Journal of information and communication convergence engineering
http://jicce.org

J. Inf. Commun. Converg. Eng. 19(1): 42-47, Mar. 2021

Regular paper

Two Verification Phases in Multimedia Authoring Modeling

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Abstract

Multimedia Authoring Tool is a tool for creating multimedia presentations. With this tool, a user can produce playable multimedia documents. A Multimedia Authoring Tool requires input in the form of a spatial layout and a temporal layout. Users can make many mistakes in creating multimedia presentations and verification is required in the Multimedia Authoring process in order to produce multimedia documents. In this study, two verification phases are proposed: Time Computation and Spatiotemporal Conflict Verification. In the experiment conducted for this study, two kinds of verification were carried out: The use of single-phase verification and the use of double-phase verifications. By using these two types of verification, it became easier to successfully detect errors in the spatial and temporal layouts, and the types of verification have also been successful in increasing the success of error detection.

Index Terms: Multimedia Authoring, Petri Net, Spatio-Temporal, Time Computation, Verification.

I. INTRODUCTION

Nowadays, multimedia presentations are widely used in various fields. Making multimedia presentations can be done in various ways such as using a tool called Multimedia Authoring Tool [1]. Multimedia Authoring Tool must be easily usable and must be able to properly transform a multimedia presentation into a multimedia document [2]. Multimedia documents produced by the Multimedia Authoring Tool will be in various multimedia languages, and examples of those that are widely used are the Synchronized Multimedia Integration Language (SMIL) [3] and the Nested Context Language (NCL) [4]. When creating multimedia presentations, a user must enter data in a manner which shows the time and space of each multimedia content [5].

Challenges that usually occur when creating multimedia presentations using the SMIL document standard are:

- Difficulty in learning Multimedia language [6]: SMIL syntax has a format similar to HTML syntax. Although simple, writing programs using hypertext markup language are not widely understood by the ordinary end-user [7].
- Conversion from timeline form/spatial layout & temporal layout (visual authoring) to SMIL Code: Straightforward conversion results in an inefficient SMIL Code. The results of the conversion will produce overhead to the SMIL presentation file player [8].
- Form of Navigation: Various forms of navigation can be applied in interactive multimedia. Navigation can be either linear or non-linear, and the viewer can accept media display as a navigation element to move from one timeline to another. The ability to move from one timeline scenario to another is possible in SMIL programming [9].
- Various annotations can be added to each media element in a timeline. There are two types of annotations, namely

Received 02 November 2020, **Revised** 11 March 2021, **Accepted** 17 March 2021
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Open Access https://doi.org/10.6109/jicce.2021.19.1.42 print ISSN: 2234-8255 online ISSN: 2234-8883

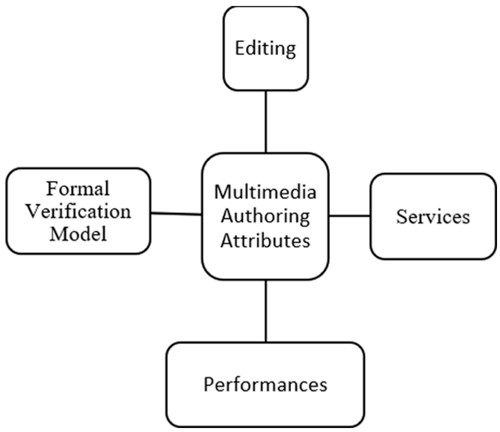

Fig. 1. Multimedia authoring attributes.

> static annotations, and continuous annotations. Static annotations are used in media such as text and images, and continuous annotations are used in media such as video, animation, and audio. Static annotations usually reach a point in which the media is either displayed or hidden. Continuous annotations are more challenging to handle because they relate to the intrinsic time of the media. A tool in the form of visual authoring can help this problem [10].

