Realizing Bullet Time in Multiplayer Games with Local Perception Filters

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Bullet time

- movies: visual effect combining slow motion with dynamic camera movement
- computer games: player can slow down the surroudings to have *more time* to make decisions
- easy in single player games: slow down the game!
- how about multiplayer games?

Bullet time in multiplayer games

- two approaches:
  - speed up the player
  - slow down the other players
- if a player can slow down/speed up the time, how it will affect the other players?
  - localize the temporal distortion to the immediate surroundings of the player
- but how to do that?

Local perception filters (LPFs)

- introduced by Sharkey, Ryan & Roberts (1998)
- a method for hiding communication delays in networked virtual environments
- exploits the human perceptual limitations by rendering entities slightly out-of-date locations based on the underlying network delays
  - causality of events is preserved
  - rendered view may have temporal distortions
  - rendered view ≠ real view

Rules of LPFs

1. Player should be able to interact in real-time with the nearby entities.
2. Player should be able to view remote interactions in real-time, although they can be out-of-date.
3. Temporal distortions in the player's perception should be as unnoticeable as possible.

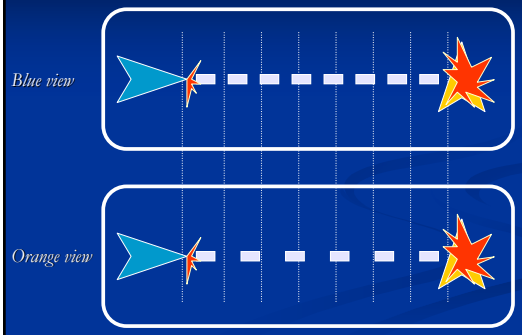
Entity types

- active: indeterministic, unpredictable (humans)
  ⇒ *players*
  - local: residing in the same computer
  - remote: connected over a network
- passive: deterministic, predictable (projectiles, buildings etc.)
  ⇒ *entities*

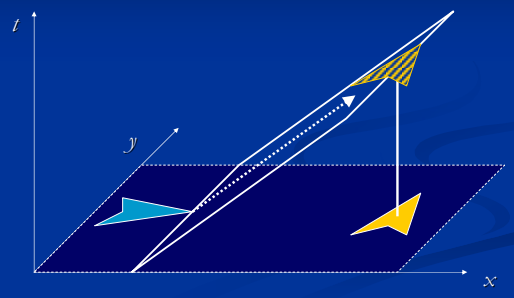
Interaction between players

- interaction = communication between the players
  - local players: immediate
  - remote players: subject to the network latency
    - time frame = current time – communication delay
- interaction = players exchanging passive entities
  - passive entities are predictable ⇒ they can be rendered in the past (or in the future)
- a passive entity can change its time frame dynamically
  - the nearer to a local player, the closer it is rendered to the current time
  - the nearer to a remote player, the closer it is rendered to its time frame

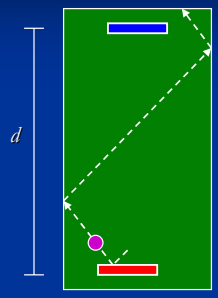
Example: Temporal distortion



Temporal contour (from the blue player's perspective)

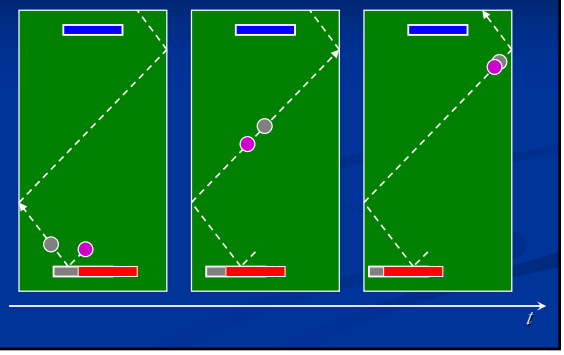


Example: Pong

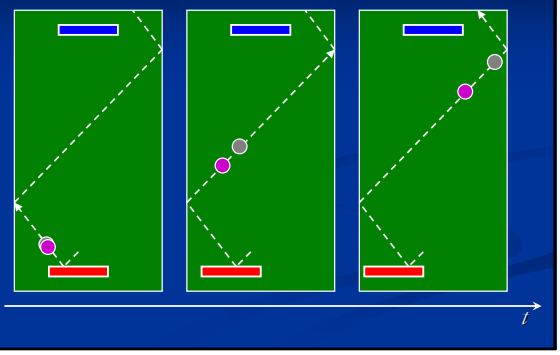


- two active entities: paddles
  - movements unpredictable
- one passive entity: ball
  - movements predictable
- latency of *d* seconds

