

# Simulating the GPU-based shaders in the graphics pipeline on a CPU-based language to allow code inspection at runtime

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by

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4. I have not published this Masterthesis in the past;
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Weingarten, September 2019

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Matthias Mettenleiter

## **Abstract**

An abstract is a brief summary of a research article, thesis, review, conference proceeding or any in-depth analysis of a particular subject or discipline, and is often used to help the reader quickly ascertain the paper's purpose. When used, an abstract always appears at the beginning of a manuscript, acting as the point-of-entry for any given scientific paper or patent application. Abstracting and indexing services for various academic disciplines are aimed at compiling a body of literature for that particular subject.

The terms précis or synopsis are used in some publications to refer to the same thing that other publications might call an “abstract”. In “management” reports, an executive summary usually contains more information (and often more sensitive information) than the abstract does.

Quelle: [http://en.wikipedia.org/wiki/Abstract\\_\(summary\)](http://en.wikipedia.org/wiki/Abstract_(summary))

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# 1 Introduction

**Explanation of debugging** "Debugging is the process of locating and removing faults in computer programs" according to [Collins 2014]. In the following only ways of debugging software problems are considered. Excluding specialized debugging hardware. The steps that are part of the debugging process are reproducing the problem, identifying the source of the problem and fixing the problem. All of these steps can be done manually but there are ways to improve and accelerate this process.

To find a way to reproduce the problem there is the option of writing tests with assertions, inserting debug outputs on the console into the source code or writing states into log files. This enables the programmer to find anomalies before, while and after running the program.

After being able to reproduce a problem to find the source of the problem there is the option of increasing the amount of debug outputs to confine the point in the code at which the error occurs.

For most programming languages there are tools to assist the programmer to narrow down the source of the bug with multiple methods.

One method is to enable the user to set breakpoints at which the program pauses and he can inspect the values of the variables directly within the code and restart the program to move to the next breakpoint or go through the single steps of the program. By stepping through the code this way the point where the error occurs can be found.

Another way to simplify the task is to have the code throw an exception when unwanted behavior occurs and stop at this exception. By saving a stack of the calls which occurred before the exception was thrown the programmer can retrace in which lines of code the error may be found.

//TODO ReverseDebugging

**Problem with debugging of shaders in the graphics pipeline**

**Existing approach for compute shaders**

**Objective of creating a general solution for debugging shaders in the graphics pipeline**

## **2 Related Work**

**2.1 Existing methods for debugging shaders in the graphics pipeline**

**2.2 Approaches for translating and simulating compute shaders**

# 3 Contribution

Steps for simulating the graphics pipeline

Steps for translating the shader code



## 4 Implementation

## 5 Conclusion

Fazit ziehen über das Projekt und die Arbeit. Welche Erkenntnisse wurden gewonnen?  
Was hat gut/schlecht funktioniert? Wurden die eigenen Erwartungen erfüllt oder nicht?  
War das Projekt erfolgreich?

# Acronyms

<b>API</b>	Application Programming Interface
<b>BDSG</b>	Bundesdatenschutzgesetz
<b>CEP</b>	Complex Event Processing
<b>DEA</b>	Deterministischer endlicher Automat
<b>EDA</b>	Event Driven Architecture
<b>GB</b>	Gigabyte
<b>GFS</b>	Google File System
<b>HDFS</b>	Hadoop Distributed File System
<b>HTTP</b>	Hypertext Transfer Protocol
<b>IDE</b>	Integrated Development Environment
<b>IP</b>	Internetprotokoll
<b>KB</b>	Kilobyte
<b>LTS</b>	Long Term Support
<b>MB</b>	Megabyte
<b>MPI</b>	Message Passing Interface
<b>MRC</b>	Map Reduce Class
<b>NAS</b>	Network Attached Storage
<b>NEA</b>	Nichtdeterministischer endlicher Automat
<b>NFS</b>	Network File System
<b>OS</b>	Operating System
<b>OSDI</b>	Operating Systems Design and Implementations
<b>PAP</b>	Programmablaufplan
<b>PDF</b>	Portable Document Format
<b>POM</b>	Project Object Model
<b>RFC</b>	Request for Comments
<b>RSA</b>	Rivest, Shamir und Adleman
<b>SAN</b>	Storage Attached Network
<b>SPOF</b>	Single Point of Failure
<b>SSH</b>	Secure Shell
<b>TMG</b>	Telemediengesetz
<b>VM</b>	Virtuelle Maschine



# List of Figures

# List of Tables

# Bibliography

Collins, Harper (2014). *Collins English Dictionary – Complete and Unabridged, 12th Edition*. URL: <https://www.thefreedictionary.com/debugging> (visited on 08/20/2019).

