Sound field calculation with GPU

Fast under water ray tracing

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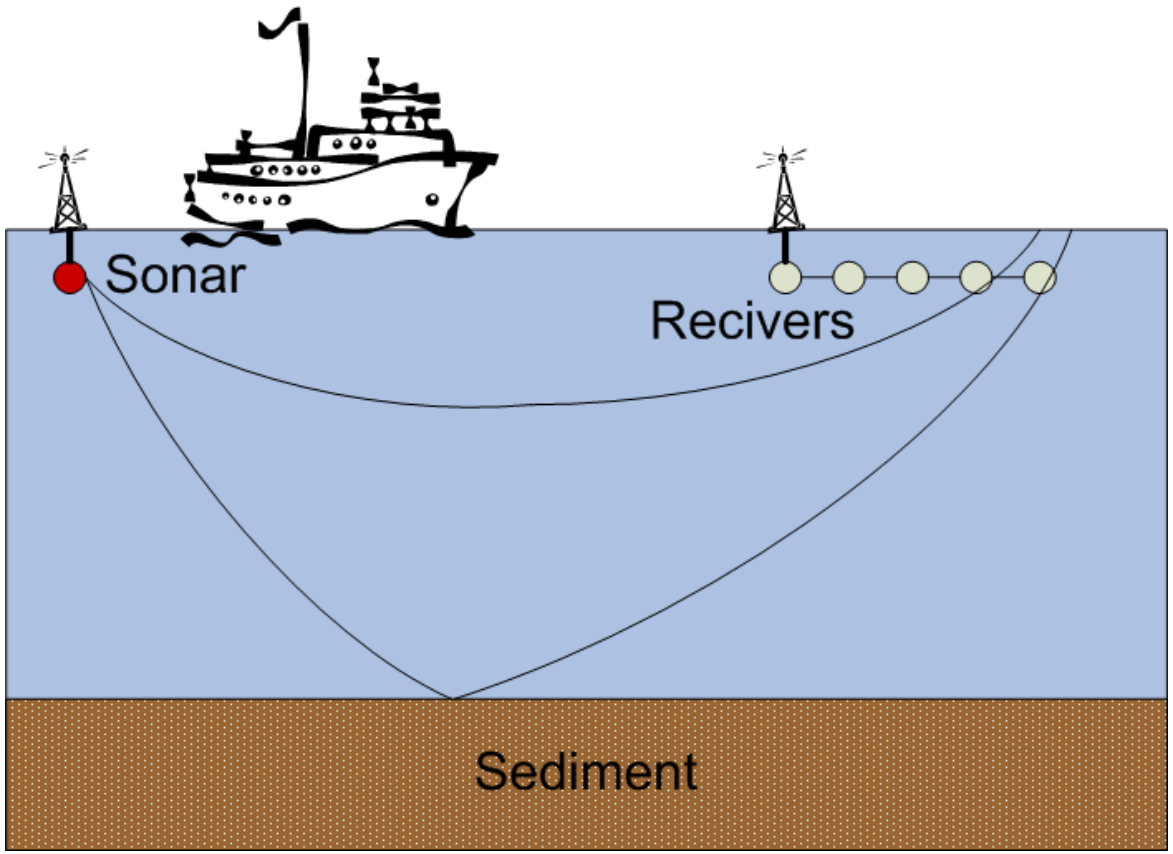
Outline

Outline

Scenario



Ray propagation

Starting condition

- Current sound speed at source, $c(z)$
- Current depth of source, z
- Number of rays, n
- Starting angles for each ray, θ_{0n}
- Receiver location

