Wide-Angle Image Stitching Using Multi-Homography Warping

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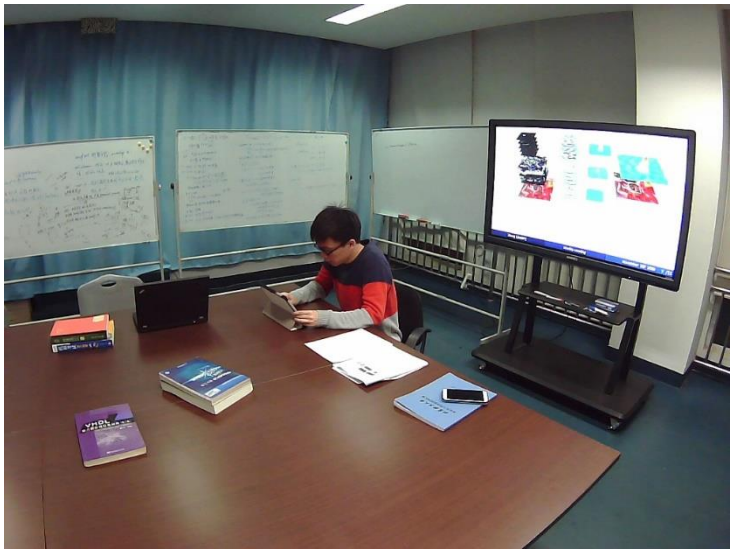
