A Semantic Reasoning Engine for Context-Awareness:
Detection and Enhancement of 3D Interaction Interests
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ABSTRACT
We propose a semantic reasoning engine for context-awareness in classic VR environments. It is currently used to automatically detect user’s interests and manage visual enhancements depending on the user’s movement.

Categories and Subject Descriptors
I.3.6 [Methodology and Techniques Subjects]: Interaction Techniques; I.3.7 [Computer Graphics]: Virtual reality; I.2.4 [Computing Methodologies]: Knowledge Representation Formalism and Methods

Keywords
Context-awareness, 3D interaction assistance, Adaptive 3D interaction,

1. INTRODUCTION
Tasks in immersive virtual environments are associated to 3D interaction (3DI) techniques and devices. As tasks and environments become more and more complex, these techniques can no longer be the same for every application. Our work focuses on 3DI assistance by adding adaptivity depending on the interaction context. To reach context-awareness, an engine has been designed, implemented with the Amine platform and tested with a Virttools application.

2. A SEMANTIC REASONING ENGINE
The engine uses rules to take decisions regarding a stored context (knowledge, events etc.). Context and decisions concern the user, the interaction and the environment. They communicate with the engine through a set of tools with a semantic description by using Open Sound Control. Tools can be actuators with perceivable multimodal effects (environment modifications etc.) or sensors that retrieve information (by monitoring the interaction, etc.). The engine uses Conceptual Graphs (CGs) which provide a good expressiveness and usability. CGs link concepts with relations, both classified in an ontology. They are used to describe rules and facts. Decision request seeks a true reaction applicable by a tool. Then, the engine aggregates its global confidence (degree of sureness) and impact (degree of perceived repercussion). A CG global confidence depends on all paths leading to a true expression of the described situation using facts, events and rules. A CG fact is certain by default or can supply its own confidence (e.g. provided by a sensor). Events confidence decreases with the ratio of their remaining validity. Rule effects confidence is equal to the rule causes average confidence, times the rule confidence itself. Finally the global confidence of a CG expression is obtained by a fusion function. With n paths and Mean as their average confidence value: Global confidence = \((1 - \text{Mean}) \times (1 - \frac{1}{n}) \times \text{Mean} + \text{Mean}\).

Next, the engine aggregates the decisions impact. Each tool has an initial impact which can be modified given specific cases. Initial impact equals to 0 (without any impacts) or 1 (with the most impact) are not modified. Otherwise at each applicable case, the impact is altered with a weight \((W, 25\% \text{if not valued})\) impact \((n) = \text{impact}(n - 1) - W \times \text{impact}(n - 1)\) for a decrease or impact \((n) = \text{impact}(n - 1) + W \times (1 - \text{impact}(n - 1))\) for an increase. An acceptable total impact limits the decisions that can be made, which induces a knapsack problem as a last classification.

3. 3D INTERACTION ASSISTANCE
The engine is applied in a case study to automatically acquire and enhance user’s interests. Sensors describe user movement, gestures and Zones of Interest (ZOI) content. Actuators create the ZOI, change objects color or add an attraction. The engine triggers adaptations using internal rules and those tools. Thereby, a object is colored red when the user passes by or points at it and reset when the user moves far away or after time. An attraction is added to the virtual hand when the object is detected several times as an interest or when the user stands next to it and removed when the user tries to resist. Attraction can not be added again for a time while coloring reactivations occur as the decision has less impact. An object (e.g. suddenly abandoned by the user) can flicker for a while. This is an unplanned mean to attract the user attention: the object is both still virtual hand when the object is detected several times as a knapsack problem as a last classification.

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