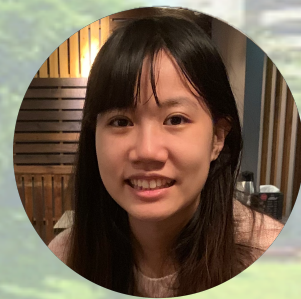




國立交通大學
National Chiao Tung University

INVERSE HALFTONE COLORIZATION: MAKING HALFTONE PRINTS COLOR PHOTOS



Yu-Ting Yen



Chia-Chi Cheng



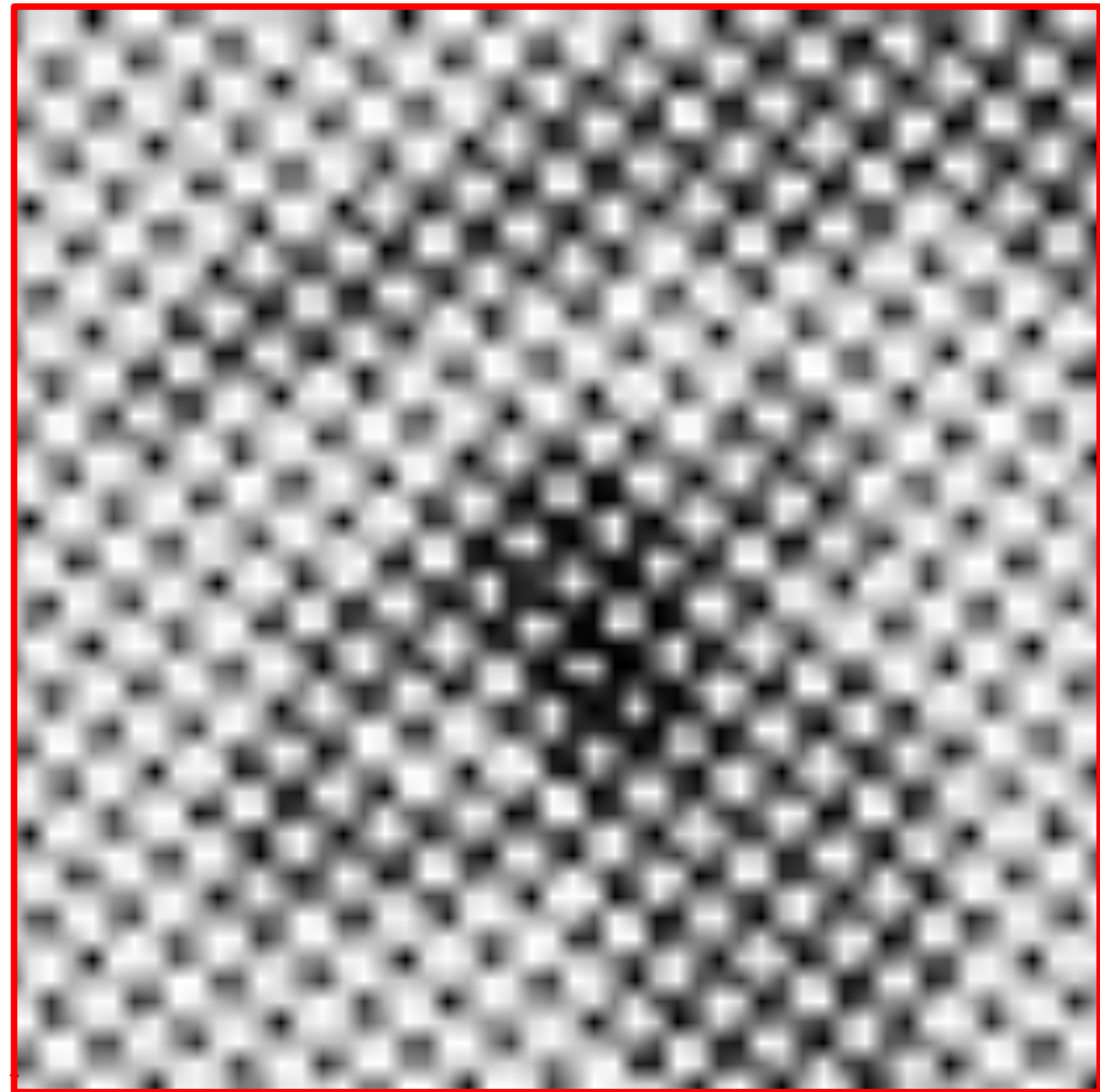
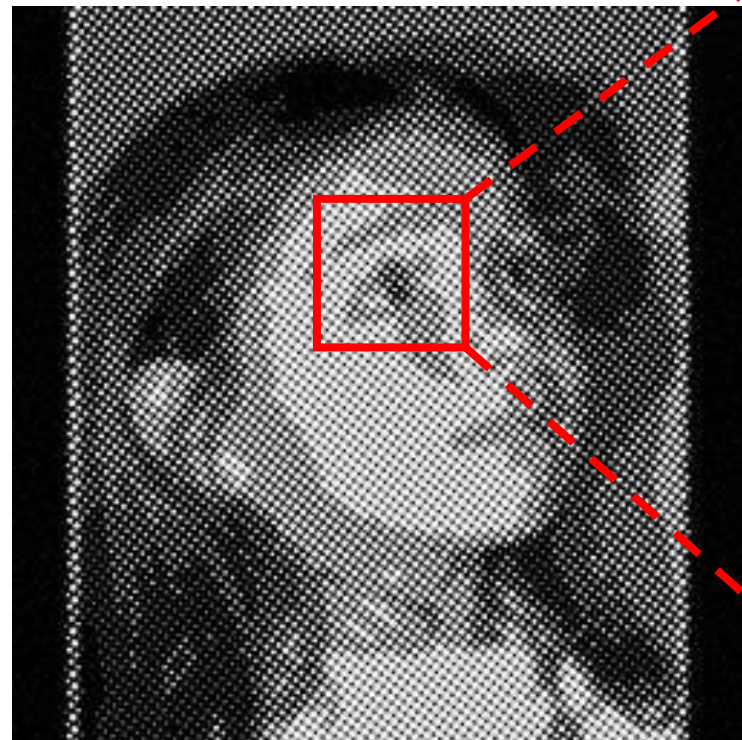
Wei-Chen Chiu