A Multimedia Authoring Tool has four attributes: Editing, Services, Performances, and the Formal Verification Model. These attributes can be used to build a model of the Multimedia Authoring Tool work properly as shown in Fig. 1 [11]. In the Multimedia Authoring attribute, there is a verification function that can be used to properly model the Multimedia Authoring process.

II. KERNEL MECHANISM

The kernel mechanism is a basic process carried out by Multimedia Authoring and must be done by a Multimedia Authoring Tool to produce a multimedia document [12]. There are several issues regarding multimedia documents that should be considered by the author when creating multimedia presentations: the creation of a multimedia query language, development of conceptual models, the ability of indices, development of efficient storage for managing real-time multimedia data, and organizational techniques for multimedia data. In the kernel mechanism, there are two main processes: modeling and verification as in Fig. 2. Both processes are mandatory in the Multimedia Authoring Tool, guarantee an error-free multimedia document [12].

Multimedia Authoring modeling mostly uses the Petri Net Model, Hoare Logic Model, and Language of Temporal Ordering Specifications (LOTOS). Each model has its advantages.

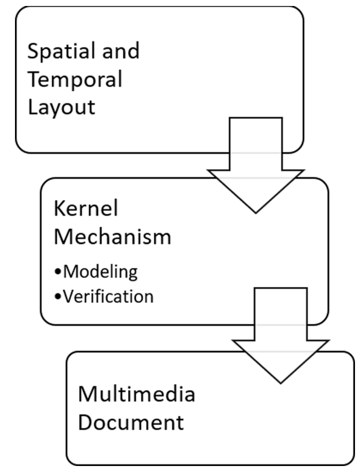

Fig. 2. Kernel mechanism.

In this study, the Petri Net model is used to observe the relationship between the verification method and the model in the Multimedia Authoring Tool.

A. Spatial and Temporal Layout

Spatial Layout is the location of the presented multimedia content. In multimedia programming using SMIL, the layout consists of a root layout and a top layout. The root layout and top layout can be divided into several regions that may overlap (as shown in Fig. 3)[13].

The temporal layout is a characteristic of multimedia presentations and the temporal layout is stated when multimedia content is presented (as shown in Fig. 4). Spatial and temporal data types can be combined more efficiently by changing into spatiotemporal data types, merging these data types, and storing them into a related data type in a database [14].

B. Multimedia Authoring Modeling - Petri Nets

Petri Net was developed in 1962 by Carl Adam Petri, and since then, it has been widely used in various fields such as telecommunications, electronics, software, manufacturing,

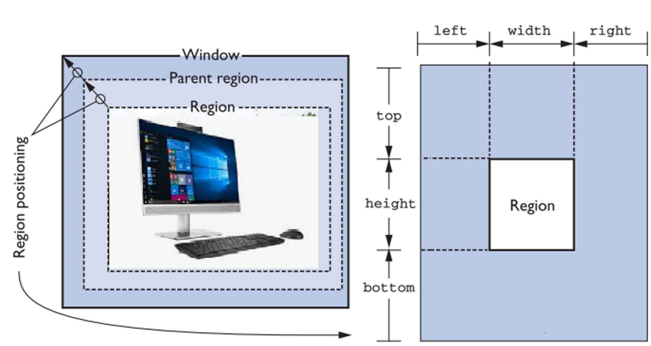

Fig. 3. Spatial layout.

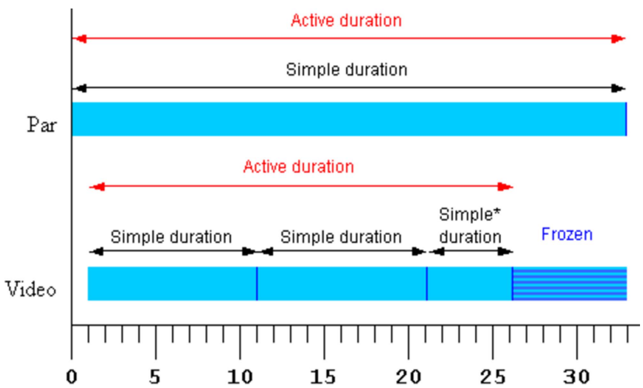

Fig. 4. Temporal layout.

