Advanced Camera Control

IMGD 4000


“An ideal virtual camera system, regardless of genre, is notable by the lack of attention given to it by the viewer”


God of War 2 trailer [https://www.youtube.com/watch?v=GjYbK_-w9pM](https://www.youtube.com/watch?v=GjYbK_-w9pM)

Note: If you don’t notice camera, then it is working well!

Camera Objectives

- Flexible and designer driven
  - Allow game designer to provide player experience from variety of perspectives
- Smooth
  - No jarring transitions
- Not require player intervention
  - Player should not have to manually adjust camera to see game
- No collision
  - Designer must constrain so doesn’t go through walls

Overview

- Zoning – deals with use of spatial database to select “right” camera
- Dynamics – calculations for a single, dynamic camera
- Blending – smooth out transitions between cameras
- Rails – constraining camera to path

Zoning: Objectives

- Have multiple stationary cameras
  - Cameras in fixed location
- Chosen by player position
  - Active camera is based on where player is
- Design so that cameras can “cover” where player is
- Switch automatically to right camera

Zoning: Design

Select camera from database based on player zone location.

If move across border, will "toggle" between cameras.
Zoning : Design

- Non-overlapping zones.
- Switch to camera when player ENTERS zone.
- Provides hysteresis.
- But may not "cover" all areas well.

Alternative is overlapping zones. When enter overlap, switch to new camera.

Zoning : Implementation

Each frame, query spatial DB and get cameras. Assume unordered (don’t want assumption about underlying DB).

If simply switch to new camera, will toggle between A and C every frame.

Zoning : Implementation

- Submission List
  - List of all cameras that were submitted last frame
  - Used to distinguish newly submitted cameras from old ones
  - New cameras inserted at top
    - So, effectively sorted by age

In this example, player moves from A to C to B.
- If then to just C, top entry would change.
Zoning : Implementation

Provide priority for more important (higher priority) camera when overlapped.

Camera A Priority 1
Camera B Priority 2

Zoning Implementation

• Submission List (with priorities)
  – Insert and delete entries to match query results
  – Unless query result was empty
  – Sorted by priority
  – Then by age
  – Top entry is active camera

Outline

• Zoning (done)
• Dynamics (next)
• Blending
• Rails

Dynamics : Objectives

• Camera impacts 3 properties of avatar as it appears on screen
  – Position – where camera is focused impacts where on screen avatar appears (e.g., center? bottom right?)
  – Size – how far away camera is impacts how big avatar appears (e.g., takes up full screen, takes up tiny portion)
  – Angle – angle of camera from avatar orientation impacts what representation avatar has (e.g., profile? top-down?)
Dynamics: Design

- Player position and viewing angle depend upon angle between camera and player.
- Specify angle viewing player from a fixed value.
- But result will be camera moves around lots (background moves) can be disconcerting.

Instead, calculate angle relative to camera location (black lines).

Only move camera if angle greater than constraints (blue lines).

This is like “high water mark” and “low water mark” in algorithms.

Dynamics: Design

Control size of player on screen, by controlling distance from camera to player.

5 metres

Similar to angle, often don’t want as fixed value (see next slide).

Dynamics: Design

Camera never gets too far from, or too close to, player.

Allow designer to set range of valid distances for camera.

Outline

- Zoning (done)
- Dynamics (done)
- Blending (next)
- Rails
**Blending: Overview**

- **Blending** – smooth out transitions between cameras
- Three aspects:
  - **Timers** – track and update each blend
  - **Ease** – controls the smoothness of blend
  - **Blend Space** – defines what a blend between two cameras does

**Timers: Design**

- Don’t actually blend pixels
- Rather, create a third camera from varying proportions of other two cameras
- Moves from first camera to second
- Position and orientation determined by blend of two cameras
- Driven by timer (started when new camera activated)

**Timers: Implementation**

- **Timer List**
  - Entry is camera fading in
  - New timers inserted at top
  - Camera can have multiple timers in list
    - This happens if player moves quickly between cameras
    - First-In, First-Out (FIFO)
    - When timer completes, all timers below it are removed

**Timers: Implementation**

- Zone A: list empty, start camera A
- Zone C: starts new timer, camera is blend of A and C
- Zone B: start new timer, camera is blend of A, B and C
- Camera C’s timer done, so drop camera A
- Back to Zone B: start new C timer (C in list twice)
- Camera B’s timer completes, drop C timer below
- Camera C’s timer completes, drop B below

At C 100%

- Start at bottom (oldest), blend in new camera (higher on list) based on timer fraction

Ease : Design

- Using as-is, get simple linear blend (see sharp corners in picture)
- When use to blend cameras, see jerk when starts to move and stops
  - Can be ugly

- Want what animators call "ease"
  - Feed linear blend into spline

Ease : Implementation

- Hermite Spline
  - Used to smoothly interpolate between keypoints (e.g., camera A to camera B)
  - Fixed endpoints at P1 & P2
  - Controllable tangents
    - ease = [0, 1]
      - 0 means no ease (linear)
      - 1 means full ease
  - Ease-in from P1 tangent, and Ease-out from P2 tangent

Ease : Implementation

- B 3/4
- C 3/3
- 3/4

Ease (3/4, ease, C.easeIn, B.easeOut)

Apply Ease() when calculate blend factor between two cameras
- ease from 0 to 1
- easeIn from old camera (C)
- easeOut from new camera (B)

Blend Space : Design

If blend positions along straight line, will get "zoom" effect.

Instead, blend along arc, fixed distance from player.

Outline

- Zoning  (done)
- Dynamics  (done)
- Blending  (done)
- Rails    (next)

Rails : Objectives

Want camera on a track  idea borrowed from film industry.
Construkt rails, put camera on little cart (a "Dolly").
Rails: Design

- Rail can be curve (e.g., spline – numeric function compose of polynomials)
- Dolly is on spline

Rails: Design

Only move Dolly by enough to keep player within constraints defined by camera.

Player is free to move within constraints, but when Player moves outside, Dolly moves to compensate as best it can.

Rails: Implementation

- Player is 2 units outside, so weight at p0 is 2.
- Move Dolly to p1, weight is 0 since inside constraints.
- Between p1 and p2, weight stays 0.
- At p3, again 2 units outside, weight is 2.

Use constraints to calculate weight at given point on spline.

Rails: Implementation

- Guess which direction player moved.
- Take step in that direction.
- If weight at new position is lower, then try another step.
- If weight is higher, turn around and go back 1/2 as much.
- If below certain threshold, then stop.

In general, may be difficult to find minima. Classic hill climbing.

Rails: Implementation

- Can experiment with weights
  - Distance from Player to Dolly
    - Classic drag/push camera down corridor
  - Amount Boss obscures Player
  - Number of minor characters out of frame
  - ...

- Also, can combine Dolly technique with earlier ones

Other Stuff (not Discussed)

- Dealing with multiple targets
  - Framing fights, using multiple targets
- Dynamic target definition, and calculation
  - Target changes, fade to different targets
- Overriding cameras at arbitrary points to focus on dynamic areas of interest
  - Different camera “states”
- Physical post effects like shake and sway

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What techniques can you identify?