Motion Estimation and Compensation of H.263 Video Via Foveation

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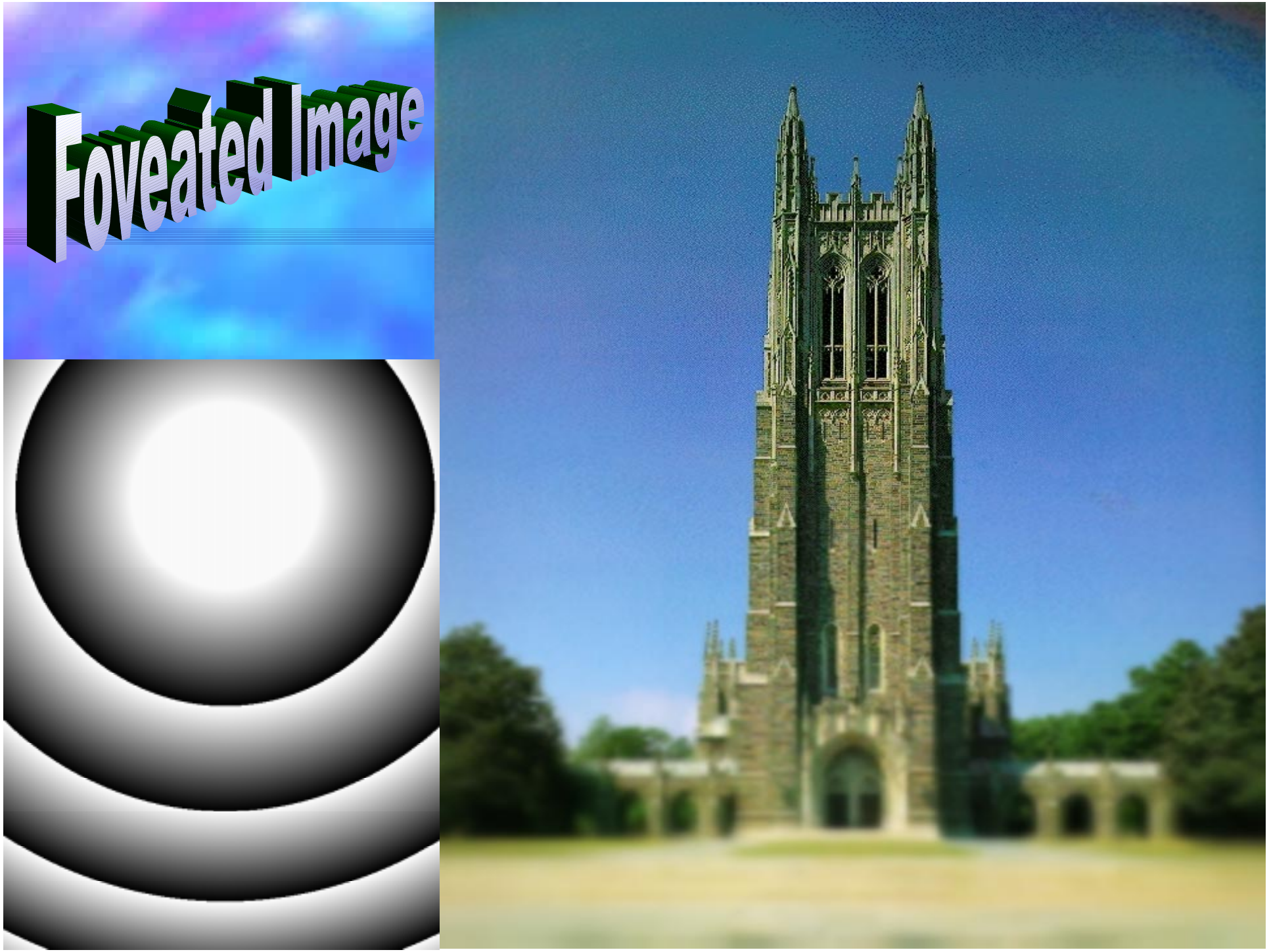
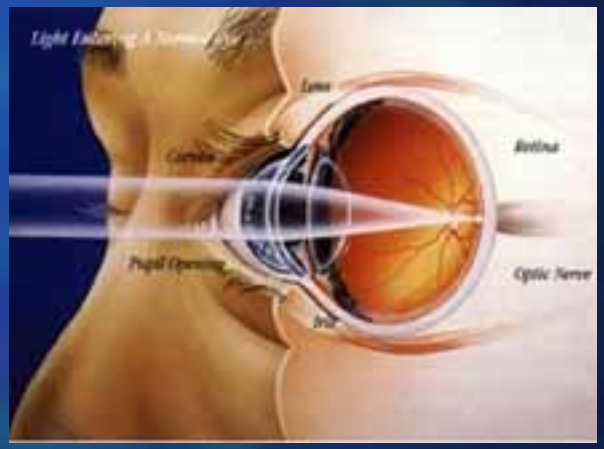
What do we see


