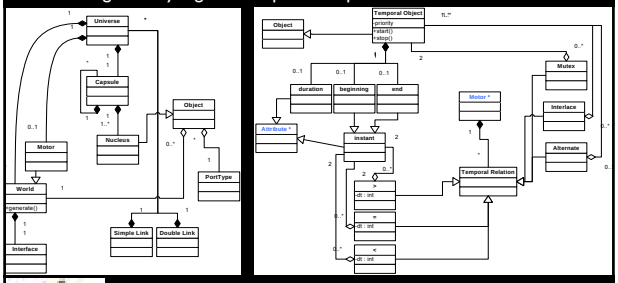
Propose a software environment for facilitating the realization of interactive poly-artistic works

- Simplify the communication process between software components
- Let the artists use their favorite (most adapted) environments
- Use a symbolic shared area to specify the relationships between the different artistic worlds.



Communicating Worlds

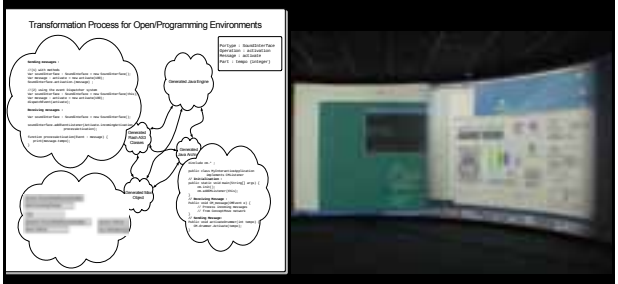
- Composed by a hierarchy of objects (capsules & nucleus) linked together by logical and spatio-temporal relations



Links between objects

- Objects are linked together by spatio-temporal and logical relations
- Allen's relations between intervals (life duration of a cluster or a nucleus)
- Particular relations:
  - Mutex
  - Alternate
  - Interlace
- Spatial relations based on triggering 3D regions

Communicating Worlds



Key Idea of the Authoring Tool

- describe the interactive art piece in the most generic way and generate automatically part of its software implementation
  - Plug-in in the Eclipse IDE

GVT: a platform to create virtual environments for procedural training

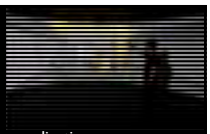
Introduction

- Context: training on complex industrial maintenance procedures
- Advantages of VR
  - To reduce costs, risks
  - To be free from the availability of equipments
  - To increase the control of the pedagogical situations
- Objective: to propose models that enable the reuse of parts of a training session to build a new one

Introduction

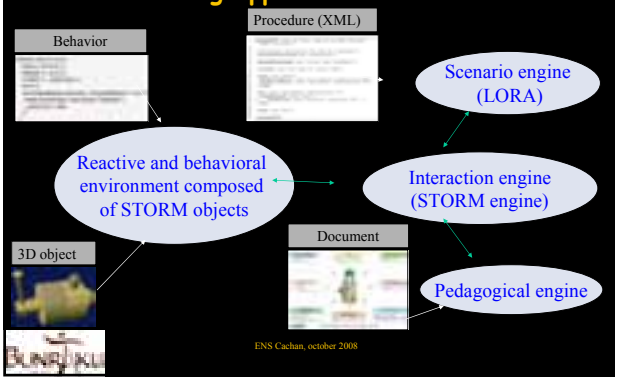
Raccourci vers presentationGVT_grosse.mpg.lnk

GVT project



- GVT = Generic Virtual Training
  - full author-platform for building VR training applications on maintenance procedures
  - Partners
    - NEXTER Group (French company)
    - INRIA (laboratory)
    - CERV (laboratory)
  - Important facts
    - Beginning of the project : 2001
    - GVT as a commercial product : 2006
    - 6 patents
  - GVT as a training application, GVT as an application development platform, GVT as a research prototype

GVT training application - overview

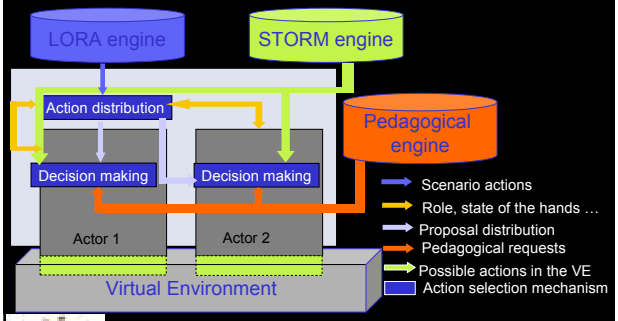


GVT platform - Authoring tools

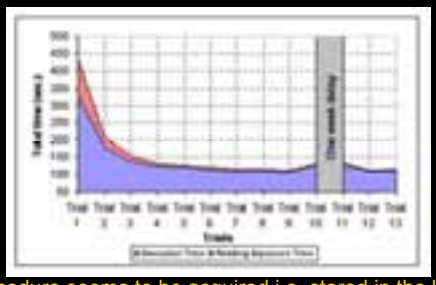
- Objective:
  - Simplicity of use: for people with no programming skills
  - Efficiency, productivity: to gain time
- Solution:
  - Intuitive tools
    - High level of abstraction
  - Reuse of previous developments
    - Data libraries (3D objects, capabilities, pedagogical actions)

GVT platform - Authoring tools

Collaboration aspects - mechanism of action selection



Assessment - Results



➡ Procedure seems to be acquired i.e. stored in the long term memory

Conclusion

- Develop a long term research objective
  - Combine physical and cognitive interaction between real and virtual humans
- A lot of work still need to be done
  - to increase the plausibility of virtual humans
  - to increase the immersion in a virtual environment
  - to increase the naturalness of interaction of real humans
- However, we have already some innovative solutions to model embodied virtual humans situated and acting in complex environments

Perspectives

- Propose a Unified model of object allowing different views about it:
  - geometry, physics, functionalities, …
- Increase the realism of multimodal interaction
- Provide a better colocated multisensory perception
- Increase the multimodal control of a virtual human
  - gesture, facial expression, speech and gaze
- Increase the realism of motion
  - more dynamics and experimental studies
- Provide a Unified Multilayered Architecture of Cognition allowing embodiement and situation
- Propose a Generic scenario language for interactive sessions

Thank you for your attention

Questions ?