A Spatio-Temporal Authoring Tool for Multimedia SMIL Documents

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Abstract—We present in this paper a spatiotemporal SMIL editor with incremental verification capabilities. Our authoring tool, named SMIL Builder V2, is the extended version of our temporal editor SMIL Builder, defined in a previous work. The new version SMIL Builder V2 deals with spatial layout as well as spatio-temporal errors, like spatial conflict.

The spatial conflict is a major problem that affects the quality of multimedia presentations. It occurs when two visual objects overlap, partially or totally, in space and in time.

The editor will have to respond to each operation of modification on the document. In the case of a spatial conflict, the author will be informed of the problem and be assisted by the system that proposes a diagnosis and some possible solutions.

Keywords—Multimedia; SMIL; Spatiotemporal Conflict; SMIL Authoring Tool

I. INTRODUCTION

Along with the broadband technology matured, more and more information can be found in the Internet. There are many types of multimedia resources in the Internet, like pictures, text, video, animation, audio, etc. Using rich multimedia presentations, combining various types of multimedia objects to express content is an invertible trend. The multimedia presentation plays an important role in data exchanges over the web, since it represents the best means to transmit the information to the user in various applications such as distance learning, virtual tourism, news delivery, entertainment, etc..

The Synchronized Multimedia Integration Language (SMIL, pronounced “smile”) [1] has been designed by the W3C (World Wide Web Consortium) for choreographing multimedia presentations where audio, video, text and graphics are combined in real time. With the W3C efforts, SMIL is the standard of multimedia over the web, and has become an integral part of the Web infrastructure for desktop and mobile devices.

Since authoring a multimedia presentation is a complex task that requires the author to specify different types of information, an authoring system is necessary [2]. The main focus of an authoring tool is to assist and guide the author all along the editing process by offering some services like visualization, consistency checking and editing facilities.

We have defined in a previous work [3] a temporal editor for SMIL documents, named SMIL Builder. In order to better fit with SMIL authoring requirements, we propose in this paper an extension of our authoring tool which supports spatial layout as well as spatiotemporal verification.

The following section gives an overview of the field of spatial relations reasoning. After that, the SMIL language is briefly presented. We then give an overview of SMIL Builder. Next, we present the new SMIL Builder V2 architecture. Finally, we conclude with a discussion about the advantages and the limitations of the proposed solution.

II. DEFINING SPATIAL RELATIONS

Nowadays, the knowledge of spatial relations between objects is a key point in many fields such as Image Processing and commonly used in pattern recognition, computer vision, scene interpretation and more specifically in Geographical Information Systems (GIS), scene descriptions in natural language and autonomous navigation of mobile robots.

Human beings are skilled in estimating spatial relationships and can make very precise deductions despite the ambiguous definition of these relations, which is not the case of a computer program. Indeed, the computer cannot reconstitute intuitively the spatial relationship between two objects in a bi dimensional space [4]. So, many studies have been achieved to define spatial relations which can be identified by machines [5] [6]. Some models have been proposed such as [7], [8] and [9].

In the case of SMIL documents, only few works have addressed the detection of spatial relationship between two objects of the presentation, such as [10] and [11]. The problem of spatial conflicts in SMIL presentations may considerably affect the quality of the presentation, so it is necessary to propose efficient solutions to detect and correct the errors. The SMIL language is briefly described in the next section.

III. OVERVIEW OF SMIL

We give a brief overview of the SMIL elements, further information can be found at [1].

SMIL is an XML-Based language for the specification of multimedia presentations. Using SMIL, an author can describe the temporal behavior of a presentation, associate hyperlinks with media objects, and describe the layout of the presentation on the screen.

SMIL could be used to describe both the spatial relationship and temporal relationship of a multimedia
presentation. The spatial relationship is concerned with the visual layout of the presentation, while the temporal relationship is concerned with the timing control of media objects.

A. Spatial Layout

The elements for spatial relationship in SMIL include the `<layout>` element and the `<region>` element. The `<layout>` element determines how the elements in the document’s body are positioned. The `<region>` element controls the position, the size, and scaling of media elements.

B. Temporal Elements

The temporal elements of SMIL include the `<seq>` element, the `<par>` element, the `<excl>` element, and the set of media object elements such as `<img>`, `<video>`, `<audio>` and `<text>`, etc. The `<seq>` element defines a sequence of elements played one after another. The `<par>` element defines a parallel grouping in which multiple elements can be played at the same time. The `<excl>` element defines a set of elements played one at a time, without imposing order.

C. Spatial Conflict Definition

We talk about spatial conflict when two or several visual elements (video, image, text) of the same document occupy, at common moments of presentation, entirely (Fig. 1) or partially (Fig. 2), the same playback zone on the presentation layout [4].

A risk of spatial conflict occurs when a visual element is added, removed, or modified (either space or temporal attributes), therefore the system will have to check (after each one of these operations) if there is a spatial conflict, to immediately inform the author by an error message and to propose solutions.

