Mixing Tile Resolutions in Tiled Video: A Perceptual Quality Assessment

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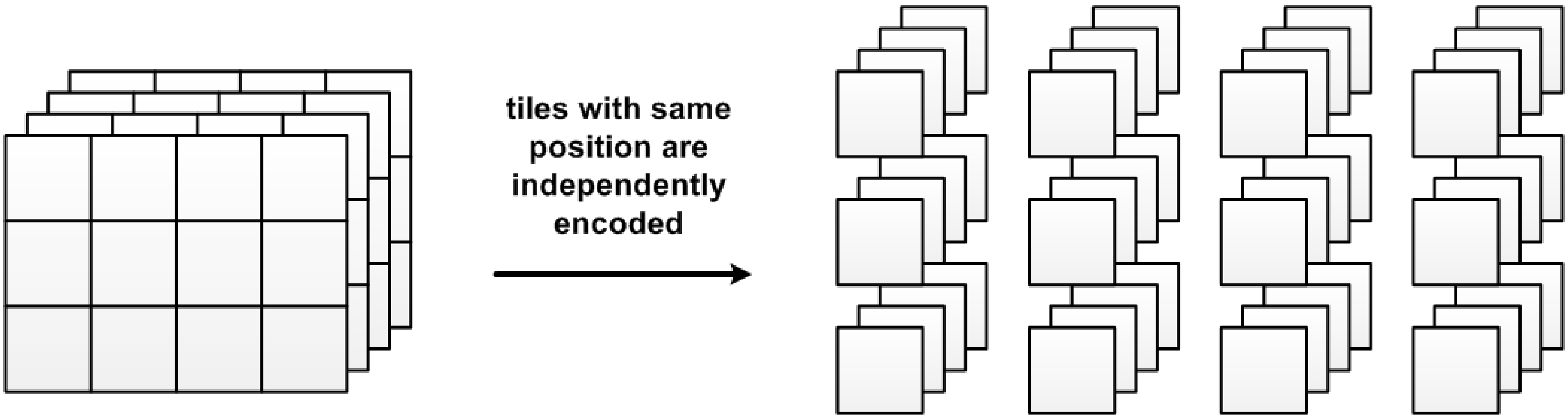
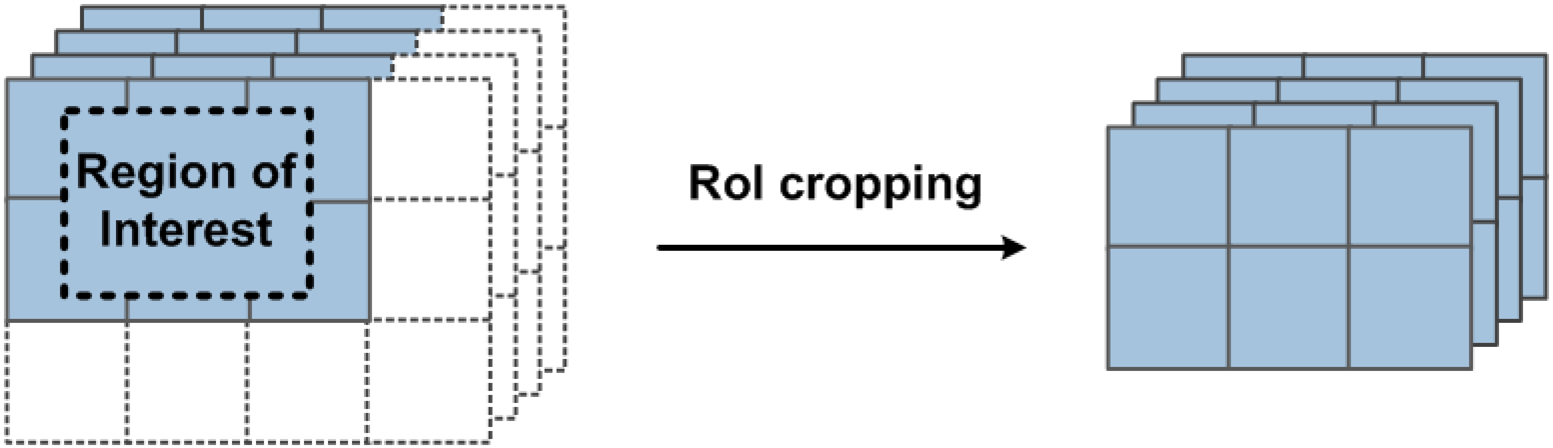
Rush-Hour V1

