

# Manga-Style Conversion of Natural Images via Adaptive Screentones

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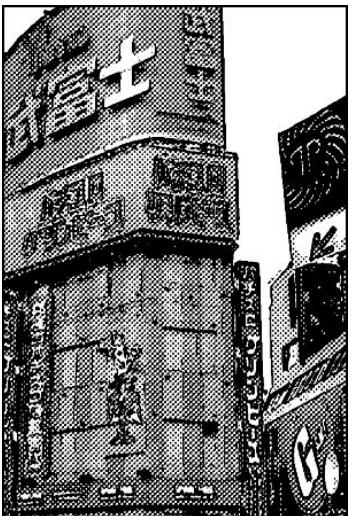
Team15: 謝至剛(R13922A03)、沈立程(R13922098)

# Motivation

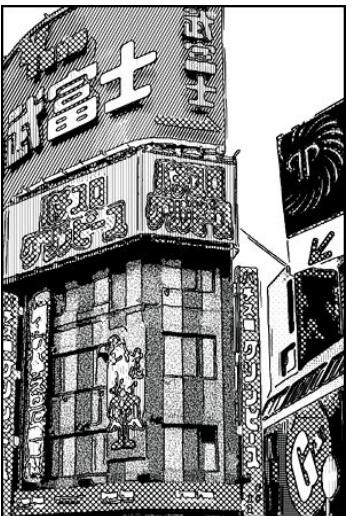
Can we perform halftoning with manga style artistic textures screentones?



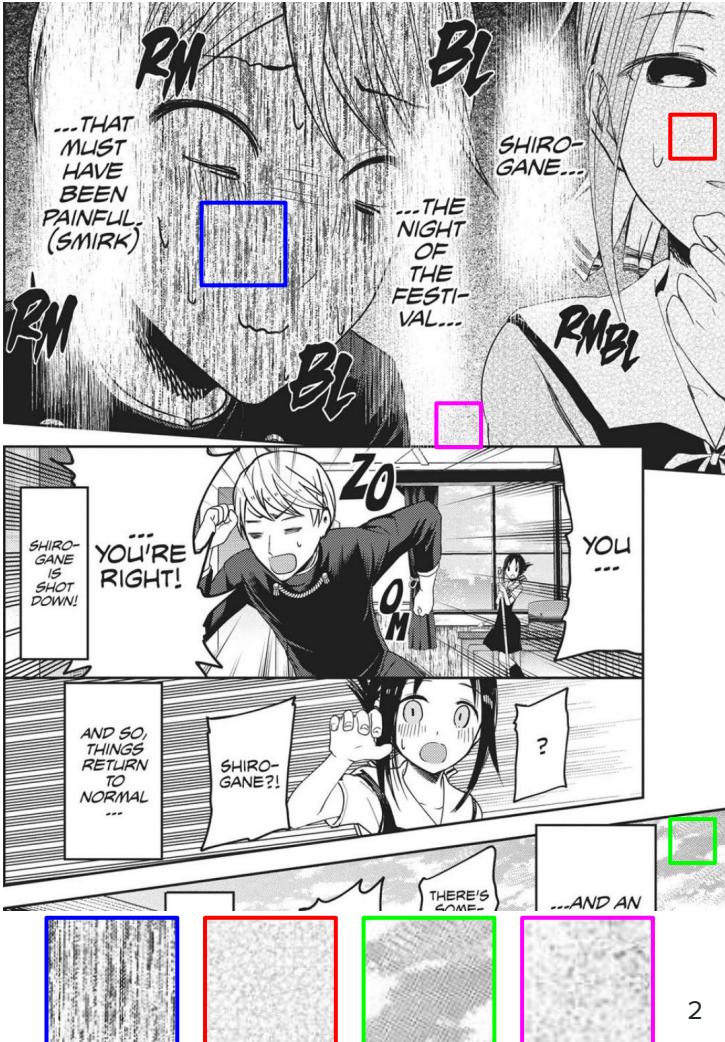
original image



halftoning image



manga image



# Problem Definition

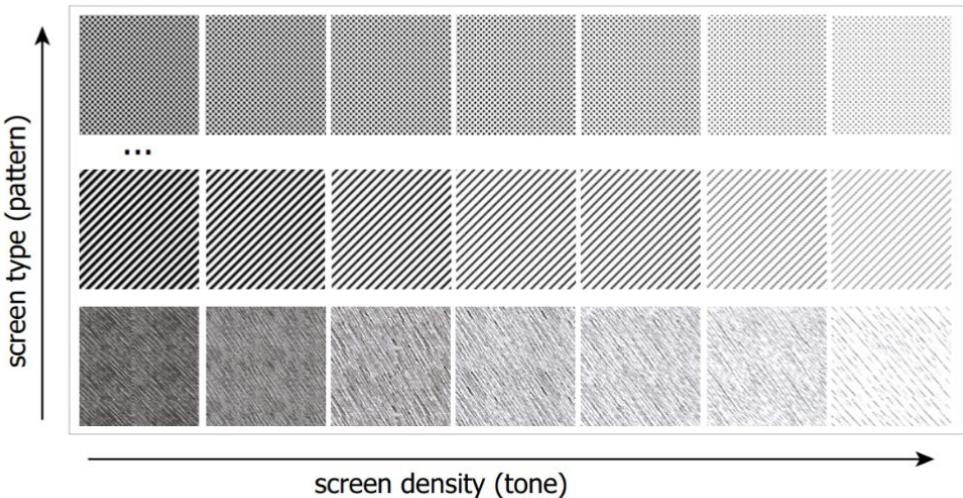
- Given input color image and screentone library with different types and densities
- Segment image into regions and assign a screentone to each segment
- Should preserve tone and chrominance distinguishability



