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Extension of the Wahl-Rothermel temporal model for the multimedia documents

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Abstract

Multimedia presentation defines composition of different media having inherent or assigned temporal behavior: text, images, animations, audio and video. Temporal composition is the most important feature of multimedia presentations because it defines the overall scheduling of temporal events. In this paper, our goal is to propose an extension of Whal and Rothermel temporal model to increase its degree of expressiveness. For that, a new delay definition is proposed.

1. Introduction

Multimedia systems integrate a variety of media with different temporal characteristics, e.g. time dependent media, such as video, audio or animation, and time independent media, such as text, graphics and images [5]. In monomedia environments, all media show the same basic temporal behavior. Time does not need any particular attention. Now with the arising multimedia systems, various temporal interrelations between media items become more and more important. Assuring the correct temporal appearance of the media items is called *synchronization*. The issue of synchronization is twofold. First, the temporal appearance including the interrelations of presentation items have to be specified. The temporal specification has to be represented for reviewing by the user, presentation planning by the system and storing purposes. Secondly, the multimedia system has to guarantee the temporal constraints when presenting the media items.

This paper focuses on the first issue of representing time in multimedia environments. To represent interval relations between multimedia presentation items temporal abstractions are needed. A set of temporal abstractions is called a temporal model in this paper.

The expressiveness is only one important criteria when choosing a temporal model. A second is the intuitivity and nature of the temporal abstractions. Although formal models in temporal logics generally have a powerful expressiveness, they are not very intuitive and not easy to handle for multimedia users that are inexperienced in formal specification techniques. Thus, intuitive and natural operators were chosen to cover the interval relation space.

Depending on their elementary units, two basic classes of temporal models can be distinguished [6], [4]. In the first class, time is expressed by means of points in a one-dimensional time space [7] whereas, in a second model class, intervals are the atomic units of the time space [1].

In this paper, we propose to extend the Whal and Rothermel temporal model to increase the degree of expressiveness. For that, we introduce the flexible delay concept.

In section 2, the Wahl and Rothermel model is presented. The model extension is developed in section 3. The conclusion is given in the last section.

2. The Wahl and Rothermel enhanced model

In the Wahl and Rothermel enhanced interval-based model [9], the 29 interval relations that are defined as disjunctions of the basic interval relations and identified as relevant for the multimedia presentation [8] was reduiced to 10 interval relations. Their gool was to simplify the edition phase and provide powerful expressiveness and intuitivity to the model and allow the specification of inderterministic scenario. The figure 1 shows the Wahl and Rothermel generic model.

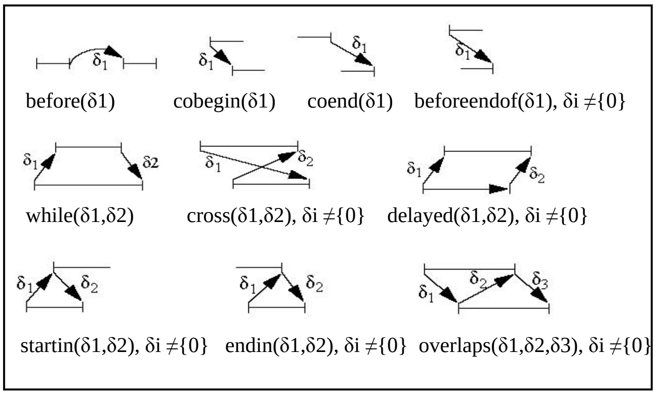

Figure 1. Wahl and Rothermel generic model.

For that, the authors beggin by define an delay parameter for each interval relations, and use the notation ‘0’ if the delay is zero, ‘+’ if the delay has a positive value, and ‘*’ if the delay is positive or zero. To avoid having several specification methods for the same interval relation, they require $\delta_1 \neq \{0\}$ for some of relations. Thereafter, they exploited the regularities between the interval relation. The first regularity is that some relations are inverse to each other. E.g., ‘x meets y’ is the inverse of ‘y meets x’. So, they use the relation *before*(δ_1) to specify both relations: *x before(0) y* for ‘x meets y’ and *x* $before^{-1}(0)$ *y* for ‘y meets x’. The second regularity is that some relations differ only by an offset from others. E.g., ‘x meets y’ and ‘x < y’ are only in so far distinct as there is a non-zero time span between x and y in the case of ‘x < y’ and a zero time span in the case of ‘x meets y’. Interval Relations that differ only in offsets are combined to the same relation. Then, the interval relations can be distinguished by the delay parameter δ_1 of the relations. In the given example, we specify *x before(0) y* for ‘x meets y’ and *x before(+) y* for ‘x < y’. As the delay parameter may be any subset of R^+_0 . We use the notation ‘0’ if the delay is zero, ‘+’ if the delay has a positive value, and ‘*’ if the delay is positive or zero.

