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Image Segmentation for Improved Lossless Screen Content Compression

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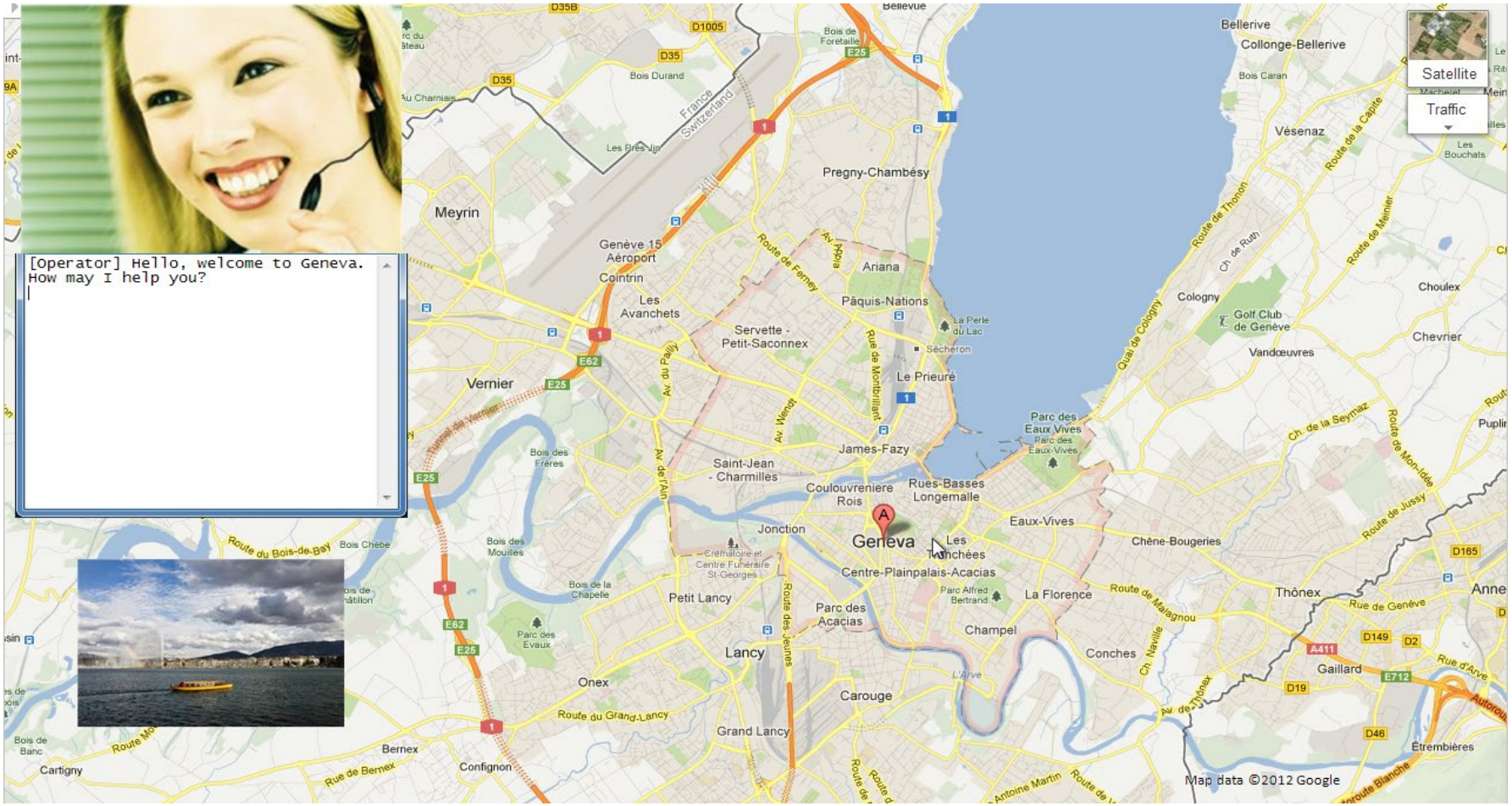
Contents

Introduction

- What are SCI's?
- SCIs comprise of synthetic and natural content (Compound)
- Synthetic – limited colours and repeating patterns
- Natural – many colours and random patterns
- Segmentation algorithm that identifies natural regions
- Two step processing of modelling and coding is performed

Introduction



Screen Content Image [6]