original image



manga image



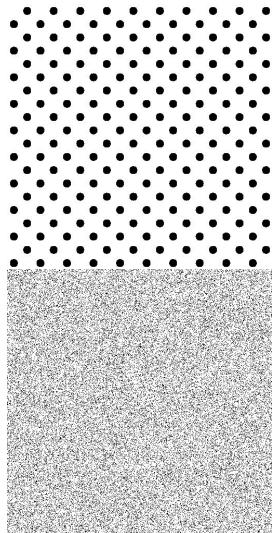
# Algorithm: Overview

- Build up screen tone library
- Image preprocessing
- Segmentation
- Color-to-pattern mapping
- Tone matching
- Add Sobel edge

# Algorithm: Build up screen tone library

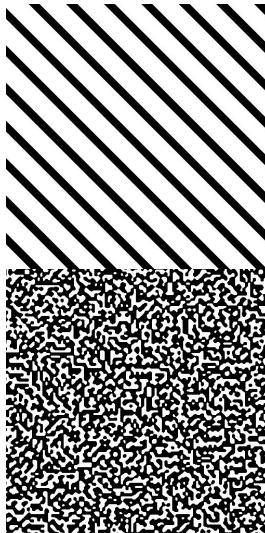
- We binarize the mathematical generated image with threshold to obtain the screen tone

Dot tone  
 $\sin(\omega x) * \sin(\omega y)$



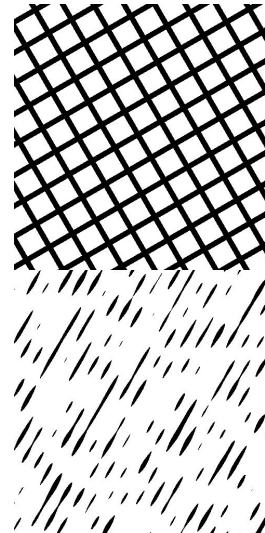
Sand tone  
(White noise)

Line tone  
 $\sin(\omega r)$



Perlin noise tone

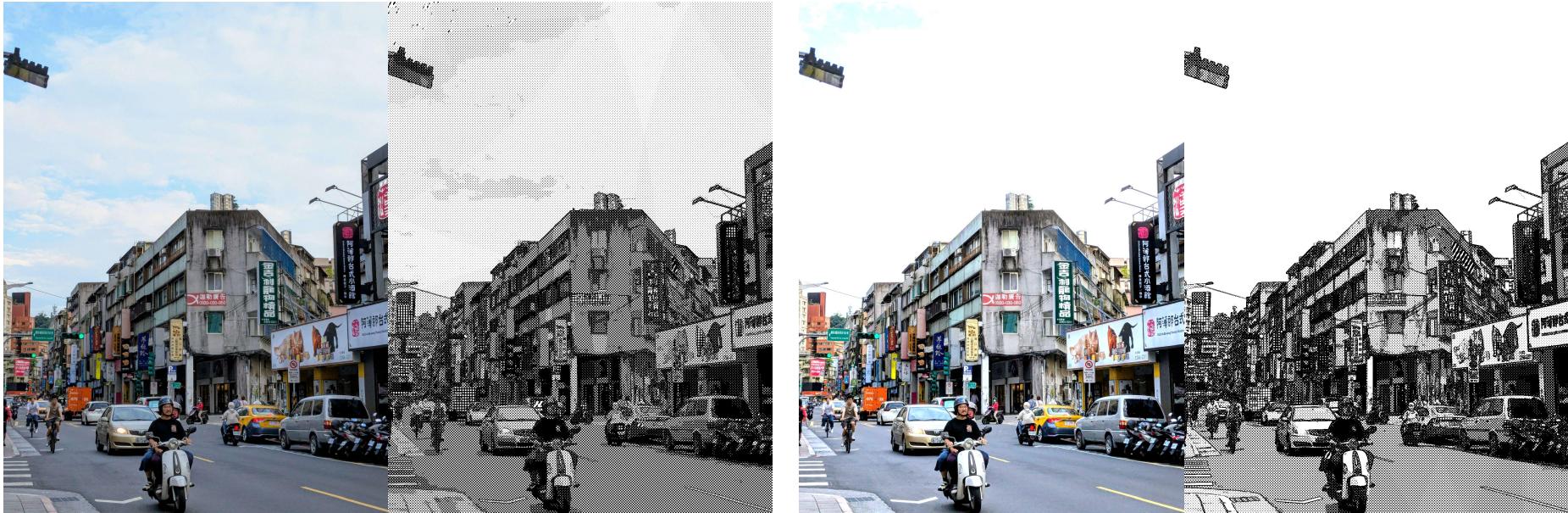
Grid tone  
two line tone added



Directional noise tone  
Perlin noise +  $\sin(\omega r)$

# Algorithm: Image preprocessing

- The original image needs preprocessing (eg, hist. eq, brightness adjust) to achieve the best manga style—eg, mangas often feature large blank areas, which requires the overexposed image.