Enriched Vision Applications
Laboratory



Introduction: Halftone Print

black and white
halftone print



Goal: Making Halftone Prints Color Photos

black and white
halftone print

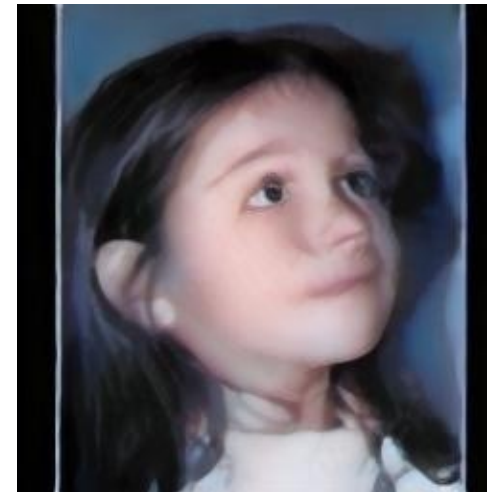


Our goal

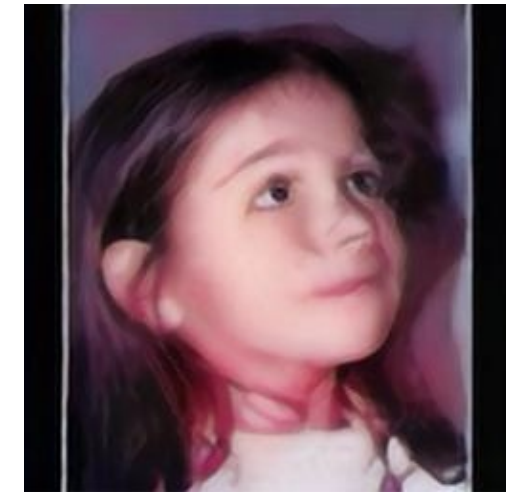


random colorization

color photo



color photo

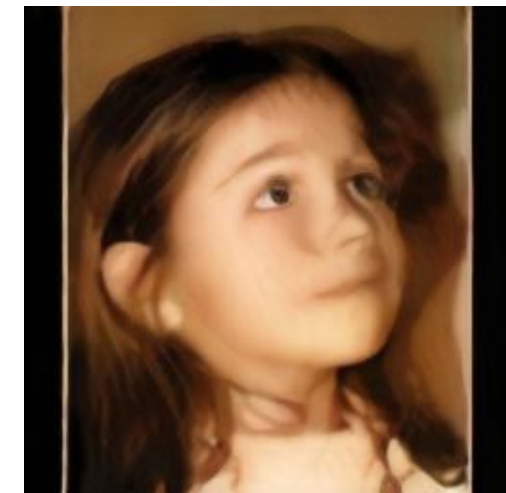


exemplar-based colorization

reference photo



color photo



Inverse Halftone Colorization

Inverse Halftone

halftone print



continuous-tone photo



grayscale photo



Colorization



color photo



Deshpande et al. [12]

We are the first of its kind to discuss such joint problem: inverse halftone & colorization

Inverse Halftone Colorization

Inverse Halftone

halftone print



continuous-tone photo



grayscale photo



Colorization



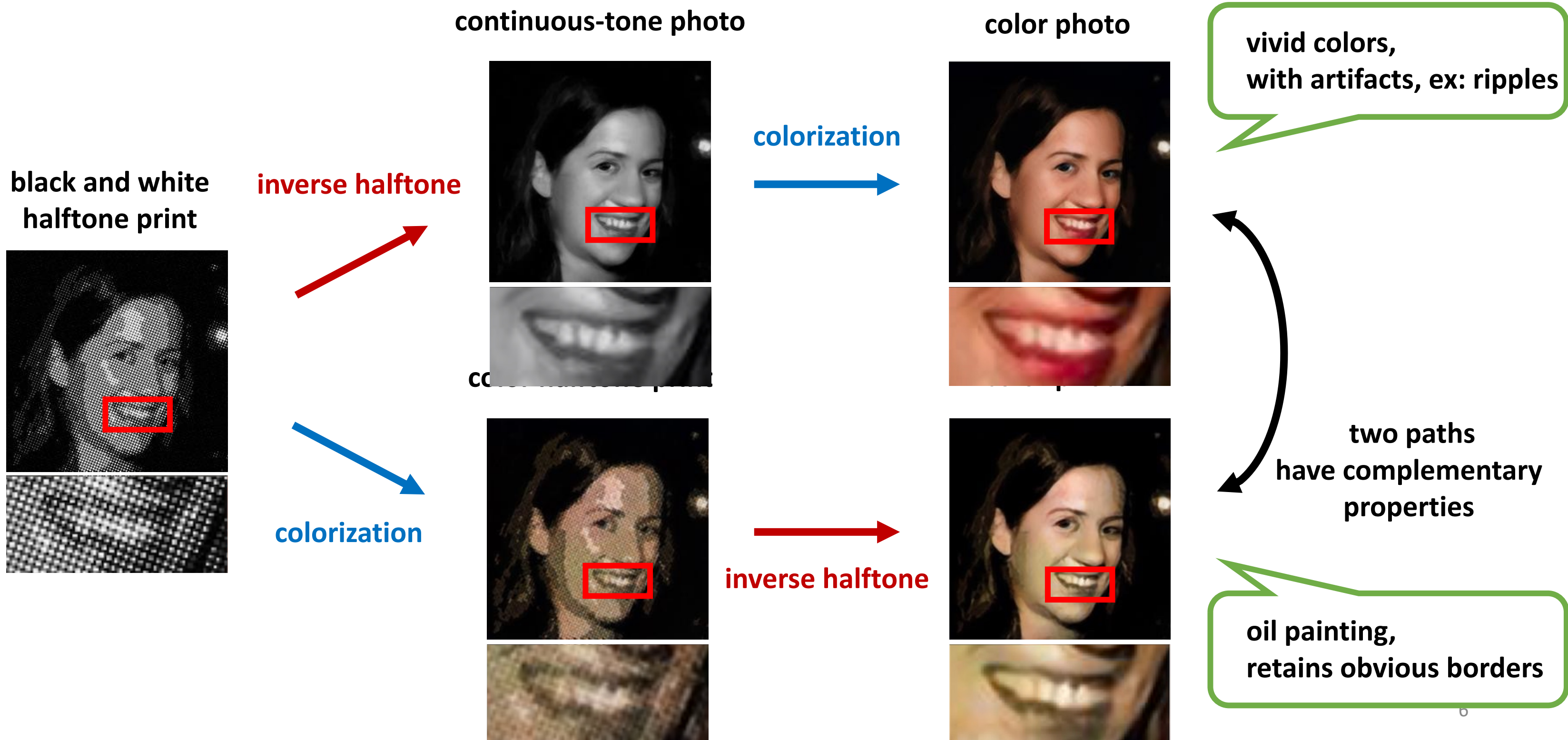
color photo



Deshpande et al. [12]

The generated color photo appears **uneven color** and **diffused contour**, which seems **unrealistic**.