Rush-Hour V2

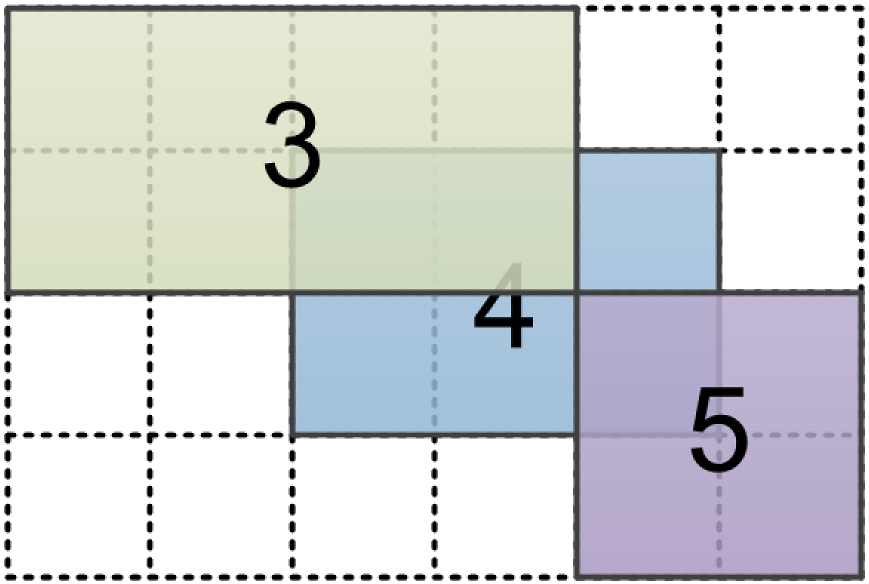
Background of tiled video

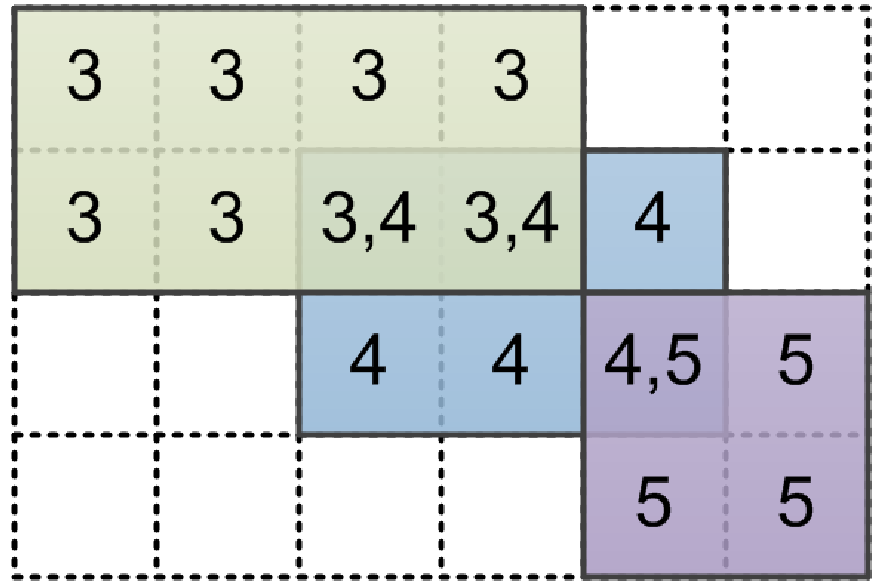


Benefits of tiled video



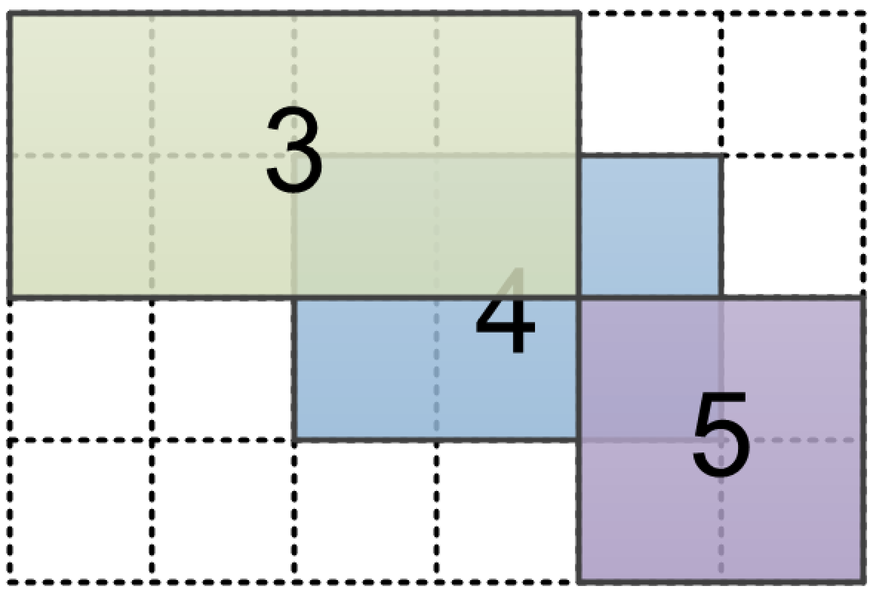
Inefficiency of wireless transmissions with multiple users

