

Smart Authoring for Location-based Augmented Reality Storytelling Applications

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Abstract: SPIRIT has been an applied research project that developed a location-based Augmented Reality prototype for outdoor museums. It uses the sensors of mobile consumer appliances to provide a variety of contexts for the delivery of adaptive and interactive stories. This paper addresses the technical authoring process to develop new non-linear story content for the app. We propose smart authoring tools to assist non-programmers. Based on requirements for authoring that we identified from issues in our first production, we describe the smart authoring tools MockAR, StoryPlaceAR, StoryStructAR and VideoTestAR. Preliminary evaluation observations support our hypothesis that these tools simplify the authoring process, in order to support museum curators and media designers during the creation of mobile experiences adapted to contextual situations.

Keywords: Authoring Tools, Interactive Digital Storytelling, Location-based, Augmented Reality

1 Introduction

In the last several years, smart and assistive systems with multi-sensor interfaces have inspired the development of novel applications for personal living as well as for cultural environments. For example, sensors in mobile consumer appliances can provide different contexts for adaptable information delivery in public spaces. This can change a museum's site into a smart personal environment for entertaining Interactive Digital Storytelling (IDS). In the applied research project SPIRIT, we developed a mobile Augmented Reality (AR) application that interprets location-dependent contexts. It presents interactive video content that fits a current user position as well as a plot- or game situation. The SPIRIT app uses mobile device sensors, such as GPS, gyroscope and Bluetooth, for detecting the gadget's spatial position. Besides these, camera image comparison with a reference image database [DSV15] can trigger prepared video and other media content. By producing fitting transparent videos, authors 'stage' characters – for example, for re-enacting historic events – in front of meaningful 'backdrops' in the real environment (see Fig. 1). More than just presenting one media clip at one location, such as in other existing apps, the SPIRIT app offers to trigger new content at the same location when the user moves the device, for example, by looking around. Our integrated plot engine [KS16] processes a given content structure to provide a fitting order of story events. Using all sensors, storytelling is then possible in three-dimensional space. At the same time, story creation becomes more

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complex for authors. Creative writers are involved to come up with enacted scenes that let visitors of a historic site empathize with its past, right on the spot. That way, providing a meaningful experience, it is essential that these authors can also relate to their own creations in a short cycle of creating and experiencing, as for them, ‘the proof of the pudding is in the eating’. It is essential that they understand and feel the systems ‘smart’ aspects, including limitations of precision in positional recognition. Some sensors only work in an incremental way, and image recognition depends on lighting. Also, the dynamics of non-linear story presentation must be anticipated by authors and experienced as turning out in a meaningful way, in advance of delivery.



Fig. 1: SPIRIT end-user experience. Holding a tablet and turning it to the left and right, users collect elements of a location-dependent story, here with authored spirits showing a possible historic situation [<https://www.youtube.com/watch?v=b9V2XblmZQw>]

In short, AR in SPIRIT aims at creating a sensible relation between the place and the story. To assist authors in achieving this, smart authoring tools should support the conception as well as the experience of appropriate content for sensorial contexts. We propose an authoring concept with tools that allow ad-hoc prototypical content creation for testing and debugging, simplifying the authoring process and assisting creators.

2 Related Work in Authoring

SPIRIT combines sensorial aspects with interactive storytelling, which, so far, no other mobile AR system offers in a comparable way. A common issue in IDS research projects concerns the cyclic development of dynamic content structures in parallel with authoring first content. Content structures rely on specific interaction styles, unless only hyper-structures are involved. XML extensions are widely used as description languages [SMR03], [SWM06], as in our project SPIRIT. The development of GUI-editors for non-programming creators – especially monolithic tools – often cannot catch up with ongoing changes in the structure, based on the demands of iterative development [PC08]. As a consequence, technical authors tend to write XML directly [SS09]. For authors, a challenge remains in interactively empathizing with their own created content, as player software often comes separated from the authoring.