Proposed Method: Key Idea

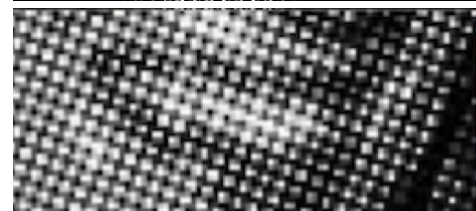


Proposed Method: Key Idea

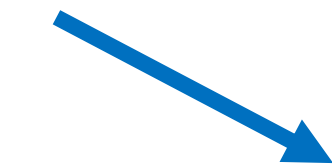
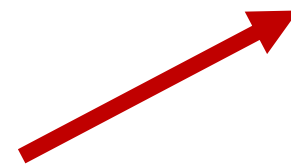
continuous-tone photo

color photo

black and white
halftone print



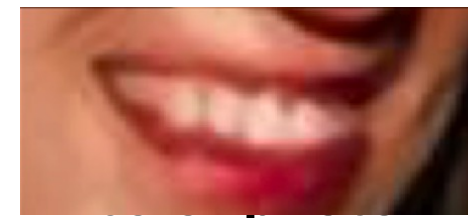
inverse halftone



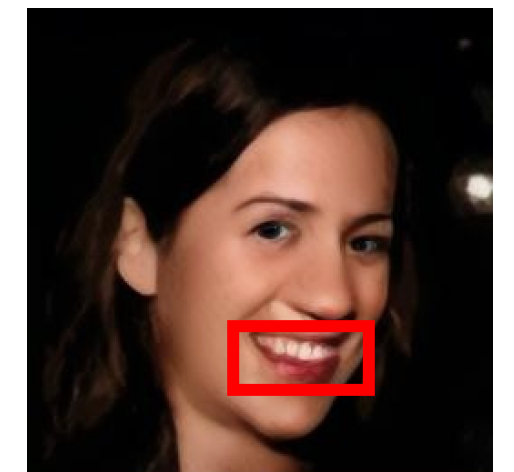
colorization



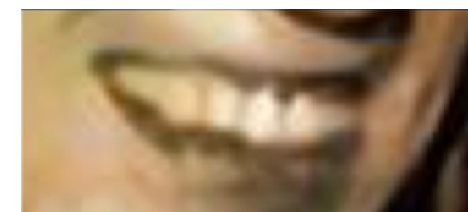
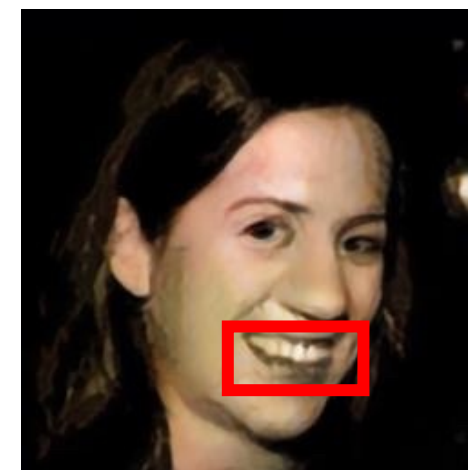
colorization