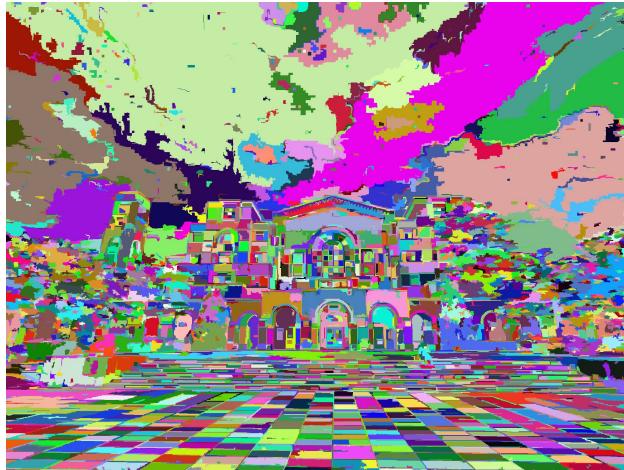


# Algorithm: Segmentation

- We use Felzenszwalb Segmentation to oversegment the image
- Each segment will be assigned a screentone



Original image

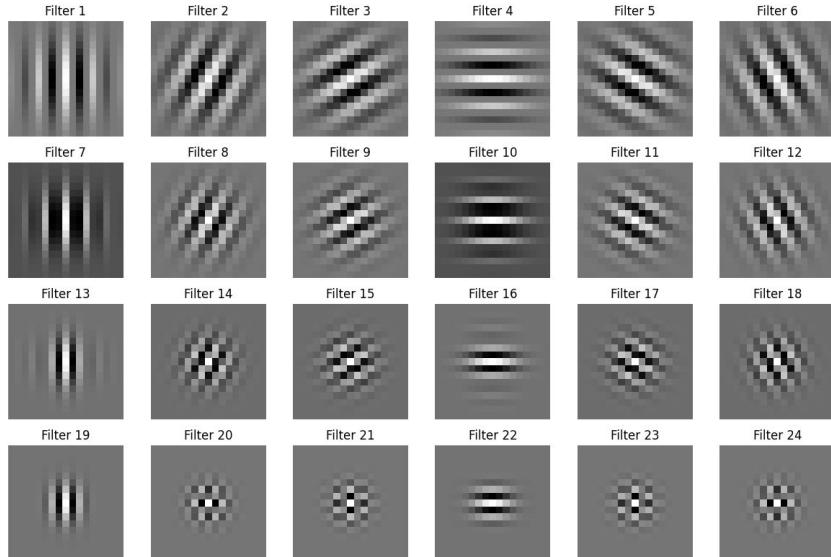


Segmented image

Felzenszwalb et al. "Efficient Graph-Based Image Segmentation." International Journal of Computer Vision (2004).

# Algorithm: Color-to-pattern mapping

- First represent each type of screentone texture with its Gabor wavelet features



$$g(x,y) = \left( \frac{1}{2\pi\sigma_x\sigma_y} \right) \exp \left[ -\frac{1}{2} \left( \frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2} \right) + 2\pi j W x \right]$$

$$g_{m,n}(x,y) = a^{-m} G(x',y')$$

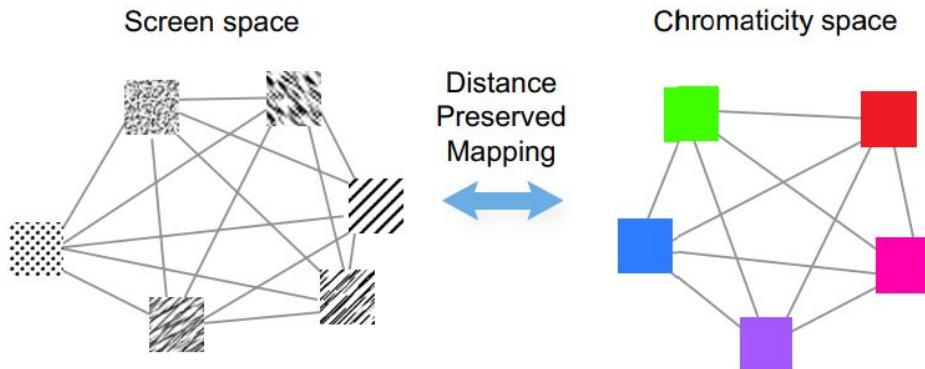
$$x' = a^{-m} (x \cos \theta + y \sin \theta),$$

$$y' = a^{-m} (-x \sin \theta + y \cos \theta),$$

Manjunath et al. "Texture features for browsing and retrieval of image data." IEEE Transactions on Pattern Analysis and Machine Intelligence (1996).