To check if there is a spatial conflict between two elements, first we have to check if there is a temporal intersection between these two elements, and then we verify if there is a spatial intersection between the playback areas corresponding to these elements. When both conditions are satisfied, a spatial conflict is detected.

The Allen algebra [13] of intervals relationship, usually used to express temporal relations, can also be used to define spatial relations [14]. While focusing on the horizontal axis, we can define 13 Allen relations between multimedia objects: before (b), meets (m), overlaps (o), starts (s), finishes (f), during (d), equals (e), contains (di), finished by (fi), started-by (si), overlapped-by (oi), met-by (mi) et after (bi). We can define 13 relations for the vertical axis in the same way. We can therefore deduct 169 directional spatial relations between two objects interpreted like intervals in a two-dimension space.

So, given two areas R1 and R2 (see Fig. 3), 169 spatial relations can be defined. From these 169 possible spatial relations between two areas, we find 81 cases of spatial overlapping (Fig. 4).

There is no mathematical formula for the general definition of spatial overlapping cases. The idea is to gather these cases of overlapping into classes according to mathematical relations. The solution will be detailed in the following sections.
IV. SMIL BUILDER OVERVIEW

In this section, we give a brief overview of the SMIL Builder temporal editor for SMIL documents. For more details, please refer to [3].

SMIL Builder allows the author to “build” his document step by step, while insuring at every stage the validity of the current state of the document. These incremental authoring and consistency checking features are based on the H-SMIL-Net [15] model (Hierarchical SMIL Petri Net), a temporal extension of Petri Nets. The authoring environment is divided into four modules that interact all along an editing session (Fig. 5):

A. Opening/Saving Module

When opening an existing SMIL file, the system proceeds to lexical and syntactic analysis in order to verify that the SMIL document is valid and well formed according to the XML-based SMIL DTD.

B. Modelling Module

This module parses the input SMIL document and translates the temporal scenario to the H-SMIL-Net model, which is the internal format used in all modules of our authoring tool.

C. The User Interface

This module offers a number of graphical tools allowing the author to create and modify the document.

Our goal is to offer an easy-to-use temporal editing environment to both novice and experienced users; so, we have designed an interface combining simplicity and ergonomics (Fig. 6). We have opted for a very simplified interface because a more sophisticated interface can be too complex which can affect its accessibility.

The main window is divided into four parts:

- the menu bar;
- the editing toolbar;
- a workspace divided into four views: the hierarchical view, the textual view, the attributes view, the temporal view;
- the message zone.

D. Authoring / Verification Module

This module provides functions to create or to modify a SMIL temporal scenario. In order to maintain the coherence of the specification, the environment shouldn’t allow the document to enter in an inconsistent state. Each editing operation is first applied on the H-SMIL-Net model and then the optimal verification algorithm is executed. If the author’s modification leads to inconsistency, it is rejected by the system and a diagnosis is given to the author; otherwise the modification is accepted and the document is updated.

Note that this first version of the Editor is focused on temporal information, so the spatial information contained in the original SMIL document is directly saved in the document and remains unchanged. Consequently, no verification is made to detect spatial conflicts.

E. SMIL Builder Advantages and Limitations

SMIL Builder enhances the existing authoring tools by offering the following features:

- An easy editing: the editing process in SMIL-Builder reflects the methodology followed by most authors. The document is specified in a series of steps going from a general definition by components to a more detailed specification.
- Incremental verification: SMIL Builder follows an incremental editing process giving an interactive feedback after each operation made on the document in order to guarantee its consistency according to the current state of the document.
- Diagnosis service: SMIL Builder offers an efficient diagnosis service in order to help the author to correct the time conflicts detected in the document.
Although most of the objectives of SMIL Builder have been reached, some issues still have to be addressed. In the second version (which is presented here), we have integrated spatial and spatio-temporal elements in order to obtain a complete authoring environment for SMIL documents. SMIL Builder V2 is presented in the following section.

V. THE ENHANCED EDITOR SMIL BUILDER V2

In the second version of the editor, we have conserved the same structure of the authoring environment, while adding spatial-related elements and functionalities.

The new user interface (see Fig. 7) is divided into four parts:

- The views zone: in this part, we can find the four views defined in the previous versions (hierarchical, temporal, attributes and textual views), as well as the new spatial view which gives access to the spatial dimension of the SMIL document. A spatial element (region, root-layout) can be added either in the spatial view or in the hierarchical view. The spatial view allows the author to draw the regions by a simple click, and to define the associated attributes. The hierarchical view has been extended to represent the different regions and their dependencies.

- The toolbar: some spatial function buttons have been added to the toolbar in order to support spatial editing (like adding a region), and a button of presentation preview has also been included.

- The menu bar: the spatial functionalities have been integrated in the menu bar. The menu gives access to all the operations on spatial elements (adding a region, ...)