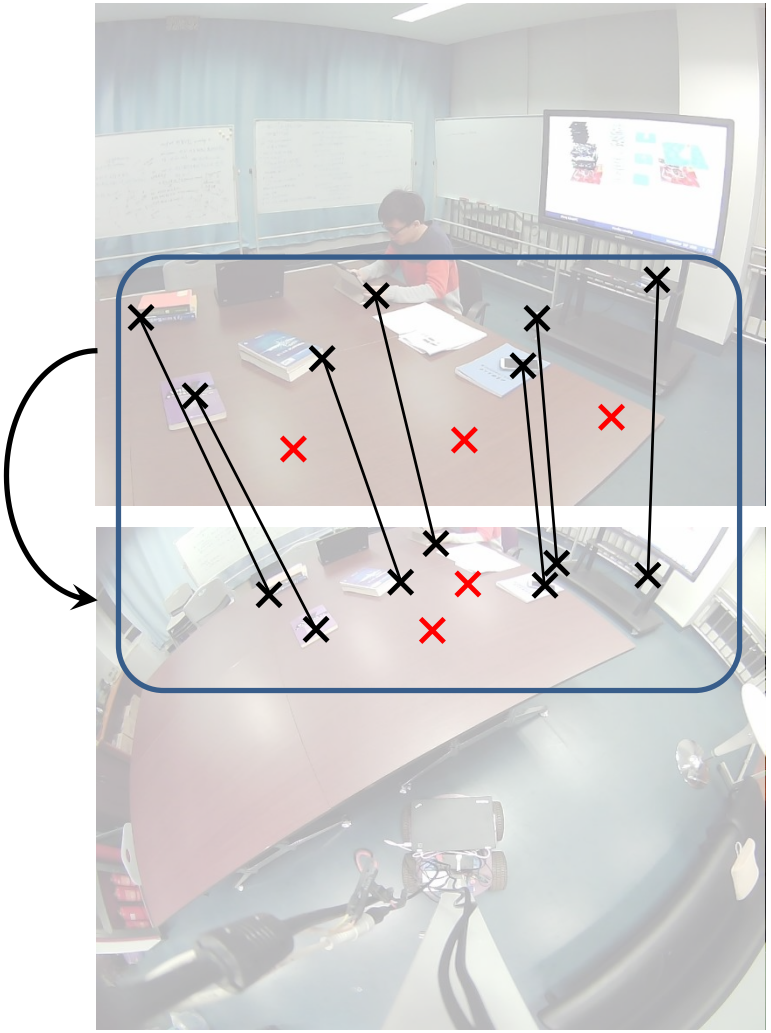
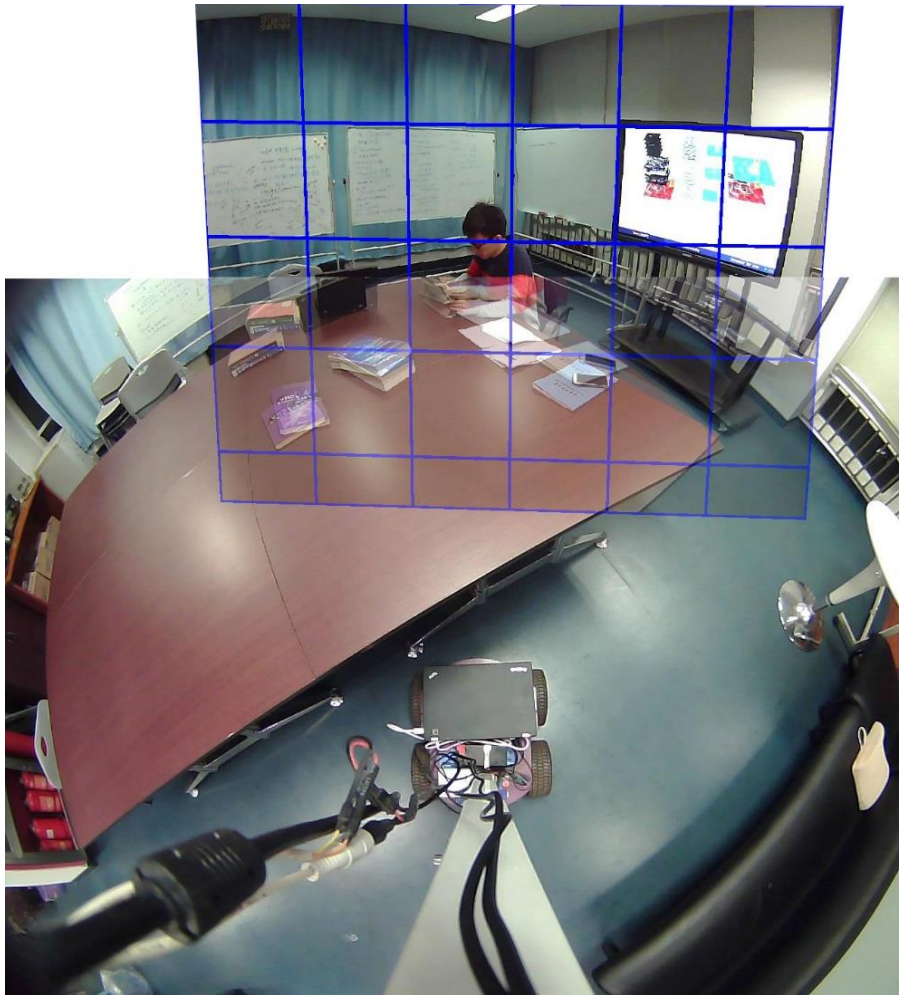
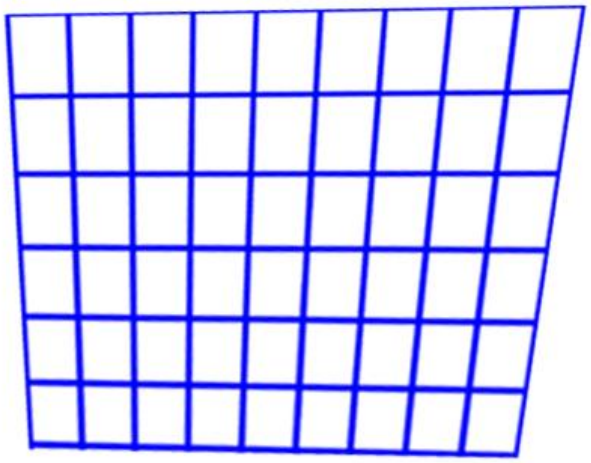
Wide-angle image stitching