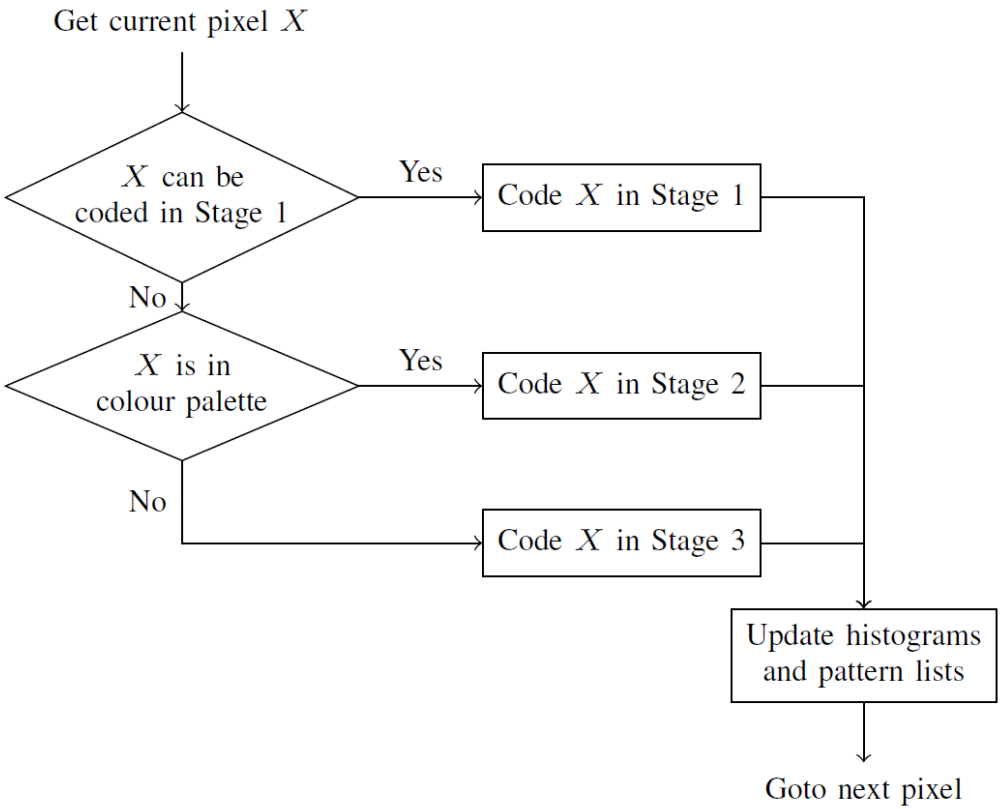
Soft Context Formation (SCF)

- SCF is the most recent and successful approach for lossless coding of SCI
- Probability distribution model, fully adaptive arithmetic coding
- Pattern list (6 neighbours) and global colour palette.
- A pattern comprises a template with the colours of the closest six causal neighbours with respect to the current pixel position.
- Global colour palette contains all seen colours and their counts.
- Pixel is coding in one of three stages.

X – Current pixel to encode
X'– already encoded pixel

A, B, C, D, E, F – Neighbours

Soft Context Formation (SCF)

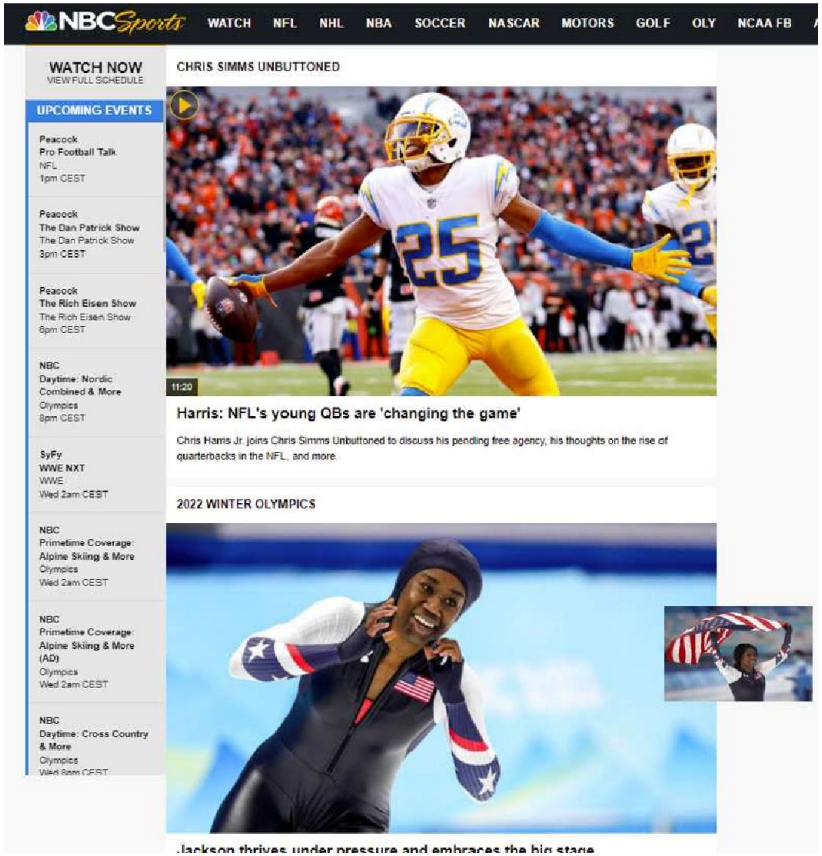


Coding Stages [3][4]