# Algorithm: Color-to-pattern mapping

- Aim to preserve the chromatic relationships
- Reduce the 48D features to 2D (AB channels from LAB) via Multi-Dimensional Scaling
- Match each image segment to a screentone pattern

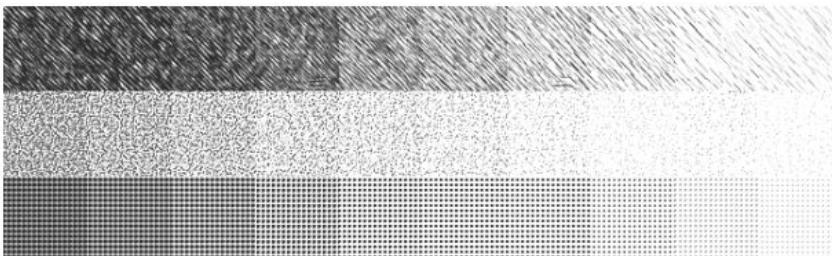
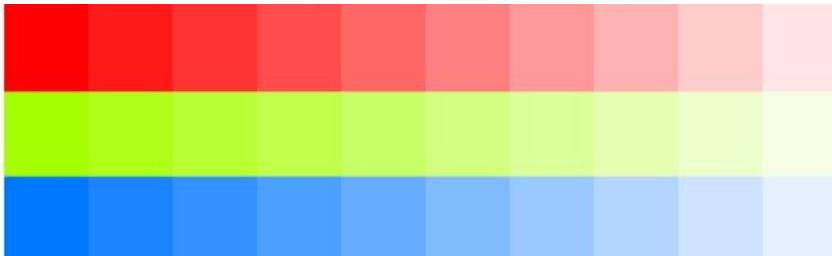


$$QQ^T = -\frac{1}{2}[I - \frac{1}{n}[\mathbf{1}]]D^2[I - \frac{1}{n}[\mathbf{1}]].$$

$$QQ^T = V\Lambda V^T, \quad Q = V\Lambda^{1/2}.$$

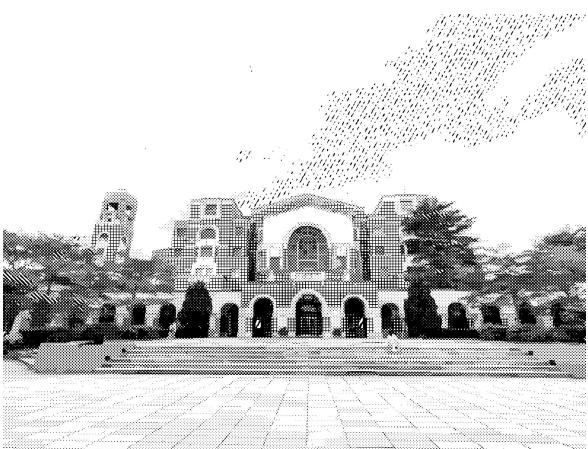
# Algorithm: Tone matching

- The density of the screen is matched with the luminance (L channel from LAB)

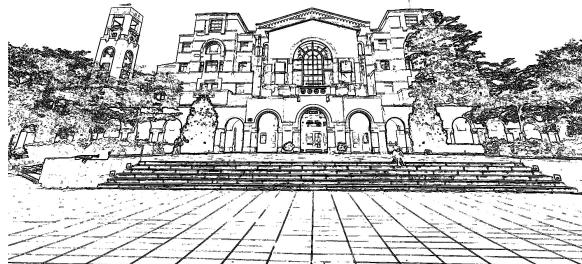


# Algorithm: Add Sobel edge

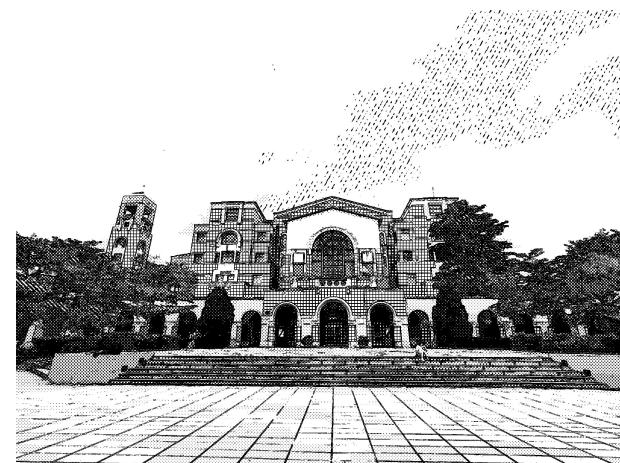
- Manga = Line drawing + screentones
- Overlay screentone map and Sobel edge map



