Multimedia Data Modeling Based on Temporal Logic and XYZ System

MA Huadong (马华东)\textsuperscript{1,2} and LIU Shenquan (刘慎权)\textsuperscript{2}

\textsuperscript{1}Department of Computer Science & Technology, Beijing University of Posts and Telecommunications, Beijing 100876, P.R. China
\textsuperscript{2}CAD Laboratory, Institute of Computing Technology, Chinese Academy of Sciences Beijing 100080, P.R. China
E-mail: mhd@bupt.edu.cn.
Received February 26, 1998.

Abstract This paper proposes a new approach to modeling multimedia data. The new approach is the multimedia data model based on temporal logic and XYZ System. It supports the formal specifications in a multimedia system. Using this model, we can not only specify information units but also design and script a multimedia title in an unified framework. Based on this model, an interactive multimedia authoring environment has been developed.

Keywords information unit, script, synchronization, XYZ System, temporal logic, multimedia

1 Introduction

The multimedia software platform mainly includes the title authoring tools and the media producing tools. The key to those problems is the data models, especially the information unit model and the spatial and temporal synchronization model in multimedia presentations.

The synchronization in multimedia presentations can be divided into three layers: script, composition and system. The script synchronization and the composition synchronization can be defined by the specific time semantics. For example, Petra Hoepner proposed to describe the synchronization of media objects in a script by using the temporal operators based on the temporal relation between two objects\textsuperscript{[1]}; Little and Ghafoor proposed OCPN model\textsuperscript{[2]}, which can be used to model the temporal relation between two objects.

Developing a large multimedia title is a complex procedure. In order to raise the efficiency, it is necessary that a powerful stepwise refinement design environment be available. But few work aims to solve the above problem. XYZ System designed by Prof. Tang Zhisong is a temporal logic based CASE environment\textsuperscript{[3,4]}, whose kernel is a temporal logic language XYZ/E. XYZ System has the following functions: abstraction specification, concurrency specification, fast rapid prototyping, stepwise refinement design specification and verification, etc. We think that this idea is fit for specifying multimedia systems. Some attempts\textsuperscript{[5,6]} to apply this idea to describe animation script have been successful. This paper introduces our work in modeling multimedia systems.

2 Temporal Logic and XYZ System

2.1 XYZ System

Manna and Pnueli created a linear temporal logic system called MPTL\textsuperscript{[7]}. Based on the

The project is supported by the National Natural Science Foundation of China and the Science Foundation of the Ministry of Posts and Telecommunications for Young Teachers.
linear temporal logic theory, Tang Zhisong designed XYZ System, which supports various ways of programming\[4\]. In other words, XYZ System is a family of programming languages extended by XYZ/E.

A multimedia system requires a powerful CASE environment to be used easily. XYZ System provides an efficient way to develop a good multimedia platform. Temporal Logic based design environment supports not only the specification of various objects in multimedia system but also the specification of the procedure of designing a multimedia title.

### 2.2 Concurrency and Synchronization

In XYZ/E, the statement is called condition element (c.e.). In order to describe non-determinism and concurrency, the form of c.e. is as follows:

\[
LB = y_1 \land P \implies @(Q_{j1} \land LB_{j1} = z_{j1}) \land \ldots \land @(Q_{jk} \land LB_{j1} = z_{j1})
\]

Here, \( @ \) is \("\&\","\&\) or \("\cdot\","\cdot\) and \( \& \) is \("\cdot\","\land\" or \("\lor\" (xor). If we use the instances of process, \( P_{rm} \), the above two formulae can be written as:

\[
LB = y_1 \land P \implies @(P_{rj1} \land \ldots \land P_{rjk})
\]

Two kinds of the above combinations are meaningful in the view of programming. The first is "selection statement" whose form is as follows:

\[
LB = y_1 \land P \implies O(Con_{1} \lor EzeAct_{1} \land \ldots \land Con_{k} \lor EzeAct_{k})
\]

It is equal to

\[
LB = y_1 \land P \implies O(Con_{1} \land EzeAct_{1} \lor \ldots \lor Con_{k} \land EzeAct_{k})
\]

Here, \( "Con_{i}" \) and \( "EzeAct_{i}" \) represent the part of condition and the part of action respectively. Assume that the forward labels of all \( EzeAct_{i} \) are EXIT.

The second is "parallel statement" which describes the concurrency in programming, and its form is as follows:

\[
LB = y_1 \land P \implies O(P_{rj1} \land \ldots \land P_{rjk})
\]

Here, \( "[P_{rj1},\ldots,P_{rjk}]" \) represents

\[
\{P_{rj1} \lor \ldots \lor P_{rjk}\}
\]

### 2.3 Communication Mechanism

The message passed from one process to another is implemented by using channel operations. In XYZ/E, channel can be dynamically determined. There are two channel operation commands: output command (write channel) \( Ch_{y} \) and input command (read channel) \( Ch_{x} \), here \( Ch \) is the name of channel from the input process to the output process, \( y \) is an output variable of the output process, \( x \) is an input variable of the input process.

### 3 Modeling Information Unit

A multimedia presentation is a spatial and temporal composition. The temporal composition requires specifying the temporal relations between single objects in the composed objects, which is solved by the synchronization of information units.

#### 3.1 Information Unit Model

A multimedia system is on the basis of modeling information unit. MHEG standardization models the MH objects by using OO methods. MH objects are divided into output content