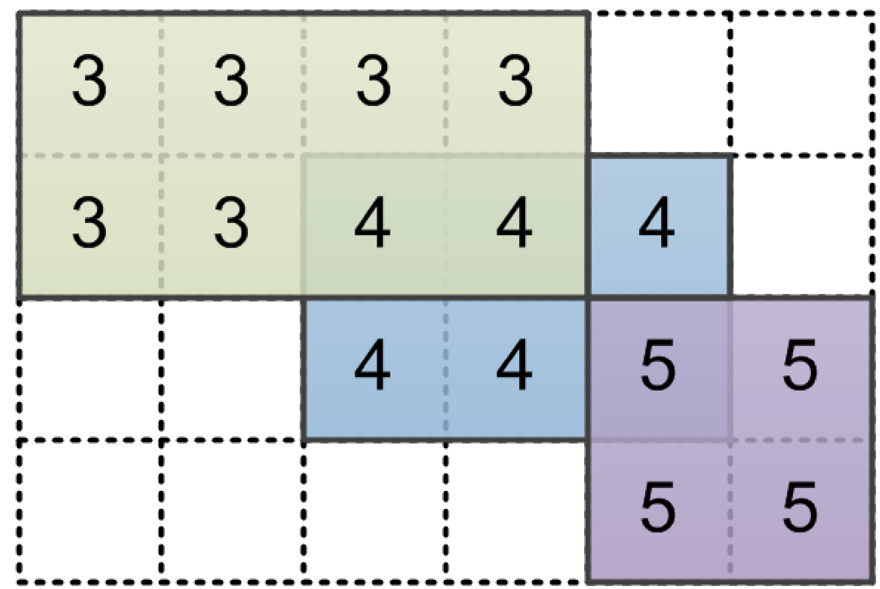




Multiple transmissions for one tile

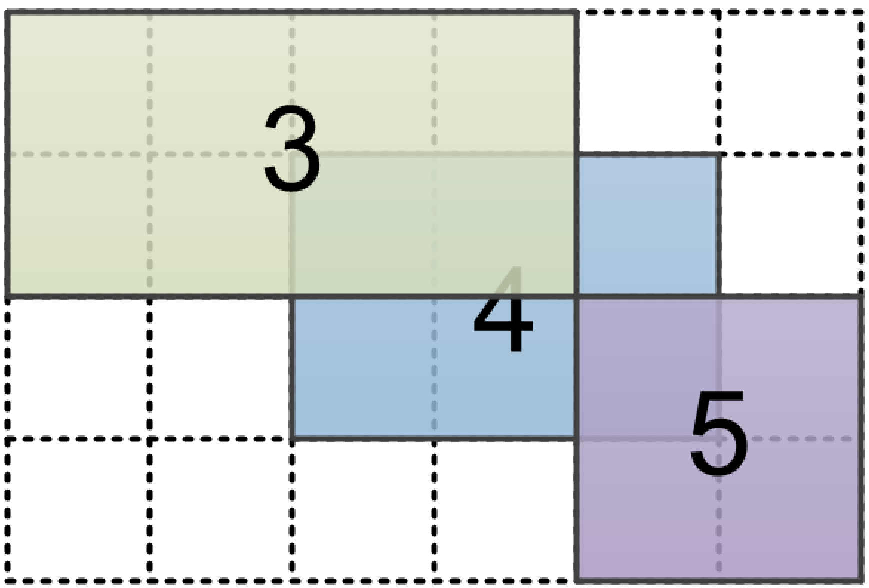
Mixing tile resolutions (Reduce transmissions)

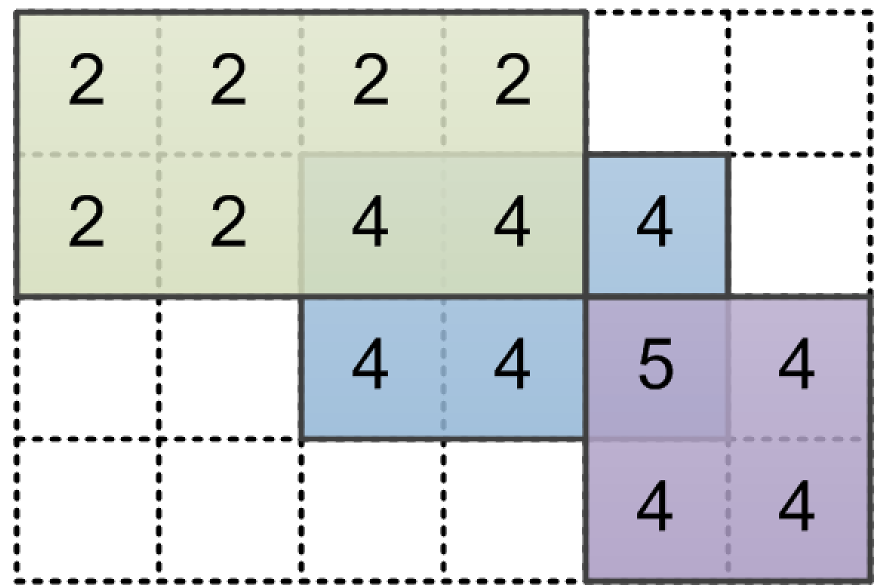




Highest quality among all requests

Mixing tile resolutions (Reduce bandwidth)





Unpopular tile with lower quality

Perceptual quality assessment

- **The perceptual quality impact of mixing tiles with different resolutions**

- Psychophysical experiment: *method of limits*
  - Gradually change tile resolutions to identify the *Just Noticeable Difference* (JND) and *Just Unacceptable Difference* (JUD) thresholds

Video 1: Crowd-Run (Dense Motion)

Video 2: Old-Town-Cross (Medium Motion)

