“Scritter” to “1p2x3D”: application development using multiplex hiding imaging technology

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ABSTRACT
In this paper, we establish a roadmap of Scritter, a promising multiplex hidden imaging technology enabling multiple users to watch different contents on the same display at the same time. After a review of each generation’s improvements and features, we present the major applications developed in order to promote the multiplex hidden imaging technique to the public and content creators. We then introduce a plug-in designed for the Unity3D Game Engine to help content creators and artist get more easily involved in the search for innovative content using multiplex hidden imaging. We eventually review the potential applications we explored so far, and suggest new fields of investigation where the Scritter series could add a significant value regarding entertainment, social experiences, and utility.

Categories and Subject Descriptors
I.3.1 [**Computer Graphics**]: Hardware Architecture—*Parallel processing, Three-dimensional displays*

I.3.3 [**Computer Graphics**]: Picture/Image Generation—*Display Algorithms*

I.3.6 [**Computer Graphics**]: Methodology and Techniques—*Interaction Techniques, Languages*

General Terms
Algorithms, Performance, Design, Experimentation, Human Factors, Standardization, Languages.

Keywords
Multiplex Imaging, Image Hiding, Unity3D, Innovative Content, Stereoscopic, Display Technology

Laval Virtual VRIC ’14, April 9-11, 2014, Laval, France.

1. INTRODUCTION
Three-dimensional cinema has become popular over the past decade and has made its way into homes with the development of personal 3D displays. Although several technologies currently coexist, we can expect 3D support to be a standard for the next generations of displays. However, the current use of multiplex technology is limited to the superimposition of a ”left-eye” image and its associated “right-eye” image to provide the user with the desired stereoscopic effect. The doubled image resulting from the merging of both images on the display (as seen with the naked eye) prevents users without the appropriate filtering device from using the same screen at the same time.

These current limitations led us to focus on finding innovative solutions to improve existing devices by following a systematic methodology based on continuous development. The purpose of this project is to enable new multiplex imaging experiences far beyond the sole focus on 3D movies. We intend to increase not only the “entertainment value” of available displays but also the “social value” of the living room by allowing multiple users to enjoy a different experience on the same screen without the need to wear any additional device.

2. RELATED WORK
ThirdEye by Mistry [1] is a technique that enables multiple viewers to see different images on a display screen at the same time. This technique is similar to the objective of Scritter. However, this project is only concerned with the development of shutter-based hardware and does not address the issue of creating new user experiences or applications.

Sega Enterprises (1994) and Sony Computer Entertainment (2010) patented similar technologies that enable multiple users to visualize two different images on the same screen simultaneously [2], thus allowing two players to share a display while viewing their own game screen. SimulView by Sony allows a movie to be played by a user while another user is playing a videogame. However, this development only focuses on hardware and not content creation. The main difference with Scritter is the filtering technology. The chart in Figure 1 justifies the choice of a polarization-based filtering technology.

	Polarization-based	Shutter-based
Contrast	-	+ +
Resolution	+	- -
Frame rate	+	- -
Fatigue	+	- -
Price	+ +	- -
Scalability	+ +	X
Naked eye	+ +	-

Figure 1. Polarization vs. shutter-based filtering

Furthermore, SimulView ignores the double image resulting from the superimposition of images on the naked eye.

3. ROADMAP OF SCRITTER

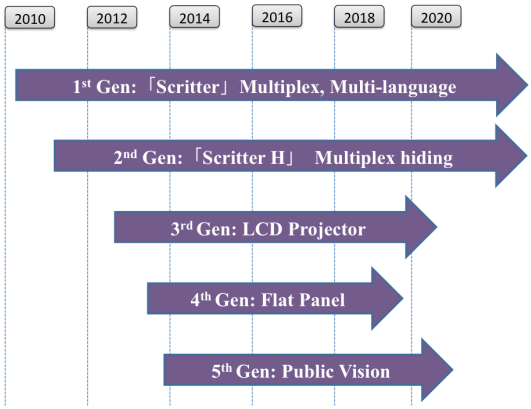

Figure 2. Roadmap of the Scritter series

3.1 First Generation: "Scritter"

Scritter, which started development in 2010, aims to display multiple content on the same screen by using polarization [3]. Scritter is fully compatible with existing hardware, as evidenced by the use of this method in current 3D projection techniques.

The original purpose of Scritter was to display real-time "tweets" that could be viewed on a separate channel (i.e., "Scritter" = Screen + Twitter). The polarization technique enabled the use of other applications, such as multi-language subtitles (see Figure 3), to achieve the primary goal of Scritter, that is, screen sharing with other users.