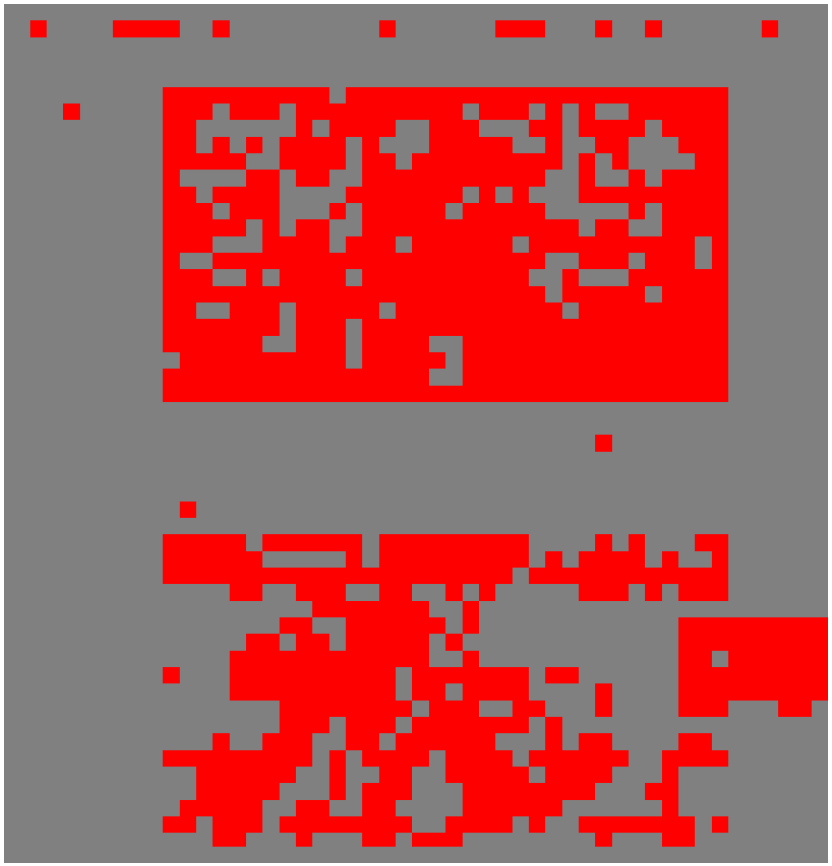
Segmentation – Introduction

- Compound SCIs make estimation of proper distributions difficult.
- Segmentation algorithm to detect and extract natural regions.
- Synthetic background and natural segments are coded separately.