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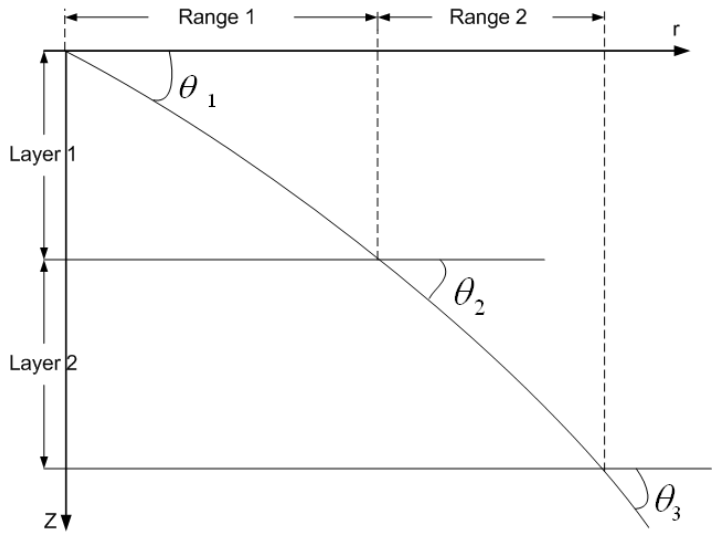
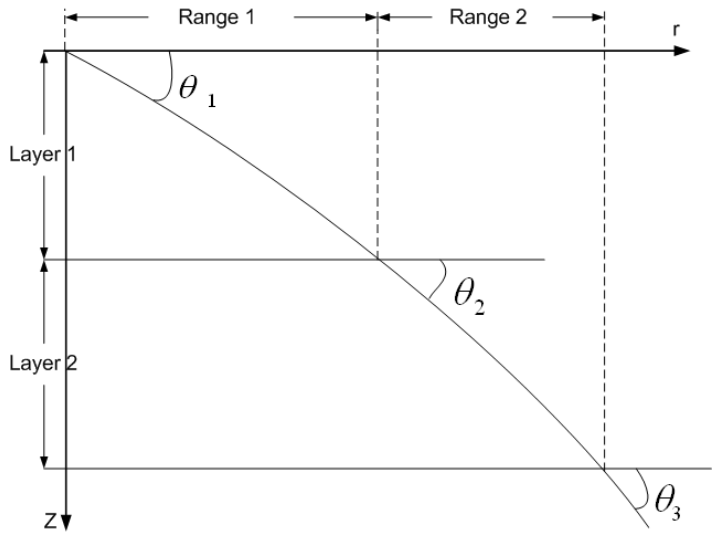


Calculating a step

- Depth steps with $\pm\Delta$ layer
- Sum of all ranges will give the total range

Ray propagation



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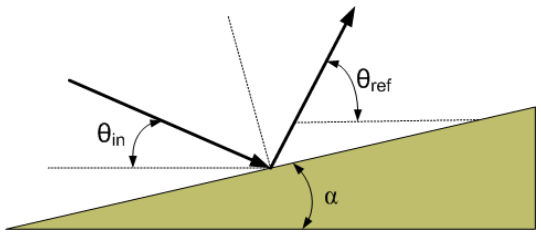

Bottom inclination

- $\theta_{ref} = \theta_{in} + 2\alpha$
- The ray will as consequence change direction in accordance with Snell's law.

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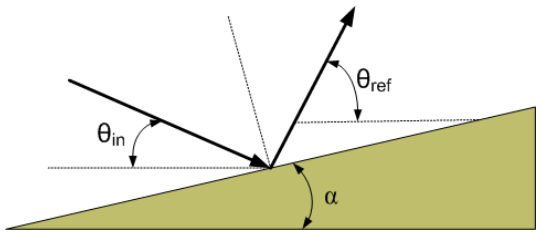

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Values storage

Values to store

- Bottom and Surface reflection
  - Range
  - Travel time
  - Intersection angle
- Eigen values at receiver
  - Intersection angle
  - Range
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  - Depth
  - Start angle for ray

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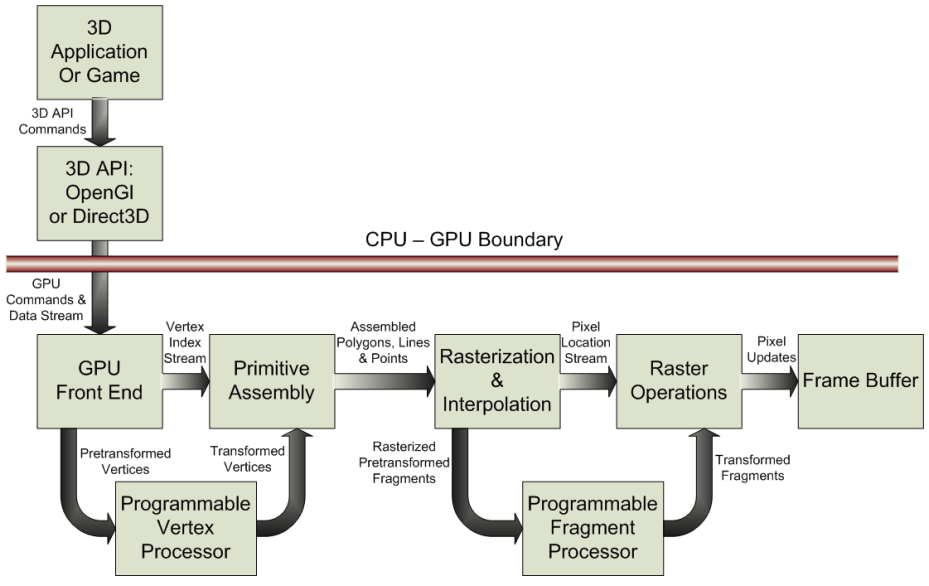
Overview