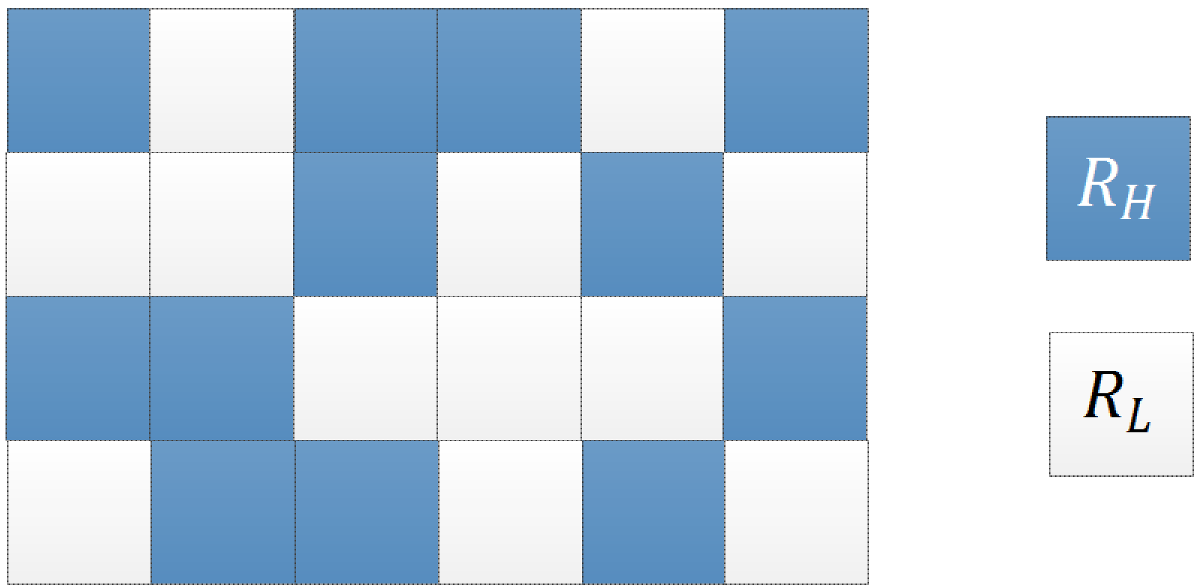
Video 3: Rush-Hour (Low Motion)

Video resolutions, number of tiles, tile resolutions

level	frame	16×9 tiles	80×45 tiles
5	1920×1080	120×120	24×24
4	1600×900	100×100	20×20
3	1280×720	80×80	16×16
2	960×540	60×60	12×12
1	640×360	40×40	8×8

Constructing mixed-resolution tiled video

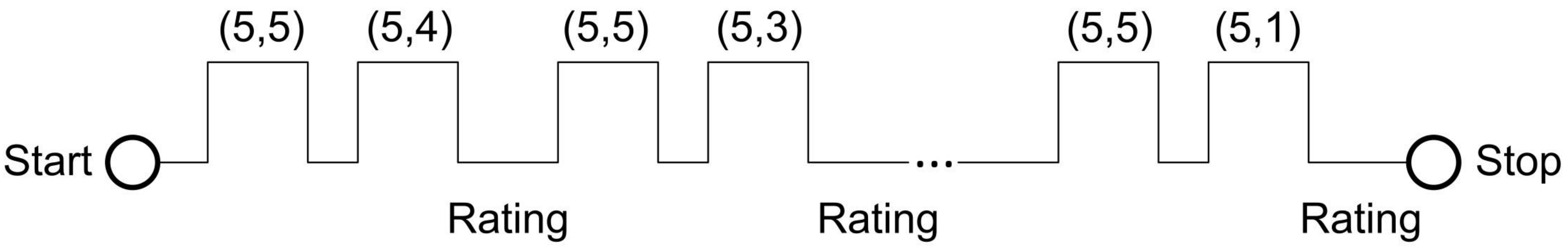
- Given configuration (R_H, R_L), randomly mixing tiles with resolution levels R_H and R_L



