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API Development for Efficiently Mapping between SEDRIS and Simulation Systems

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Abstract. The modeling & Simulation (M&S) in CPS environment needs to integrate the various 3D resources and environment data. The SEDRIS guarantees possibly to work the reuse and interoperability of heterogeneous environment data with standardization of data storage method. To guarantee this, it provides developers with its API in SEDRIS, but developers not easily use the low level APIs without understanding the structures of DRM, SRM, and EDCS. To solve this problem, we propose the SEDRIS High-level API (SHA) (such as STF management, terrain I/O, mesh I/O, texture I/O, and map I/O) that abstracts the existing APIs in SEDRIS for general simulation developers to easily to use them without understanding SEDIRS's structures. That is, our SHA is aimed that the normal developer using SEDRIS can easily develop the simulator without understand SEDRIS's structure. The proposed SHA includes initiation and input/output functions that directly inputs and outputs from 3D resource data to the STF file of SEDRIS.

1 Introduction

Cyber Physical Systems (CPS) is system of systems, which are combined with various physical elements and real-time control computing elements [1]. CPS defines in each little different word [2-4], but has a common feature combined with computing systems and physical systems. To be realized, the major CPS needs to have techniques of abstract, architecture, distributed computations, networked control, and verification & validation, etc. [5]. Modeling & Simulation (M&S) of these techniques is also important element for visualizing the physical status and monitoring the control system. M&S in CPS possibly should represent compound elements combined with between various physical systems and virtual systems [6]. The previous M&S in the existing environment simulates a system, but current M&S in CPS concurrently simulates various combined systems. Therefore, M&S in CPS

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requires the compound environment integrally to manage and represent various environment data.

It is possible to represent the CPS simulation data with Sharing Environmental Data Responsibly with an Interface Specification (SEDRIS) [7]. Also, SEDRIS guarantees the reuse and interoperability of environment data, which is suitable for the various combined systems. When applying to CPS simulation environment with SEDRIS, we can reduce the time and cost because of reusing and interoperability of environment data developed in a particular domain environment.

Nevertheless, to use environment data in SEDRIS, any simulation developers need to understand the basic components such as Data Representation Model (DRM) [8], Spatial Reference Model (SRM) [9], and Environmental Data Coding Specification (EDCS) [10]. By supporting the Software Development Kit (SDK) [11] in SEDRIS, the developers easily generate environmental data with SEDRIS, but impossible to use the APIs without any knowledge on DRM, EDCS, and SRM due to low level API.

In this paper, we propose the SEDRIS High-Level API (SHA) to use, manage, and build the environment data without knowledge about DRM, EDCS, and SRM. SHA support abstract API needed to save and read the environment data in SEDRIS from 3D resources (such as mesh, texture, map, etc.) using simulation in CPS. The proposed SHA supports the APIs such as initialize, STF management, terrain I/O, mesh I/O, texture I/O, and map I/O. This paper introduces the proposed SHA and case study applying to 3D object.

The paper is organized as follows. Chapter 2 presents the proposed SEDRIS High-Level API. Chapter 3 describes a case study about 3D building using simulation. Chapter 4 gives conclusion and future works.

2 What is SEDRIS High-Level API (SHA)?

Why we suggest SHA? We propose high-level APIs (named SHA) from low-level API in SEDRIS. Because a user easily use and build without the knowledge of DRM's structure in SEDRIS STF file. SHA in figure 1 consist of two steps such as a production step and a consumption step. The production step makes the STF file in SEDRIS with graphic resource data and environment data from the outside. The consumption step supplies graphic and environment data from STF file in SEDRIS to simulator. SHA consists of APIs to produce and consume such as initialize, STF management, terrain I/O, mesh I/O, texture I/O, and map I/O.

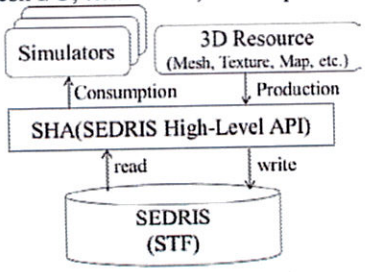


Fig. 1. The structure of SEDRIS High-Level API (SHA).

Table 1 shows some proposed SHA. To distinguish API for Cyber Physical Systems, we attach the prefix named "cps" before API names. Without the prefix, the API name is normal type as name expressed about feature of general function. To keep independent from other libraries, SHA is to use only the most basic data type and Standard Template Library (STL) in C++ for data structure. In some cases, happened many input or output data, SHA is to use the 'struct' structure of C/C++ Language.

Table 1. The Specification of SEDRIS High-Level API (SHA).

