3D Graphics Authoring System: CGI Studio

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Systems that apply 3D graphics are beginning to become common in automobiles, as in instrument clusters integrating full-color LCDs. Fujitsu Semiconductor Embedded Solutions Austria GmbH, a group company of Fujitsu Semiconductor, has developed CGI Studio as a tool for developing these systems. As a framework of authoring tools to develop 3D graphics content for automotive systems, CGI Studio provides a workflow for embodying a designer's ideas in an actual target system (such as an actual product and prototype for product development). CGI Studio can also be used in combination with other widespread graphics authoring tools, and thus consolidate the existing tools used by customers. CGI Studio integrates multiple pieces of software and includes analysis tools for identifying performance bottlenecks in the execution of applications on the hardware used. They include software for 2D and 3D composition, authoring tools, scene generation, the Candera software graphics engine and scene player. This paper outlines the trends in automotive application of graphics and describes the features of CGI Studio and the collaborative workflow between designers and embedded system developers realized by CGI Studio.

1. Introduction

Along with the recent evolution of microelectronics, high-function and high-performance computer graphics have come to be realized as inexpensive and low-power-consumption system-on-a-chip (SoC) products. These new SoC products have made it possible to improve user-friendliness by having graphical user interfaces in embedded devices, and the diffusion of these devices have accelerated the development of even more sophisticated graphics SoCs.

This trend is mostly driven by mobile devices. High-performance graphics have already given sophisticated graphical user interfaces and game applications comparable to dedicated machines to smartphones and tablets. This trend is spreading to other embedded devices and, among automobiles, applications with graphics features are rapidly spreading to low-end cars, not to mention high-end cars. In many cases, these automobiles have two or more displays including the car navigation system and instrument panel. Instrument panels may provide some graphical indication in addition to mechanical meters or indicate everything with graphics. As the third display, head-up displays, which project images on the windshield, are also beginning to become widespread.

These displays are becoming an essential part of the brands of automakers or vehicle models. This is because these systems constitute a vital portion of the interior of automobiles and are an important factor in differentiating automakers or vehicle models from their rivals. **Figure 1** shows an example of an instrument cluster that entirely uses graphics.

The functions of displays include not only indication of basic information such as the speed, number of engine revolutions, and fuel level but also operation of a navigation map and entertainment devices such as an audio system. These were conventionally shown by animation with bitmap images drawn in advance, which is called 2D graphics. Recently, new applications have come into existence including those that offer at-a-glance notification to the driver about self-diagnosis and failure points in the vehicle by means of real-time

Figure 1
Instrument cluster using graphics.

3D graphics.

Fujitsu has developed and offered CGI Studio as a software tool that assists graphics content development for embedded devices including automotive devices.

This paper gives an overview of CGI Studio.

2. Issues with HMI development by customers

In operating various devices in automobiles, the interior and human-machine interface (HMI) need to reflect the corporate image and identity of the respective automaker. For this reason, many automakers define their own HMIs and graphics content used in them. However, the actual development of instrument clusters and car navigation systems is often taken charge of by system suppliers for automobiles, and workflows of content production tools are required to support such joint development.

In addition, there has conventionally been a separation between designers who design the content and engineers who actually develop the devices. For example, the feasibility of the expected appearance and operability was not determinable in the early stage of development due to limitations such as costs and device hardware, and a large amount of reworking and revisions were required to bring the actual devices closer to the expected results.

Specifically, tools used by designers are generally incompatible with the rendering technologies of target systems (such as actual products and prototypes for product development). Image effects that can be used by tools are not necessarily portable to target hardware and the created preview may not be available with the target hardware or a slight change to the content may have a serious impact on the performance.

Furthermore, the actual HMIs need to be capable of providing different indications depending on the driving conditions in an easy-to-understand manner, which requires an appropriate structure to be designed so that the views and indications can be changed according to the situation and controlled, in addition to simply displaying content.

3. CGI Studio framework

CGI Studio, which is a 2D and 3D graphics interface software development platform, has the following features for resolving the issues described in the previous section.

1) Provision of authoring tools specialized for HMI applications of embedded devices including automotive devices
2) Creation of scene composition using both 2D and 3D graphics
3) Seamless porting of graphical content design to target hardware
4) Linking with existing graphics tools
5) System solution by provision of both hardware

and software

CGI Studio is composed of the following components (**Figure 2**).

1) CGI Scene Composer

CGI Scene Composer is the key tool of CGI Studio and is used for inputting graphical images created by designers. Then, it combines control logic and scenes and creates a scenario for displaying those images on the target system to ultimately output the content for the target hardware. This is a 2D/3D development tool that assists drawing designers with intuitive creation of sophisticated HMIs.

