

Design of 3D Animation Builder with HLA Based Distributed Simulations

Sangha CHOI, Wooshik KIM, Sugjoon YOON

Department of Electronics, Information and Communication Engineering, Department of Aerospace Engineering, Sejong University, Seoul
Gwangjin-gu Gunja-dong Korea

oldood@naver.com, wskim@sejong.ac.kr, sjyoon@sejong.ac.kr

Abstract— MATLAB has been widely used for providing a variety of functions and tools in engineering computing, numerical analysis, modeling and visualization. In particular, through 3D animation, MATLAB has advantages for M&S (Modeling & Simulation). High Level Architecture (HLA) is a general standard for interoperability and reusability in M&S. 3D animation has been used in the distributed simulations for the simulation analysis. In the distributed simulations, objects or entities continuously occur changes. Each change requires modifying its 3D animation objects or entities. It would be a problem in larger simulation environment. This paper proposes the method of an automatic-generate-3D-animation builder in MATLAB. The 3D-animation builder supports advantages of the HLA based distributed simulations. In this paper, we introduce design of a 3D-animation builder. We also present the example of an HLA-based simulation with the 3D-animation builder that could fully support the advantages of HLA simulation.

Keywords—3D Animation, Distributed Simulation, Modeling & Simulation, HLA, analysis

I. INTRODUCTION

MATLAB has been widely used for providing a variety of functions and tools in engineering computing, numerical analysis, modeling and visualization. In particular, through 3D animation, MATLAB has advantages for M&S (Modeling & Simulation). 3D animation has been used for data analysis in various domain. In particular, it has lots of advantages for movement visualization in simulations (e.g. simulations of electronic warfare and engine crank, etc.).

The High-level architecture (HLA) is a standard for building a simulation for a larger purpose by combining several simulations in distributed simulation [1]. The standard supports interoperability and reusability. The HLA suggests common architecture. The US Department of Defense (DoD) and others had developed standards in the 90'. These standards were later transitioned. The standards had become an open international IEEE standards. North Atlantic Treaty Organization (NATO) also recommends the standards.

Generally, the HLA is difficult to fully understand due to high entry barriers. In order to build 3D animation in HLA standard, M&S engineers have worried about taking time to study the HLA standard. In addition, distributed simulation generally has many changes of objects and entities. Therefore, we have considered a method that builds 3D animation in HLA based simulation.

II. DESIGN

In this Section, we introduce design of 3D-animation builder (3D-AB) that we recommend in HLA based simulation.

A. HLA standard

we first present HLA standard to introduce the design. The standard consists of three parts:

- IEEE std 1516-2010 Framework and Rules
- IEEE std 1516.1-2010 Federate Interface Specification
- IEEE std 1516.2-2010 Object Model Template (OMT) Specification

The Framework and Rules specifies architectural rules for HLA based simulations. The Federate Interface Specification specifies Application Programmer's Interface (API) set of HLA interfaces. Object Model Template (OMT) Specification specifies the object model of HLA based simulation. In order to simulate the simulation, simulators must follow the three parts. "Federates shall have an HLA SOM, documented in accordance with the HLA OMT" is one of the rules [2]. In an HLA simulation, all information of objects is in HLA OMT [3]. 3D animation generally requires location data and rotation data of objects to show movement of the objects. As shown in Figure 1, HLA OMT has object classes with their attributes and interaction classes with their parameters, what the 3D-AB requires to draw a 3D animation.

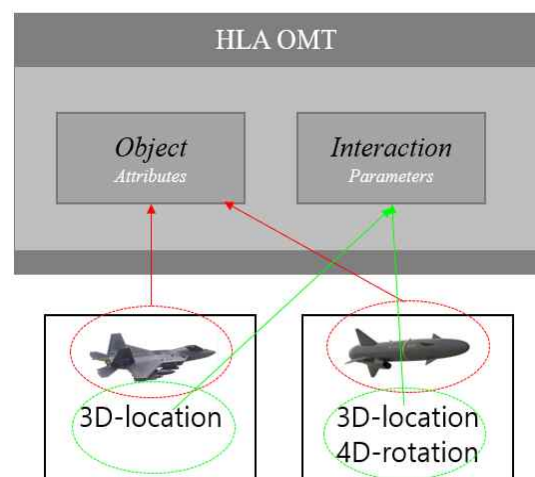


Figure 1. Object components of 3D animation in HLA OMT

TABLE 1. OMT FOR THE EXAMPLE

Federate name	Object name	Parameter name	Data type	Demension	S/P
3D-AB	Aircraft Missile	Aircraft.location	HLAinteger16BE	3	S
		Missile.location		3	S
		Missile.rotation		4	S
Aircraft	Aircraft	Aircraft.location	HLAinteger16BE	3	P
Missile	Missile	Missile.location	HLAinteger16BE	3	P
		Missile.rotation		4	P