Projective transformation (Homography)



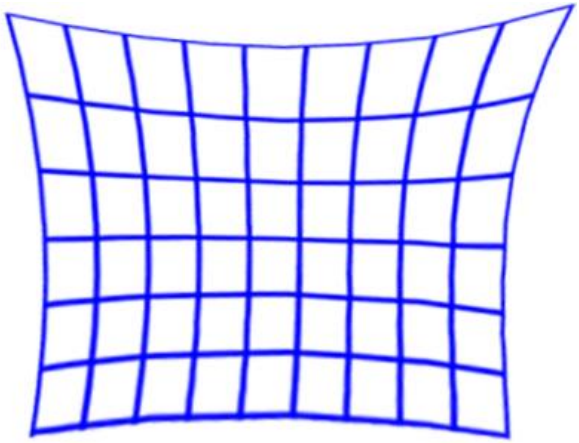




- Single global homography

  Misalignment

$$p' = H_g p$$



- Division model

  Shape and area distortion

$$x' = x/(1 + \lambda||x||^2)$$

- Globally similar

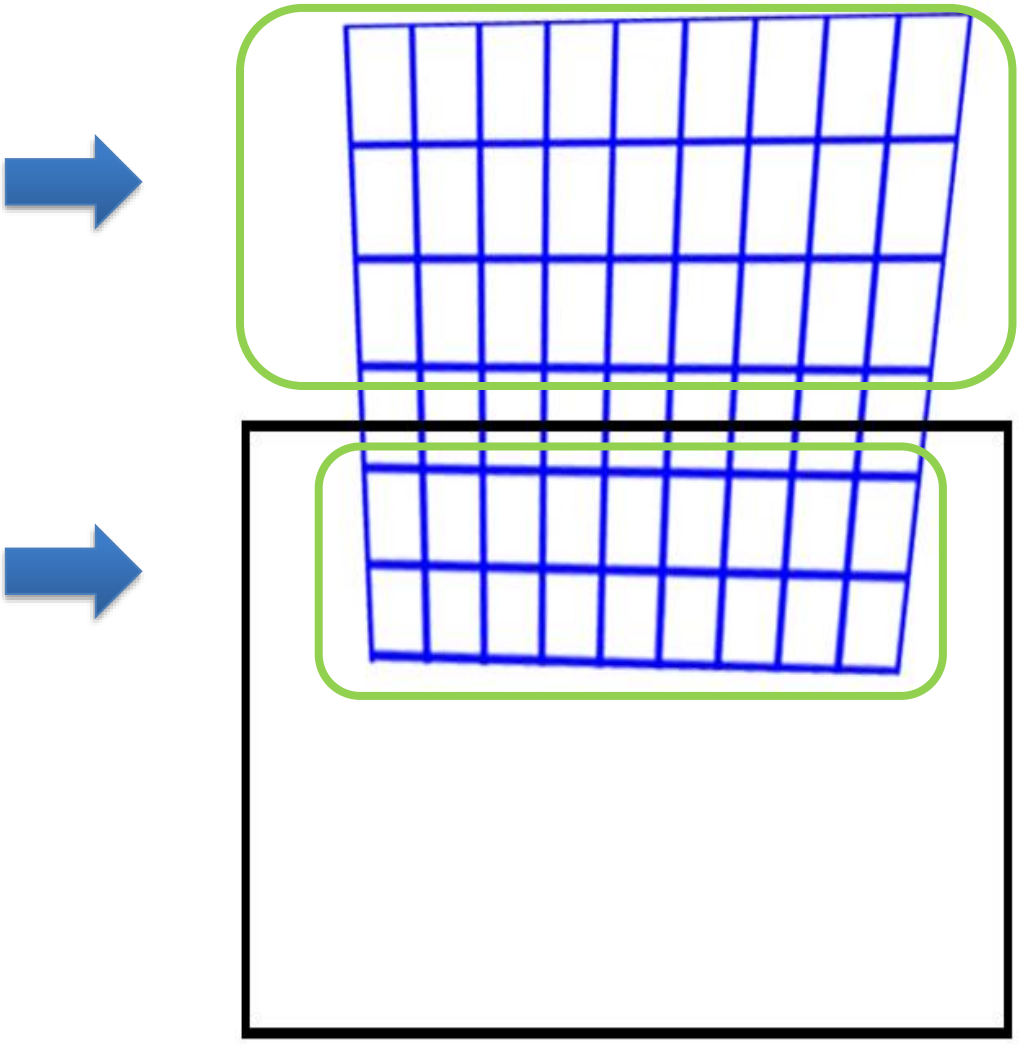
  (SPHP Warp, Chang' 14)

