Silesian
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MASTER THESIS

Selected techniques of rendering shadow models in interactive computer graphics

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Thesis title

Selected techniques of rendering shadow models in interactive computer graphics

Abstract

(Thesis abstract – to be copied into an appropriate field during an electronic submission – in English.)

Key words

(2-5 keywords, separated by commas)

Tytuł pracy

Wybrane techniki renderowania modelu cieni w interaktywnej grafice komputerowej

Streszczenie

(Streszczenie pracy – odpowiednie pole w systemie APD powinno zawierać kopię tego streszczenia.)

Słowa kluczowe

(2-5 słów (fraz) kluczowych, oddzielonych przecinkami)

Contents

Chapter 1

Introduction

- introduction into the problem domain
- settling of the problem in the domain
- objective of the thesis
- scope of the thesis
- short description of chapters
- clear description of contribution of the thesis's author

Chapter 2

Problem analysis

2.1 The task of rendering

In this thesis, rendering is understood as the process of obtaining an image from a description of a three-dimensional scene. A scene can be rendered in a multitude of ways, with differences both in the specifics of the initial scene description and the rendered result. The rendered visuals can range from stylized to photorealistic. Rendering happens everywhere where a computer generated image is created for a viewer to see.

The wide spectrum of possible rendering results hints at the multitude of ways in which rendering is actually performed. There are various techniques employed during the rendering process, which can be utilized together to create a desired look and fit within performance constraints. In more complex processes, there are many techniques used to render a scene, each responsible for modeling the visual aspects of different real-life phenomena or artificial effects. A renderer could be capable of adding stylized edge detection and cell-shading to an image, rendering glossy and rough surfaces, simulating shadows, reflections, caustics and refraction, dealing with hair and fur or volumetric participating media such as fog, smoke and clouds. Each of the mentioned effects can be rendered using one of many techniques, and many of them are being actively improved upon and researched.

The fact that there are many techniques currently in use to render a single type of effect creates and advantageous situation where the techniques used can be chosen for each application, depending on its characteristic. Two main factors can be discerned as defining the needs of an application: the performance requirements and the desired visual style.

The desired visual style is partially just a matter of preference defined by the style of the project. More importantly however it is a matter of clearly and efficiently conveying visual information, in a way that is consistent with the rest of the application and with what the end user expects. This means that realism, often touted the pinnacle and goal of computer graphics, is not necessarily always the best approach. A CAD (computer-aided design) application or a 3D modelling tool would be made less useful by including realistic reflections, highly contrasting full shadows and motion blur in the rendered viewport, as these programs need to clearly convey information about the shape and design of 3D objects, without distractions and obstructions. On the other hand, when a player starts a modern action-adventure game, they expect a level of realism in the game's graphics that allows for immersion in the presented world. The intricate visuals also make for a more engaging experience and can mean a better reception of a game. At the same time, design choices should be made to ensure that the realism or intricacy of the presented graphics does not get in the way of enjoying the gameplay, which in the end should be the main attribute of a video game.

The performance requirements, or performance constraints, are usually better defined and divide rendering into two general categories: real-time rendering and offline rendering. When designing an offline renderer the performance constraints would most likely concern memory usage and possibly general time efficiency, as with offline rendering the time it takes to render an image is of small importance. Most important are image quality and fidelity, often also realism. Techniques used in this context can spend as much time performing calculations as is necessary for the desired output. Offline rendering work can also easily be distributed between many machines, so-called render farms. Real-time rendering on the other hand works with very strict and small time budgets. Because a real-time application needs to be responsive to user inputs and give the illusion of continuous motion it is expected to render at least 30 frames per second (FPS), giving the time budget for a single frame of at most 0.03 seconds. This time cannot all be spent rendering, as user inputs need to be handled and application logic performed in the same time frame.

Different current techniques for shadow rendering?

- What problem do I want (have to :-) to solve?
- Why the problem is important?
- How do others solve the problem?
- What are pros and cons of my solution?

References to book [1], scientific papers in journals [2], conference papers [3], and web pages [4].

Equations should be numbered:

$$y = \frac{\partial x}{\partial t} \tag{2.1}$$

Chapter 3

[Problem analysis]

- problem analysis, problem statement
- state of the art, literature research (all sources in the thesis have to be referenced, eg journal article [2] book [1], conference paper [3], internet source [4])
- description of known solutions, algorithms
- location of the thesis in scientific domain
- The title of this chapter is similar to the title of the thesis.

Definition 1. *body of the definitions*

Theorem 1 (optional name)**.** *body of the theorem*

Example 1 (optional name)**.** *body of the example*

Chapter 4

[Subject of the thesis]

- solution to the problem proposed by the author of the thesis
- theoretical analysis of proposed solutions
- rationale of applied methods, algorithms, and tools

Here I should describe my reasoning for the testing, reasoning for selecting the techniques that I do select, my program for testing.