B. Position

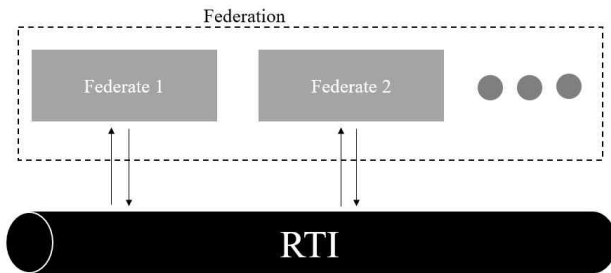


Figure 2. general structure of an HLA simulation

Figure 2 illustrates general structure of an HLA simulation with Run-time Infrastructure (RTI). The RTI is software that manages connection of a federation and federates. it provides API set for data exchanges for HLA simulations. The 3D-AB also joins into the RTI as a federate. As shown in Figure 3, The builder connects 3D animation to RTI as a federate. It analyses OMT file, connects OMT components to objects of VR world, and handles RTI API to receive data via the RTI.

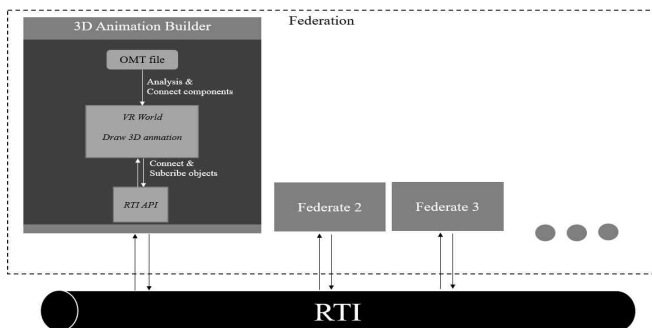


Figure 3. Position of the 3D animation builder

C. Processes

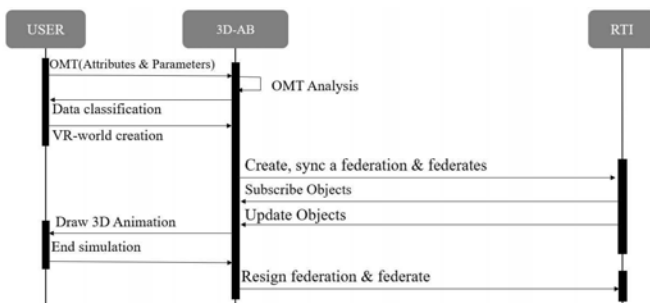


Figure 4. Sequence diagram of the 3D-AB

Figure 4 shows sequence diagram of the 3D-AB. Following the rules of HLA, the 3D-AB requires OMT file from users. The 3D-AB analyzes to classify all attributes and parameters. The 3D-AB demands data confirmation to select only 3D-animation data. After data confirmation, the 3D-AB requires VR-world to VR-world for 3D animation in MATLAB. User can be easy to create the VR-world by data classification from the 3D-AB. The 3D-AB need to handle RTI API for data exchange via the RTI. The 3D-AB need to create a federate and subscribe the attributes and the parameters what users select. 3D-AB will receive data of the objects via the RTI and draw 3D animation in the VR-world until end condition of the simulation.

III.EXAMPLE

As shown in Figure 5, we created a federation and three federates including a 3D-AB federate. The example is that we suppose the missile shoots down the aircraft.

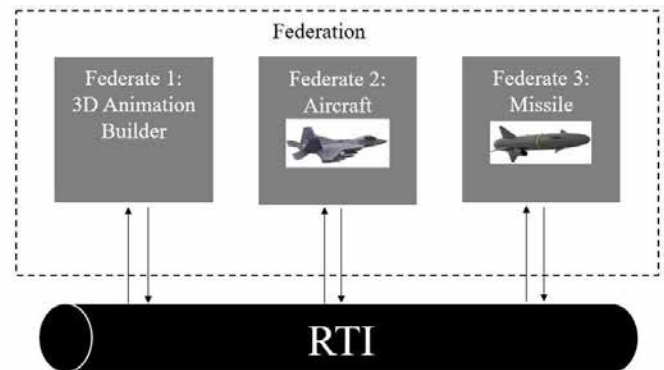


Figure 5. Federation members of the example

A. OMT

Table 1. shows the selected OMT data for the example. The 3D-AB subscribes location of the Aircraft and the Missile and rotation of the Missile. The federate of the Aircraft publishes location of its object. The federate of the Missile publishes location and rotation of its object.