Type	*SEDRIS High-Level API (SHA)*	*Description*
Initialize	void cpsInitialize() void cpsClear()	Initialize Release
STF management	void cpsCreateSTFFile(const char *file_name) void cpsLoadSTFFile(const char *file_name, int type = READONLY)	Create file Load file
Terrain I/O	BOOL cpsLoadMapGuideFile(const char *file_name) CPS_TERRAIN cpsGetTerrain() std::list<CPS_ENTITY>* cpsGetEntityObject()	Load map Get map data Get map entity
Mesh I/O	BOOL cpsImportMeshFile(const char *mesh_file_name, const char *mat_file_name) CPS_VET_POSITION* cpsGetVertexPosition(const char *submesh_file_name, unsigned int &size) CPS_VET_NORMAL* cpsGetVertexNormal(const char *submesh_file_name, unsigned int &size) CPS_TEX_COORD* cpsGetTextureCoord(const char *submesh_file_name, unsigned int &size) CPS_FACE* cpsGetFace(const char *submesh_file_name, unsigned int &size) CPS_MATERIAL cpsGetMaterial(const char *submesh_file_name)	Import mesh Get vertex value Get normal value Get texture coordination Get index value Get material
Texture I/O	BOOL cpsImportTextureFile(const char *img_file_name) BYTE* cpsGetTextureData(const char *submesh_file_name, int &width, int &height, unsigned int &size)	Import texture Get texture
Map I/O	BOOL cpsImportHeightmapFile(const char *map_file_name, int width, int height) BYTE* cpsGetHeightMap(const char *img_file_name, int &width, int &height, unsigned int &size)	Import map Get map

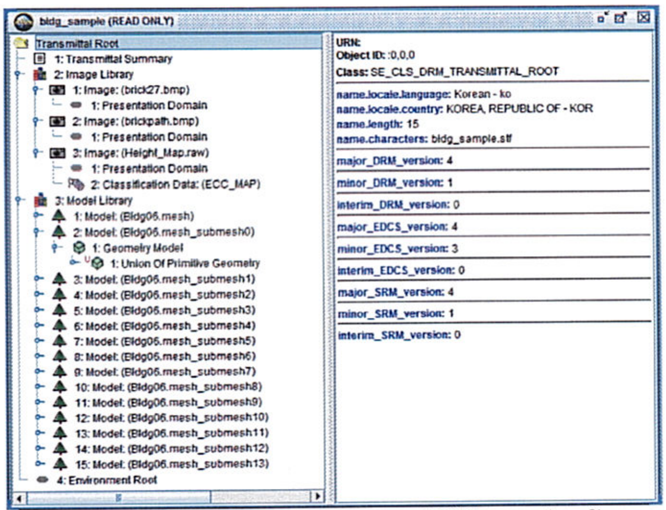
3 A Case Study

In this chapter, we show an example to create a *building* showed in figure 2. First, data is initialized using the *cpsInitialize()* function. Second, "bldg_sample.stf" file is created with the *cpsCreateSTFFile()* function. Third, two texture files such as "brick27.bmp" and "brickpath.bmp" is imported using *cpsImprotTextureFile()* function before loading the texture. Fourth, two of the mesh and material file is imported using the *cpsImportMeshFile()* function. Last, data is released using the *cpsClear()* function.

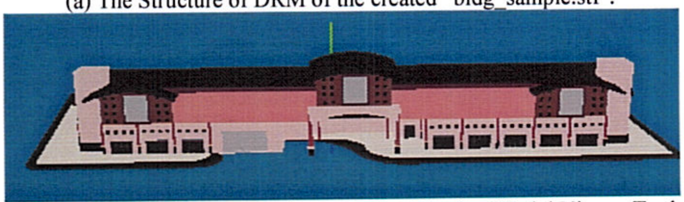
```
#include "ETRI_CPS_HIGHLEVEL_API.h"
void main() {
    cpsInitialize(); //Initialize
    cpsCreateSTFFile("bldg_sample.stf"); //Create STF file
    cpsImportTextureFile ("brick27.bmp"); //Add Texture
    cpsImportTextureFile ("brickpath.bmp"); //Add Texture
    //Add mesh
    cpsImportMeshFile("Bldg06.mesh.xml","Bldg06.material");
    cpsClear(); //release
}
```

Fig. 2. The Example of C++ Program using SHA.

Figure 3(a) shows the result from SEDRIS's Focus Tools with the "bldg_sample.stf" file generated after running the program code in figure 2, and also show to register two texture images in image library, and one *mesh* file and fourteen *submesh* files in model library. Figure 3(b) shows the result with SEDRIS Model Viewer Tools. With these results, we can validate to build the complete *building* structure.



(a) The Structure of DRM of the created "bldg_sample.stf".



(b) The Result of the created "bldg_sample.stf" using Model Viewer Tools.

Fig. 3. The Result of C++ program using SHA.

4 Conclusion

CPS Simulation should simulate various embedded systems simultaneously because of compoundly representing various combined systems. Therefore, to solve this problem, we need SEDRIS that can express the various environment data. So we propose the SEDRIS High-Level API (SHA) to use, manage, and build the environment data without knowledge about DRM, EDCS, and SRM. When applying to CPS simulation environment with SEDRIS, we can reduce the time and cost because of reusing and interoperability of environment data developed in a particular domain environment. In this paper, we introduced SHA needed to apply SEDRIS in CPS simulation. Especially, proposed SHA focus on terrain data management such as texture, polygon, vertex, and map. Further research should be conducted, which is not dealt in this study on terrain map of complex format and environment data such as atmospheric, pressure, and temperature.

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