Procedure

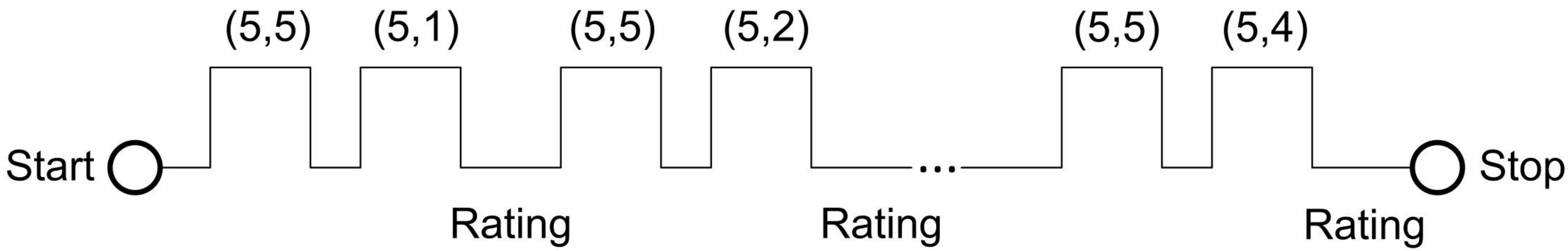
- 50 participants
- 12 stimuli series
- Each stimuli series is randomly descending or ascending

Descending Stimuli Series



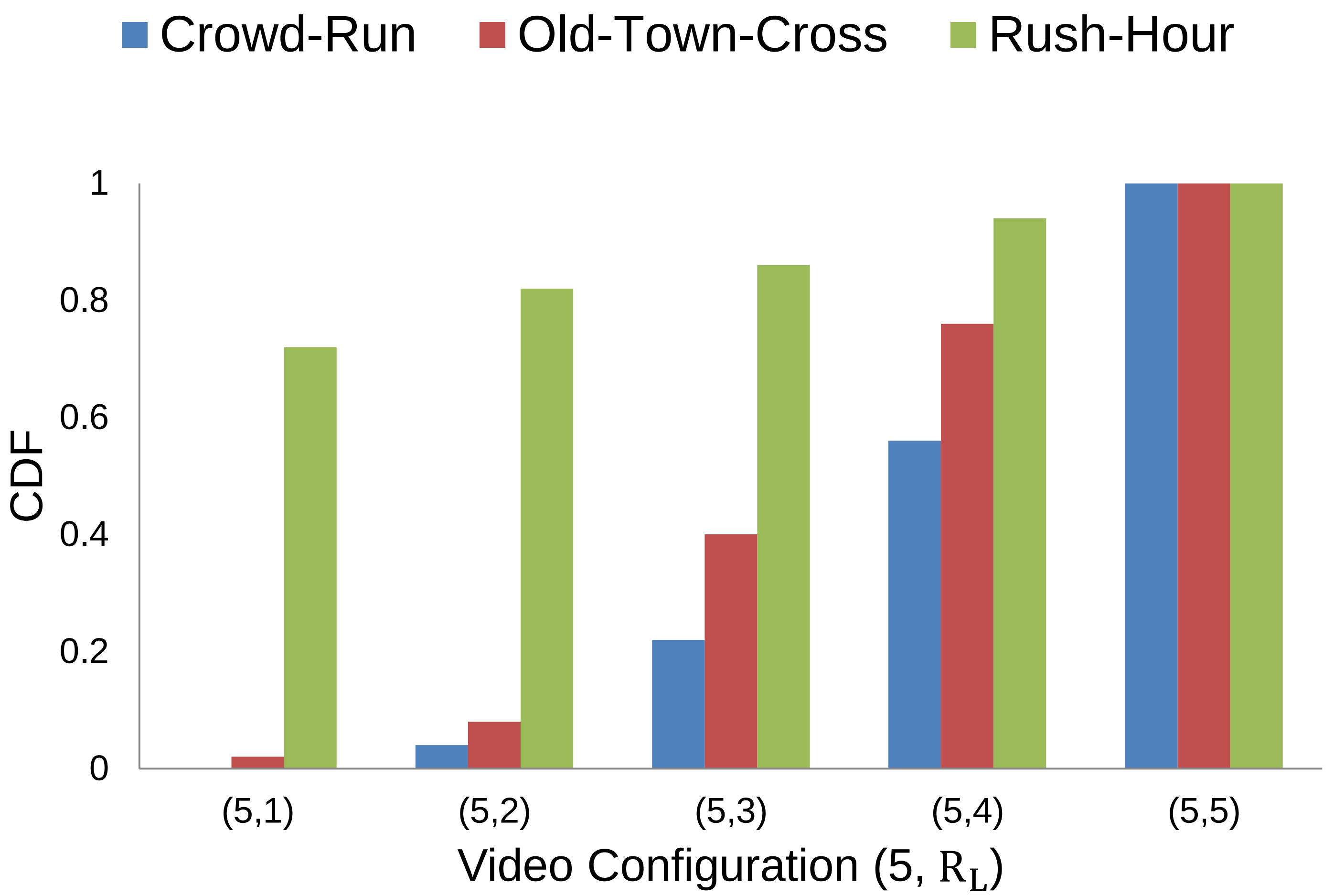
- Rating pair (5, 5) and (5, R_L):
  - *i. Is the quality difference noticeable?*
  - *ii. Is the quality difference unacceptable?*
- Decreasing R_L from 4 to 1 or until the quality difference is unacceptable

