Mobile Image Retargeting

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Image Retargeting
Image Retargeting
Image Retargeting

crop center

scaling
Image Retargeting

- crop center
- scaling
- letterbox
Image Retargeting

retargeting
Image Retargeting

- content-aware
- objectives
  - preserve important structure and content
  - no artifacts
Image Retargeting

saliency map

• content-aware
• objectives
  ▸ preserve important structure and content
  ▸ no artifacts
Image Retargeting

- content-aware
- objectives
  - preserve important structure and content
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artifacts
Goals

• bring image retargeting to a mobile device
  ‣ limited CPU, GPU and screen size
• intuitive user interface for small displays
• combine cropping and warping techniques
Related Work
Seam Carving

- Seam Carving

repeatedly remove the least salient path

„Seam carving for content-aware image resizing.“ Avidan and Shamir, SIGGRAPH 2007
Warping Techniques

- look for a continuous mapping $F : I \rightarrow I'$
Warping Techniques

• look for a continuous mapping \( F : I \rightarrow I' \)
Warping Techniques

- look for a continuous mapping $F : I \rightarrow I'$
- modelled as energy minimization

$$S(x, y) \parallel J_F(x, y) - \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \parallel^2$$

saliency map

Jacobian of the mapping
Warping Techniques

- look for a continuous mapping $F : I \rightarrow I'$
- modelled as energy minimization

$$E(F) = \int_{x=0}^{H} \int_{y=0}^{W} S(x, y) \parallel J_F(x, y) - \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \parallel^2 dx dy$$

saliency map

Jacobian of the mapping
Warping Techniques

- discretization on regular grid
Possible Discontinuities

- impose hard constraints
- leads to a convex optimization problem
- optimization is expensive and only feasible on coarse grids
Possible Discontinuities

- impose hard constraints
- leads to a convex optimization problem
- optimization is expensive and only feasible on coarse grids
Our Retargeting Operator
Axis-Aligned Image Deformations

- linear number of variables
- fast optimization

\[ s = (s^{\text{rows}}, s^{\text{cols}})^T \]

„Robust image retargeting via axis-aligned deformation.“
Panozzo et al., EG 2012
ASAP Energy

- locally correspond to a similarity transform

Important cells should not change their aspect ratio
ASAP Energy

• locally correspond to a similarity transform

\[ \left( \Omega_{i,j} \left( \frac{M}{H} s_i^{\text{rows}} - \frac{N}{W} s_j^{\text{cols}} \right) \right)^2 \]

average saliency per grid cell
change in aspect ratio

• we use a grid of 25 x 25 cells
ASAP Energy

• locally correspond to a similarity transform

\[ E_{ASAP} = \sum_{i=1}^{M} \sum_{j=1}^{N} \left( \Omega_{i,j} \left( \frac{M}{H} s_{i}^{\text{rows}} - \frac{N}{W} s_{j}^{\text{cols}} \right) \right)^2 \]

average saliency per grid cell
change in aspect ratio

• we use a grid of 25 x 25 cells
Constraints

- row and column sums are target image size

\[
s_{1}^{\text{row}} + s_{2}^{\text{row}} + \cdots + s_{M}^{\text{row}} = H' \\
s_{1}^{\text{cols}} + s_{2}^{\text{cols}} + \cdots + s_{N}^{\text{cols}} = W'
\]
Constraints

• no grid cell disappears: minimum cell size

\[ s_{i}^{\text{rows}} \geq \bar{H}_{i}^{\text{min}}, \quad i = 1, \ldots, M \]

\[ s_{j}^{\text{cols}} \geq \bar{W}_{j}^{\text{min}}, \quad j = 1, \ldots, N \]
Constraints

• no grid cell disappears: minimum cell size

\[
\begin{align*}
    s_i^{\text{rows}} & \geq H_i^{\text{min}}, \quad i = 1, \ldots, M \\
    s_j^{\text{cols}} & \geq W_j^{\text{min}}, \quad j = 1, \ldots, N
\end{align*}
\]
Automatic Saliency Detection
Automatic Saliency Detection

• What is important?
• Low-level stimuli driven approaches
  ▸ regions of high contrast
  ▸ we use gradient magnitude with dilation
Automatic Saliency Detection

• What is important?

• Low-level stimuli driven approaches
  ▸ regions of high contrast
  ▸ we use gradient magnitude with dilation

• High-level object based saliency
  ▸ we use the iOS face detector
User Interface
Problem
Problem

- small screen does not allow split view
Problem

- small screen does not allow split view
- combine saliency map and retargeted image
Problem

- small screen does not allow split view
- combine saliency map and retargeted image
- updated warp moves image under the finger
Fixed-point stabilization

- move the image to fix the point at the finger
Fixed-point stabilization
Cropping
Threshold-based Cropping

1. optimize
Threshold-based Cropping

1. optimize  
2. crop

crop threshold
Threshold-based Cropping

1. optimize  
2. crop

crop threshold
Threshold-based Cropping

1. optimize
2. crop
3. optimize

crop threshold
Results
RetargetMe Benchmark

original  CR  SV  MULTIOP  AAIR  our operator
Results

- interactive performance of 60 fps
- cropping operator
  - greediness of threshold approach
- application
  - picture gallery
Results

- interactive performance of 60 fps
- cropping operator
  - greediness of threshold approach
- application
  - picture gallery
Future Work

- more sophisticated cropping approaches
- application in a (mobile) web browser
- video retargeting
Conclusion

• fast, fluid, fun to use application
• cropping operator is simple yet effective
• next steps
  ‣ make source code publicly available
  ‣ submit app to the iOS App Store
Questions
Thank you for your attention.