animosaics

Kaleigh Smith†‡  Yunjun Liu†  Allison Klein†

†McGill University  ‡MPI Informatik
Static Mosaics

Mosaic imagery - traditional and modern

Detail of Roman mosaic, Herculaneum  Magritte photomosaic, Silvers
Static Mosaics

- Arrangement (packing) of objects (tiles)
Static Mosaics

- Arrangement (packing) of objects (tiles)
- Perceptual duality of mosaics:
  - Individual tiles
  - Whole depiction
Animated Mosaics

- Mosaic that changes over time
- Form of stop-motion animation
- Perceptual duality of mosaic animation:
  - Movement of tiles
  - Movement of overall scene
Animated Mosaics

- Our goal: system for creating animated mosaics
- Challenges:
  1. Per-frame Quality
  2. Temporal Coherence
  3. Performance
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions
Outline

- Introduction
- Related Work
  - Process Overview
  - Challenges and Approach
  - Packing
- Results and Conclusions
Related Work : Static Mosaics

Simulating Decorative Mosaics
[Hausner, 2001]

- Restricted tile shapes
- Point-based centroidal Voronoi diagram for tile placement.

Jigsaw Image Mosaics
[Kim, Pellacini, 2002]

- Library of tiles
- Specified mosaic quality metric
Related Work: Static Mosaics

Rendering traditional mosaics
[Elber, Wolberg, 2003]
- Stack tiles along contour lines
- Restricted tile shapes

Beyond stippling - methods for distributing objects on the plane
[Hiller et al., 2003]
- Centroidal area Voronoi diagrams
- Stipple primitives
Related Work: Animated Mosaics

**Painterly rendering for animation** [Meier, 1996], **Processing images and video for an Impressionist effect** [Litwinowicz, 2000].

- NPR primitives (strokes) tied to underlying geometry (explicit or derived)
- Primitives can blend, grow and warp

**Coherent stylized silhouettes** [R. Kalnins et al., 2004].

- Propogate NPR stylized contours
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions
Process Overview

- **Containers** are input bounding shapes
- **Tiles** are packed into containers
- SVG defines container contours and deformations
Process Overview

- **Containers** are input bounding shapes
- **Tiles** are packed into containers
- SVG defines container contours and deformations
Process Overview

For each container, make an **initial packing of tiles**

- User specifies the tile shapes and number of tiles
Propagate initial packing to pack subsequent frames

Tiles are **ad vected** to following frame

Add/remove tiles and adjust tile positions
Process Overview

- Input Containers
- Initial Packing
- Coherent Packing
- Final Animation

- Result: coherent packing of container over time
- Render frames or use tile positions as key frames
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions
Challenges

1. Static Mosaic: Per-frame Quality
   - Dense, evenly spaced packing
   - Appropriate tile alignment
   - Arbitrary tile shapes
   - Multiple tile shapes within a single container
Challenges

1. Static Mosaic: Per-frame Quality

2. Temporal Coherence

- Packings should change smoothly over time.
- Tiles should appear attached to depicted object.
- Minimize tile appearances and disappearances (“pops”).
Challenges

1. Static Mosaic: Per-frame Quality

2. Temporal Coherence

3. Performance
   - Efficient packing method
     - Fast for single frames
     - Supports incremental changes
   - Interactive control for animator
Perceptual Approach

- Ultimate challenge: create a visually appealing animosaic
- Use grouping theory and perceptual aspects of HVS to:
  - Understand our perception of animated mosaics
  - Create animated mosaics that will simplify visual processing
Static Mosaic Perception

Group tiles to simplify and segment a scene according to:

- Similarity (colour, shape, orientation)
- Tile proximity
- Likeness to common shape
Static Mosaic Perception

Group tiles to simplify and segment a scene according to:

- Similarity (colour, shape, orientation)
- Tile proximity
- Likeness to common shape
Animated Mosaic Perception

Maintain previous grouping and make changes coherent:

- Common movement of grouped tiles
- Insertion and deletion of groups, not individuals
- Maintain emphasis of contours

Observation: uncoordinated changes among groups of tiles will yield distracting, incoherent animations, even if individual tiles have temporal smoothness.
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach

Packing

- Results and Conclusions
Packing: Tile Positioning

- No previous method packs multiple and arbitrary tile shapes in interactive time.
- Pack with centroidal area Voronoi diagram (CAVD).

Standard Voronoi Diagram
Area Voronoi Diagram
Packing: Tile Orientation

- Tiles oriented to nearest container edge.
- Fast to compute using AVD.
- Small container deformations yield coherent changes to tiles orientations.

![Container](Image)
![Container’s Orientation Field](Image)
![Resulting Packing](Image)
Packing: Tile Orientation

- Also supports equivalent tile orientations
- Better packing with no impact on packing speed
Packing: Tile Orientation

- Tile orientations respect and reflect container shape
- Continuous changes in continuous container regions
- Sharp changes in discontinuous container regions
Packing: Result

- Tightly packed tiles.
Packing: Result

- Tightly packed tiles.
- Arbitrary and multiple tiles shapes.
Packing: Result

- Tightly packed tiles.
- Arbitrary and multiple tiles shapes.
- Placement and orientation respects and reflects the container shape.

Input (7 Containers)
Packing: Tile Advection

Temporal Coherence:

- Translations and rotations easy
- Deformations are hard because tiles must be displaced, added and deleted
Packing: Tile Advection

- What would happen if tiles were advected uniformly over the container area?
- Example: map tiles to the next frame according to all container edges.
Packing: Tile Advection

- What would happen if tiles were advected uniformly over the container area?
- Example: map tiles to the next frame according to all container edges.

No tiles close to container edge

No space to place new tiles
Packing: Tile Advection

Recall, in order to promote perceived coherence:

- Related tiles should move in groups
- Avoid individual tile insertions by concentrating insertion locations
- Concentrate deletions
- Emphasize container contour
Packing: Tile Advection

We propose two tile advection methods:

- Anchor Point Mapping
- Nearest-Edge Mapping

Previous techniques in NPR animation do not target group motion or perceptual grouping.
Anchor Point Mapping

- Appears that the tiles are being added to the border of the existing packing.
- During container contraction, outlying tiles are deleted.
Anchor Point Mapping

Uses container center point as anchor point
Anchor Point Mapping

Uses container center point as anchor point

Frame 0
Nearest-Edge Mapping

- Container boundaries coherent and strongly preserved
- Tiles added in a group at the center of the container
- Overlapping tiles are removed from center of container during container contractions
Nearest-Edge Mapping
Nearest-Edge Mapping
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing

Results and Conclusions
Conclusions

- New techniques for static mosaic creation
  - Multiple tile shapes
  - Improved tile orientation

- New characterization of temporal coherence
  - Group movement
  - Underlying geometry not necessary

- New system for mosaic animations
  - Easy animation specification
  - Original, stylized results
Future Work

- Further applications of perceptual grouping laws
- Make system choices more automatic
- Consider optimizing tile orientation according to the placement of neighbouring tiles
Acknowledgements

- Natural Sciences and Engineering Research Council of Canada
- Le Fonds québécois de la recherche sur la nature et les technologies
- ATI Technologies Inc. and Alias Systems Corp.
- Karol Myszkowski and Hans-Peter Seidel of MPI Informatik
- Louisa Sage
- Chansoo Kim and Yorico Murakami of UCLA Animation