게임 그래픽을 위한 비사실적 랜더링에 관한 연구

벌러르마 바트-오처* , 김수균**

요약

비사실적 랜더링은 비디오 게임, 영화, 애니메이션에서 많은 인기를 누리고 있다. 요즘에는 디지털 예술 분야에서 비사실적 랜더링을 이용한 기술들을 효율적으로 사용하고 있다. 전통적인 컴퓨터 그래픽스는 거의 포토 리얼리즘에 집중되어 있으나, 최근 몇 년 전부터 게임 그래픽 분야에서 비사실적 랜더링 기술이 중요하게 부각되었고, 이러한 기술은 페인팅, 드로잉, 일러스트레이션, 애니메이션 카툰 등의 예술적인 스타일에 영향을 받은 것이다. 본 논문에서는 게임 그래픽에 응용 가능한 비사실적 랜더링 기술에 대해 연구하였다.

A Survey on Non-Photorealistic Rendering for Game Graphic

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ABSTRACT

Two-Dimensional and Three-Dimensional Non Photorealistic Rendering(NPR) is style that is popular in video games, movies and animations. NPR techniques are developing to more efficient on digital art. Traditional computer graphics, mostly focused on photorealism. But, recent years, NPR style is important to game graphic and it is inspired on artistic styles, which is painting, drawing, technical illustration, animation and cartoon. The goal of this paper explains NPR and how can use NPR technique in game graphic.

Key Words : Painterly Rendering, Cel Animation, Computer Animation, NPR

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Ⅰ. Introduction

NPR is the contrast of the photorealism. Recently, NPR is important and impressive branch of computer graphics. The model in 3D environment, NPR work to when the increased availability of programmable GPU's and applied to the rasterised image then result is displayed on the screen. NPR techniques attempt to create images or virtual worlds visually comparable to renderings produced by a human artist.

Several artwork styles have been explored in the NPR literature, such as pen and ink, painting, engraving, informal sketching, charcoal drawing, watercoloring etc. NPR algorithms mostly focus on a specific artistic style. In animation techniques have used impressionistic painting and cartoon style rendering.

NPR is separated to 3 categories:

- Artistic media simulation
- User - Assisted image creation
- Automatic Image creation.

This paper is focused on these 3 categories. Next sections introduces some techniques of non-photorealistic rendering. Also this paper is based on Gooch & Gooch [1].

Ⅱ. Non-Photorealistic Rendering Techniques

2.1 Pen-and-Ink Illustrations

This technique is based on hatching, outlines, lines art and so on. The pen-and-ink drawing has a long history. The pen-and-ink illustration has been developed as an art form of itself since the end of the 19th century.

Georges Winkenbach and David Salesin[2] describe the principles of traditional pen-and-ink illustrations. They started to present algorithms and techniques for rendering polygonal models. Pen-and-ink has a limited result, because there is no color tone, so both colors and also shading must be suggested individual stroke. These had attractive qualities: outlines and tones and texture and so forth (See Figure 1).

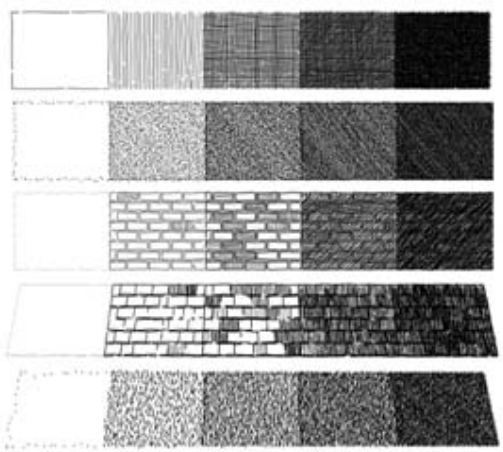

그림 1. 텍스처와 톤의 이용

Fig 1. Using strokes to indicate both texture and tone. The stroke textures used, from top to bottom, are: a.cross-hatching; b. stippling,; c.bricks; d/shingles and grass. Notice how the outline style of the white areas is also particular to each texture [2].

Stroke: Curved lines of varying thickness and density. This is produced by placing the point, or nib of a pen in contact with the paper. And brush must look natural. Pen-and-ink illustrations are made strokes. Stroke perturbed by waviness and pressure function.

Outline: Boundary lines that disambiguate structure. It's defined by variations in texture and tone. Outlines must be introduced where tones are omitted to convey shape.

Tone and Texture: Texture is the character conveyed by collection of strokes. Tone is perceived gray level across image of segment. It is impossible to portray the value of each surface precisely; instead, combinations of strokes are used to create an overall impression of the desired tone.

In traditional computer graphics rendering, tone and texture are separate elements of the rendering pipeline. In 3D objects or scene need to interact with 2D images. Pen-and-Ink is create 2D image, and then textured by model by showing the result. Winkenbach and Salesin made to standard for graphics pipeline:

- Manintainin a two - dimensional spatial subdivision.
- Rendering of texture and tone.
- Clipping.
- Outlining.