Authoring AR content has been made accessible for programmers with systems like EDoS [TSM10] and ComposAR [WA09], and for non-programmers with Layar [LAY17] and Aurasma [AUR17]. These tools do not support story-specific content structures. The system iaTAR (immersive authoring for tangible AR) transforms ‘*What You See Is What You Get*’ into the concept of ‘*What You Feel Is What You Get*’ [LE04]. This concept has not been used in location-based storytelling contexts so far. ARIS [ARI17] and Ingress Mission Creator [IMC17] are authoring tools for location-based stories, but do not support AR content and storytelling. The closest match to storytelling with geospatial AR content is TaleBlazer [TAL17], which offers a script language similar to Scratch [SCR17] with a graphical editor for location-based scavenger hunts. However, it has no open story structure and does not support transparent AR video to visually integrate characters in the environment. None of the storytelling tools so far address further device sensors such as the gyroscope.

3 Technical XML Authoring Process

For sensorial contexts, we developed a formalized story structure called STARML (Story Telling Augmented Reality Markup Language) [KS16], derived from ARML, a standard proposed by the Open Geospatial Consortium [OGC13]. STARML supports non-linear IDS by using conditions for referencing sensorial contexts and story states to trigger content. Fig. 2 shows technical authoring steps for a SPIRIT experience. Based on historical research, authors find interesting places and capture backdrop images in the environment. Writers, directors and designers create film scripts, produce video, audio, image and text content, as well as GUI elements. Then a technical author writes the story structure into STARML and links all produced media content. After copying all data onto the mobile device, the SPIRIT experience can be tested and debugged.

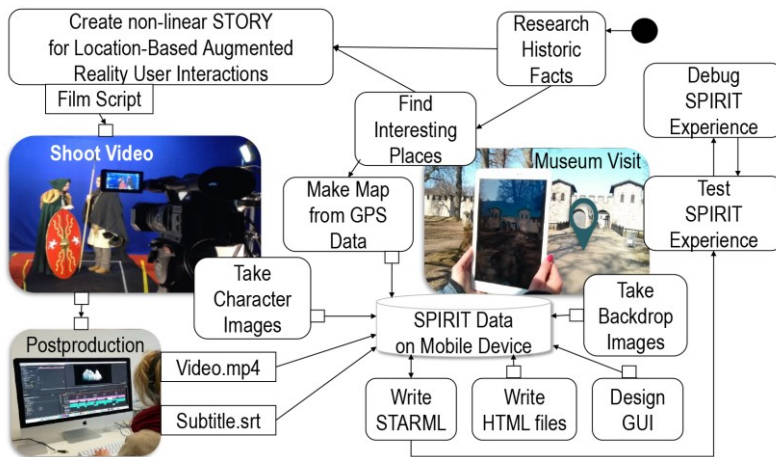


Fig. 2: Technical Authoring process: activities and assets

The STARML elements have been specifically designed to support their understanding by authoring target groups in media, storytelling and museums. Non-programming writers shall be able to start a project by simply editing a template XML file. By descriptive tag names related to the storytelling domain, STARML is intended to be authoring-friendly. As has been stated in [ARD04], the relevant tasks that authors have to fulfill are then reduced to their core domain and competencies. In addition to that, supporting tools are proposed in the following.

4 Specific Requirements for Authoring SPIRIT Experiences

Authoring large SPIRIT stories becomes a matter of organization. Here we describe authoring issues that we experienced during our first full showcase production (Fig. 1).

Change of Workplace: On-site testing and debugging in the outdoor museum has been costly, time consuming and cumbersome, due to travel and outdoor conditions. Results of story conception and media production are easier achieved at a desktop computer. Some testing can be done in the office by faking GPS data and using printed backdrop images. Other tests must be performed on-site, e.g. for validating GPS data, image recognition in daylight, map visualization and GUI visibility. However, debugging is easier performed at a desktop computer than outdoors with a laptop, including weather conditions.