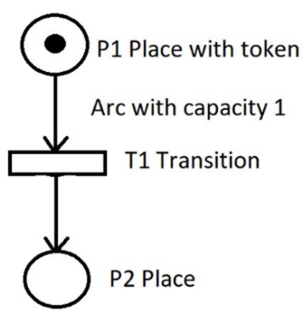

Fig. 5. Petri nets.

and others. Petri Net uses graphs as representations of the systems being modeled and uses arcs, transitions, and places as representations of the various states in a system (as shown in Fig. 5).

On a Petri Net, there are either one or more tokens. Tokens will move from one place to another. The transfer of tokens is called a fire, and tokens represent multimedia content that is being played by the player. Petri Net can be modified in many other ways, but the three notations are still used. The modifications of the Petri Net include the following:

- Real-Time Synchronization Model
  Real-Time Synchronization Model is a Petri Net with synchronization relationships on related places using transitions between places (as shown in Fig. 6) [15]. The model also has the advantage of using multimedia data transmission.
- Petri Nets Model With Non-Deterministic Event
  Petri Nets Model With Non-Deterministic Event is a Petri Net that is modified into Object Composition Petri Net. This modification aims to solve the problems that occur in real-time synchronization [5].
- Hierarchy SMIL Petri Net (H-SMIL Net)
  Hierarchy SMIL Petri Net is a Petri Net that uses incremental authoring [16]. It also has the advantage of hypertemporal processing [17].

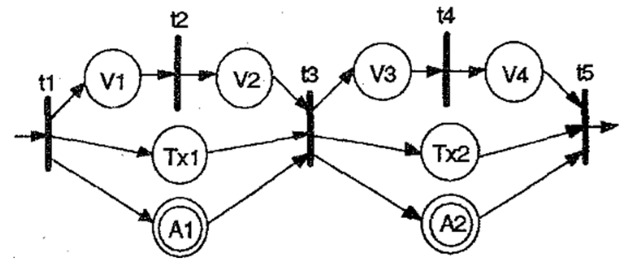

Fig. 6. Example of real-time synchronization model.

- Timed Petri Net
  Timed Petri Net was introduced in 2010 to verify temporal consistency [18]. It is a modified Petri Net in the transition section with a box shape. The transition on the Timed Petri Net is also an event [19], [20].
- Petri Net with Fuzzy Logic
  Petri Net with Fuzzy Logic was introduced in 2012 by T. Hrkac and S. Ribaric. Fuzzy logic on the Petri Net is used for spatiotemporal knowledge [21].

C. Verification

Verification is an important part of the kernel mechanism of the Multimedia Authoring Tool. Verification must be done in the phase before the kernel mechanism, in the spatial and temporal layout phases. Moreover, if necessary, the phase after the kernel mechanism in the multimedia document produced by the Multimedia Authoring Tool should be verified [16]. If the process of eliminating the errors that appear is executed correctly, it will streamline the multimedia authoring modeling algorithm process [22].

D. Multimedia Document

A multimedia document is a collection of multimedia objects and multimedia model applications. It contains communication and information which are a combination of various media such as video, text, animation, sound, and interactive reality [23] (as shown in Fig. 7). There are three main parameters in a multimedia document: events, spatiotemporal composition, and scenario. Events can be simple and complex and can also be related to spatiotemporal composition in a multimedia document. The scenario will trigger an event (start and stop) and presentation action that will be executed by the system.