A reasonable starting point is to take the traditional "graphics rendering pipeline" for photorealistic imagery and see which parts, if any, need to be altered in order to support this style of non-photorealism. Here some example Figure 1 to 5.

Winkenbach and Salesin' rendering [2] proceeds as follows:

1. The visible surface polygons and shadow polygons are computed.
2. These polygons are projected to screen space and used to build a 2D BSP tree and planar map data structure.
3. Each surface is rendered by invoking the procedural texture attached to it.
4. Stroke generated by the procedural texture are clipped using the 2D BSP tree.
5. Finally the outline strokes are drawn using the planar map data structure.

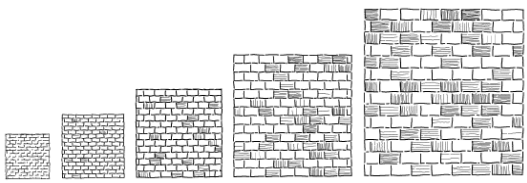

그림 2. 스케일링 텍스처와 톤 [2]
Fig 2. Scaling texture and tone. Same style but different size of texture and tone [2]

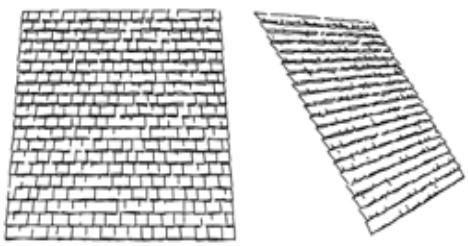

그림 3. 뷰잉 방향의 변환 [2]
Figure 3: Changing viewing direction (Anisotropic) [2]

그림 4. 두꺼운 스트로크 [2]
Fig 4. There are Bold stroke indicate detail segment [2].

a. b.

그림 5. 텍스쳐 [2]

Fig 5: Indicating texture; (a) house is drawn using "indication"; (b) house is not; Georges Winkenbach and David H.Salesing 1994 [2].

2.2 Painterly Rendering

This technique uses 3D model with particles, surface lighting apply to 2D brush strokes and texture. Finally, we can see rendering result in screen space [3]. Painterly Rendering is used by the painter's algorithm to render particles as 2D brush strokes and based on real artistic painting (Fig 6). Real artistic painting [4] is used by the watercolor, oil painting, acrylic style. The painting process composed to brush. Brushstroke contain the artistical view, each brushstroke rendered one particle. It's including to location, color, size of stroke [5], direction of the paper [6] and canvas angle, shape for brushstroke, and specified by a set of reference pictures or by data that is stored with the particles.

그림 6. 페인트 랜더링 결과 [4]

Fig 6. Some result for Painterly Rendering by Hertzmann, A -1998 [4]

Figure 7 shows the circle of rendering pipeline. In 3D some geometry model which is rendered using shaders to create brushstroke. And then put on a color or texture and find to orientation which provide the image to model. Size is also boundary of image in the model. Finally, put a particle to image and brush texture.

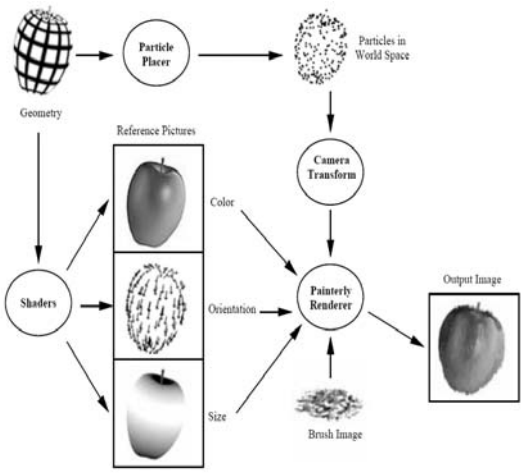

그림 7. 페인트 랜더링 파이프라인 [3]

Fig 7. Illustrate the painterly rendering pipeline [3].

Curtis [3] presented to generate watercolor system in computer. First, they are generated the paper (See Figure 8). And then add to watercolor image. This method is computing fluid flow and light interaction. Curtis used wet-in-wet and wet-on-dry simulated watercolor effects (See Figure 9).

그림 8. 종이 생성 [4]

Fig 8. Paper generations [4]

a. b. c. d. e. f.

그림 9. 시뮬레이션된 효과의 예 [4]

Fig 9. Example of simulated effect: a. Dry-brush effects, b. Edge darkening, c. Intentional back-runs, d.Granulation and separation, e. Flow patterns, f. Color glazings [4].

The Figure 10 shows the simulated wash techniques and use the three layers [4].

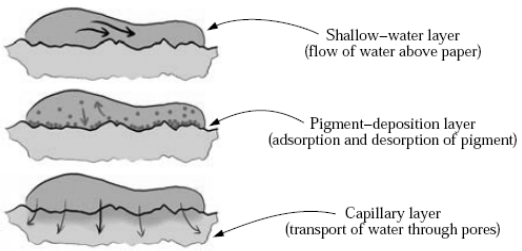

그림 10. 액체 모델 [4]

Fig 10. The three-layer fluid model by Small. a. The shallow-water layer, b. The pigment-deposition layer, c. The capillary layer [4]

Figure 11 shows the interactive painting, it use the brush type of effect.