Processors

- Vertex processor (pass the data trough)
- Fragment processor (executes the math)

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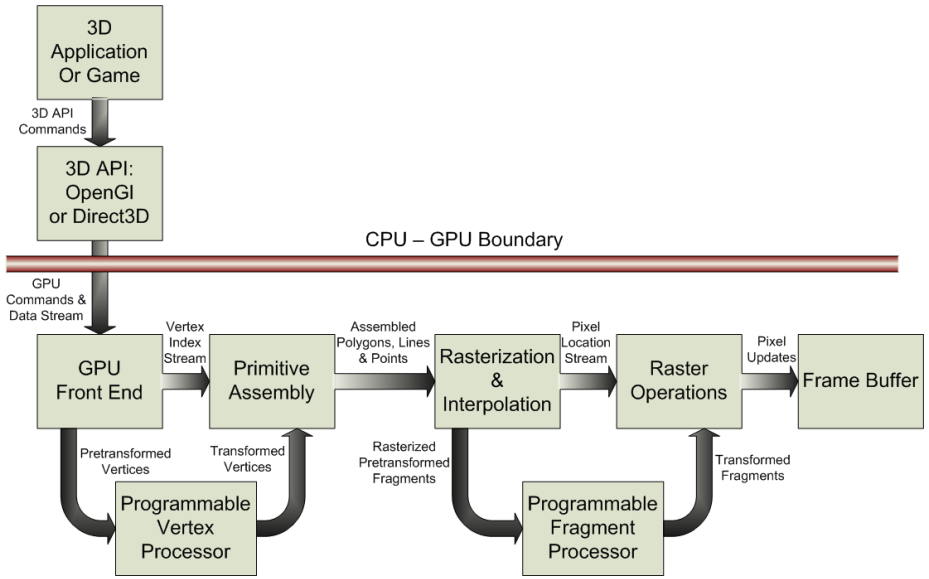

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Vertex and fragment programs

Vertex shader

- Pass the initial data trough
- Sets up the space coordinates

Fragment shader

- A pixel is thought of as one ray
- 8x8 pixels will result in 64 rays
- Different values for every pixel
- All rays are computed in parallel
- Computes the range and travel time for every loop