However, the degree of expressiveness of a temporal model is function of the set of relations which compose the model, of the delay values and of the delays number associated to the relations. Consequently, the degree of expressiveness is closely related to the choice of the relations and the delay definition.

3. Extended interval-based model

In the multimedia systems, a temporal model is characterized by its expressiveness; it must allow the specification of arbitrarily complex scenarios. An evaluation of the expressiveness can be brought back to a measurement of the scenarios “number” which we can express [2]. By its degree of intuitivity, the author must be able to find in the temporal relations of the model, the mental representation which it is made of his scenario. By the the possibility to express the indeterminism relation, the author must be able to specify objects of which he does not know in advance their beginnings or their durations [3].

However, the degree of expressiveness of a temporal model is determined by the set of relations which compose the model, by the delay values and by the number of delays associated to the relations.

Consequently, the degree of expressiveness is measured by the choice of the relations and the delay definition.

A delay can be described as a subset of the non-negative real numbers R^+_0 [Wahl *et all*, 1994]. It connects the beginnings and ends of two objects A and B bounded by a temporal relation. The definition of the delay values influences considerably the degree of expressiveness. Indeed, a relation with a delay is more expressive than the same relation without delay and a relation with several delays is more expressive than the same relation with less delays.

In the Wahl and Rothermel model, the 10 relations represent a complete set for the multimedia systems; we can find until 3 delays associated to some relations, the delay parameter may be any subset of R^+_0. The authors use the notation '0' if the delay is zero, '+' if it has a positive value, and '*' if it is positive or zero.

In order to increase the degree of expressiveness of the model, we studied the possible values which a delay can take. For that, we listed the whole expressions which a delay can generate between the beginnings and ends of two objects. Lets A and B two objects bound by temporal relation *A R(d) B*, *R* is the relation *starts or finishes* and *d* the delay. The figure2 gives the whole values of the delay generated by the relation *R*.

Relations	Delays Values
A (*starts*, *finishes*) at the same time then B	delay = 0
A (*starts*, *finishes*) x units (before, after) then B	delay = x, x>0
A (*starts*, *finishes*) (before, after) then B	indeterministic delay
A (*starts*, *finishes*) at the earliest x_1 unités and at the latest x_2 units (before, after) then B	$x_1 \leq$ delay $\leq x_2$, $x_1, x_2 > 0$ and $x_2 > x_1$

Figure 2. D*elay values genereted by the relation R*

According to the relations interpretations, the delay can take the zero value, a positive fixed value, an indeterminate value or a value from an interval. This last possibility, is not taken into account in Whal and Rothermel model, we focus on it to increase the degree of expressiveness. To achieve this purpose, we introduce the flexible delay concept.

Contrary to the existing models where the delay is defined as a simple value, the flexible delay value *d* is defined in an interval, $d \in [\delta^1, \delta^2] \subset R^+_0$ where the edges values can be specified or unspecified. If specified, they are positive or null ($\delta^1, \delta^2 \geq 0$), else they are represented by the '–' character.

The figure3 gives the delay interpretations according to the interval edges values.

Flexible delay Intervals	**Delay interpretations**
$[\delta^1,-]$	at the earliest δ^1 units; $\delta^1>0$.
$[-,\delta^2]$	at the latest δ^2 units; $\delta^2>0$.
$[\delta^1, \delta^2]$	at the earliest δ^1 units and at the latest δ^2 units; $\delta^1, \delta^2 > 0$ et $\delta^2 > \delta^1$
$[\delta^1, \delta^1]$	exactly δ^1 units; $\delta^1 \geq 0$.
[-,-]	indeterminate delay

Figure 3. *Interval edges values and delay interpretations*

In addition to express all the delay values defined in the Wahl-Rothermel model, the flexible delay concept enables to introduce the *at the earliest* and *at the latest* expressions which are not provided by the existing intervals based models. Consequently, the degree of expressiveness is considerably increased. E.g., the *before* relation, in the Wahl and Rothermel model generates only the 3 following specifications :

B before (0) A : A starts exactly after the end of B.
B before (+) A : A starts x units after the end of B, x>0.
B before (*) A : A starts after the end of B.

In the proposed model, the 5 following specifications can be expressed :

B before [δ^1, δ^1] A : A starts exactly δ^1 units after the end of B; $\delta^1 \geq 0$.
B before [δ^1, δ^2] A : A starts at the earliest δ^1 units and at the latest δ^2 units after the end of B; δ^1, δ^2 >0 and $\delta^2 > \delta^1$
B before [-,-] A : A starts after the end of B.
B before [δ^1,-] A : A starts at the earliest δ^1 units after the end of B; δ^1>0.
B before [-, δ^2] A : A starts at the latest δ^2 units after the end of B; δ^2>0.