Authoring Activity	Best Authoring Location
Research historic facts	Desktop computer, office
Find interesting places	On-Site, outdoors
Envision story structure	On-Site, outdoors
Write and test story structure in STARML	Desktop computer, office
Test story experience in context	On-Site, outdoors
Envision user interaction	On-Site, outdoors
Write user interaction in STARML	Desktop computer, office
Test user interaction	On-Site, outdoors
Capture backdrop images	On-Site, outdoors
Link backdrop images in STARML	Desktop computer, office
Test backdrop image recognition in daylight	On-Site, outdoors

Tab. 1: Selected authoring activities and workplaces at which they are most effective

Table 1 visualizes single authoring tasks, grouped together in work steps. Best authoring locations often change in between the same logical work step. Further, debugging has to be added, which ideally requires frequent changes of the workplace, compare Figure 3.



Fig. 3: Authoring activity outdoors: black; at desktop computer: white; at both locations: gray

Envisioning Experiences: Authors have to envision the end-user experience of their creation, which is a story integrated with location-dependent and interactive sensorial conditions. In some of our first design sessions, creatives and programmers developed different understandings of the described experiences, while traditional media design techniques, such as storyboards, wireframes and click-dummies, turned out to be limited.

Structuring Task: STARML, which needs to be written by non-programmers, provides a potentially non-linear content structure by utilizing conditions as mentioned in Section 3. Short SPIRIT experiences may count about 520 lines of code, while our first complete story (see Fig. 1) contained over 1200 lines of code. Organizing, linking and structuring all data into one XML file needs at least the structural knowledge of STARML.

Story Testing Needs Content: Authoring of a story element leads to testing (compare Fig. 4). Hence, media assets are needed to display preliminary story elements. Because media assets are expensive, the final production should only start after the story has been debugged. However, the non-linear discourse, continuity, impact and ambience of a story need to be tested with prototypical content, in order to prevent the discarding of expensively created media in the debugging process.

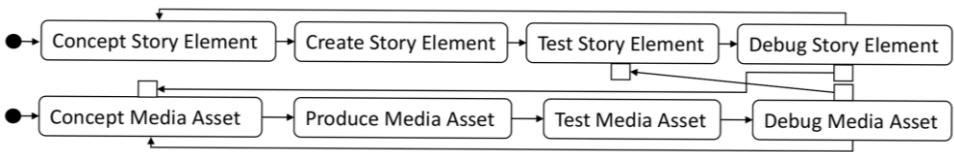


Fig. 4: Story element creation process (above) and media assets production process (bottom).

5 Engineering Smart Tools for Specific Authoring Requirements

For limiting the “Change of Workplace” issue, we implemented authoring tools to run on the same platform as our mobile SPIRIT app (Android 6.0.1). With these, testing and debugging can be accomplished outdoors, on the same mobile device. Android Intents and Intent Filters automate switching between mobile applications. As this functionality of the operating system handles data transfer, development has been easier. Several single smart authoring tools have been developed, while each tool addresses a certain set of authoring tasks that together form one work step (compare Table 1) by using sensors of the device. Android Intents and Intent Filters enforce the strict separation of functionality in the tools. The benefit of this resembles the advantage of the facade pattern [GHJ94], by making a software easier to develop, understand, and test, as well as easier to maintain. It contributes to readability and reduces dependencies of outside code on the inner workings, allowing more flexibility in developing software systems [GHJ94]. This in mind, we developed the smart authoring tools MockAR, StoryPlaceAR, StoryStructAR and VideoTestAR.

StoryPlaceAR was developed for limiting the issue we called “Change of Workplace”, by offering ad-hoc testing. It is used to add and delete reference images and to edit GPS

data. It is smart, because it interprets GPS data of location-dependent STARML elements and visualized information relative to the author's on-site position. StoryPlaceAR validates edited data. It shows hints during the authoring process about whether or not the resulting STARML code can be played by the SPIRIT app.

MockAR [KSS16] was developed for the requirement of "Envisioning Experiences". It visualizes transparent images in a declarable sequence on top of the camera image of a mobile device. Sensor signals can be defined as conditions for progress. Designers can use it similarly to their traditional wireframing technique, in order to test preliminary ideas as a mockup before any XML exists, using the same 'smart' sensors as the SPIRIT app.