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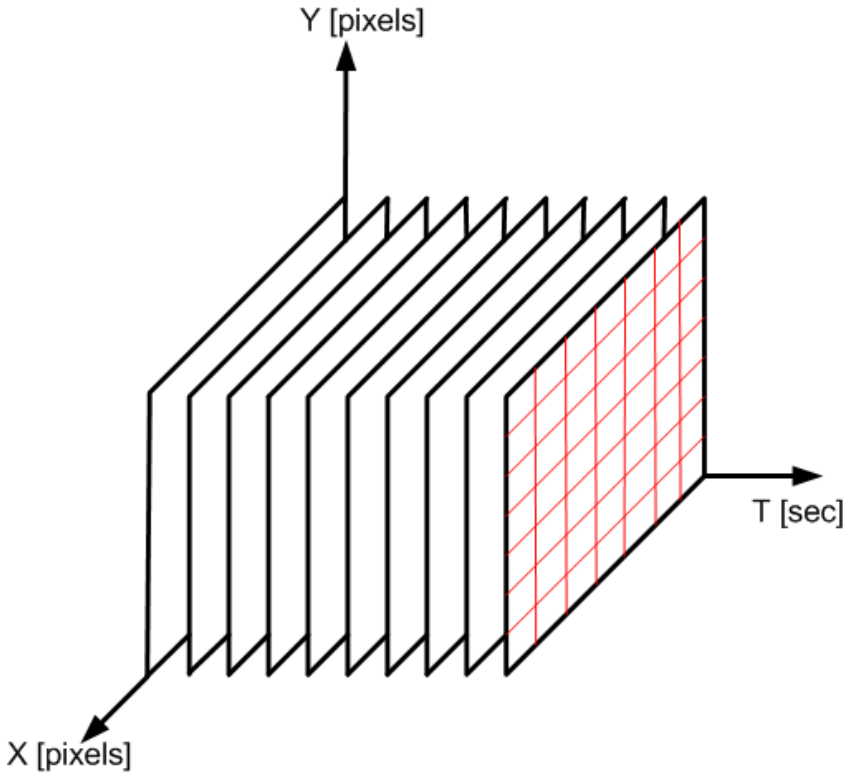
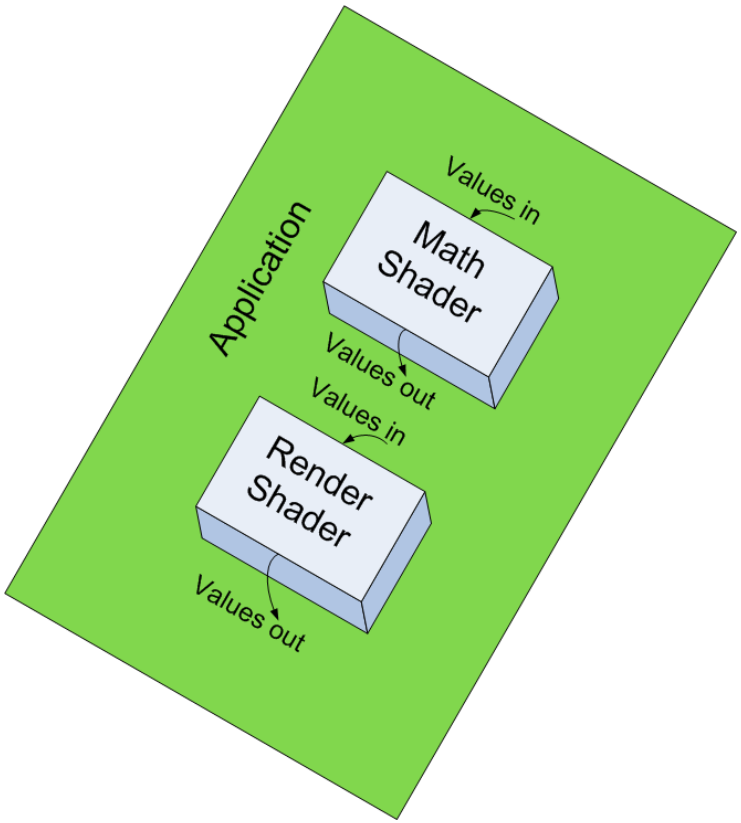
Pixel matrix

Frame generation



Looping



Looping

- Values read into math shader
- Results from math shader to screen
- Results from math shader set as input to next loop
- Ping-ponging

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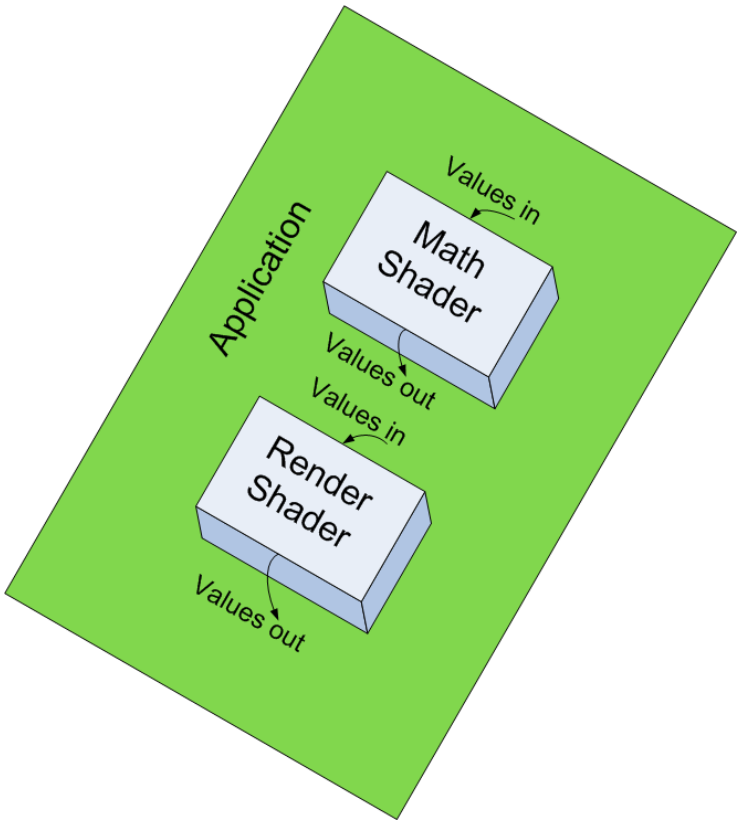

