Supporting the Fast Prototyping of Personalised Narratives for Tangible Interaction in Cultural Heritage

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Abstract. Our research combines personalisation and tangible interaction to support visitors of cultural heritage sites. It is a complex setting of technology, people, objects and content all affecting each other and changing the final rendering and ultimately the visitor's experience. We present a completely open architecture for the fast prototyping of such personalised experiences tuned to the physical context. We used it to test personalisation applied to different types of tangible interaction, i.e. a soundscape controlled via physical movements and the a book like device or a haptic device that leads to personal destinations.

Keywords: Personalisation; Tangible Interaction; Fast Prototyping

1 An Open Framework to Model Content and Context

To date, personalisation applied to cultural heritage has not experimented with the possibilities offered by tangible interaction [1]. This new area of research needs to develop tools that allow to explore the many facets personalisation can take when applied in a tangible and/or embodied context, e.g. when objects and spaces react to people's presence, movement and gesture. Design uses fast prototyping as a technique to give form to an idea, show its strengths and weaknesses and identify new directions [2]. In computing most of the time prototypes are created to put forward a solution to a problem (experimental prototypes) or as steps toward the final product (evolutionary prototypes); but computational prototypes can be as exploratory as those developed in design that are informal, offers alternatives, are unstructured and messy, are used to communicate and then are thrown away [3]. The power of computational exploratory prototypes comes at an early stage in the project life cycle and lays in supporting the widest possible exploration of alternative solutions at the minimal cost. As part of meSch [6], we have developed such a framework for the fast prototyping of personalised interactive narratives, i.e. at any point in time the system has available many possible fragments of stories and has to decide which one is the right one for every specific dynamic user context. We are not prescriptive on which type of tangible interactive experiences will be offered to visitors: so far we have experimented with a magnifying glass, a book-like device, a haptic ovoid shell, a smart plinth and an interactive display case. The framework allows to experiment with personalised content in

all these settings and many more. The personalisation features come from a wide range of equally possible options; e.g. where the user physically is and where they have been; what is nearby; the type of device they interact with; what type of gesture/movement they make; their age, knowledge and interest; the content available and its media type; and many more [5]. Which set of features is more suitable for a given tangible interaction setting is what needs to be experimentally determined via fast prototyping. Further challenges are the computational constraints posed by small computational units and the increasing number of sensors for tangible interaction [4].

In our proposal small chunks of self-contained content are controlled by a set of triggers, high-level expressions of any kind such as interpretation of sensor data or the visitor's selection of a specific theme. Specifically, seven elements model content, conditions and how to activate the first on the basis of the second:

- *Point of Interest* (POI): A POI marks a place in a cultural heritage site or an object in a museum. A POI is used to aggregate multiple content nodes or as a station in a multi-stage narrative.
- *Content Node*: A content node delivers its media if its activating condition is matched. The condition is defined by a set of pairs trigger-value. A content node may have predecessors, nodes that must be used before this one is activated, e.g. providing in-depth information.
- *Trigger*: A trigger is a personalisation feature with a discrete set of possible values. Triggers can map physical settings, people's choices, stages in the story, locations, or anything else that can be a condition.
- *Context*: A context is a set of active triggers. It contains the current value of each trigger for which sensor data is available.
- *State*: The state holds the current context as well as the set of all visited nodes, so it captures the visit so far and the condition for the next selection.
- *Active Set*: the set of content nodes that can be selected, i.e. they don't have any predecessors or the predecessors have been used already.
- *Inactive Set*: the set of content nodes for which the predecessor nodes are still to be used.

The openness of this framework is clear as both the content (nodes) and the conditions (triggers) can be anything we want to try. The creation of an interactive narrative prototype follows these stages: locations or objects that are part of an interactive story are associated to a POI; then a set of content nodes is defined for each POI to capture different layers or types of information; for every node the corresponding activation condition is defined, that is to say the set of triggers with their activation values must be listed; if any content had to be delivered before, a predecessor list is created.

The selection of which content node should be delivered at every point in time starts with the sorting of content nodes into two sets: Active or Inactive. At the start the active set contains all content nodes without predecessors while the inactive set contains all the nodes with a predecessor. This sorting reduces the computational time needed to test the context against nodes that cannot be activated anyway, a substantial advantage when the nodes are counted in hundreds. As the visit progresses, the context is continuously updated adding or removing triggers and their value; for example if a POI is reached, the location trigger is included in the context with the value corre-

sponding to this specific POI. Every time the context changes it is checked against all the nodes in the Active Set and a node is selected for delivery (if there is more than one candidate the selection is random). At this point the State is updated to include the newly activated node and the nodes in the Inactive set that have the selected node as predecessor are moved into the Active set (Fig. 1).