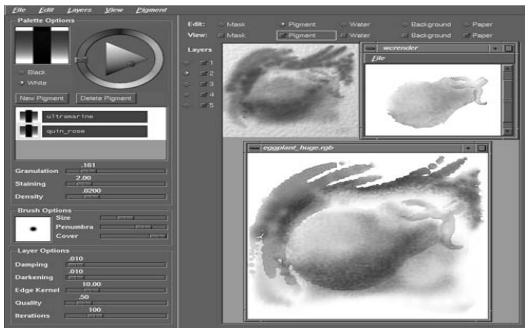

그림 11. 상호작용 페인팅 [4]

Fig 11. Interactive painting. The process is running, user input and simulating [4].

III. Cartoon Shading and Cel Animation

In traditional cartoon have to draw all of frame by hand. Computer graphics add to hand drawing style, and create techniques of cartoon. It is also called to Cel animation's painting process is similar to the Hard-Shading[7]. The cartoon shading is based on real artistic techniques and it is using by the line drawings and filled with areas of solid color to object. Lake [7] generated texture map of the colors.

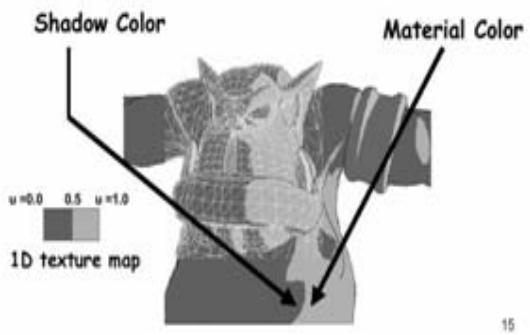

그림 12. 카툰 세이딩 [7]

Fig 12. Olaf Rendering using cartoon shading [7].

Figure 12 shows 3D character featured by the cartoon shading which uses Lake's technique and apply it 1D texture mapping with light to surface of the object.

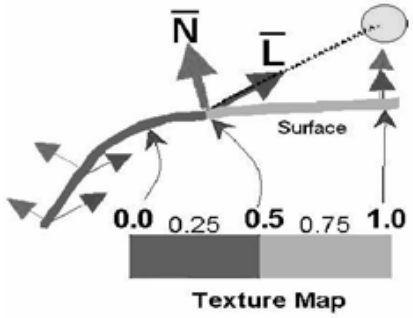

그림 13. 텍스쳐의 생성 [7]

Fig 13. Generation of texture (light and normal) [7].

Here more important thing is light. Cartoon shading based on shading and outline drawing.

V. Conclusion

This paper introduced the two kinds of NPR techniques. These are based on real artistical drawing technique. In 3D geometric object apply 2D image, which is created by pen-and-ink or painterly rendering techniques.

Traditional cartoon technique draw all frames by hand. Cartoon shading techniques based on traditional drawing and it used by the texture, course of light, edges detecting and mixed with 2D and 3D object.

In this paper we explained NPR and how can use NPR technique in game graphic.

Reference

[1] Gooch and Gooch, "*Non-Photorealistic Rendering*" 2001

[2] Georges Winkenbach David H. Salesin, "Computer-Generated Pen-and-Ink Illustration", Department of Computer Science and Engineering University of Washington Seattle, Washington 98195, 1994

[3] Barbara J. Meier, "Painterly Rendering for Animation", In proceedings of SIGGRAPH 96, Computer Graphics Proceedings, Annual Conference Series, edited by Holly Rushmeier, pp. 477-484, Reading, MA:Addison-Wisly, 1996

[4] Curtis, S.J., Seims, J. E., Fleischer, K. W., and Salesin, D. H.,"Computer generated watercolor", In Proceeding of SIGGRAPH 97, Computer Graphic Proceeding, Annual Conference Series, edited by Turner Whitted, pp. 421-430, Reading, MA: Addison-Wisley, 1997

[5] Hertzmann, A.,"Painterly rendering with curved brush strokes of multiple sizes", In Proceeding of SIGGRAPH 97, Computer Graphic Proceeding, Annual Conference Series, edited by Michael Gohen, pp. 453-460, Reading, MA: Addison-Wesley

[6] Small, "Simulating watercolor by modeling diffusion, pigment and paper fibers", In Proceeding of SPIE' 91, February, 1991

[7] Williams, L. "Shading in Two Dimensions", In graphic interface '91, pp.143-151, San Francisco: Morgan Kaufmann Publishers, 1991

[8] Lake, A., Marshall, C., Harris, M., and Blackstein, M., "Stylized rendering techniques for scalable real-time 3d animation", In NPAR 2000: First International Symposium on Non-Photorealistic Animation and Rendering, edited by Jean Daniel Fekete and David H. Salesin, pp. 13-20, New York: ACM SIGGRAPH, 2000

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