Figure 4 compares the two models in terms of the number of possible specifications.

Relations	**Specifications Number in Wahl-Rothermel model**	**Specifications Number in proposed model**
cobegin	3	5
before	3	5
beforeendof	2	5
coend	3	5
while	9	25
delayed	4	25
startin	4	25
endin	4	25
cross	4	25
overlaps	8	75
Total	**44**	**220**

Figure4. *Specifications number in the two models*

The total specifications number in the proposed model is multiplied by 5.

The specifications number is determined by the delays number associated to a relation and their combinations values. Thus, a relation with one delay has 5 specifications, a relation with two delays has 25 specifications and a relation with three delays has 75 specifications.

Figure 5 shows the generic model proposed. We have retained the 10 Whal and Rothermel relations to which we have added the three Allen relations *starts, finishes* and *equals*. The flexible delay is represented in the model by # parameter.

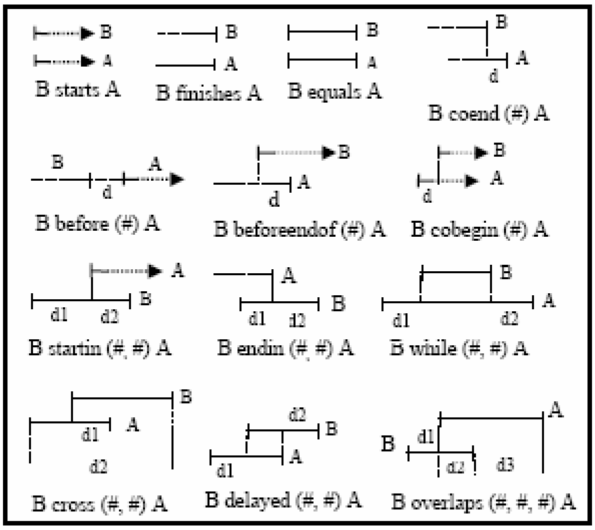

Figure 5. *Basic interval relations model proposed*

The *starts, finishes* and *equals* Allen relations have a high degree of intuitivity and they are often used in the multimedia scenarios, in spite of that they can be expressed by, respectively, the *cobegin, coend* and *while* relations.

Indeterministic scenarios can be expressed by the proposed model. E.g., B before [-, -] A is an indeterministic form, which only indicates that A starts after B. Moreover, the flexible delay provides, in certain cases, useful information for the indeterminism management. E.g., B before [δ^1, δ^2] A, we can deduce that the beginning of A is between δ^1 and δ^2 after the end of B.

4. Conclusion

In this paper, we presented an extension of the Wahl and Rothermel temporal model. The new flexible delay defintion allows us to enhance the model expressiveness degree. Because of their great use and their intuitive nature, we have added the three Allen relations to the model. Lastly, the expression of the indeterminism is not only possible, but certain relations offer useful information for its management at the analysis and presentation phases.

References

[1] Allen J. F, "Maintaining Knowledge about Temporal Intervals", Comm. ACM, 26(11):832–843, 11 1983.

[2] Blakowski G., STEINMETZ R., ``A Media Synchronisation Survey: Reference Model, Specification, and Case Studies'', IEEE Journal Of Selected Ares In Communications, vol. 14, num. 1, pp. 5-34, janvier 1996.

[3] Layaïda N., L. Sabry-Ismail, C. Roisin, "Dealing with uncertain durations in synchronized multimedia presentations", Multimedia Tools and Applications Journal, Kluwer Academic Publishers, vol. 18, num. 3, December 2002. pp. 213-231

[4] Richter Michael M.. "Prinzipien der Kuenstlichen Intelligenz", B.G Teubner Stuttgart, 1989.

[5] Ralf Steinmetz. ``Synchronisation Properties in Multimedia Systems'', *IEEE Journal on Selected Areas in Communications*, 8(3):401–412, 4 1990.

[6] Vanbeek P., ``Reasonning about qualitative temporal information'', Proceedings of AAAI, vol. Boston, MA, pp. 728-734, 1990

[7] Vil M. and H.A. Kautz. "Constraint propagation algorithms for temporal reasoning", In AAAI-86 Philadelphia, PA, pages 132 –
144, 1986.

[8] Wahl T. and Rothermel K. "Representing Time in Multimedia Systems", Technical Report 12, Universitaet Stuttgart, 1993.

[9] Wahl T. and Rothermel K. ``Representing Time in Multimedia Systems'', IEEE Proceedings of the International Conference on Multimedia Computing and Systems, pp. 538-543, IEEE Computer Society Press, Boston, Massachusetts, 14-19 mai 1994.