As illustrated in Figure 6, the HLA OMT shall adhere to eXtensible Markup Language (XML). As provide the XML nodes on GUI in MATLAB, the 3D-AB can make easy to select 3D-animation data for user.

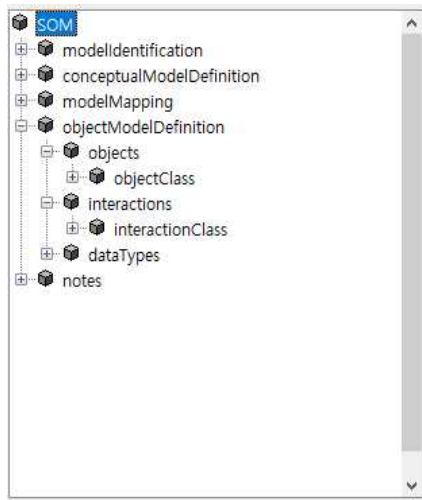


Figure 6. MATLAB/GUI for XML file

B. RTI API

RTI API is need to be coded for data exchanges via the RTI [4]. As shown in Table 2, we present essential RTI API for the 3D-AB. Using the API, the 3D-AB receives data via the RTI for drawing 3D animation.

TABLE 2. ESSENTIAL RTI API

API Name	Description
joinFederationExecution()	Join a federate in a federation
resignFederationExecution()	Resign a federate in a federation
subscribeObjectClassAttributes()	Subscribe object class attributes
requestObjectAttributeUpdate()	Request object attribute value update
receiveInteraction()	Receive Interaction.

C. Structure

Figure 7 illustrates the structure of the example. The 3D-AB connect VR-world to the OMT. Using the data of the OMT, the 3D-AB receives data for the 3D animation via the RTI.

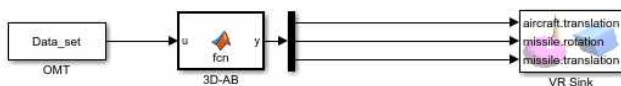


Figure 7. Structure of the example

IV. CONCLUSIONS

MATLAB has been widely used for providing a variety of functions and tools in engineering computing, numerical analysis, modeling and visualization. In particular, through 3D animation, MATLAB has advantages for M&S (Modeling & Simulation). The HLA is difficult to fully understand due to high entry barriers. In order to build 3D animation in HLA standard, M&S engineers have worried about taking time to study the HLA standard. In addition, distributed simulation generally has many changes of objects and entities. Therefore, we introduce design of a 3D-animation builder. We also present the example of an HLA-based simulation with the 3D-animation builder that could fully support the advantages of HLA simulation. The 3D-AB will automatically allow to build a 3D animation in different circumstances of simulations. Our future work is other a 3D-animation builder using other platforms (e.g. HoloStudio in Microsoft)

ACKNOWLEDGMENT

The authors gratefully acknowledge the support from Electronic Warfare Research Center at Gwangju Institute of Science and Technology (GIST), Defense Acquisition Program Administration (DAPA), and Agency for Defense Development (ADD).

REFERENCES

- [1] IEEE, IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) – Federate Interface Specification, IEEE Std 1516.1-2000.
- [2] IEEE, IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) - Framework and Rules, IEEE Std 1516, 2000.
- [3] IEEE, IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) – Object Model Template (OMT), IEEE Std 1516.2-2000.
- [4] RTI 1.3-Next Generation Programmer's Guide Version 3.2, Department of Defense, Defense Modeling and Simulation Office High Level Architecture Run-Time Infrastructure.
- [5] Microsoft, "hokoStudio", <https://aspenspreview.onedevices-p.azurewebsites.net/en-us/hololens/apps/holostudio>



Sangha Choi currently a M.S. student in Department of Electronics, Information and Communication Engineering at the University of Sejong, Seoul, Korea. His current research interests are DSP and its application to Communications, Modeling and Simulation, etc.



Wooshik Kim received his B.S. and M.S. degrees in Electronics Engineering in 1984 and 1986, respectively, from Seoul National University, Seoul, Korea, and his Ph.D. degree in 1991 from Georgia Institute of Technology. Currently, he is a professor with the Department of Information and Communications Engineering, Sejong University. His current research interests are DSP and its application to Communications, VHDL, Sensor Networks, Modeling and Simulation, etc.



Sugjoon Yoon holds a Ph.D. degree in Aerospace Engineering from University of Michigan, USA, 1987. He received his M.A. and B.A. from Seoul National University, Seoul, South Korea, 1983. For past 15 years, he is working as a Professor in Sejong University, South Korea. His research interests include flight dynamics, control, hardware-in-the-loop simulation. He is the CEO of Model Sim, a flight simulator company. Prof. Sug Joon Yoon is a fellow member of AIAA