# Design Support of Modalities for Mixed Interactive Systems.

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## 1 Introduction

Mixed Interactive Systems (MIS) are interactive systems which merge physical and digital worlds to create rich interaction (Augmented Reality, Pervasive systems or Tangible User Interfaces). Their deployment is still in its infancy and mature tools addressing their development remain unavailable. Indeed, much works on MIS are based on ad-hoc development or dedicated SDK, following a bottom-up approach. We prefer a top-down approach which allows exploring the many facets of MIS and the complexity and richness of mixed interactive situations. With the perspective to address the different steps of their development, we define several models and the way to interlace them [3].

## 2 MIS development support

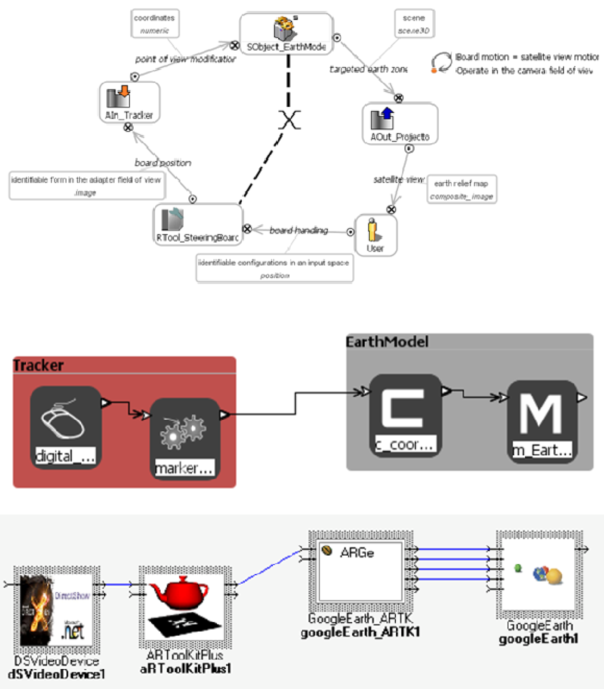
We focus in this paper on the design and implementation steps of our process to depict the design of interaction modalities. We describe such development steps with the creation of a system which enables to interact with the Google Earth software through the use of mixed input modalities. The system named "GE-SteeringBoard" [2], provides a board, representing a navigational compass, that the user holds and moves to modify its point of view on Earth. The three next sections present the three stages that our process involves to realize such a system.

### 2.1 Interaction modelling

The aim of this stage is to describe how the interaction takes place for a specific mixed interactive situation, presenting the user, the physical and digital resources and the interaction channels between them. The communications between entities are described considering the channel, the sensing mechanism – receiver – and the modification method – emitter. Furthermore, a channel is characterized with attributes such as the medium carrying the data, the language form to express the data, its dimension, etc.

### 2.2 Software Architecture modelling

This second stage is about the description of the software architecture as a component-based architecture. ASUR-IL is used to identify each component required, their role in the system and the communications between them.




**ASUR model – ASUR-IL model – WComp assembly**

### 2.3 Implementation

The third stage of this process consists in the implementation of the system, in our case using the WComp platform, a rapid prototyping platform based on the .NET framework and which has the advantages of being simple and efficient and offering low resource consumption. The WComp metamodel implies the description of an assembly, the components and their interfaces and the connectors between them. Once compiled, the assembly can be loaded with WComp in order to test the system.

## 2.4 Articulations

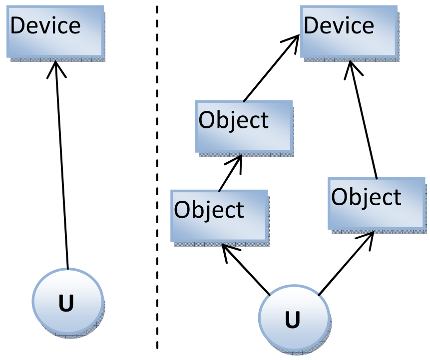
Each stage of the process is interlaced with the others thanks to Model-Driven Engineering tools and the model transformation ability. The aim is to consider the modelling results of each phase as a source for the next phase. Once the interaction described with ASUR, the model is transformed into a ASUR-IL model which initialize the design of the software architecture. Finally, an ASUR-IL model is transformed into a WComp assembly and component skeletons. Such a process allow us to rapidly prototype a MIS, by using each model as a support to each stage and as a source for further stages.