Segmentation – Block Classification

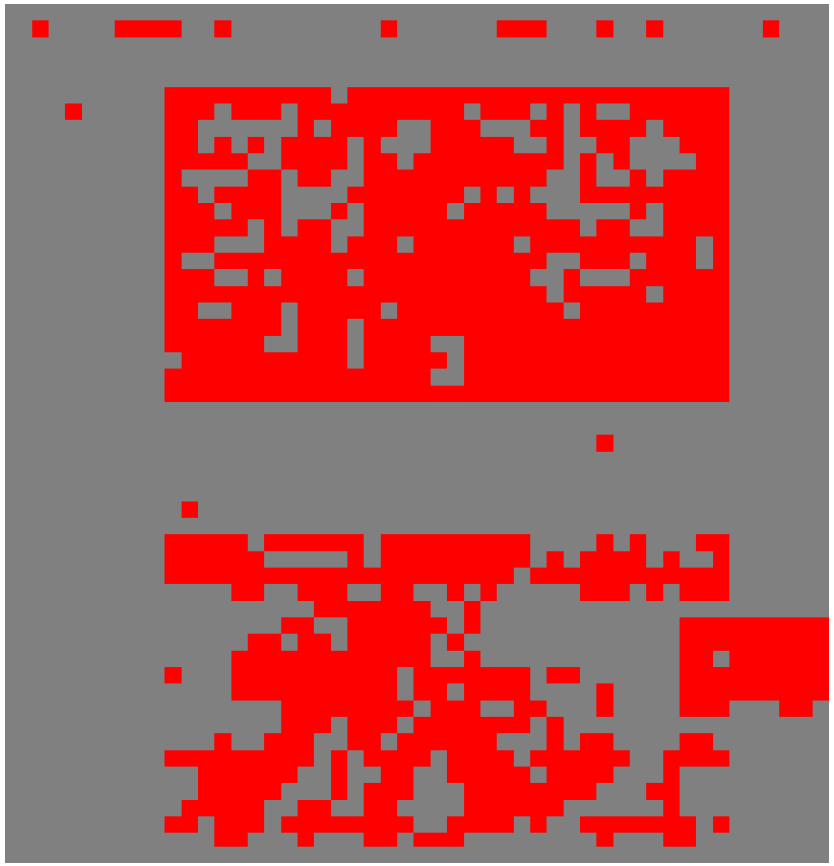


(I) Original image

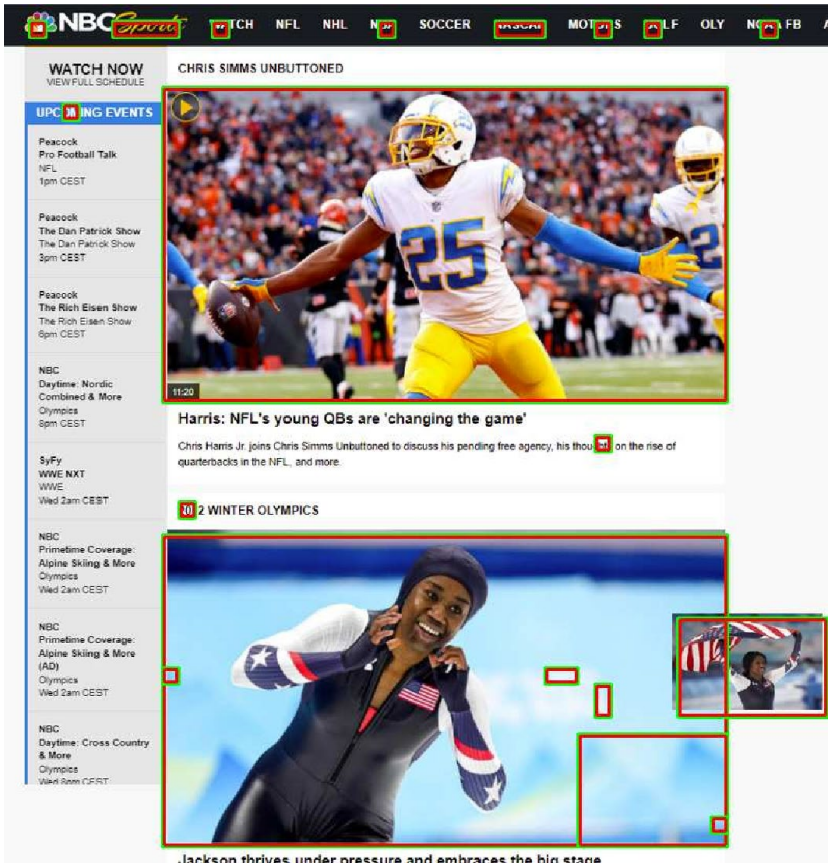


(II) Block classification