III. METHOD

As discussed in section II, verification plays an important role in a Multimedia Authoring Tool. Correct verification can make the translation process from spatial and temporal

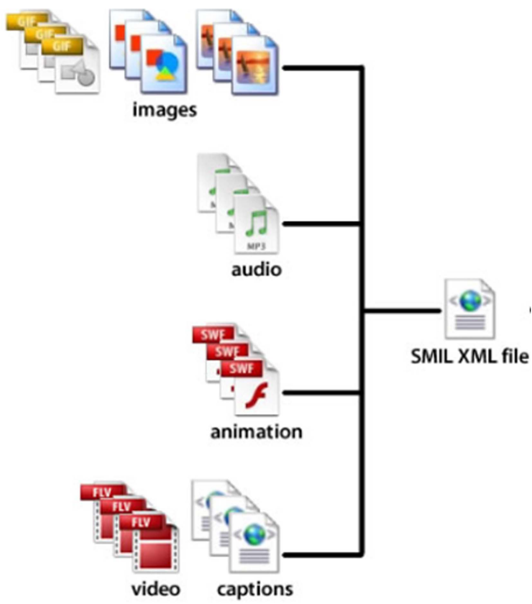

Fig. 7. Multimedia document.

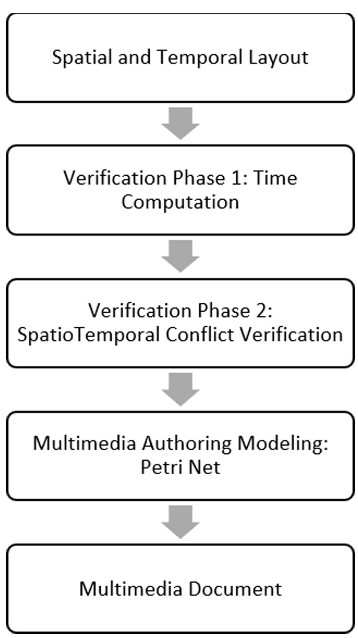

Fig. 8. Two verification phases.

layouts to multimedia documents run smoothly. This study proposes two verification phases as shown in Fig. 8. The proposed verification is using Time Computation and spatio-temporal conflict verification.

In the first phase, verification is carried out using Time Computation because the verification is general for Multimedia Authoring. It is followed by spatiotemporal verification to check for conflicts between spatial and temporal layout at a certain time.

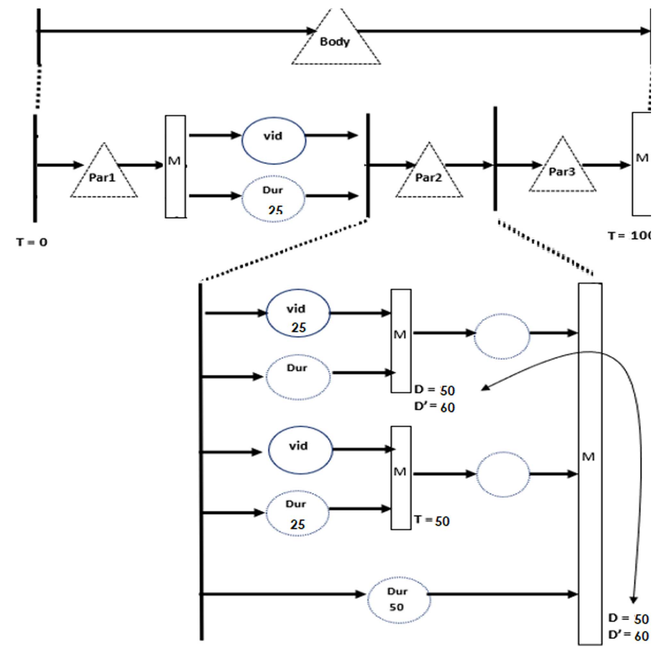

Fig. 9. Time computation

A. Time Computation

In Time Computation, a comprehensive calculation of the duration of each multimedia object is carried out. Time calculation is done in stages, starting from the top-level or the body level of the multimedia file. After the upper stage is calculated, the calculation is carried out in stages in the other levels.