StoryStructAR eases the "Structuring Task". It is smart, because it interprets and visualizes non-linear story structure by highlighting story courses. With StoryStructAR, authors can manipulate story elements in STARML, without coding XML, through StoryStructAR's UI. The tool provides STARML templates, visualizes conditions and validates the STARML code.

VideoTestAR solves the "Story Testing Needs Content" premise and limits the issue "Change of Workplace". It searches a STARML file for missing media assets. After visualization, it suggests ad-hoc prototyping of the missing media assets. VideoTestAR records audio and video. It also offers a collection of transparent images to be used ad-hoc for transparent AR video production with still frames. VideoTestAR produces compatible AR videos (H.264 encoded videos with baseline profile in an mp4 container [DSV15]). Producing ad-hoc prototypical transparent AR video content enables ad-hoc on-site testing and debugging of story elements (compare Fig. 4).

6 Preliminary Evaluation Results and Discussion

The proposed tools have been developed partially during the authoring of the first showcase, and partially as a result of evaluating this process, for future work. Thus, some have been successfully used, while others are currently under a preliminary test with two ongoing authoring projects.

MockAR has been used by a few students in Media Management with no programming experiences during the research project SPIRIT. They produced several sequences for demonstrating different designs of transparent AR video appearances, user interactions and GUIs. The results served as helpful demonstrators, by which our interdisciplinary project team was able to discuss different designs of possible SPIRIT experiences [KSS16]. We also observed a decrease of misunderstandings about requirements of the SPIRIT application. After that, visualized requirements were implemented faster and with greater attention to detail. We conclude that MockAR facilitates communication between programmers and designers, by supporting "Envisioning Experiences". [ARD04] states that a goal in authoring for IDS is to "provide communication interfaces between technology experts, storytelling experts and application domain-experts" [ARD04]. We

argue that MockAR can accomplish this goal, and that it can be used by designers and museum curators. Further, StoryPlaceAR has been used during the evaluation phase of the first SPIRIT showcase by a group of students who prepared and conducted several tours with visitors of the partner museum. Here, due to changing weather conditions and changes in the facilitated plan of the course, it was frequently necessary to adapt reference images ad-hoc, fitting them to the geographical map. The students were able to do so successfully on-site, without looking into the code.

In another ongoing academic project, eight media students with no programming experiences evaluate our smart authoring tools together with a complete authoring process for new content ideas. At first, they reported that STARML is easy to understand as an XML dialect. They edited first location-based story elements, GPS data and GUI assets with the help of an XML editor, by using templates. So far, we can state that non-programmers can easily adopt the skills of writing and debugging simple STARML code from templates. We hypothesize that next to templates, this is supported by the authoring-friendly and descriptive tag names stemming from the storytelling domain. VideoTestAR is currently under evaluation, so, getting feedback in comparison with using traditional media production suites is future work. Because of our preliminary observations, we estimate that the concepts are suitable also for museum curators and media designers, as it was the goal to enable authors with different backgrounds to create IDS experiences.

7 Conclusion

We described the authoring process of a SPIRIT experience based on the developed STARML content structure, as well as smart tools to assist authors on-site. We pointed out specific issues that make this authoring process unique: “Change of Workplace”, “Envisioning Experiences”, the “Structuring Task” and “Story Testing Needs Content”. For tackling them, we developed the tools StoryPlaceAR, MockAR, StoryStructAR and VideoTestAR. We described their concept and their benefit of being ‘smart’ authoring tools. Based on our preliminary evaluation results, we conclude that when addressing ‘smart’ sensors in an end-user experience of IDS, ‘smart’ authoring tools assist authors during interactive content creation, as well as with the communication in an interdisciplinary production team. We suppose that museum curators and media designers can utilize these smart authoring tools for developing location-dependent Augmented Reality Interactive Digital Storytelling experiences.

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