Segmentation – Initial bounding boxes

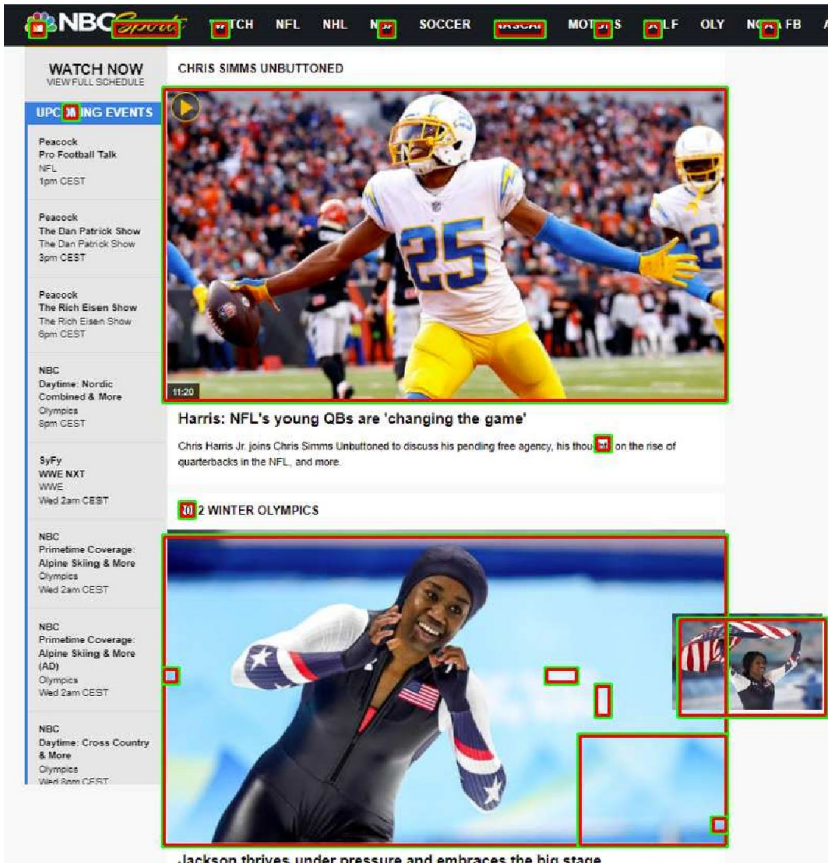


Block classification

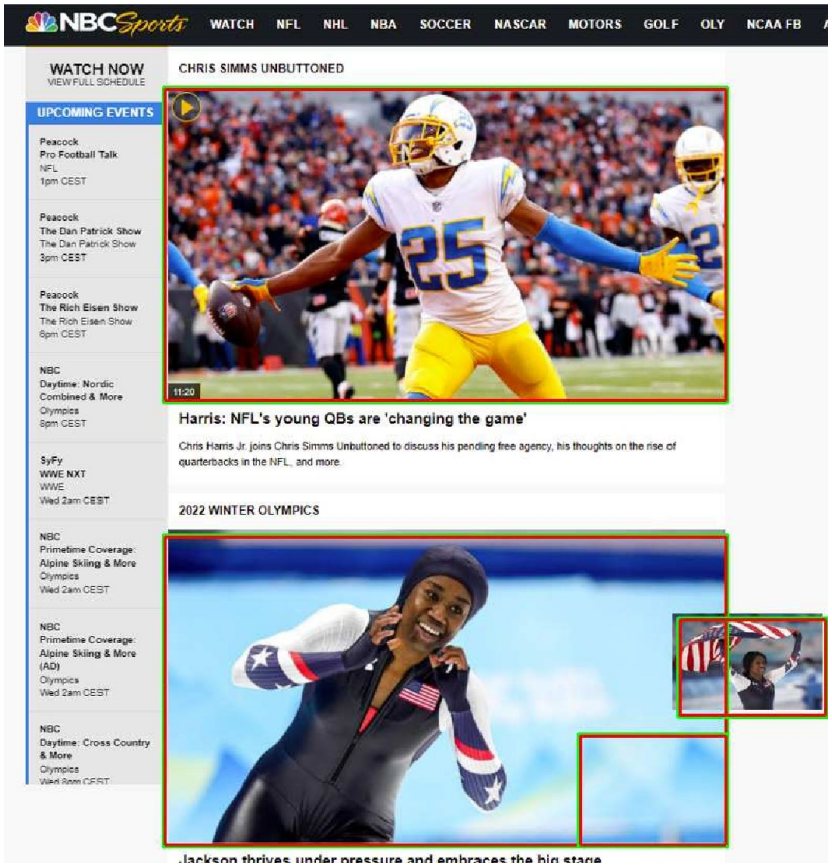


Inital bounding boxs

Segmentation – Area threshold