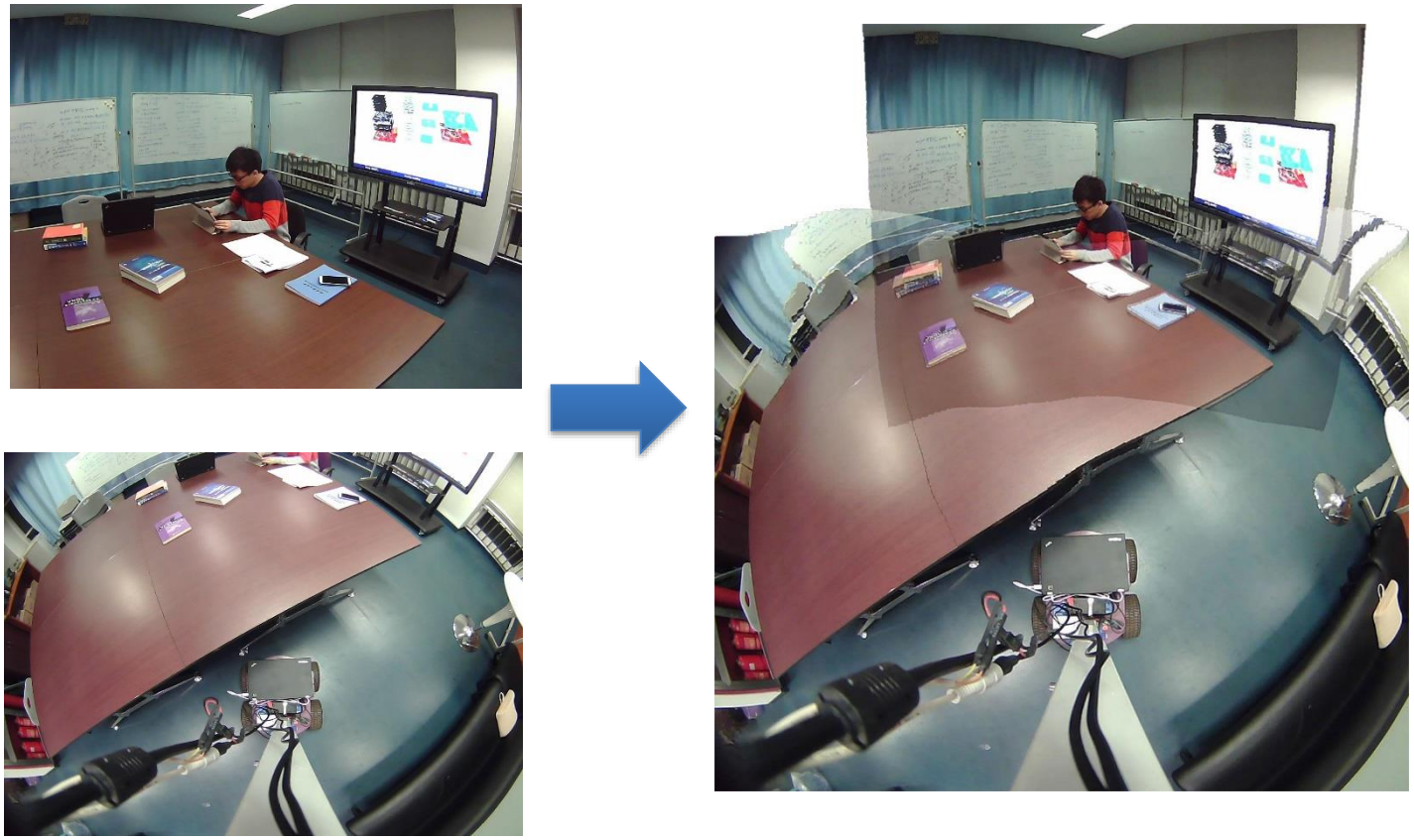
  (ANAP Warp, Lin' 15)