Screentone map



Sobel edge map

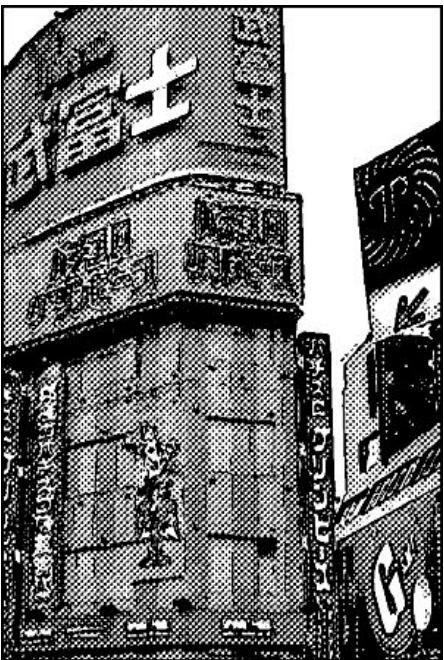


Result

# Results: Reproduce sample



original image



halftoning image



manga image (paper)



manga image (ours)

# Results: Our sample



Original image



Result

# Results: Our sample



Original image



Result

# Results: Our sample



Original image



Result

# Results: Our sample



Original image



Result

# Results: Our sample



Original image



Without histogram equalization

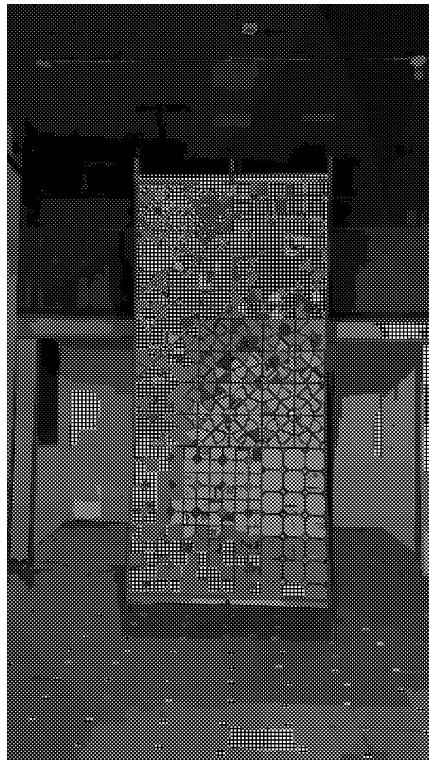


With histogram equalization

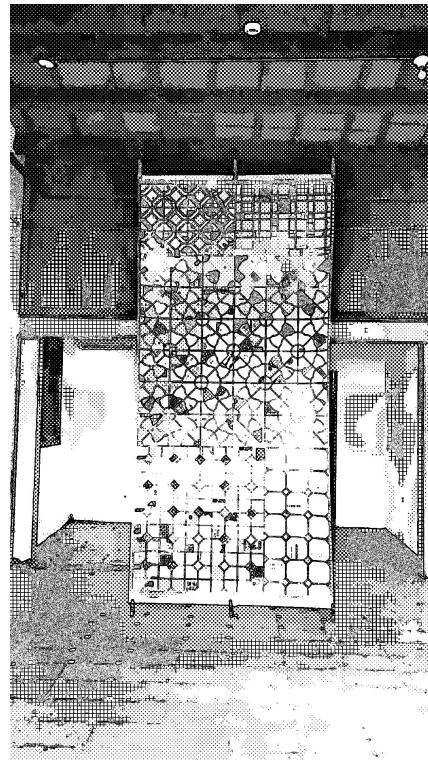
# Results: Our sample



Original image



Without histogram equalization



With histogram equalization

# Results: Failure case



Original image