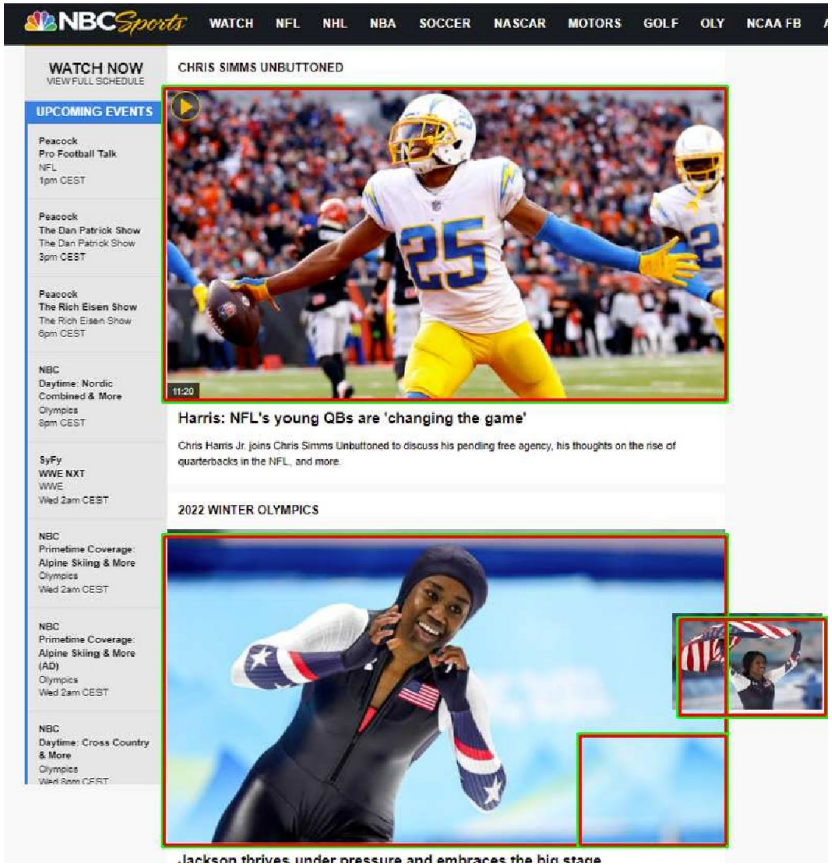


(II) Block classification

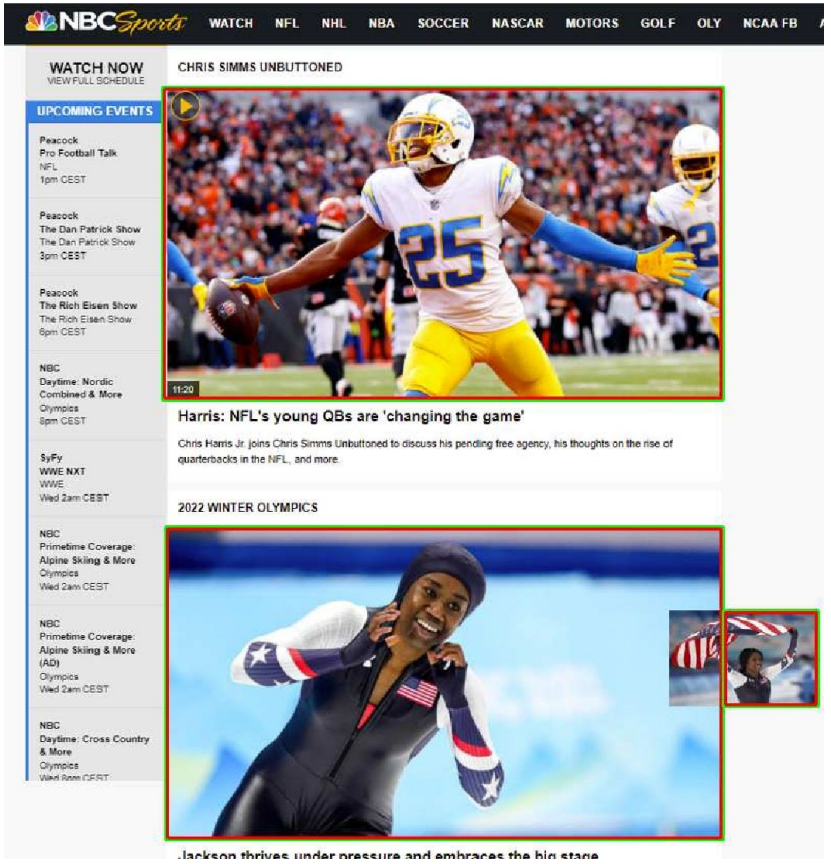


(III) Area threshold

Segmentation – Bounding box refinements (Overlap)

