Parcel Dynamics

Object Density Acoustic Model

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Goal

Simulate echo/reverb from the proximity of several objects to the listener.

Notes

- This system applies to all sound effects in the game world, but parameters are only driven by object density around the listener. Modeling each source's acoustic response, as perceived by a separate listener, based on the source's unique surroundings would be far more complex and computationally expensive.
- This system foregoes stereo panning of reverberations. This would require independent echo/reverb DSPs for each channel with parameters driven by objects on each side of the listener.

Algorithm

Driving Data:

- Density of objects around to the listener, determined by:
  - The number of objects near the listener
  - The average distance of nearby objects from the listener

Logic:

Initialization:

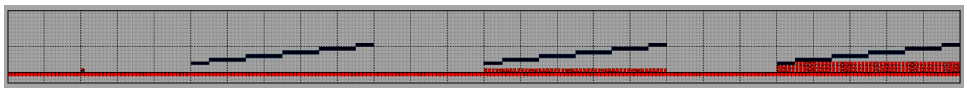
- The listener stores the positions of all static objects.
  - Optionally, this may also record object sizes.

Each frame:

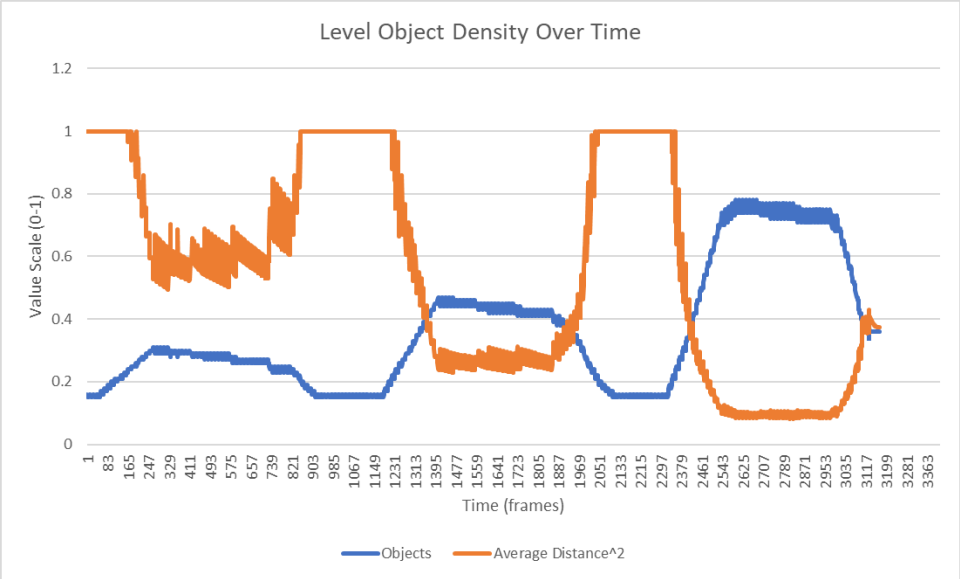
- Each dynamic collider reports its position to the listener.
  - Colliders may optionally report their sizes.

- The listener sorts through the position data and ignores objects over a certain distance from the listener.
- The listener sets its echo/reverb DSP parameters as following:
    - Echo/reverb balance:
        - Number of objects near the listener
            - More objects = biased toward reverb
            - Less objects = biased toward echo
        - Average distance of objects from listener
            - Greater distance = biased toward reverb
            - Lesser distance = biased toward echo
        - Optional: average objects size
            - More small objects = biased toward reverb
            - More large objects = biased toward echo
    - Echo time:
        - Average distance of objects from listener
            - Greater distance = longer time
            - Lesser distance = shorter time
    - Reverb time:
        - Number of objects near listener
            - More objects = shorter time
            - Less objects = longer time
    - Effect level:
        - Number of objects near listener
            - More objects = lower level
            - Less objects = higher level