# 3 Multimodality and Mixed Interactive Systems

With the "GE-SteeringBoard" system, some gestures on the board may be difficult to realize, especially the tilt movement. The concurrent use of all the functionalities is also hard to control. We realize another prototype based on two complementary modalities: the motions of the board on 3 axes and a touch sensor to separate two modes: position/elevation and tilt/azimuth. When designing such a system, thinking about how integrating multimodality contributions to MIS design leads us to identify several concerns of MIS for applying multimodality. They are about three main purposes: the description of the interaction, the composition of a modality and the evaluation concerns.

## 3.1 Characterizing the interaction

MIS highlighted the use of physical resources in the interaction which makes the modalities more and more heterogeneous and plural. Multimodality must take into account this diversity, forget that a device is a dedicated electronic device and accept every perception sense and every action means as potential modalities. Consequently, a user may interact through a modality constituted of heterogeneous physical artefacts instead of a specific set of peripherals. Each physical object has a particular shape, weight, colour, lightning properties,… i.e. each one has specific physical properties, that affect the way to combine them. Furthermore, several objects can be involved for the same modality. To deal with such an evolution, the definition of a modality must be adapted.




**Evolution of a Modality**

## 3.2 Describing a modality

The works around multimodality gave one point of view on what is a modality, establishing the duet: device and language [5]. If we consider such a distinction, MIS introduce profound differences especially at the device level. Some elements exist to characterize a peripheral, as the Card et al. approach [1] which introduces 5 dimensions for that purpose. But considering peripherals, the kind of data captured or emitted and the transformation function, are induced by the nature of the device. With MIS, the nature of an electronic device is not sufficient to understand the device capabilities. To catch such information, each communicating artefact (physical object or device) must be described with additional information to catch for example, the difference between capturing a finger contact and a hand gesture with visual systems. Languages can be described with elements such as the Bernsen dimensions for output modalities, but others elements have to be proposed to also describe languages for input, or haptic feedback.

## 3.3 Evaluating a system

MIS have also the particularity to be involved in low-constraint spaces. Mobility and wide spaces can characterized some of the situations related to MIS. In order to evaluate such systems, the description of modalities may have to be completed by spatial and focus level considerations. Ambient spaces are such situations where modalities are used to spatialize information, their source and their importance. With such considerations added, expressing a multimodal relationship with for example the CARE properties, may require additional concepts to address the MIS specificities.

# 4 Conclusion

Several MIS concerns affect the implementation of multimodality in MIS context. They constitute anchor points for multimodality tools and methods, with a focus on the definition of a mixed modality. It cannot be described as a duet: device and language, but may consider several "devices", or sensing mechanisms/modification methods, and different forms of language to consider each information path between physical and digital artefacts: $< D \times L > \rightarrow < \{D_1,..,D_n\} \times \{L_1,..,L_n\} >$. The representation of a concept has yet been decomposed when Ishii et al. [4] introduced the MCRit for TUI and expressed the intangible and tangible representations. With such elements identified, the question is now to know if multimodal tools and methods have to be adapted or modified in order to consider mixed interactive situations. Is the CARE set complete to address the different kinds of modalities combination?

# 5 References


1. Card, S.K., Mackinlay, J.D., and Robertson, G.G. A morphological analysis of the design space of input devices. *ACM Trans. Inf. Syst. 9*, 2 (1991), 99-122.

2. Dubois, E., Truillet, P., and Bach, C. Evaluating Advanced Interaction Techniques for Navigating Google Earth. *Proceedings of HCI 2007*, British Computer Society (2007), 31-34.

3. Gauffre, G., Charfi, S., Bortolsaso, C., Bach, C., and Dubois, E. Developing Mixed Interactive Systems: a Model Based Process for Generating and Managing Design Solutions
. In *Engineering of Mixed Reality Systems*. Springer-Verlag, 2009, to appear.

4. Ishii, H. and Ullmer, B. Emerging Frameworks for Tangible User Interfaces. *IBM Systems Journal 39*, (2000), 915-931.

5. Nigay, L. and Coutaz, J. Multifeature Systems: The CARE Properties and Their Impact on Software Design. *Intelligence and Multimodality in Multimedia Interfaces*, (1997).