2) CGI Player

CGI Player provides a runtime environment for displaying and controlling the HMI created with CGI Scene Composer in the systems for image content development and the target. CGI Player uses multiple views to display interactive scenes and allows the creator to execute the sequences of animations, tests and specific applications.

3) CGI Analyzer (optional)

CGI Analyzer is a performance analysis tool that provides an intuitive graphical user interface for easy identification and tracing of bottlenecks in performance. CGI Analyzer supports both an online mode for visualizing performance during application execution and an offline mode for examining the performance log after application execution.

4) CGI Translator (optional)

CGI Translator is a Web-based tool for online translation of multilingual text with the HMI application.

5) CGI Interaction Framework Courier (optional)

CGI Interaction Framework Courier is a tool for connecting multiple application components by making use of the high extensibility and programmable messaging environment. This framework provides message-based view control, data binding and interaction with external systems for linking application logic (e.g., state machine) with the external environment.

4. Candera graphics engine

Candera, which is at the core of CGI Studio, is a software graphics engine independent of the execution environment such as hardware and OS. By being embedded into the tool on the PC and the target system, this engine allows exactly the same representation to be reproduced in an embedded system as the content created with the tool.

Candera3D is implemented in OpenGL ES 2.0, an industry standard graphics library, and highly portable

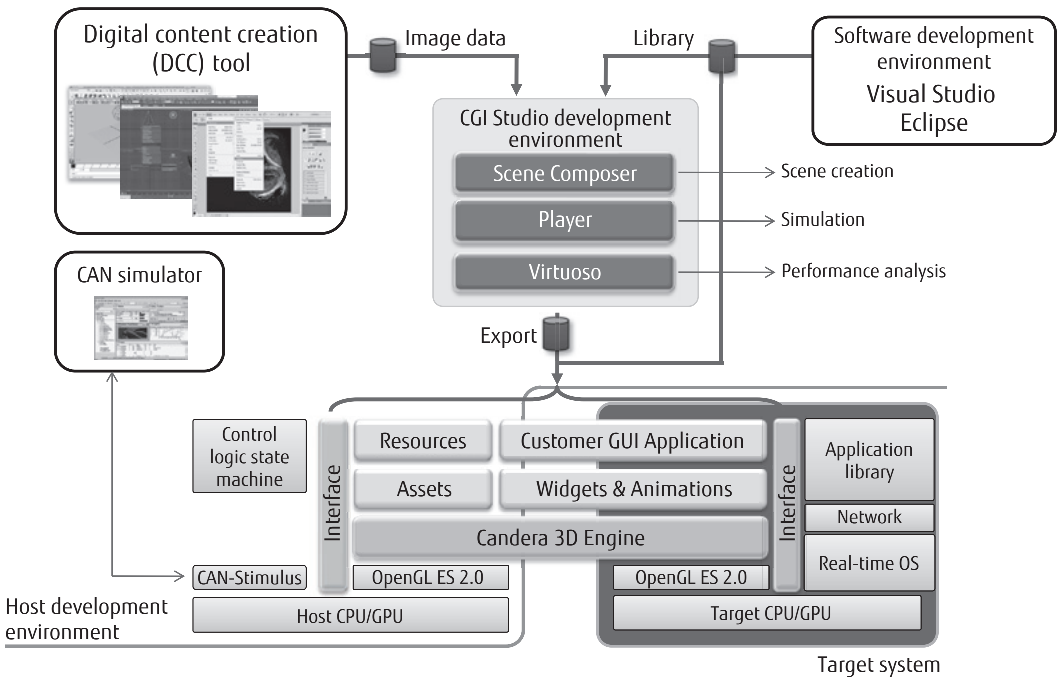

Figure 2
CGI Studio configuration.

content can be created. Together with Candera2D, it allows easy creation of content that integrates 2D graphics optimized for the target system and 3D.

5. Workflow of graphics content production

The following describes a workflow of a graphical HMI development using CGI Studio (**Figure 3**). The workflow consists of five steps:

- Content creation
- Adaptation to the target system
- Scene and scenario composition
- Application development and execution
- Result analysis

CGI Studio provides a framework for repeated implementation of this workflow in a prompt and seamless manner.

1) Content creation

Creation of 3D content involves many more processes and has a higher complexity than 2D content and requires creation of the types of data listed below. An example of content production using CGI Scene Composer is shown in **Figure 4**.

- Mesh (polygon) attributes, conversion, material and texture
- Light and camera
- Animation

2) Adaptation to the target system

The content must be adapted to the following restrictions and requirements of the target system.

- Restrictions on the structure and data volume of polygons and drawing objects
- Texture size and mapping method settings
- Additional effect settings

3) Scene and scenario composition

Scenes are composed with an editor while checking operation in the target system.