The messages zone: it has been extended to show spatiotemporal conflicts detected in the document. The kernel mechanism allowing this verification is presented in the following section.

VI. DETECTION OF SPATIOTEMPORAL CONFLICT

We have seen in Section 2 that we can define 81 types of spatial overlapping (Fig. 4).

There is no mathematical formula for the general definition of spatial overlapping cases. The idea is to gather these cases of overlapping into five classes. These classes do not represent a semantic grouping, but a set of overlapping cases satisfying the same mathematical equation. Once a spatial overlapping is detected, we verify if the conflicting elements have also a temporal intersection. If yes, a spatio-temporal conflict is detected and the author is advised. Otherwise, there is no problem, since the elements do not play at the same time.

A. Class 1

The elements of this class satisfy the following property:

\[(Y_2 < Y_1 < Y_2 + H_2) \land (X_1 < X_2 + L_2) \land ((X_1 + L_1) > X_2)\]

Fig. 8 gives the different overlapping cases that belong to this class.
B. Class 2

The elements of this second class satisfy the following property:

\[(Y_2 < Y_1+H_1 < Y_2+H_2) \land (X_1< X_2+L_2) \land (X_1+L_1) > X_2)\]

Fig. 9 gives the different overlapping cases that belong to this class.

C. Class 3

The third class regroups all the cases satisfying the following condition:

\[((Y_2 < Y_1+H_1 < Y_2+H_2) \land (Y_2<=Y_1)) \land (X_1< X_2+L_2) \land (X_1+L_1) > X_2)\]

Fig. 10 gives the different overlapping cases that belong to this class.

D. Class 4

The elements of this fourth class satisfy the following property:

\[((Y_1<=Y_2) \land (Y_2+H_2<= Y_1+H_1)) \land (X_2 < X_1<X_2+L_2)\]

Fig. 11 gives the different overlapping cases that belong to this class.

E. Class 5

The fifth class regroups all the cases satisfying the following condition:

\[((Y_1<=Y_2) \land (Y_1+H_1>= Y_2+H_2)) \land (X_1<=X_2) \land (X_1+L_1)=X_2 +L_2)) || \]

\[((Y_2<Y_1) \land (Y_2+H_2>= Y_1+H_1)) \land (X_2<=X_1) \land (X_2+L_2)=X_1 +L_1)\]

Fig. 12 gives the different overlapping cases that belong to this class.

Fig. 12 Overlapping cases of Class 5

When a spatiotemporal conflict is detected, the system displays an error message in the message zone. The message gives a diagnosis to help the author to understand the error. Moreover, the system calculates a number of possible solutions to avoid spatial overlapping. The recovery mechanism is illustrated in the next section.

VII. SPATIAL CONFLICT SOLVING

Our idea is to determine, at any instant of the time interval of the element causing the conflict, the list of free spaces in order to solve the overlapping without creating conflicts with other elements. If the author gives his consent, the element is then positioned in one of these free spaces according to its spatial attributes.

In order to illustrate this method, let us consider the following example:

\[
<\text{smil}>
<\text{head}>
<\text{layout}>
<\text{root-layout} width="800" heigth="400"/>
<\text{region} id="A" top="0" left="0" width="300" height="200"/>
<\text{region} id="B" top="300" left="0" width="300" height="100"/>
<\text{region} id="C" top="150" left="400" width="200" height="200"/>
</\text{layout}>
<\text{head}>
<\text{body}>
<\text{par}>
<\text{img} id="A" src="image1.JPG" dur="10" region="A"/>
<\text{img} id="B" src="image2.JPG" dur="20" region="B"/>
<\text{img} id="C" src="image3.JPG" begin="1" dur="15" region="C"/>
</\text{par}>
</\text{body}>
</\text{smil}>

Now we suppose that the author wants to add a D element on the interval of presentation [5, 15]:

\[
<\text{img} id="D" src="image4.JPG" begin="5" dur="15" region="D"/>
<\text{region} id="D" top="100" left="200" width="200" height="230"/>

The Fig. 13 gives the relative positions of spatial elements on the cited interval.
The adding of the ‘D’ element leads to a spatial conflict (partial overlapping) with ‘A’ and ‘B’, as shown in Fig. 14.

In order to help the author in correcting the spatial conflict error, the system starts with determining the rectangles available during the time interval of the ‘D’ element. First, the system eliminates the spaces that are already occupied by A, B and C; then it calculates the available rectangles on the remaining space. If one or more solutions are found (see Fig. 15), the system can suggest to the author to replace the ‘D’ element.

We have presented in this paper the SMIL Builder V2 authoring tool, an extension of our previous editor to support spatial editing functions as well as spatio-temporal editing.

SMIL Builder V2 inherits from all the functionalities of SMIL Builder V1, while adding new features like Preview functionality, spatial editing, as well as a new user interface, more attractive and easy to use. Our perspective concerns the integration of the hypermedia dimension in the authoring tool.

REFERENCES


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