Foveated Image

Objective

- Reduce bit-rate of H.263 video via foveation
  - Human visual system (HVS) samples non-uniformly
  - Point of fixation is known as *foveation point*
  - Foveation point may be
    - Fixed (easy to tackle)
    - Moving (harder to deal with)
- Applications
  - Image compression
  - Video compression
  - Thinwire visualization
    - Servers having large databases, *fovea-first* transmission



Previous Method #1
[Foveation as preprocessing]

- Via spatial filtering
  - Pyramidal decomposition
    [Lee and Bovik, 1998]
  - Using Wavelets
    [Chang and Yap, 1997]
  - Discard redundant samples
- Advantages
  - No change in decoder
- Disadvantages
  - Extra overhead

Previous Method #2
[DCT domain foveation]

- Via quantization of DCT
  [Tsumura, Endo, Miyake, 1996]
  - Quality factor
    - 100% around fovea
    - Lower near periphery
- Advantages
  - No overhead
- Disadvantages
  - Has block artifacts
  - Difficult to find quality factor matching HVS

Previous Method #3
[Foveation of motion vectors]

- Hierarchical block matching algorithm

  [Lee and Bovik, 1999]

  - Defined foveal mean squared error (FMSE)
  - Blocks matched to reduce FMSE
- Disadvantages
  - Needs pyramidal decomposition (more memory)

Previous Method #3
[Foveation of motion vectors]

- Motion blurring

  [Bonmassar and Schwartz, 2000]

  - Eye is an "open shutter"
  - Nearby objects have more velocity
  - Motion blurred for nearby objects away from fovea

- Disadvantages
  - Needs log transform and chirp transform

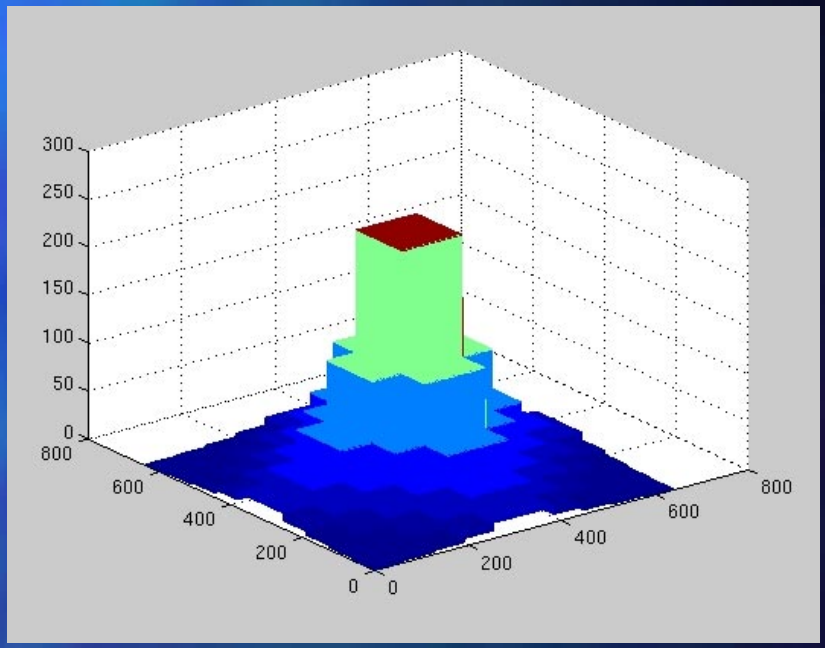
Comparison

- Figures of merit evaluating compression system
  - Compression
  - Complexity
  - Quality
- Compression figures comparable

Method	Method #1	Method #2	Method #3
Complexity	$O(N^2)$	O(1)	$O(N \log N)$
Quality	Good	Artifacts	Good

Proposed Method

- Use slice-structured mode in H.263
- Fixed foveation point
  - Allocate bits inversely proportional to distance
  - Have non-uniform frame update rate for slices
- Moving foveation point
  - Update background if new foveation point is retained



Slice-structured mode in H.263

Conclusions

- Video quality
  - Perceptually lossless video compression systems can be designed via foveation
  - At same bit rate, foveated video has higher subjective quality
  - For same subjective quality, foveated video has lower bit rate
- Fovea-first transmission
  - For unacceptable blur at receiver end, image quality can be increased via fovea-first transmission
  - Possibly useful for large image databases