fuse result
from two paths

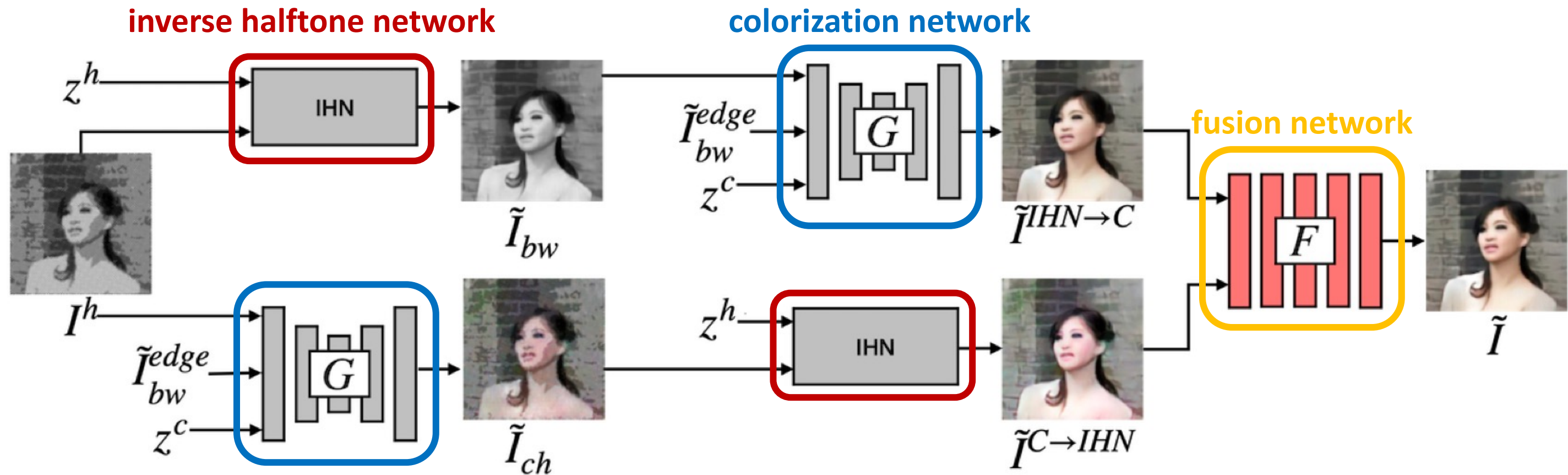


inverse halftone

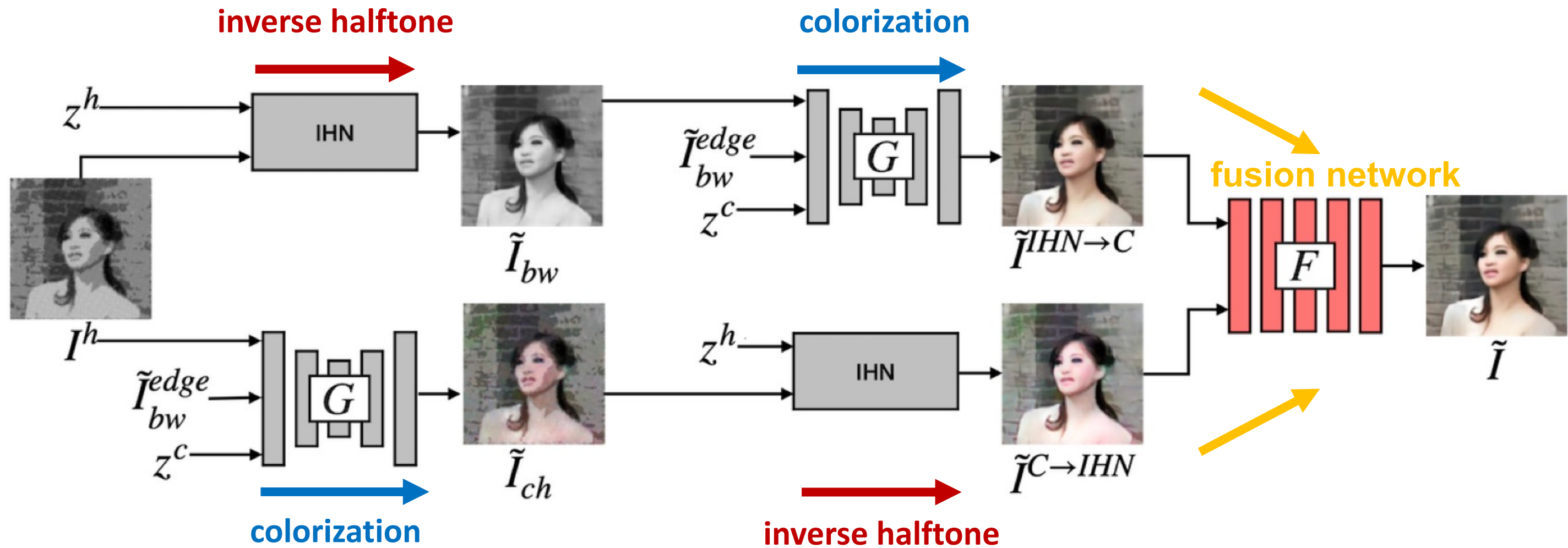


1. detail enhancement
2. artifact removal
3. color tone correction

Proposed Method: Overview



Proposed Method: Overview

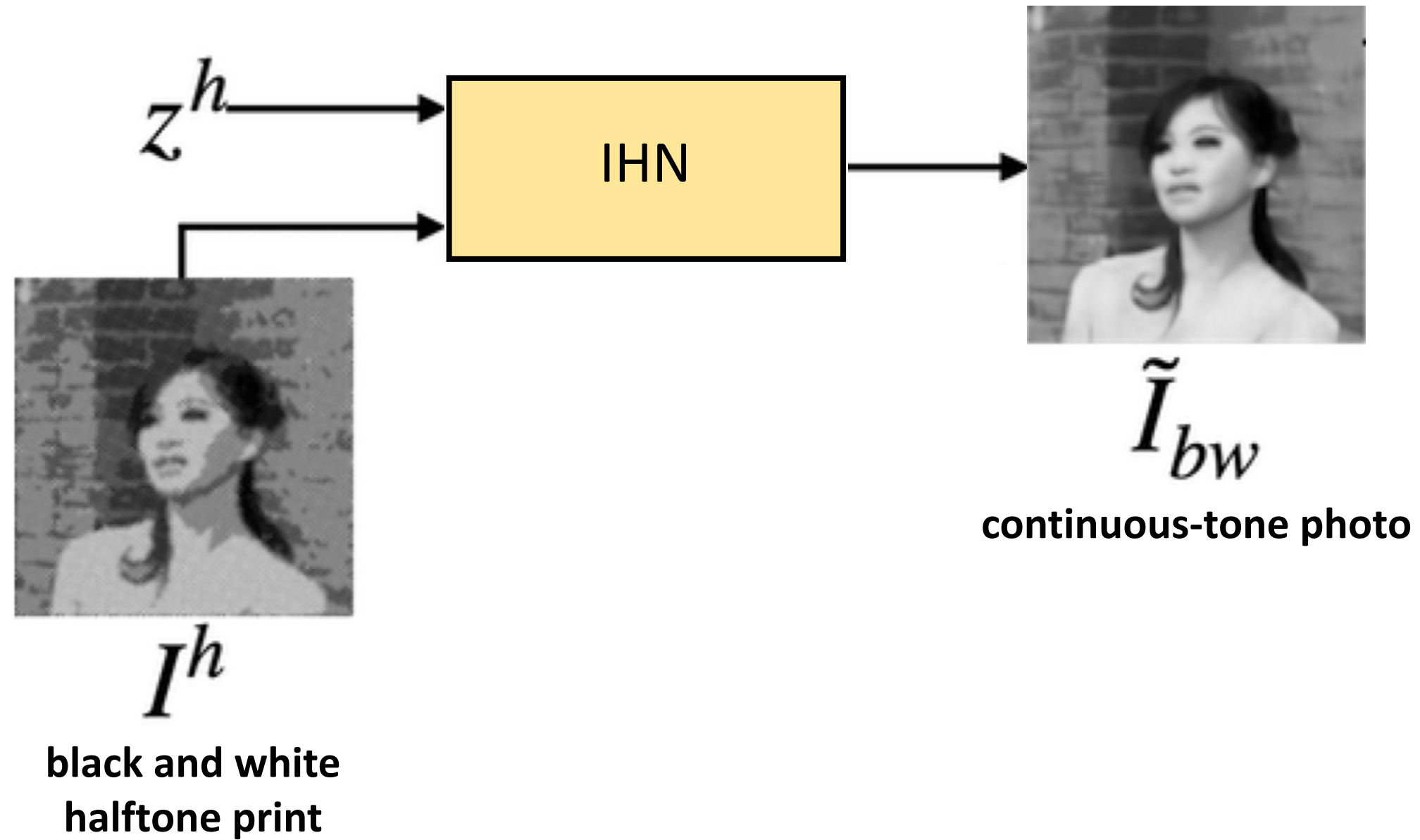


+

several novel objective functions :