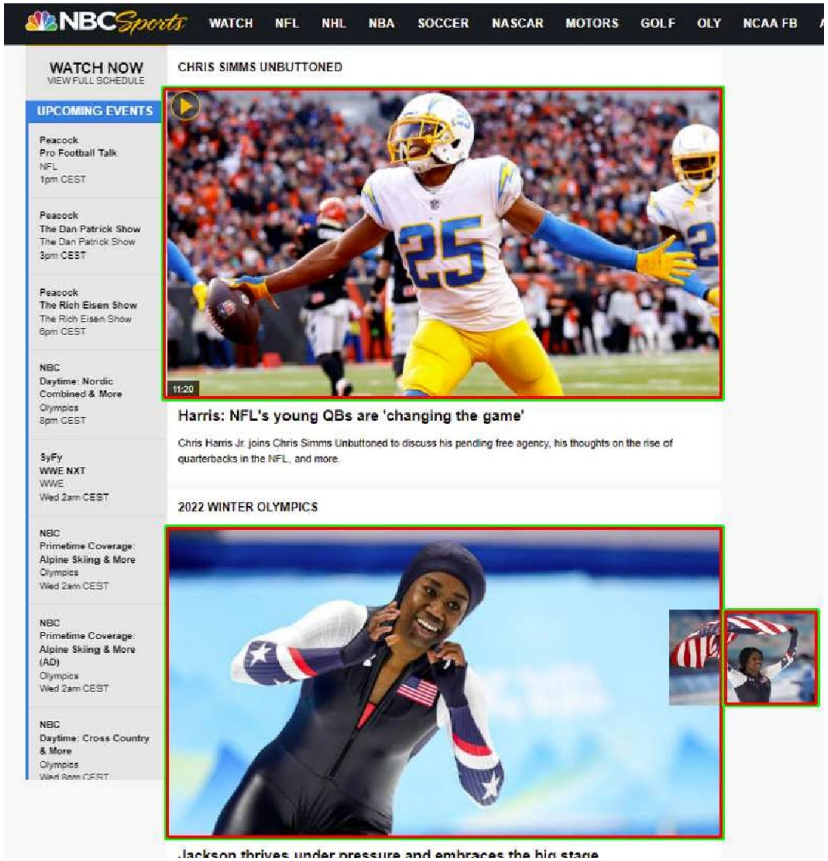


(III) Area threshold



(IVa) Remove overlap

Segmentation – Bounding box refinements



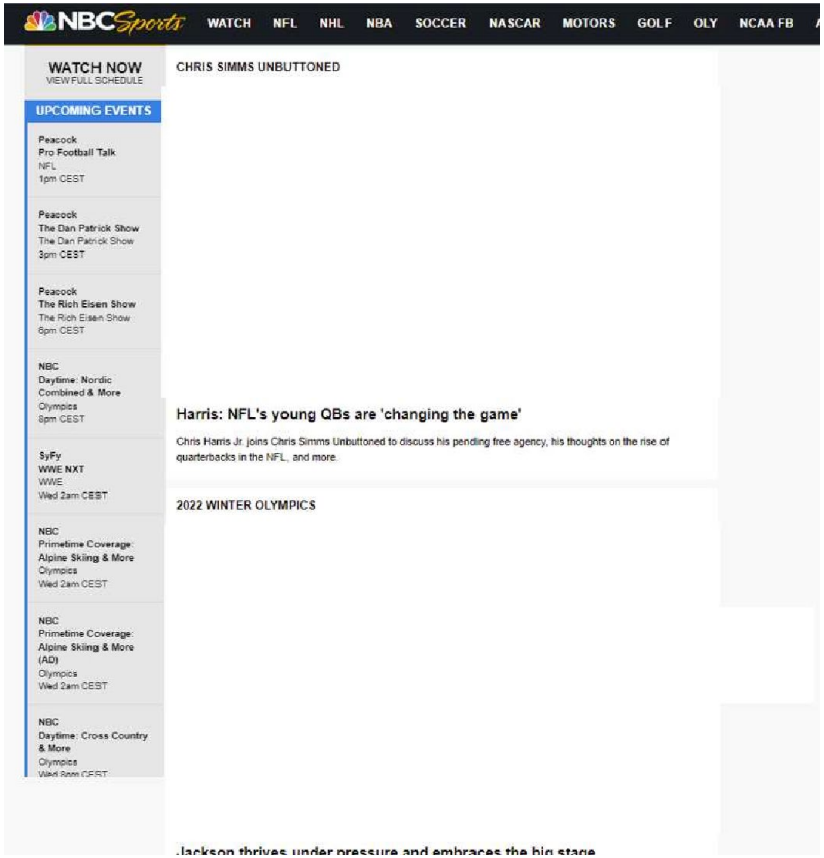
(IVb) Border refinement

Before

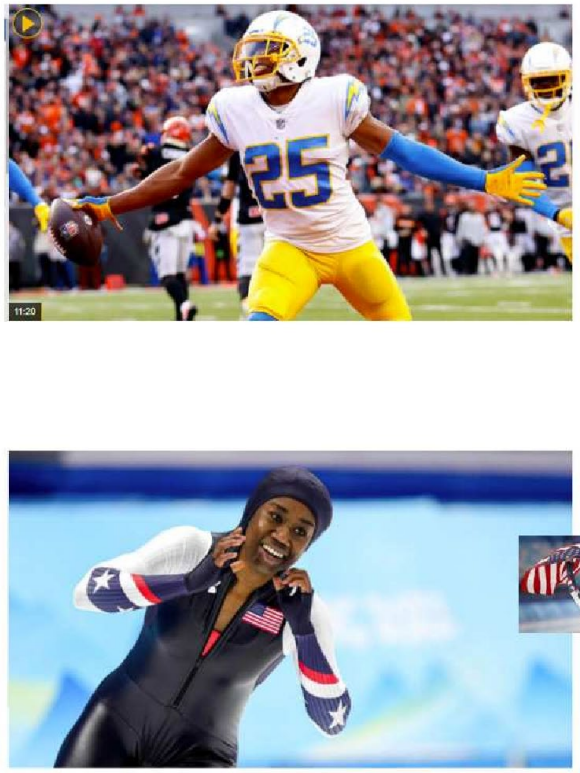
After

(IVc) Enlarged parts

Segmentation – Synthetic and Natural Regions



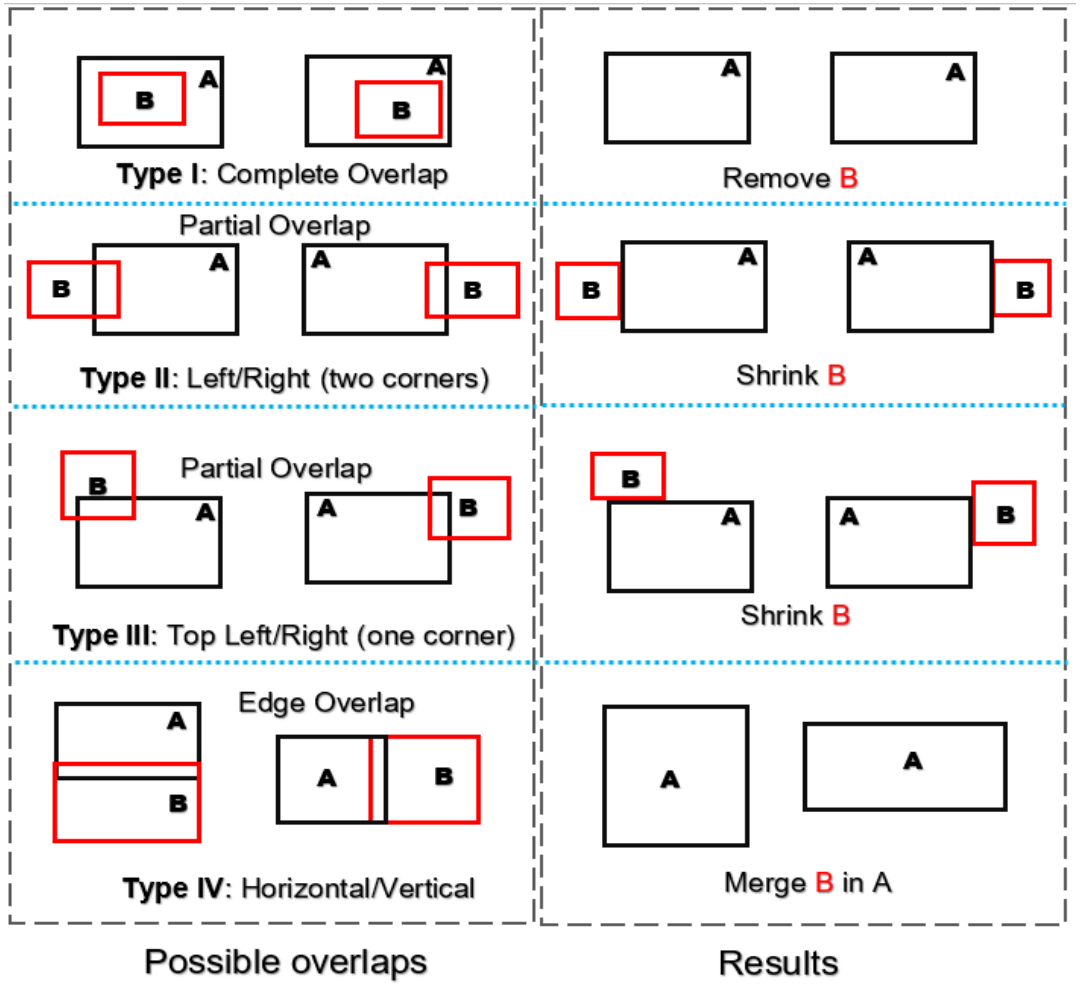
(V) Background image (Synthetic)



(V) Segment image (Natural)

Segmentation – Overlap removal

- Always retains the larger bounding box.
- Remove “**B**“ in case of complete overlap.
- Shrink “**B**“ in case of partial overlap.
- Merge “**B**“ in case of edge overlap.
- Avoid unecessary transmission of bounding boxes.



Segmentation – Encoding/Decoding

- Two step processing of modelling and coding is performed.
- Atleast one natural segment should be found.
- The decoder is made aware of the following:
  - **Segmentation flag is signelled (1 bit)**
  - **Bounding box co-ordinates are transmitted (40 bits\bounding box)**
  - **Top colour is transmitted (26 bits)**
- Background image and segment image are encoded/decoded separately.
- After decoding, the natural segments are stitched back into the background image.

Evalutation

- Proposed SCF version is compared to HEVC and previous version of SCF.
- Investigated a collection of 306 (6 testsets) SCI's.
- The proposed version identifies 76 images with synthetic background and at least one natural segments
- The other images are fully natural or fully synthetic or natural background images with synthetic segments