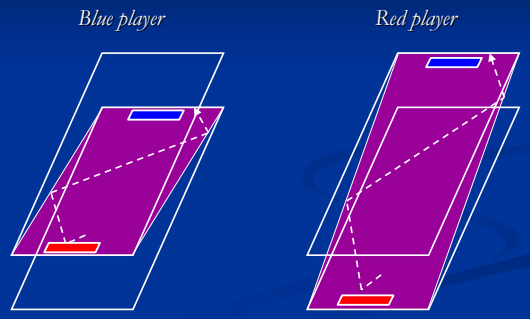
The view of the blue player



The view of the red player

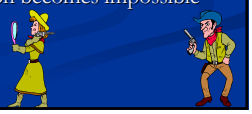


Temporal contours in Pong

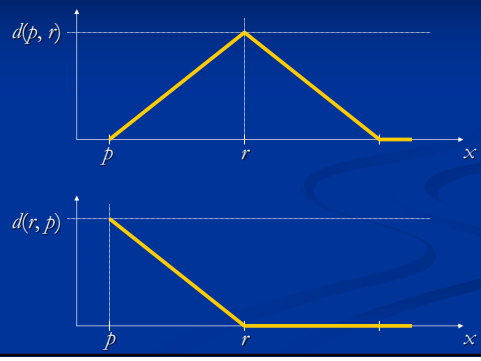


Worth noting

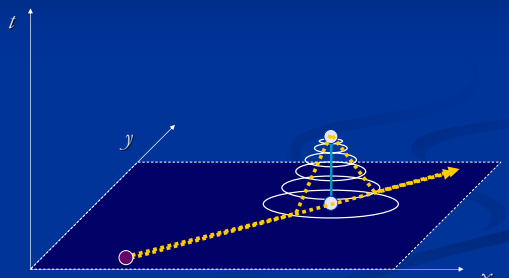
- original paper: continuous temporal contours; here: simple linear functions
- LPFs are the 'opposite' of dead reckoning
  - no prediction for remote players
- the closer the players get, the more noticeable the temporal distortion becomes
  - in critical proximity interaction becomes impossible
  - no mêlée



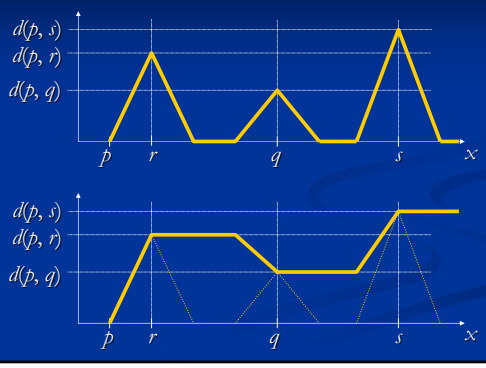
Example: Temporal contours



2½-dimensional temporal contour



Many players



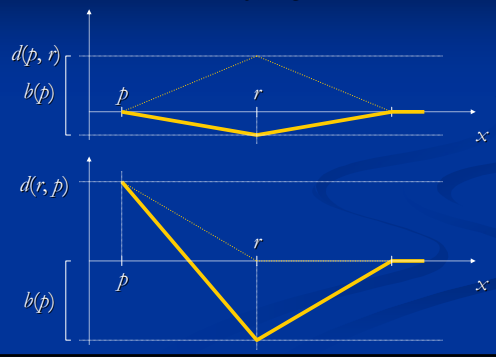
Problems

- original approach: visual disruptions on impact ⇒ shadows (see the paper for details)
- sudden changes in the player's position or delay can cause unwanted effects
  - if a player leaves the game, what happens to the temporal contour?
  - third party instrusion: someone with a high delay 'blocks' the incoming entities
  - jitter: entities start to bounce back and forth in time

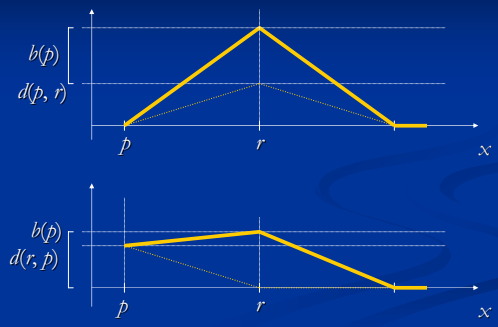
Adding bullet time

- player using the bullet time has more time to react
  ⇒ the delay between bullet-timed player and the other players increases
- add artificial delay to the temporal contour

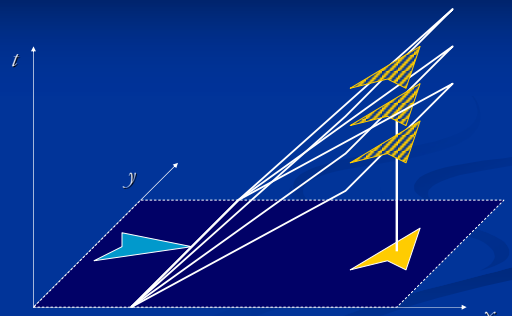
p shoots *r* while *p* is using bullet time



p shoots *r* while *r* is using bullet time

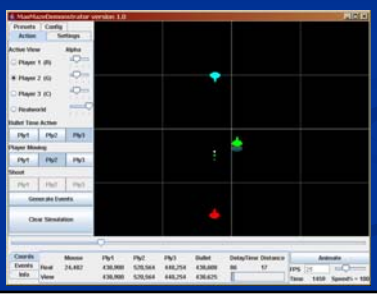


2½-dimensional temporal contour and bullet time



MaxMazeDemonstrator

http://staff.cs.utu.fi/staff/jouni.smed/mmd/



Future work

- non-linear temporal contours
  - how to compute quickly?
  - noticeable benefits (if any)?
- numerical evaluation
  - measuring the distortion and its effects
- practical evaluation
  - how well does it work?
  - does it allow new kinds of games?