Ascending Stimuli Series



- Rating pair (5, 5) and (5, R_L):
  - *i. Is the quality difference noticeable?*
  - *ii. Is the quality difference unacceptable?*
- Increasing R_L from 1 to 4 or until the quality difference is unnoticeable

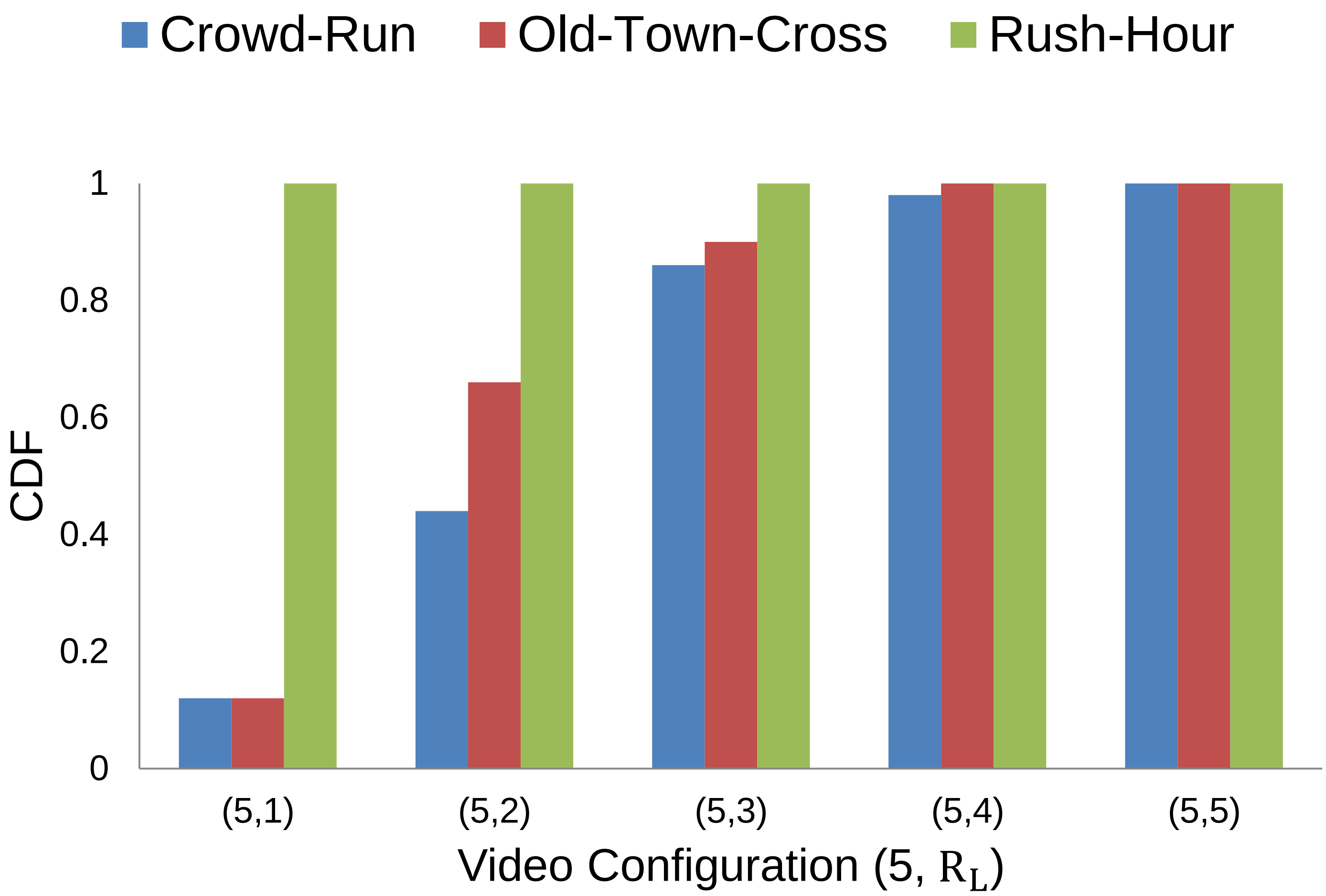
CDF distribution of participants that cannot notice any difference between tiled video (5, R_L) and tiled video (5, 5)