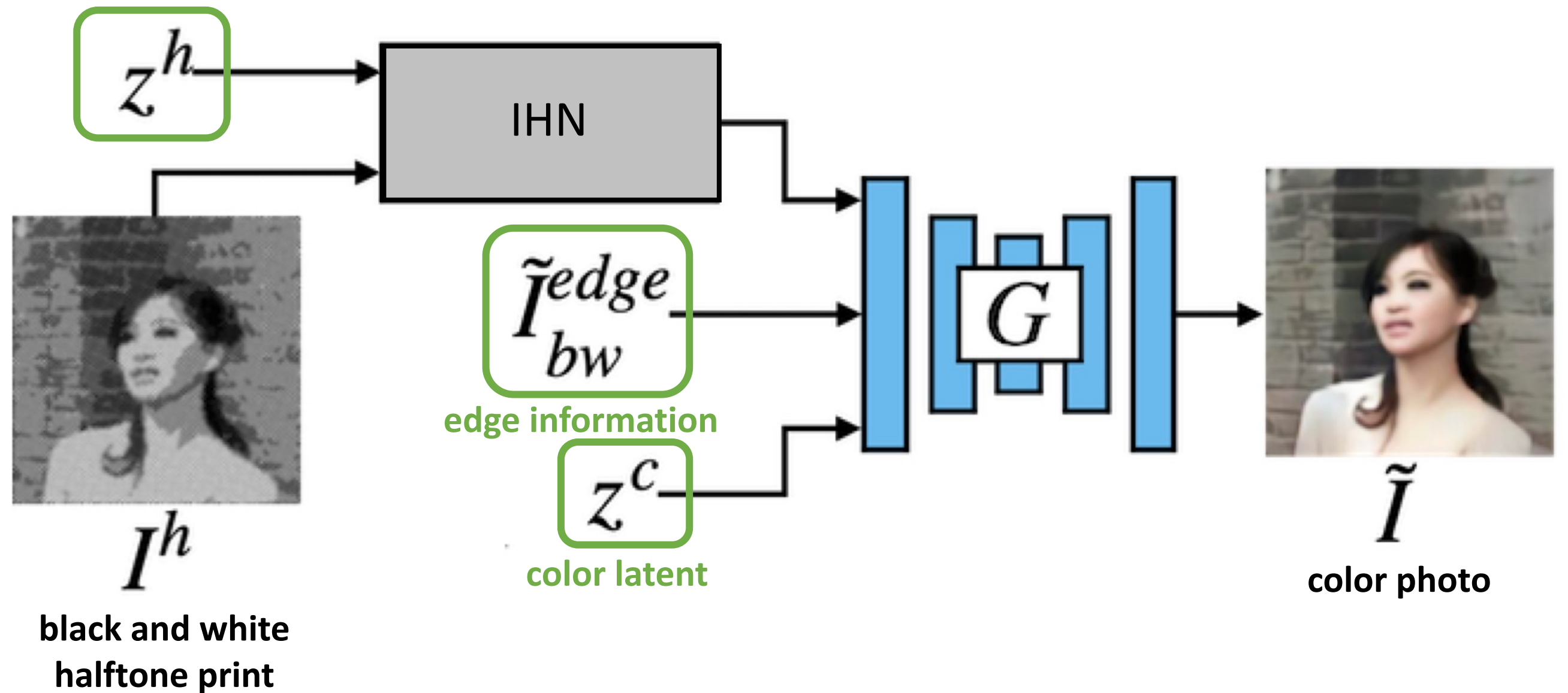
similarity loss, histogram loss, and feature-based mode-seeking loss

Architecture: Inverse Halftone Network (IHN)