- Compared to HEVC, previous SCF version achieves 11% bit-rate savings on average
- Segmentation approach marginally improves (0.4%) w.r.t previous SCF version
- Test sets are available at [5],[6],[7],[8],[9] and [10]

Evalutation

	No. of Images	HM-16.21 SCM-8.8 [1][2]	Previous SCF [3]	Proposed SCF
Entire set Percentage	306	45966722 bytes **111.01%**	41486484 bytes **100.19%**	41408200 bytes **100.00%**
Sub-set Percentage	76	20872931 bytes **107.03%**	19583094 bytes **100.42%**	19500950 bytes **100%**

Comparison of the compression performances of proposed method (SCF) with HEVC (HM-16.21+SCM-8.8) and previous version of SCF.

Conclusion

- Coding synthetic and natural regions separately helps in better estimation of probability models
- Segmentation approach - Proof of concept
- The current version only detects natural segments within synthetic background images
- In future work, we would like to extend our approach to segment synthetic regions from natural background images
- Aleast a third class should be considered representing rendered images that are computer generated but still contain a very high number of colours
- Extend the segmentation algorithm to deal with other shapes than rectangles\squares

References

- [1] G. J. Sullivan, J.-R. Ohm, W.-J. Han, and T. Wiegand, “Overview of the high efficiency video coding (HEVC) standard,” IEEE Trans. on Circuits and Systems for Video Technology, vol. 22, no. 12, pp. 1649–1668, 2012.
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Thank you

Questions?


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