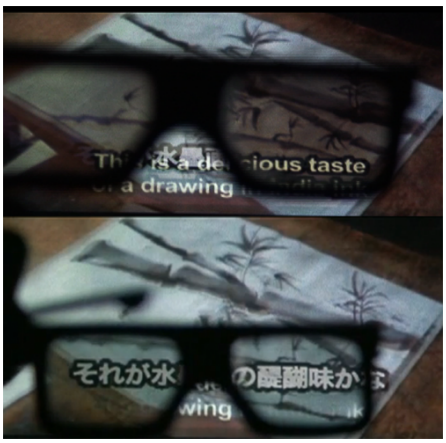

Figure 3. Scritter multi-language

3.2 Second Generation: "ScritterH"

The first generation of Scritter enabled the merging of content. However, users without polarized glasses will not benefit from this development because they will see both images on the screen. To eliminate the double image on the naked eye, a hiding algorithm was introduced in the second generation of Scritter (i.e., ScritterH) [4]. A pixel shader was created to manage double images and allow viewers without polarized glasses to enjoy the main content while enabling users with polarized glasses to access hidden content, such as subtitles (see Figure 4). Given that this original hiding technique is based on GPU processing, this technique can handle motion pictures and real-time applications and facilitate interactivity, thus enabling a variety of applications for multiplex imaging.

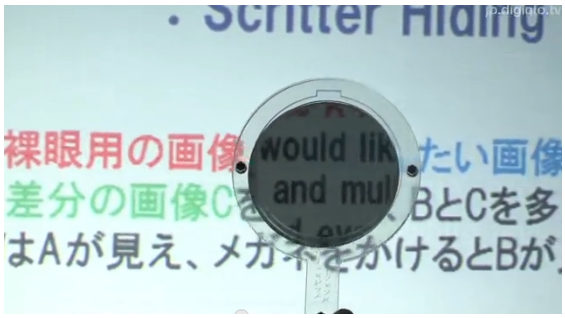

Figure 4. ScritterH image hiding for multi-language

3.3 Third Generation: "LCD"

The multiplex hiding technique was successfully adapted to LCD projectors, thus enabling users to watch two independent images in real time when switching from polarized glasses to the naked eye by using standard hardware.

3.4 Fourth Generation: Flat Panel

The previous generation of Scritter offered interesting image quality and size properties. However, the use of projector-based technology leads to several constraints: cost (the current technology uses two projectors), flexibility (setting projectors in a given position is time consuming), and the need for special ambient lighting conditions. These drawbacks can easily prevent domestic use and dissuade content creators from exploring the possibilities of this promising content-hiding technology.

To develop a version of Scritter that is appropriate for the living room, we transposed the multiplex imaging and hiding techniques to flat-panel LCDs (see Figure 5). The image merging was based on even/odd row pixel shading by using the built-in polarization of a regular 3D computer screen.

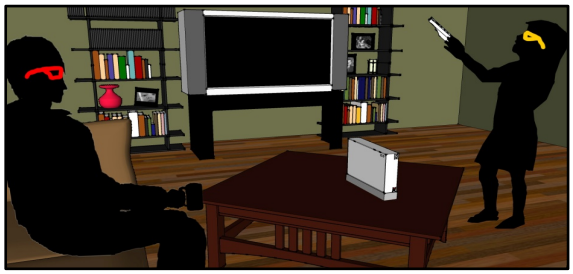

Figure 5. Flat panel multi-content for the living room

3.5 Fifth Generation: Public Signage

The fifth generation of Scritter aims to display hidden content on public signage. This objective can be achieved by adapting the multiplex hiding technique to existing public displays and by finding elegant solutions to allow users to visualize hidden content. Current polarized glasses are no longer relevant in public space. A solution to this problem is the use of a polarizing filter attached to the camera of a smartphone, thus enabling users to access hidden information via any personal device.

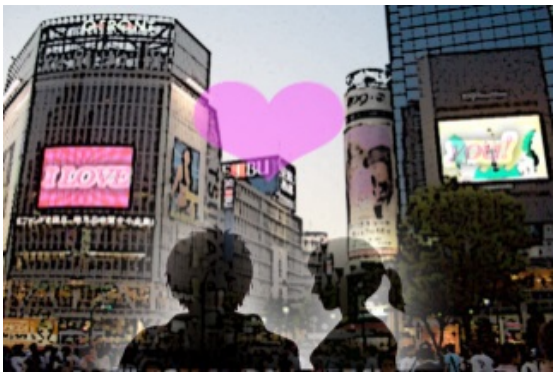

Figure 6. Public vision personal messages

3.6 "1P2x3D", Special Device for Multiplex

The last development of the Scritter series consists of a single coaxial projector, which superimposes two images for a multiplex imaging experience. The setting is greatly facilitated because only a single projector is needed. This generation is cheaper and more convenient than previous generations. Thus, 1P2x3D is poised to replace formerly used hardware in projector-based applications.

4. APPLICATIONS

The following section describes user-ready applications that are based on LCD projector multiplex hidden imaging technology (as presented at major exhibitions) to obtain feedback for further improvement.