4.1 [Section title]

4.2 [Subsection title]

Each figure in the document should be referred to at least once (fig. 4.1).

Each table in the document should be referred to at least once (Tab. 4.1).

some citation of the above 4.2

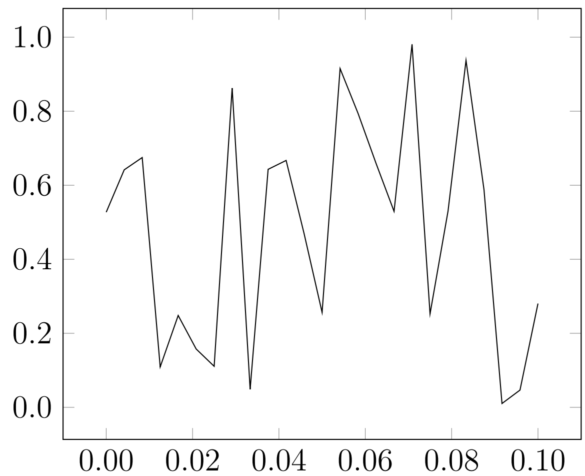

Figure 4.1: Figure caption.

Table 4.1: A caption of a table is ABOVE it.

	method						
			alg. 3			alg. 4, $\gamma = 2$	
ζ	alg. 1	alg. 2	$\alpha = 1.5$	$\alpha = 2$	$\alpha = 3$	$\beta = 0.1$	$\beta = -0.1$
0	8.3250	1.45305	7.5791	14.8517	20.0028	1.16396	1.1365
5	0.6111	2.27126	6.9952	13.8560	18.6064	1.18659	1.1630
10	11.6126	2.69218	6.2520	12.5202	16.8278	1.23180	1.2045
15	0.5665	2.95046	5.7753	11.4588	15.4837	1.25131	1.2614
20	15.8728	3.07225	5.3071	10.3935	13.8738	1.25307	1.2217
25	0.9791	3.19034	5.4575	9.9533	13.0721	1.27104	1.2640
30	2.0228	3.27474	5.7461	9.7164	12.2637	1.33404	1.3209
35	13.4210	3.36086	6.6735	10.0442	12.0270	1.35385	1.3059
40	13.2226	3.36420	7.7248	10.4495	12.0379	1.34919	1.2768
45	12.8445	3.47436	8.5539	10.8552	12.2773	1.42303	1.4362
50	12.9245	3.58228	9.2702	11.2183	12.3990	1.40922	1.3724

Figure 4.2: Caption of a figure is always below the figure akakak.

Chapter 5

Experiments

This chapter presents the experiments. It is a crucial part of the thesis and has to dominate in the thesis. The experiments and their analysis should be done in the way commonly accepted in the scientific community (eg. benchmark datasets, cross validation of elaborated results, reproducibility and replicability of tests etc).

5.1 Methodology

- description of methodology of experiments
- description of experimental framework (description of user interface of research applications – move to an appendix)

5.2 Data sets

- description of data sets

5.3 Results

- presentation of results, analysis and wide discussion of elaborated results, conclusions

5.4 testing of multiple figures

some citation of the above 5.1
some citation of the above 5.2

Figure 5.1: Caption of a figure is always below the figure akakak.

Figure 5.2: Caption of a figure is always below the figure akakak.

Chapter 6

Summary

- What problem have I solved?
- How have I solved the problem?
- What are pros and cons of my solutions?
- Can I state some recommendations?
- synthetic description of performed work
- conclusions
- future development, potential future research
- Has the objective been reached?

Bibliography

[1] Name Surname and Name Surname. *Title of a book*. Hong Kong: Publisher, 2017. ISBN: 83-204-3229-9-434.

[2] Name Surname and Name Surname. 'Title of an article in a journal'. In: *Journal Title* 157.8 (2016), pp. 1092–1113.

[3] Name Surname, Name Surname and N. Surname. 'Title of a conference article'. In: *Conference title*. 2006, pp. 5346–5349.

[4] Name Surname, Name Surname and N. Surname. *Title of a web page*. 2021. URL: `http://somewhere/on/the/internet.html` (visited on 30/09/2021).

Appendices

Technical documentation

List of abbreviations and symbols

CAD computer–aided design

FPS frames per second

DNA deoxyribonucleic acid

MVC model–view–controller

N cardinality of data set

μ membership function of a fuzzy set

$\mathbb{E}$ set of edges of a graph

$\mathcal{L}$ Laplace transformation

List of additional files in electronic submission (if applicable)

Additional files uploaded to the system include:

- source code of the application,
- test data,
- a video file showing how software or hardware developed for thesis is used,
- etc.

List of Figures

List of Tables