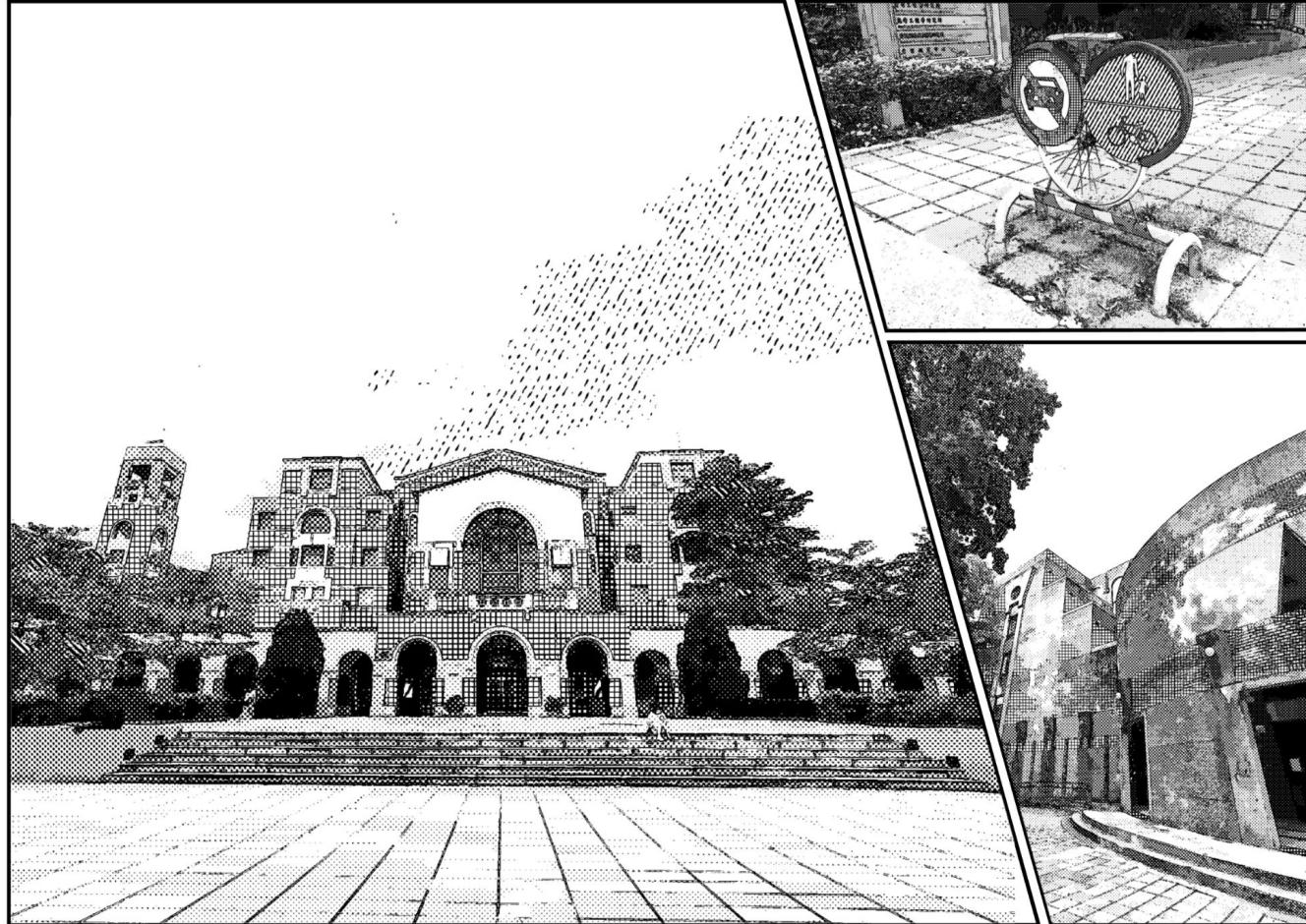


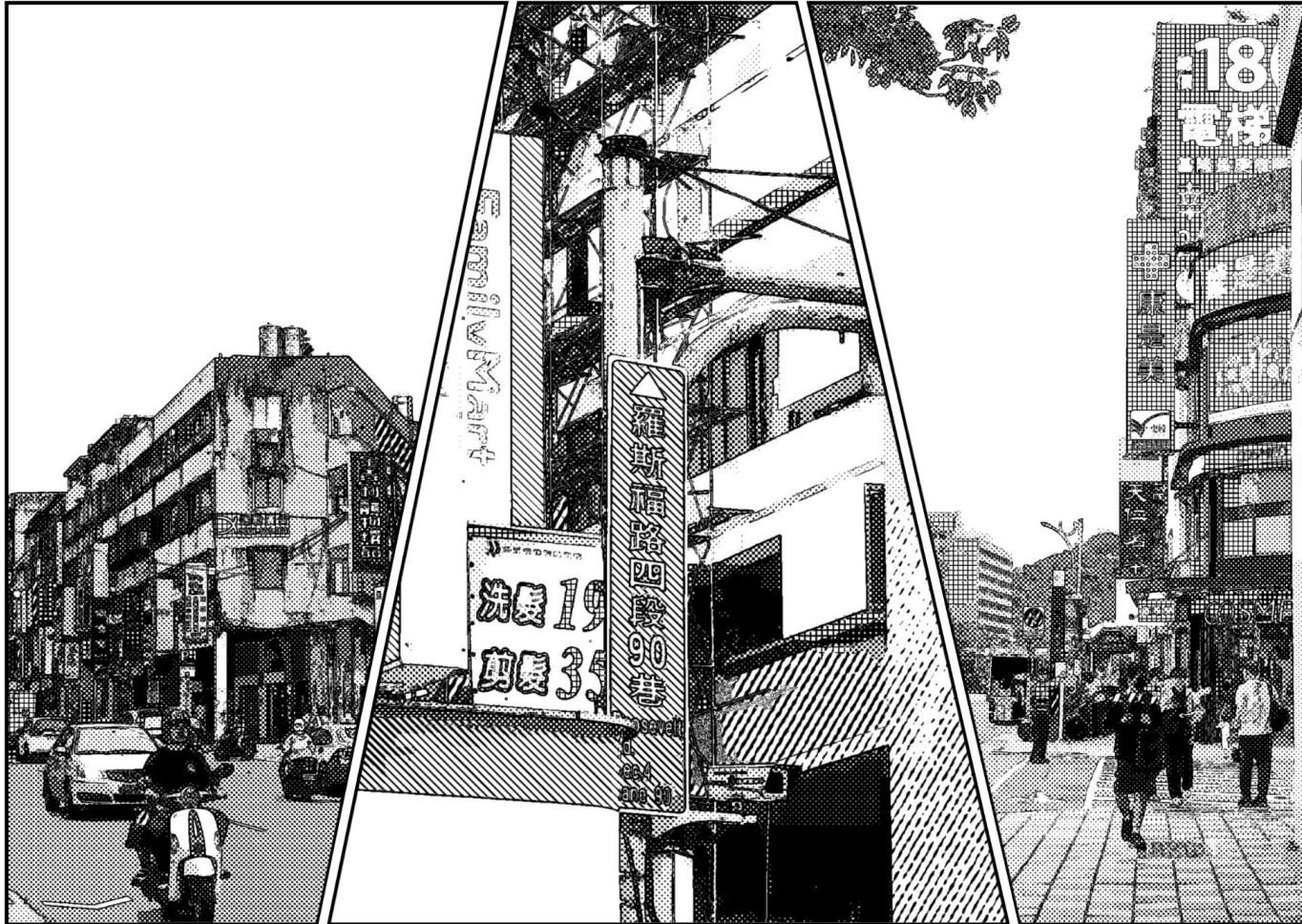
Result

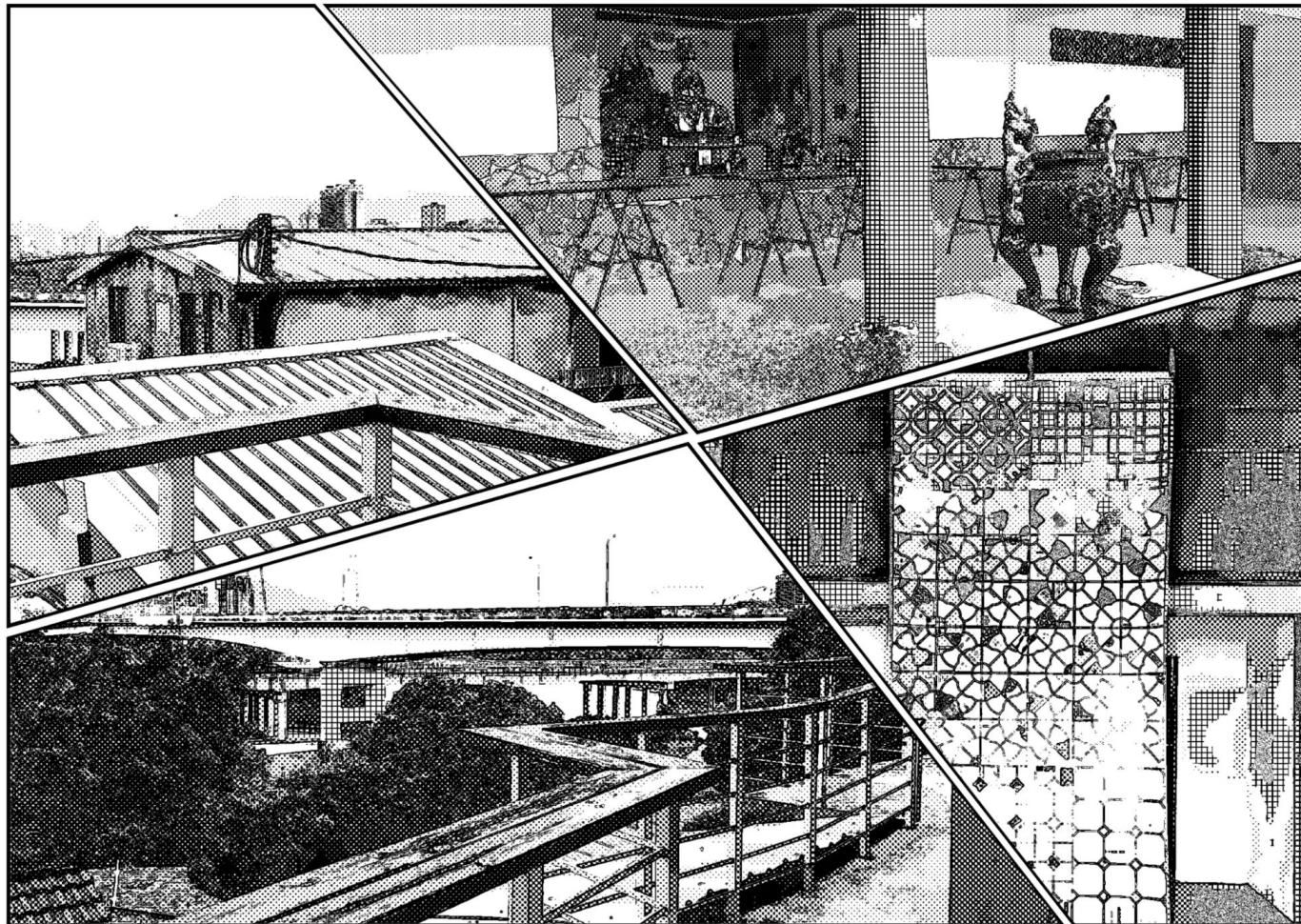


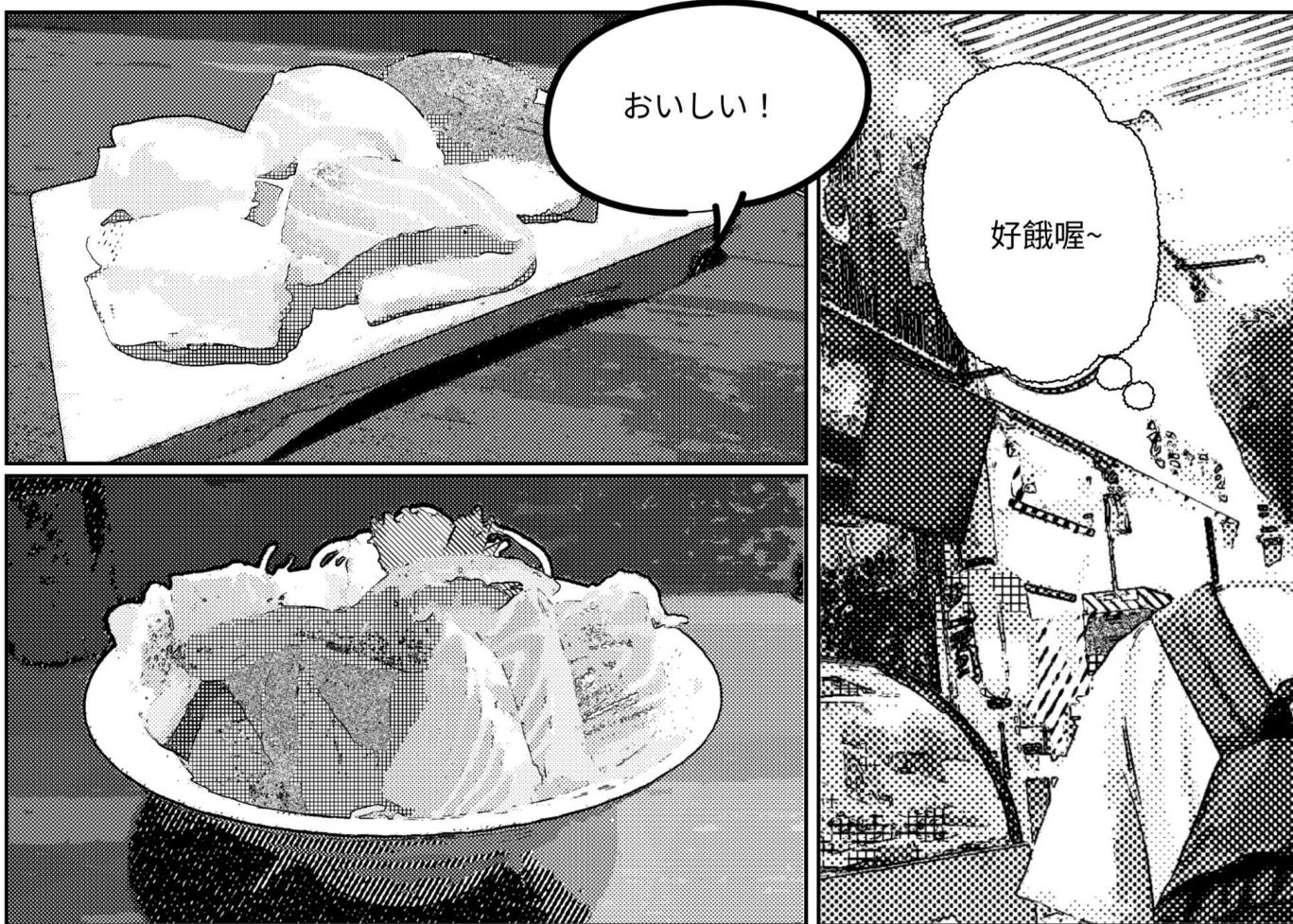
# Our manga (從臺大走到寶藏巖)

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# Reference

- Qu et al. “Richness-preserving manga screening.” ACM Transactions on Graphics (SIGGRAPH Asia 2008 issue).
- Felzenszwalb et al. “Efficient Graph-Based Image Segmentation.” International Journal of Computer Vision 59, 167–181 (2004).
- Manjunath and Ma, “Texture features for browsing and retrieval of image data.” IEEE Transactions on Pattern Analysis and Machine Intelligence 18, 8
- Cox and Cox, “Multidimensional Scaling.” Chapman & Hall.
- Aka Akasaka, “Kaguya-sama: Love is War, Volume 5.”