Fig. 9 is an example of Time Computation in a multimedia presentation. In the presentation, there are three levels: body level, level 1 (consists of three parallels and one video object), level 2 in parallel 2 (consists of two video objects). The calculation is carried out starting from the body level and then proceeding to level 1 and level 2.

B. Spatio-Temporal Conflict Verification

In a visual object such as video, image, and animation, spatial conflict may occur at a specific time. This is called a spatiotemporal conflict in a multimedia presentation. Conflicts can occur in two or more visual objectsT and can be in the form of a partial spatial conflict or a whole spatial conflict (as shown in Fig. 10).

The process of calculating spatial conflict uses the following rules:

$$((X2>X1)\ \&\&\ (X2<X1+W1))\ \|\ ((X2+W2>X1)\ \&\&\ (X2+W2<X1+W1))\ \&\&\ ((Y2>Y1)\ \&\&\ Y2<Y1+H1))\ \|\ ((Y2+H2>Y1)\ \&\&\ (Y2+H2<Y1+H1)). \quad (1)$$

where

X1, Y1 = left top position of object 1

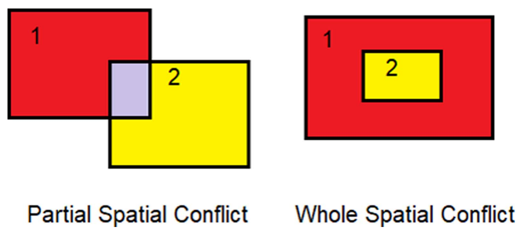

Fig. 10. Spatial conflict between object 1 and object 2.

X1, Y2 = left top position of object 2
W1, H1 = width height of object 1
W2, H2 = width height of object 2

IV. EXPERIMENT AND RESULTS

The experiments were carried out to compare verification with single-phase verification and with double-phase verification. The experimental results show that more errors are detected in a multimedia presentation if two verification phases are carried out (as shown in Table 1 and Fig. 11).

Table 1. Comparison Number of Error Detected

Experiment No.	Number of Error Detected	
	Single-phase verification (Time Computation)	Double-phase of verification (Time Computation and Spatiotemporal Conflict)
1	1	2
2	2	3
3	3	5
4	5	8
5	8	13
6	10	16
7	12	17
8	13	19

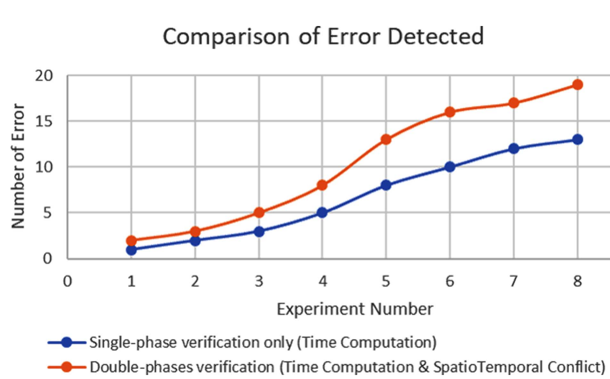

Fig. 11. Comparison of error detected.

V. CONCLUSIONS

A Multimedia Authoring Tool can function properly if it follows the kernel mechanism. In this mechanism, there are two mandatory processes, namely Verification and Modeling. Multimedia Authoring Modeling can be processed if verification has been carried out. In this study, two verification phases were carried out to improve the error detection success. In the first phase, Time Computation was used, and in the second phase, Spatiotemporal Conflict Verification was used. By using these two types of verification, the verification process was successful in detecting errors in spatial layout and temporal layouts. Based on the experimental results, it was found that using double-phases verification was the more successful method for achieving higher error detection success.

ACKNOWLEDGMENTS

This research was supported by Fakulti Teknologi Maklumat dan Komunikasi, Universiti Teknikal Malaysia Melaka – Malaysia, and the Computer Engineering Department, Faculty of Engineering, Maranatha Christian University Bandung – Indonesia.

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