OpenCollBench - Benchmarking of Collision Detection & Proximity Queries as a Web-Service

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Benchmarks are Important for Scientific Progress

- Benchmarking for collision detection (CD) & proximity query (PQ) algorithms is much more complex
Problem Definition

Collision Detection (CD)

Proximity Query (PQ)
CD & PQ: Recap of Approaches

- **Approximation methods**
  - Based on convex decomposition

- **Exact methods**
  - For rigid bodies, mostly based on BVH

![Sphere](image1)
![AABB](image2)
![k-DOP](image3)
CD & PQ: Recap of Hierarchical Methods

Motivation

CD&PQ Recap

Previous Work

Challenges

Open Benchmark

Semantic CD&PQ

Conclusion
CD & PQ: Recap of SIMD Methods

- Simultaneous traversal of sequential algorithms
- SIMD optimized simultaneous traversal using AVX512 [Tan et al., 2019]
CD & PQ: Factors Influencing Performance

- CD & PQ algorithm depends on many factors
  - Object’s polygon
  - Object’s shape and used BV
    - Obviously, sphere BV will fit better for ball object compared with AABB
  - Object’s configuration
    - Slightly change can results in completely different timings
Previous Proposals for Benchmarking CD & PQ

• Set of pre-defined objects [Woulfe & Manzke, 2009]

• Scenarios with pre-defined motion paths [Bergen, 1998] [Caselli et al., 2002] [Otaduy & Lin, 2003]

• Systematic benchmark:
  • Relative distance between objects [Zachmann, 1998]
  • Combined broad and narrow phases into CD pipeline [Trenkel et al., 2007]
  • Added relative penetration [Diktas & Sahiner, 2008] [Weller et al, 2010]
Challenges for Defining Benchmarks for CD & PQ

- Benchmarking process is often difficult and time-consuming
- Require prior knowledge about algorithms and benchmarking tools
- Hardware availability
- Results are not meaningful enough
  - Usually represented using chart or histogram
Our Contribution: Open Benchmark for CD & PQ

- OpenCollBench: Benchmarking CD & PQ as a web-service, accessible at opencollbench.com
- Intuitive & accessible for both expert & non-expert user
- Unified & dedicated hardware
  - Results reproduceable
- New metrics for benchmarking CD & PQ
  - Better understanding of benchmarking results on a sub-object level, e.g.,
    - Identify critical or outlier regions
    - Identify heavily tested configurations
OpenCollBench – System Overview

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Used Technologies
- nginx, three.js, axios, vue.js
- express
- c++ collision benchmarking suite
- three.js
- three.js

Static Collision Benchmarking Suite
3d Heatmap Generation Pipeline
Request handler
Exporter
Back end

Front end

User

3d objects
3d heatmaps

3d object + benchmark parameters

results
vertices info

3d heatmaps
OpenCollBench – Web Interface

Object File
Choose a file: bunny.obj...

Benchmark Mode
Collision

Algo
SIMDop

First / All Collision?
All

Benchmark Configurations:
Use Saved Positions

Position Finding Method:
Sphere

Rotate Object By Degree
60

Move Object By Degree
30

Relative Distance: 0

☐ Remove object after benchmark

Start
OpenCollBench – Progress Page

OpenCollBench: Benchmarking of Collision Detection & Proximity Queries as a Web-Service

1. Upload Files
2. Generate Configurations
3. Run Benchmark (20%)
4. Gather Result

Benchmark is running. You can safely close your browser and come back later to check result.
OpenCollBench – Result Page

openCollBench: Open Access Benchmarking Server for Collision Detection and Proximity Query

Result

Object Name
Top_3

Configurations

Open CollBench

CD&PQ Recap               Previous Work               Challenges

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New Metrics for Benchmarking CD & PQ

- Median timings
- Average timings
- Min timings
- Max timings
- Standard deviation
- Configurations density

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Our New Metrics Show Critical or Outlier Regions

- BoxTree
- DopTree
- V-COLLIDE
Our New Metrics Show Heavily Tested Regions

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distance of 0.0 distance of 0.2 distance of 0.4 distance of 0.6
Conclusions

- New metrics for benchmarking CD & PQ
- Sub-object level accuracy for analysis of benchmarking results
- New proposal: open benchmarking of CD & PQ as a web service

Future work:
- Extend to cover more cases related to CD & PQ, e.g., deformable objects, GPU-based algorithms, etc
- Allow user to upload their own CD & PQ algorithms and compare with existing one
Thank You!

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Source of images

- 26-DOP & AABB
  - http://www-ljk.imag.fr/Publications/Basilic/com.lmc.publi.PUBLI_Inproceedings@117681e94b6_1860ffd/bounding_volume_hierarchies.pdf

All website: last visited at 17.09.2020
Source of videos

- BART (Benchmark of Animated Ray Tracing)
  - [http://www.cse.chalmers.se/~uffe/BART/museum/museum400x300_300.mpg](http://www.cse.chalmers.se/~uffe/BART/museum/museum400x300_300.mpg)

- Multi Object Tracking

All website: last visited at 17.09.2020