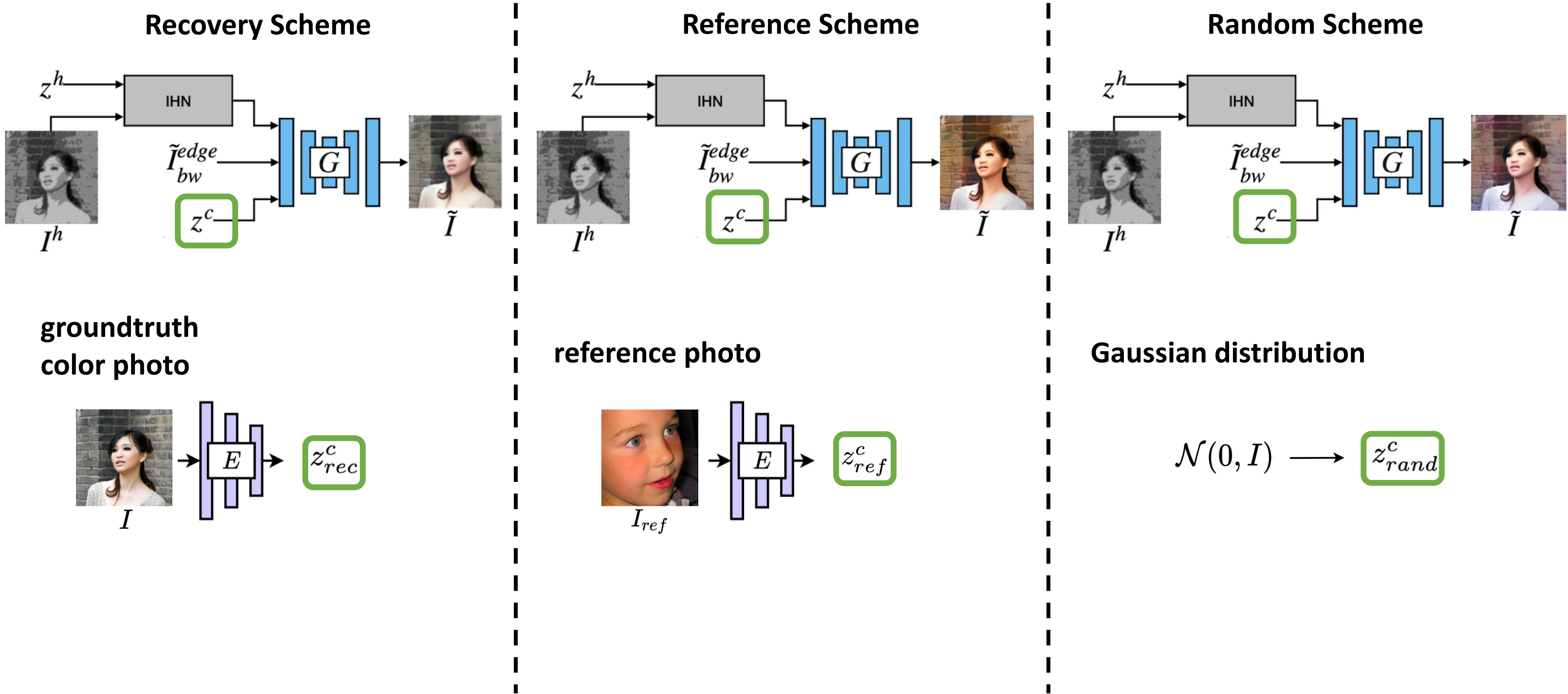


Architecture: Colorization Network

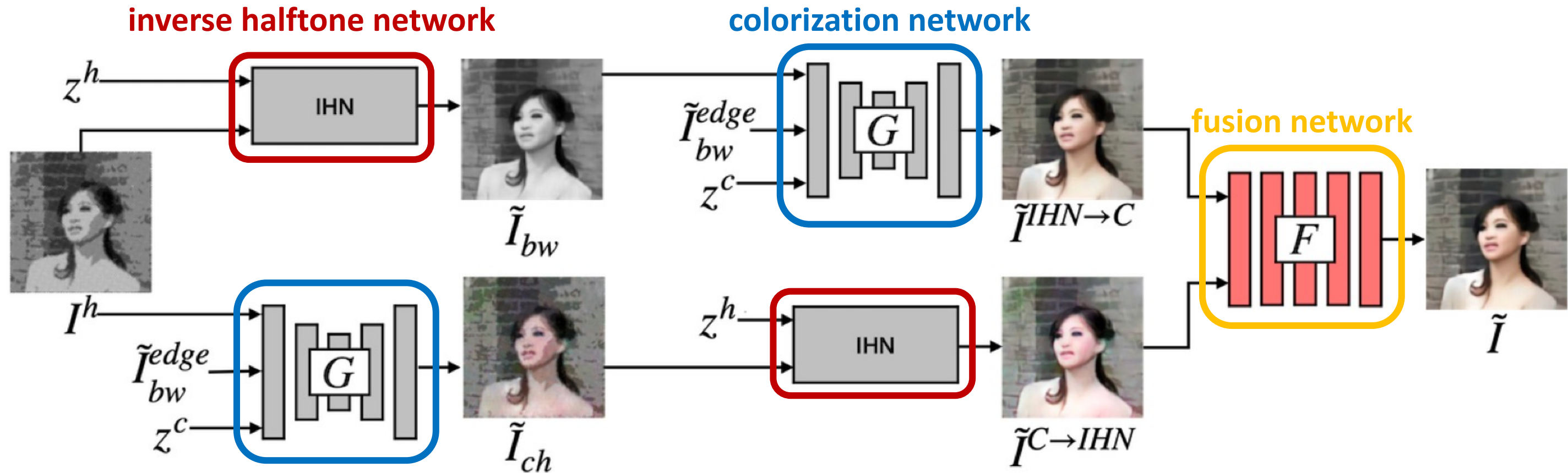
Help to synthesize missing information



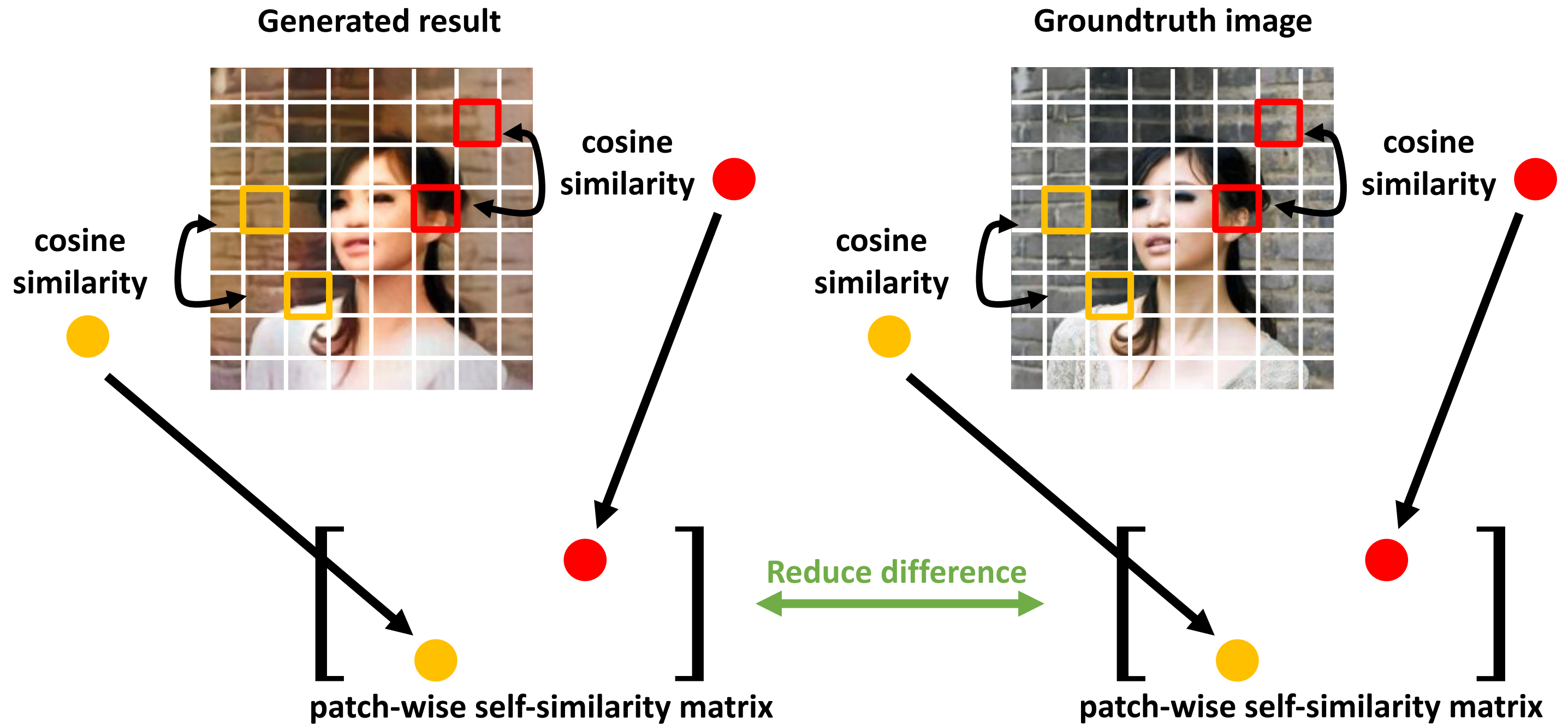
Architecture: Colorization Network



Architecture : Fusion Network



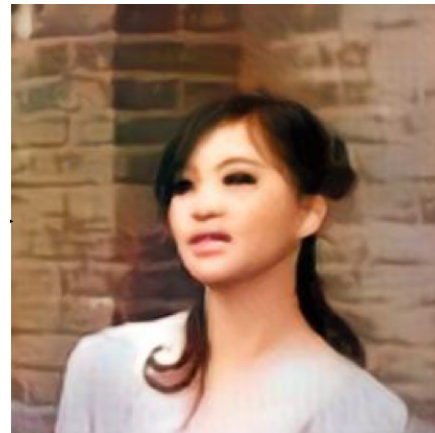
Novel Objective Functions : Similarity Loss



Encourages better coherence on the appearance for pixels of the same semantic class