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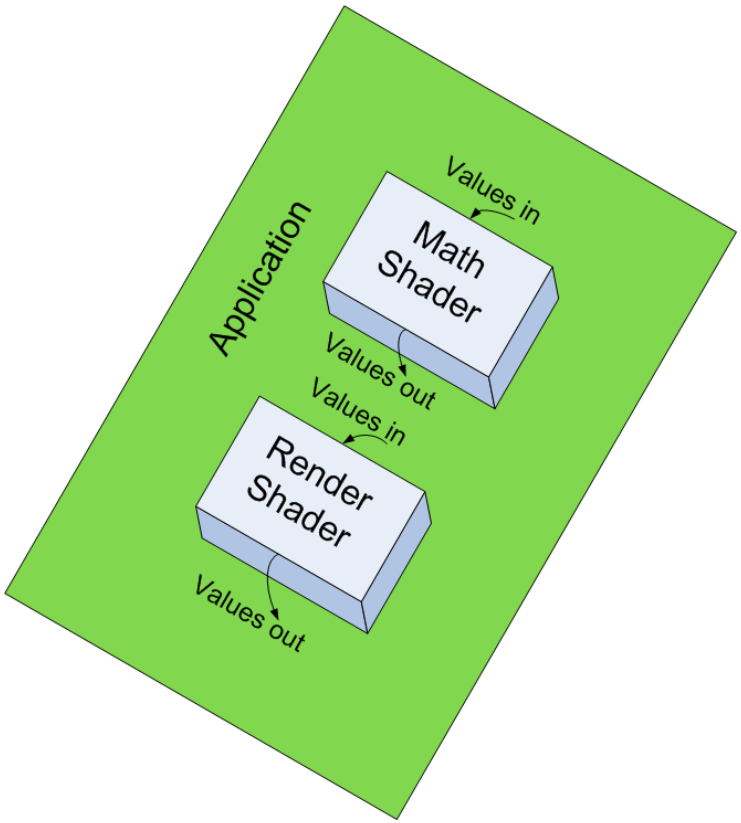

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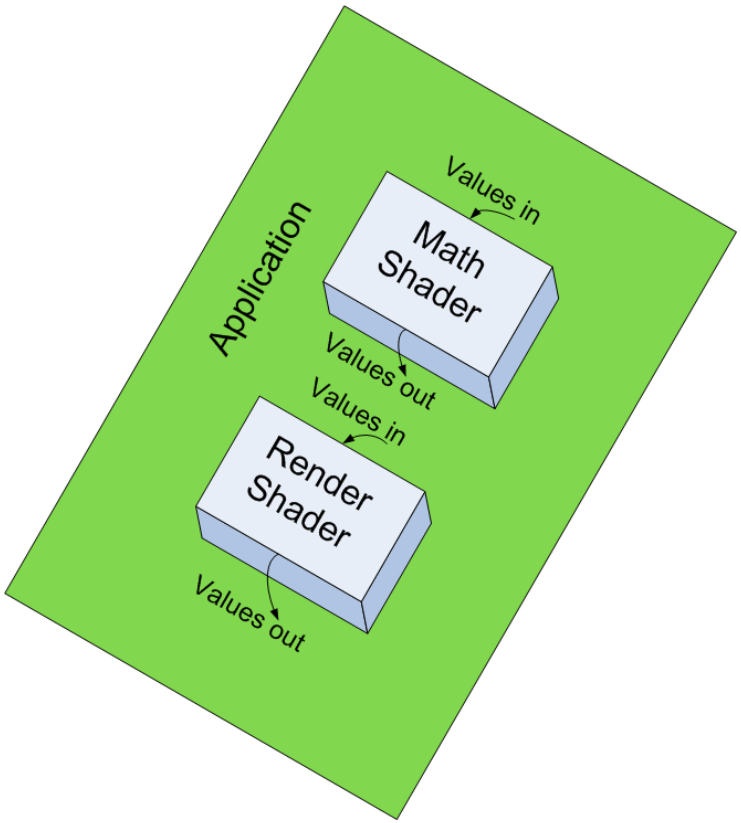

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Asynchronous read back

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- Asynchronous read back will speed up the process. (GPU-pixel buffer-GPU)

All values are stored in a text file for use i later stages.

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Theorem

Program demonstration

Conclusion

- Matlab is not optimized CPU code.
- GPU program is theoretically 200 times faster.
- GPU program is timed to be 45 times faster with 40000 rays.
- The GPU program is not optimized.

Summary

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- The GPU has increased the speed by 40-50 times.
- Accuracy is the same
- The performance will increase when program is optimized

End

Questions?