- Verification of the composition by real-time graphics engine rendering
- Scene graph and widget composition, and confirmation of operation of animation, shader and effect
- Viewport and display setting

4) Application development and execution

Application development and execution are carried out in the target platform.

- Implementation of the application flow and logic (e.g., state transition)
- Definition of connection operation with the

Figure 4
Example of use of CGI Scene Composer.

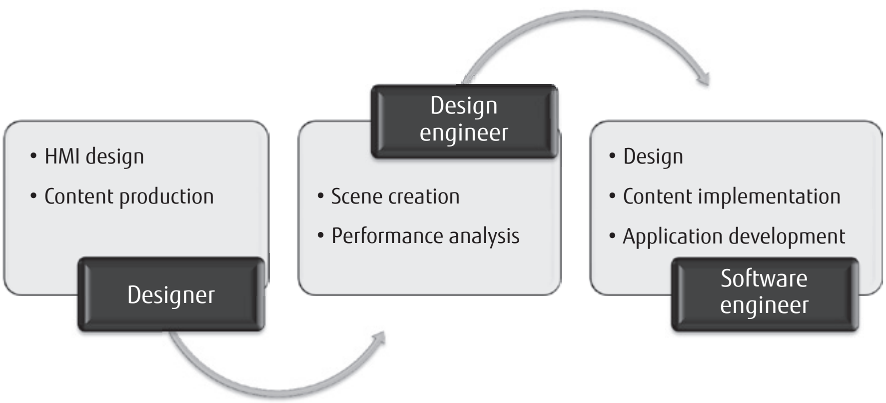

Figure 3
HMI production workflow.

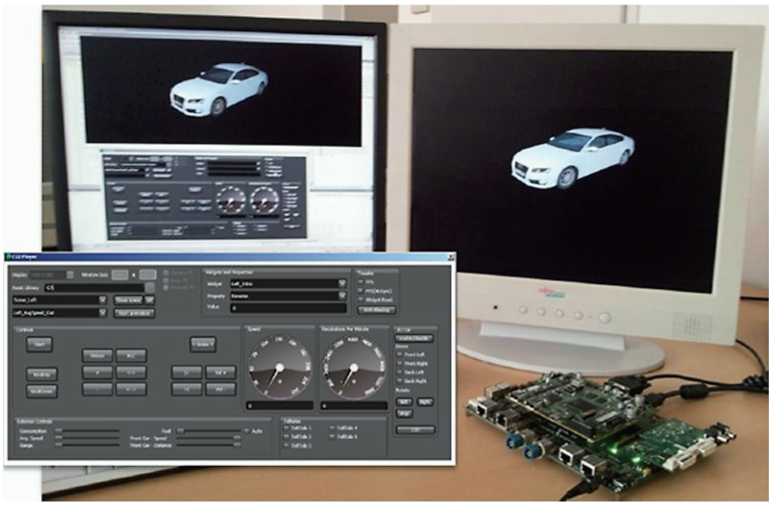

Figure 5
Linking with target system.

external (signal messages)

5) Result analysis

To detect any bottleneck in the performance, the content execution and performance are analyzed directly on the target device.

- Load balance between the CPU and GPU
- Experiment and verification with the rendering settings changed

6. Benefits of tool introduction

As an HMI creation tool intended for embedded devices such as automotive devices, this tool also assumes it will be used by developers who are not very familiar with graphics. This is because the introduction of graphics for HMIs and other purposes is in progress among applications that conventionally did not use complicated graphics, such as automobile instrument clusters. Accordingly, this tool allows designers and engineers who are new to the development of HMIs to develop systems easily.

In addition, this tool assumes that designers who produce the content are not the same people as the engineers who embed it in the actual target hardware. Furthermore, because work is often shared by different organizations and enterprises as in design by an automaker and its implementation by an electrical equipment supplier, this tool has been developed to offer ease of such collaborative work. Especially, in the past, when the design developed on a workstation by a designer was actually implemented in the embedded target hardware, the results expected by the designer were often not achieved in terms of the performance, appearance and operational feel. Hence, there was a need to make design compromises and great efforts for tuning on the target system. With this tool, the content created by designers can be run as it is on the target hardware, which allows the results of execution of the application to be shared and allows the development workflow to be efficiently implemented. **Figure 5** shows an example of an HMI created on a PC (left) run on the target hardware (right).

7. Conclusion

Fujitsu has been continuously developing and providing LSI products intended for automobiles and embedded devices. In addition to LSIs, we are committed to offering system solutions including software such as libraries and tools. The tool presented in this paper has been developed as part of such activities and allows customers to easily develop HMIs and embed them in equipment.

We intend to work not only on enhancing the functions of this tool and offering support for the next LSI products but also on development with a view to linking this tool with other tools offered by Fujitsu.

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