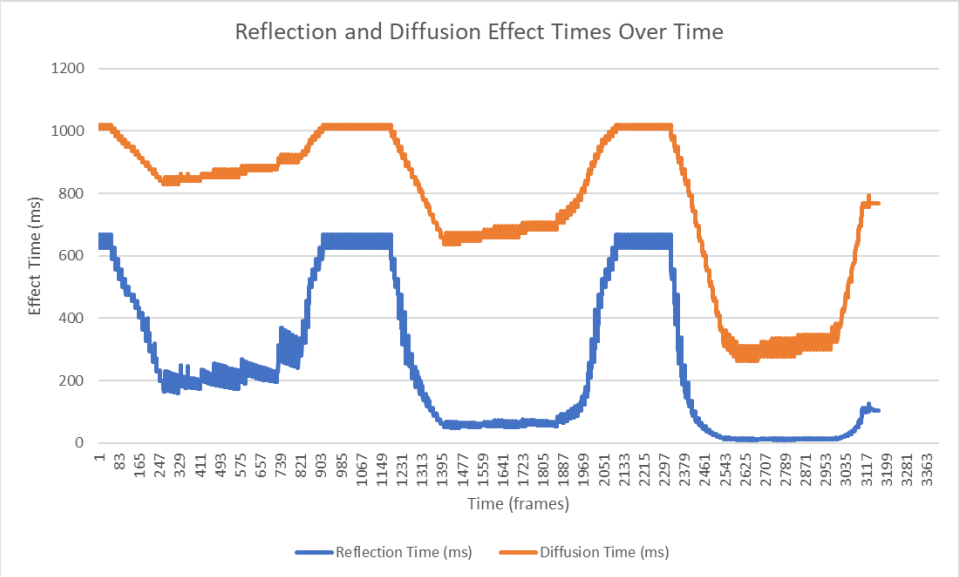
Test Level Data



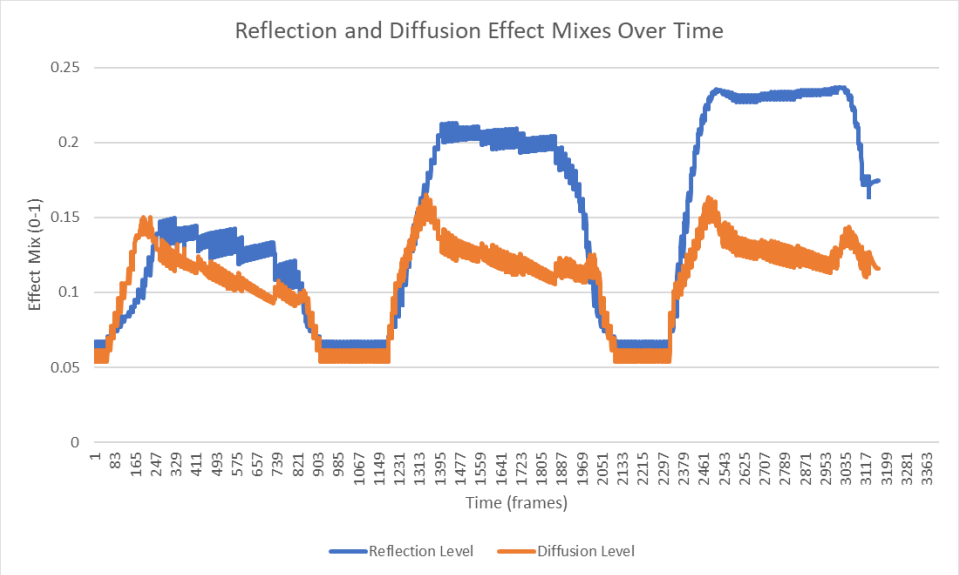
The test level consisted of 3 sloped corridors, each gradually increasing in room size. The first ramp contained no objects, the second contained a single row of objects, and the third contained two rows of objects. During data collection, the listener moved at a constant horizontal speed through the level.



This graph illustrates the two parameters for the acoustic model, proximal object count and average object distance^2, as the listener moved through the test level at a constant rate. Frames below 250 may be disregarded, as they were affected by a mistakenly-placed foreground object.



This graph illustrates the reflection and diffusion times in response to the object density parameters as the listener moved through the test level at a constant rate.



This graph illustrates the reflection and diffusion mixes, ranging 0-1, in response to the object density parameters as the listener moved through the test level at a constant rate.

Example Scenarios

Open Space

Reflection:

Amount: Very low

Time: Short

Diffusion:

Amount: Verylow

Time: Long

Large Enclosed Space

Reflection:

Amount: Medium

Time: Long

Diffusion:

Amount: Small

Time: Long

Large Enclosed Space With Objects

Reflection:

Amount: Medium

Time: Long

Diffusion:

Amount: Medium

Time: Medium

Medium Enclosed Space

Reflection:

Amount: Medium

Time: Medium

Diffusion:

Amount: Medium

Time: Medium

Medium Enclosed Space With Objects

Reflection:

Amount: Low

Time: Medium

Diffusion:

Amount: Medium

Time: Short

Small Enclosed Space

Reflection:

Amount: High

Time: Short

Diffusion:

Amount: Small

Time: Medium

Small Enclosed Space With Objects

Reflection:

Amount: Very low

Time: Very Short

Diffusion:

Amount: Very low

Time: Very short

Possible Optimizations

- A simplified data model could assume reverberation time and level solely from the number of objects near the listener.
- Updates could be distributed over multiple frames.