Average Just Noticeable Difference threshold with 95% Confidence Interval value

	 (Dense Motion)	 (Medium Motion)	 (Low Motion)
Average JND	$3.68\ (\pm 0.52)$	$3.25\ (\pm 0.47)$	$0.81\ (\pm 0.23)$
Mixing Resolutions	$R_H = 5, (1920 \times 1080)$ $R_L = 4, (1600 \times 900)$	$R_H = 5, (1920 \times 1080)$ $R_L = 4, (1600 \times 900)$	$R_H = 5, (1920 \times 1080)$ $R_L = 1, (640 \times 360)$
Bandwidth Reduction	15.6%	18.7%	41.2%

CDF distribution of participants that accept the quality difference between tiled video (5, R_L) and tiled video (5, 5)



Average Just Unacceptable Difference threshold with 95% Confidence Interval value

	 (Dense Motion)	 (Medium Motion)	 (Low Motion)
Average JUD	$2.03\ (\pm 0.31)$	$1.76 (\pm 0.27)$	$0\ (0)$
Mixing Resolutions	$R_H = 5, (1920 \times 1080)$ $R_L = 3, (1280 \times 720)$	$R_H = 5, (1920 \times 1080)$ $R_L = 2, (960 \times 540)$	$R_H = 5, (1920 \times 1080)$ $R_L = 1, (640 \times 360)$
Bandwidth Reduction	24.7%	34.5%	41.2%

Impact of tile size

	 (Dense Motion)	 (Medium Motion)	 (Low Motion)
Average JND (16x9 tiles)	3.68 ($\pm$0.52)	3.25($\pm$0.47)	0.81 ($\pm$0.23)
Average JND (80x45 tiles)	3.30 ($\pm$0.48)	3.04($\pm$0.44)	0.76 (0.20)
Average JUD (16x9 tiles)	2.03 ($\pm$0.31)	1.76($\pm$0.27)	0 (0)
Average JUD (80x45 tiles)	1.76($\pm$0.29)	1.63($\pm$0.25)	0 (0)

Conclusion & Future work

- **Save bandwidth consumption by mixing tiles with different resolutions *without noticeable* quality degradation or *with noticeable but still acceptable* quality degradation**

- Intelligently determine the tile resolution based on content or user interests

- Optimally determine resolutions of each tile for each user, given the resource constraints