Novel Objective Functions : Histogram Loss

Generated result



Reference image



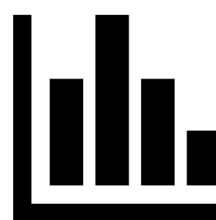
histogram estimator



histogram estimator



estimated histogram



estimated histogram

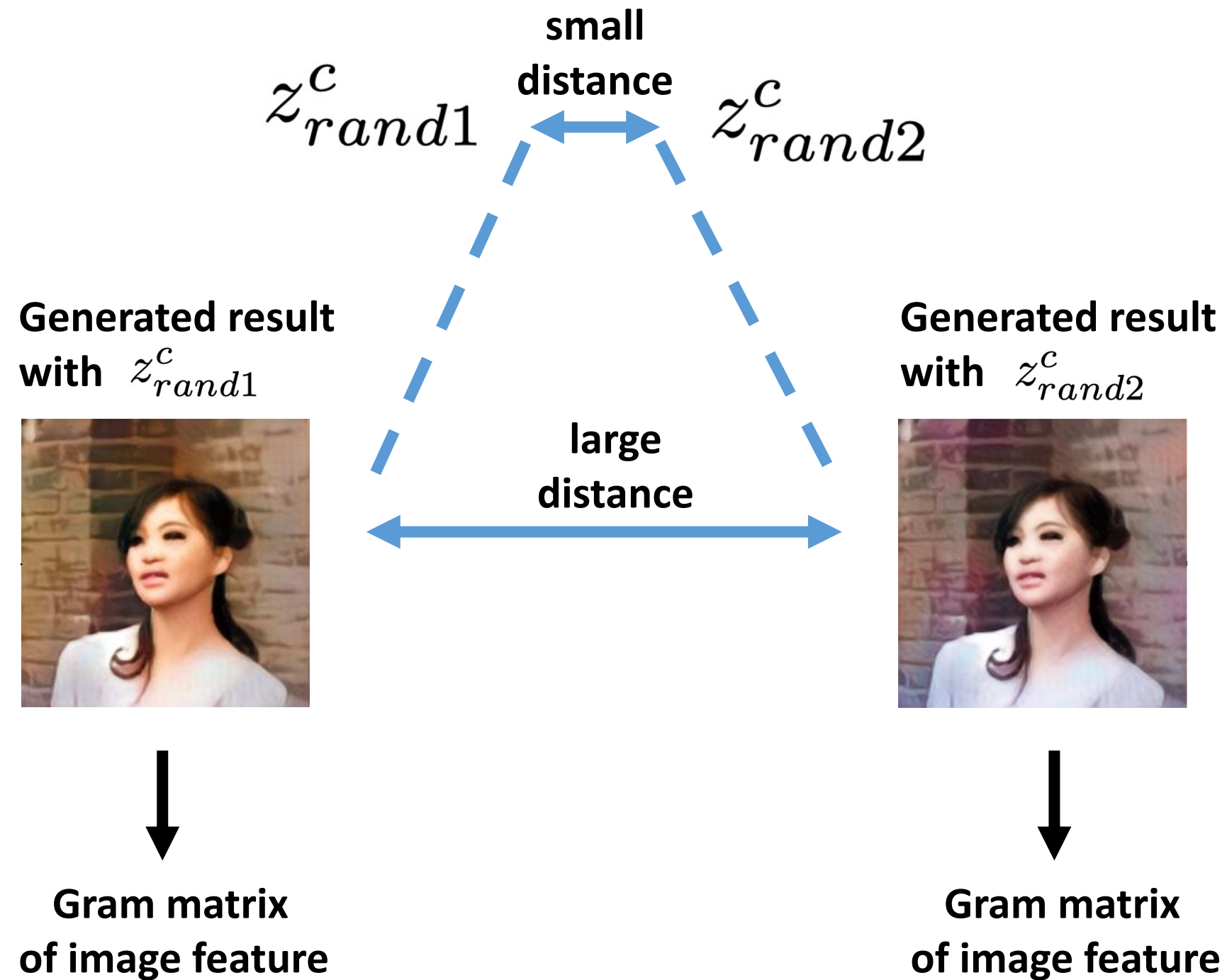


Reduce difference



Encourage the consistency between color distributions

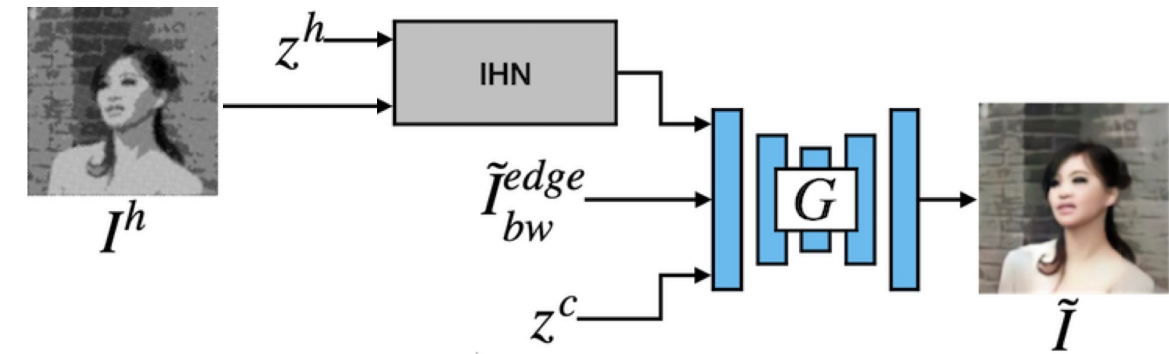
Novel Objective Functions : Feature-Based Mode-Seeking Loss