To increase the social value of current movie entertainment, a hybrid theater that enables viewers to watch movies in 2D with the naked eye or in 3D with glasses simultaneously was created (see Figure 7). This application of Scritter, called 2x3D [5], allows stereoblind individuals and people whose eyes fatigue easily to watch content without glasses while allowing 3D lovers to enjoy the stereoscopic experience by wearing appropriate glasses. The left-eye movie sequence is projected on the naked eye, and the right-eye movie sequence is transmitted through a polarizing filter.

Figure 7. 2x3D real-time hybrid theater

Parallel Augmented Reality for Audience-Oriented Karaoke Entertainment or PARAOKE [6] is a multiplex imaging application of ScritterH that provides a new entertainment value to Karaoke. Audiences listening to the singer are no longer passive and are instead involved in parallel activities such as a dancing game (see Figure 8). An original controller based on the Nintendo Wii, named "Fil-Con," was created to navigate a hidden menu that is superimposed on the shared screen. This interactive hidden feature opens interesting prospects for the next generations of the Scritter series.

Figure 8. PARAOKE

Ubicode [7] is another direct application of the ScritterH hiding algorithm and is applied to QR codes. These graphical patterns provide useful information when scanned but may appear unaesthetic or meaningless on the naked eye. The Scritter technique is used to hide QR codes behind expressive content, such as a picture or a caption (see Figure 9). The hidden code can be visualized and scanned by any smartphone with a camera that is equipped with an additional polarizing filter.

Figure 9. Ubicode: scanning hidden QR codes

5. CONTENT CREATION TOOLS FOR SCRITTER WITH UNITY 3D

The continuous development of the Scritter project will enable each Scritter generation to offer incredible potential for new user experiences. To explore these amazing possibilities, the creation of innovative content has to be facilitated to increase the transparency of the technique and allow artists and designers to focus on content creation. Easier means of creating content for Scritter will increase the number and variety of available content, thus making the Scritter technology appealing to end users and increasing its popularity.

We have also developed a plug-in for the Unity3D Game Engine that allows external users to maximize the potential of Scritter in multiplex imaging and hidden content creation. The Unity3D Game Engine offers excellent prospects because this engine is already widely adopted by independent content creators and artists. The purpose of this plug-in is to automate the image merging and processing: users are only required to drag and drop content to set an input (e.g., standard format video files and images; webcams and game cameras from the Unity game scene). The output can be visualized easily by starting the scene within Unity or exported to any platform/web player as a standalone application (see Figure 10).

Figure 10. Hidden content in a Unity 3D car game

6. FUTURE APPLICATIONS AND IMPROVEMENTS

The primary purpose of the Scritter series is to enable new entertainment experiences based on multiplex imaging. The 2x3D hybrid theater is a perfect match for the cinema industry and public entertainment, whereas flat-panel LCDs are suited for the living room. The following features have been successfully explored: 3D movies, movies with hidden content such as subtitles or comments, 3D videogames, single screen multiplayer games, games with hidden content (which could provide an interesting new role to players in the "backseat"), multi-audience levels for content with PEGI classification, and the possibility to enjoy two independent contents (i.e. two different movies or a movie and a videogame) on the same screen at the same time.

In addition to the entertainment value of multiplex hidden imaging, this technique offers promising prospects to various fields. Education methods can be improved by allowing teachers to add hidden hints or extras to lessons and exercises. In the medical field, additional information can be provided inconspicuously to medical crews to reduce patient stress. This technique can also provide a convenient means of filtering real-time global models to a specific component or layer.

Any application that provides additional information can benefit from the multiplex hidden imaging technique of Scritter (e.g, signage in museums, shops, buildings or public areas can give valuable complements on pieces of art, products, opening times, procedures) while preserving the aesthetics of the place on the naked eye. The possibility of hiding real-time menus or links on the original display can allow users to interact with content by using smartphones while remaining offline compared with current QR codes, thus enabling the filling of surveys or the placing of orders. This technology can usher a new era of "invisible advertising and marketing." To simplify the image processing involved in the multiplex hiding algorithm and dissociate it from the personal device of users to create a distributable version, a plug-and-play hardware version of Scritter is currently being developed.

7. CONCLUSION

Scritter launched a continuous development project that investigated the field of multiplex imaging. Each "generation" of the Scritter series aims to allow multiple users to enjoy a different experience while sharing the same screen. The accessibility and acceptance of the technology by content creators and end users have been the major guidelines in the development of the project. This strategy will enable Scritter to be supported by standard hardware components exclusively. The setting of content as input has been reduced to a drag and drop of standard file formats in a user-friendly plug-in, thus helping content creators to be easily involved in the search for innovative user experiences. Owing to the hiding algorithm, users without any filtering device can still enjoy the main content with the naked eye while users equipped with glasses or a polarized smartphone camera will have access to additional hidden content: subtitles, comments, hints, multimedia, or even "invisible advertising."

8. REFERENCES

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