3D INTERACTION ASSISTANCE THROUGH CONTEXT-AWARENESS

A semantic reasoning engine for classic virtual environment

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ibiSc
I. 3DI adaptation interests

• Advantages:
  ➢ To speed up the interaction
  ➢ To diminish the cognitive load
  ➢ To tailor the interaction
  ➢ To add or manage possibilities

• Examples:
  ➢ Choose between techniques (specificities, Bowman2006)(Lee2004)(Octavia2010)
  ➢ Make techniques variations (flavors, Bowman2006)(Octavia2010).
  ➢ Automatically add/manage modalities (Lee2004) (Bouyer2007).
  ➢ Automatically perform parts of the task (Celentano2004)

• Manage any adaptations?
• Achieve better adaptation?
• Apply adaptation automatically?

Use context!
II Context-awareness

• Context: any information that can be used to characterize the situation of an entity (person, place, object, user, applications etc.)

• A context-aware system: uses context to provide relevant information and/or services to the user. (Dey 2000)
III. 1 Representation and reasoning choices

- Direct control / physical sensors
- Interaction information
- Environment description
- Services presentation
- Technique choice and adaptation
- Modalities and modifications

Available tools: Internal flow
Engine flow

User
Interaction
Environment

Sensors
Actuators
Engine

Context
Reasoning
### III. 1 Representation and reasoning choices

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III.2 Ontology interests

Ontology: explicit and formal specification of a shared conceptualization (Gruber 1995)

• Ontology advantages:
  - Make the environment understandable by computers
  - Ease interoperability and reusability
  - Allow high level interpretation
III.2 Ontology interests

• Ontology classification: engine and applications separation
• Add semantic information in the environment.
### III.3 Representation and reasoning choices

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III.4 Conceptual graphs interests

- Based on an ontology
- Universal descriptors
- Usability: readable by humans and machines
- Nested graphs: context relativity
- Situation comparator

\[ \Phi(G) = \exists y_2 y_3 y_4 (\text{Person}(Peter) \land \text{Stick}(y_2) \land \text{Announcement}(y_3) \land \text{Billboard}(y_4) \land \text{agent}(y_2, Peter) \land \text{object}(y_2, y_3) \land \text{location}(y_2, y_4)). \]

(M. Chein and M-L. Mugnier 2009)
III.4 Conceptual graphs interests

- Allows further description
- Allows rules and semantic description for the core’s reasoning
- Allows the same representation for context and reasoning
- Other reasoning techniques can be nested in a CG
### III.5 Representation and reasoning choices

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III.5 Conceptual graphs interests

- Allows further description
- Allows rules and semantic description for the core’s reasoning
- Allows the same representation for context and reasoning
- Other reasoning techniques can be nested in a CG
- Other reasoning techniques results can be expressed as a CG
### III.5 Representation and reasoning choices

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III.6 Implementation choices summary

- Engine advantages:
  - Independent semantic engine core.
  - Good expressiveness and usability.
  - Useable for any applications with their own tools.

- Methods advantages:
  - Ontology: reusability and interoperability.
  - Conceptual graphs: usability and expressiveness.
  - Logic programming: facts management and reasoning.

IV. 1 A parallel engine

- Direct control / physical sensors
- Interaction information
- Environment description

User

- Services presentation
- Technique choice and adaptation
- Modalities and modifications

Interaction

- Available tools
- Internal flow
- Engine flow

- Engine
- Context
- Reasoning

Actuators

- Sensors
- Semantic description
- Semantic description possibility
IV. A parallel engine

Services presentation

Interaction

Environment description

Modalities and modifications

Direct control / physical sensors

Technique choice and adaptation

Available tools

Internal flow

Engine flow

Context

Reasoning

Actuators

User

Interaction

Environment

Sensors

Engine

Semantic description

Semantic description possibility

Engine flow
IV.2 The engine

Context
- Ontology
- Rules /Facts
- Events
- History
- Available tools

Reasoning
- Time manager
- History & facts update
- Facts update
- Adaptations classification

Decisions request
- Questions
- Adaptations

Information request
- Belief vs Risk
- Semantic definitions
- Semantic descriptions
- Semantic descriptions possibility
IV.4 Test scenario: acquire and enhance user’s interests

• General Rules:
  - Define interests.
  - Define our will to enhance interests.
IV.4 Test scenario: acquire and enhance user’s interests