Encourage the color diversity to prevent mode collapse

Results

Colorization Scheme



halftone print

exemplar-based colorization

random colorization



I_h

I_{ref-1}

\tilde{I}_{ref-1}

I_{ref-2}

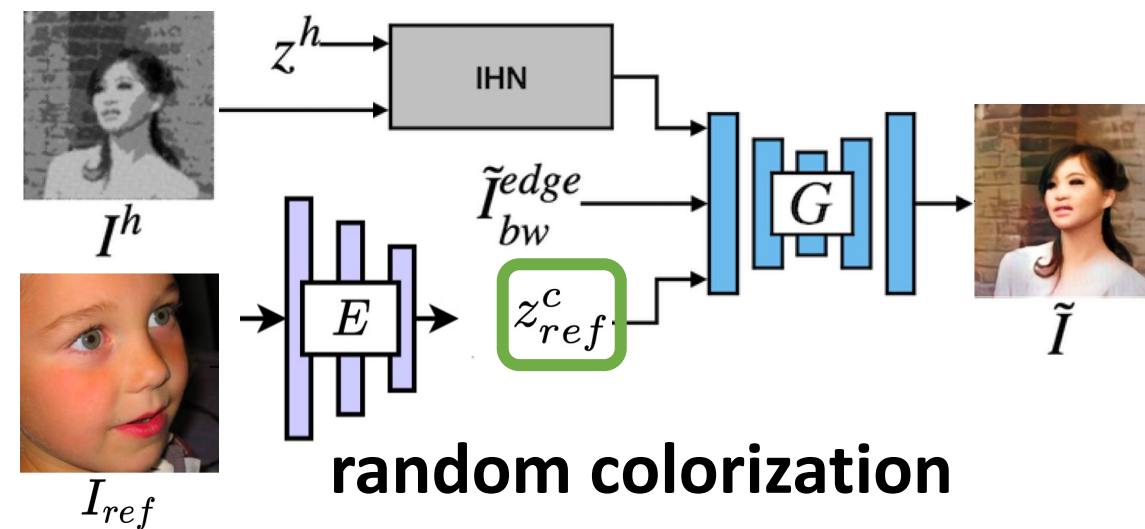
\tilde{I}_{ref-2}

\tilde{I}_{rand-1}

\tilde{I}_{rand-2}

Results

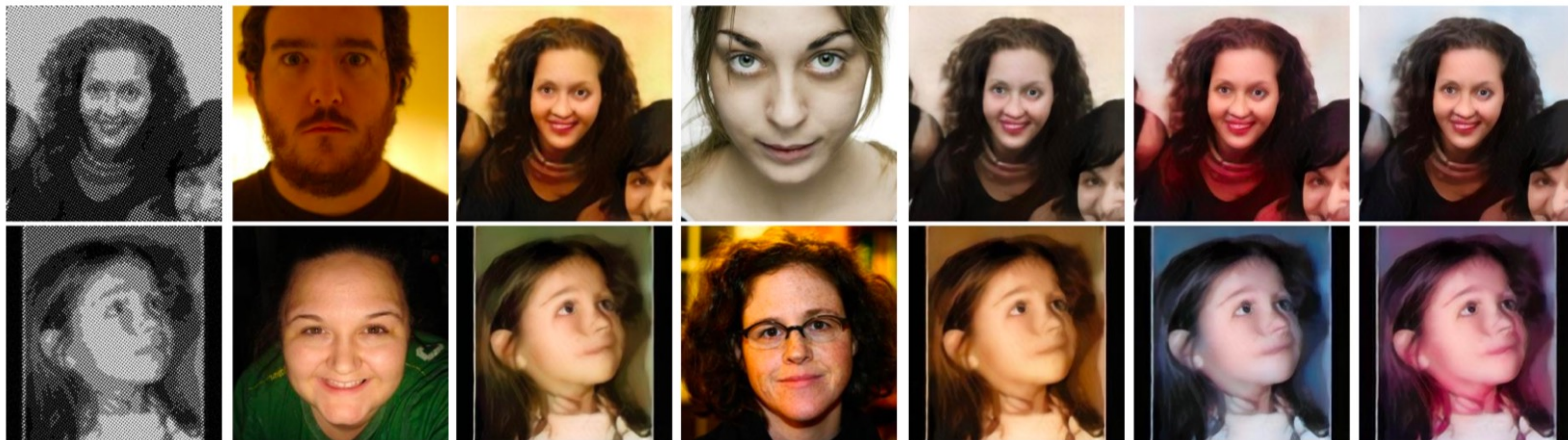
Reference Scheme



halftone print

exemplar-based colorization

random colorization



I_h

I_{ref-1}

\tilde{I}_{ref-1}

I_{ref-2}

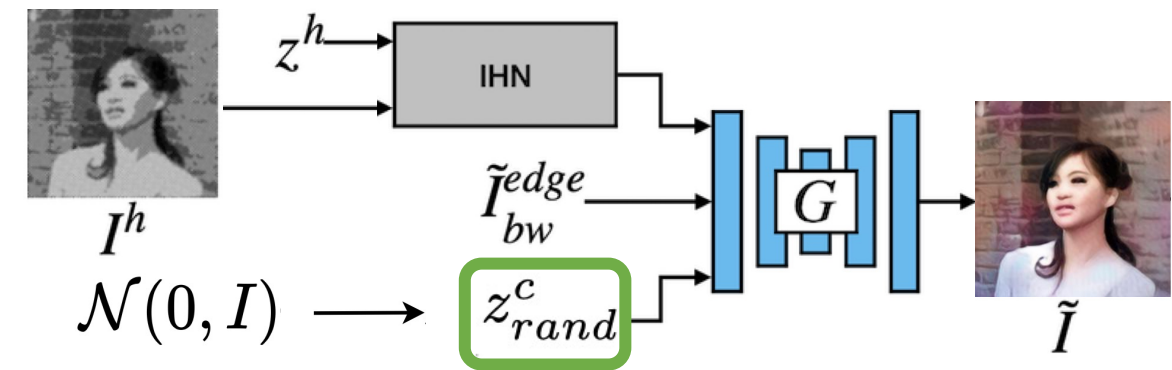
\tilde{I}_{ref-2}

\tilde{I}_{rand-1}

\tilde{I}_{rand-2}

Results

Random Scheme



halftone print

exemplar-based colorization

random colorization



I_h

I_{ref-1}

\tilde{I}_{ref-1}

I_{ref-2}

\tilde{I}_{ref-2}

\tilde{I}_{rand-1}

\tilde{I}_{rand-2}

Results

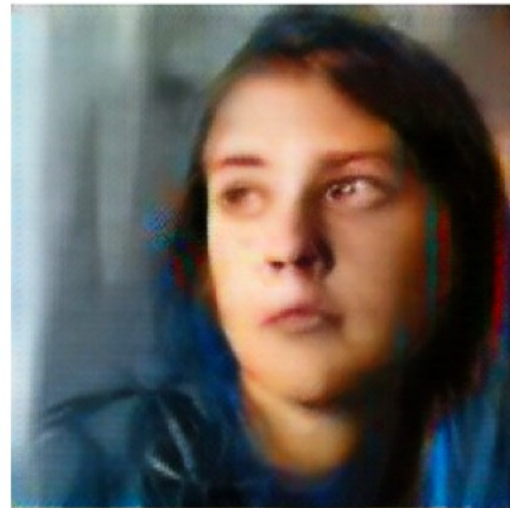
artifacts

scattered
color blocks

uneven color,
diffused contour

low diversity
with grayish color

diverse and realistic



I_h

$IHN+[9]$
BicycleGAN

$IHN+[11]$
Cao et al.

$IHN+[12]$
Deshpande et al.

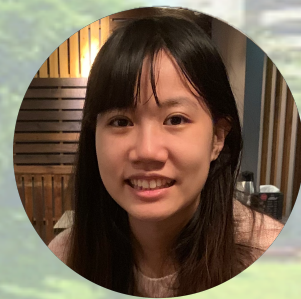
$IHN+[21]$
Lei et al.

Ours



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