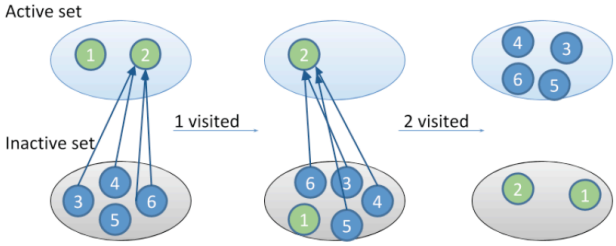

Figure 1. Shift of nodes between Active/Inactive sets following the delivery of content.

The activation mechanisms are completely independent from the content nodes and the triggers: defined both using XML, they can be extended or modified at any point in time without having to change the implementation at all thus supporting the prototyping of new interactive stories. A simulation mode allows to test at the desk what a specific visitor would receive when visiting in person; the only input required is the sequence of POIs the hypothetical visitor will follow.

The following section illustrates the framework using implemented prototypes.

3 Examples of Personalised Tangible Interactions

The *Companion Novel* (Fig. 1) is a book-like device complemented by a set of Bluetooth speakers located at POIs. Every page is a theme and the visitor can choose one (among 4 available) by placing a magnetic bookmark on a page. Designed for an outdoor setting, the Novel tracks the visitor walking the ground: when a POI is detected the Novel instructs the loudspeaker to play an attraction sound; if the visitor get closer to the POI a content specific to the theme currently selected is played.

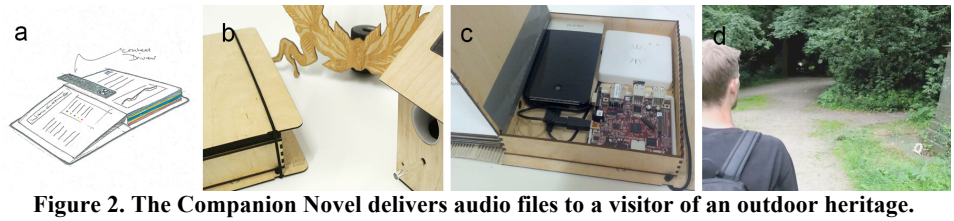

Figure 2. The Companion Novel delivers audio files to a visitor of an outdoor heritage.

The Novel has 7 POI and 4 pages so 4 parallel themes. The content nodes for this prototype are audio only, but of 2 different types: the attraction sound and the story. Each POI holds 4 attraction sounds (one for each theme), and 4 stories (played when the visitor is close by) (Fig. 2). The triggers defined for the Novel are: themes (values 1-4) mapping the pages of the book; location (the 1-7 POI); proximity (‘far’ or

'close'). When composed in a context the triggers capture the visitor's choice (the theme); the visitor's position (the location); their movement (proximity). At the beginning the visitor choses the theme, for example Nature, and 'theme: 1' is put in the context; when the visitor enters the area of POI 5 the context is updated adding 'location: 5' and 'proximity: in'. The trigger set of each node is checked against the current context: the node with triggers [theme:1 POI:5 proximity:in] is played. The visitor approaches POI-5; the sensor detects 'proximity: close' and updates the context accordingly starting a new node selection process for [theme:1 POI:5 proximity:close].

The *Way Detector* leads visitors to a very specific POI via haptic feedback: the closer to the target POI the stronger the vibration. The bottom round shape of the Way Detector fits the hand; on its top flat face are 4 small buttons, each one associated to a different POI. By selecting each button in turn the visitor is taken through the heritage stopping at four different stations where the visitors scans the Detector (which holds an NFC tag) and access the content nodes at the POI location: the content nodes are images and text displayed on tablets installed at each POI. By pressing button 3 the visitor has selected 'POI:3' and following the vibration they reach the location; the scan of the Detector updated the context in the tablet to [stage:3]; however the content nodes are played only if POI 1 and 2 have been already visited; this is achieved by the set of predecessors that create a chine of content nodes. If the order has not been followed, only the content node that hints to follow the order is displayed.

The two very different examples show how our framework allows to prototype different personalised interactive narratives that are instantiated in very different tangible contexts as both the content nodes and the triggers are defined by the applictaion.

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