• General Rules:
  - Define interests.
  - Define our will to enhance interests.
  - Associate possible enhancements:
    ▪ visual modifications through color change.
    ▪ interaction modifications through gain (visual or haptic).
  - Manage adaptations states
    ▪ remove added visual modification for previous interest.
    ▪ remove added active gain if the movement is abnormal.
  - Increase some concepts’ risk: haptic, gain etc.
  - Increase identical decision repetitions’ risk.
  - Decrease interaction modifications ‘ risk for slow movements.
IV.4 Test scenario: acquire and enhance user’s interests

- Scene rules:
  - Supply a specific cognitive load value
  - Monitor the hand

- Scene tools:
  - a Zones Of Interest (ZOI) sensor
  - an object’s movement sensor
  - an actuator to change the color of an object
  - an actuator to add a haptic/visual gain to an object
IV.4 Adaptation graph:

Legend:
- Local influence of events
- Decisions
- Scene states
- Other steps (state, events influence, decisions)

Object in the aura?
Decision present in history?

Red color added for all
Attraction and red color added
Red color deactivated
Movement high & local?
Attraction removed

Movement local?

Adaptation active?
Red color added

N > 1

0

1
"N value of the acceptable cognitive load"
Several objects: All are colored red, no attraction
Aura and movement sensors activated
Passing near an object:
Red color added
Two coloring activation allowed
Visual and interaction modifications reset differently
Moving around an object:
Red color and attraction added
User seems bothered:
Attraction removed
Not a single reactivation for gaining:
Riskier than coloring
no attraction
Conclusion

• Properties summary (Bettini 2010):
  ✓ Heterogeneity and mobility of context.
  ✓ Relationships and dependencies between context.
  ✓ Imperfection: data can be uncertain or incorrect.
  ✓ Reasoning: to decide or to derive information.
  ✓ Usability of modeling formalisms.
    ▪ Efficient context provisioning.
    ▪ Timeliness: access to past and future states.

• Next works:
  ➢ Improve overall performances
  ➢ Obtain better users intention hint.
  ➢ Try more complex scenario
Questions?
II.2 Context-aware systems are adaptive systems

Adaptation creation:
- Modification
- Testing

Designer, User, System offline, System online.

Adaptation steps:
- Initialisation
- Proposition
- Decision
- Execution

User, System.

Adaptation steps timeline:
- Reactive
- Pro-active

Dieterich 1993

Identification

System intelligence for context analysis and plan recognition

Paramythis 2009

Adaptation steps:
II.2 Common properties

- Identification and/or assistance:

  ![Intelligent Systems continuum](adapted from Brezillon 1999/2011)

- List of ideal properties for context-awareness (Bettini 2010):
  - Heterogeneity and mobility of context.
  - Relationships and dependencies between context.
  - Timeliness: access to past and future states.
  - Imperfection: data can be uncertain or incorrect.
  - Reasoning: to decide or to derive information.
  - Usability of modeling formalisms.
  - Efficient context provisioning.

- Designers, system and users possible roles at each steps.
IV.3 Context hierarchy in the engine’s core

Comprehension

Plan

Assistance

Identification

Data

Belief

Activity relative context

Specific facts

Specific knowledge

Tools

General context

Events

Knowledge

Interests/Difficulties

Objectives

Decisions set context

Proactive adaptation

Reactive adaptation

Information request

Meta-Adaptation

Decisions

Classification or planning

Plan

non-organised decisions

Reasoning

Representation

Bet

Decision
II.1 Context-awareness

• Context (Dey 2000): *any information that can be used to characterize the situation of an entity. (person, place, or object, user and applications).*

• A context-aware system (Dey 2000): *uses context to provide relevant information and/or services to the user.*

• Classification:
I.3 Travaux précédents

• Techniques embarquées ou implicites: Go-Go (Poupyrev1996), l'interaction continue FlyOver (Boudoin2008), Bubble Cursor et Depth Ray (2009).


• Un salon d'exposition virtuel (Celentano2004) : identifie des schémas récurrents d'interaction.

• Un framework de gestion du contexte VR-UCAM (Lee2004) modèle conceptuel basé sur le W5H

• L'assistance utilisateur via une supervision de la tâche (Bouyer2007).

• (Octavia2010) : personnalisation de l'interaction d'un utilisateur à l'aide d’un moteur utilisant un modèle utilisateur générique, un modèle particulier et un ensemble de contexte.

• (Frees 2010) Association contexte/tâches