# Appendix

A. Screenshot NameNode Web-Interface

B. DVD Inhalt

C. DVD



## A. Screenshot NameNode Web-Interface

**Hadoop** Overview Datanodes Datanode Volume Failures Snapshot Startup Progress Utilities ▾

Overview 'localhost:9000' (active)

Started:	Fri Jul 10 00:23:31 CEST 2015
Version:	2.7.0, rd4c8d4d4d203c934e8074b31289a28724c0842cf
Compiled:	2015-04-10T18:40Z by jenkins from (detached from d4c8d4d)
Cluster ID:	CID-322169a1-9f18-4284-9cfa-490bd79c1dd4
Block Pool ID:	BP-1249407956-127.0.1.1-1436480592942

Summary

Security is off.  
Safemode is off.  
1 files and directories, 0 blocks = 1 total filesystem object(s).  
Heap Memory used 26.65 MB of 50.49 MB Heap Memory. Max Heap Memory is 966.69 MB.  
Non Heap Memory used 30.99 MB of 32.25 MB Committed Non Heap Memory. Max Non Heap Memory is 214 MB.

Configured Capacity:	18.58 GB
DFS Used:	24 KB (0%)
Non DFS Used:	2.85 GB
DFS Remaining:	15.73 GB (84.67%)
Block Pool Used:	24 KB (0%)
DataNodes usages% (Min/Median/Max/stdDev):	0.00% / 0.00% / 0.00% / 0.00%
Live Nodes	1 (Decommissioned: 0)
Dead Nodes	0 (Decommissioned: 0)
Decommissioning Nodes	0
Total Datanode Volume Failures	0 (0 B)
Number of Under-Replicated Blocks	0
Number of Blocks Pending Deletion	0
Block Deletion Start Time	10.7.2015, 00:23:31

NameNode Journal Status

Current transaction ID: 1

Journal Manager	State
FileJournalManager(root=/tmp/hadoop-root/dfs/name)	EditLogFileOutputStream(/tmp/hadoop-root/dfs/name/current/edits_inprogress_0000000000000000001)

NameNode Storage

Storage Directory	Type	State
/tmp/hadoop-root/dfs/name	IMAGE_AND_EDITS	Active

Hadoop, 2014.

## C. DVD Inhalt

└ <b>Anwendung/</b>	
– pom.xml	⇒ <i>Maven POM Datei</i>
└ <b>conf/</b>	⇒ <i>*.properties Dateien für Konfiguration</i>
└ <b>src/</b>	⇒ <i>Quellcode Dateien</i>
└ <b>target/</b>	
– Logfileanalyzer-1.0-SNAPSHOT.jar	⇒ <i>Ausführbare JAR-Datei</i>
└ <b>site/apidocs/</b>	⇒ <i>JavaDoc für Browser</i>
└ <b>Literatur/</b>	⇒ <i>PDF Literatur &amp; E-Books</i>
└ <b>Praesentationen/</b>	
– Abschlusspraesentation.pptx	⇒ <i>Präsentation vom 21. August 2015</i>
– Abschlusspraesentation.pdf	
– Kickoffpraesentation.pptx	⇒ <i>Präsentation vom 03. Juni 2015</i>
– Kickoffpraesentation.pdf	
└ <b>Sonstiges/</b>	
– LineareRegression.xlsx	⇒ <i>Berechnung der linearen Regression</i>
└ <b>Latex-Files/</b>	⇒ <i>Editierbare L<sup>A</sup>T<sub>E</sub>X Dateien der Arbeit</i>
– bibliographie.bib	⇒ <i>Literaturverzeichnis</i>
– dokumentation.pdf	⇒ <i>Bachelorarbeit als PDF</i>
– dokumentation.tex	⇒ <i>Hauptdokument</i>
– einstellungen.tex	⇒ <i>Einstellungen</i>
└ <b>ads/</b>	⇒ <i>Header, Glosar, Abkürzungen, etc.</i>
└ <b>content/</b>	⇒ <i>Kapitel</i>
└ <b>images/</b>	⇒ <i>Bilder</i>
└ <b>lang/</b>	⇒ <i>Sprachdateien für L<sup>A</sup>T<sub>E</sub>X Template</i>