- Locally aligned

  (APAP Warp, Zaragoza' 13)

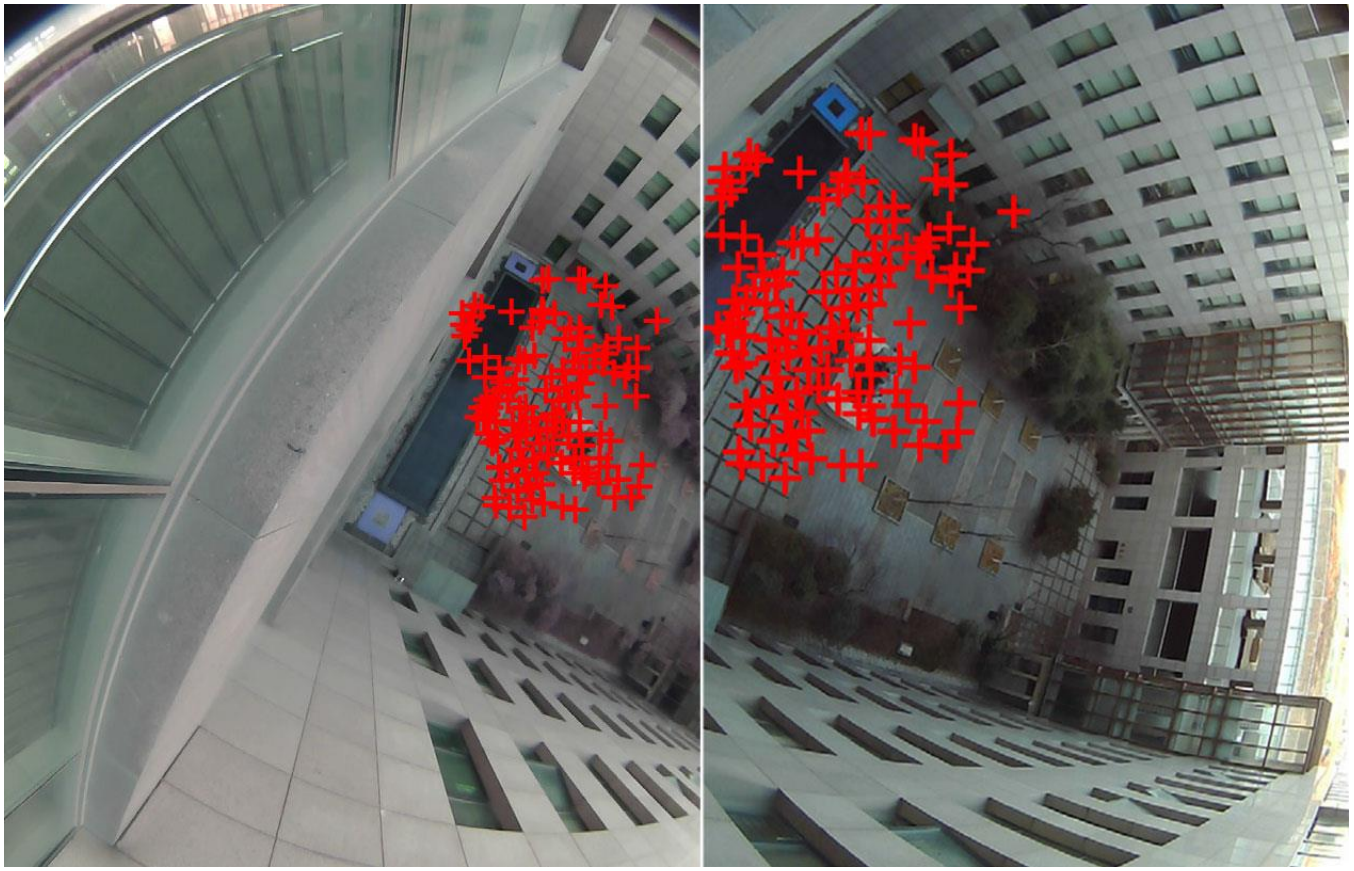
  (L-mDLT, Joo' 16)





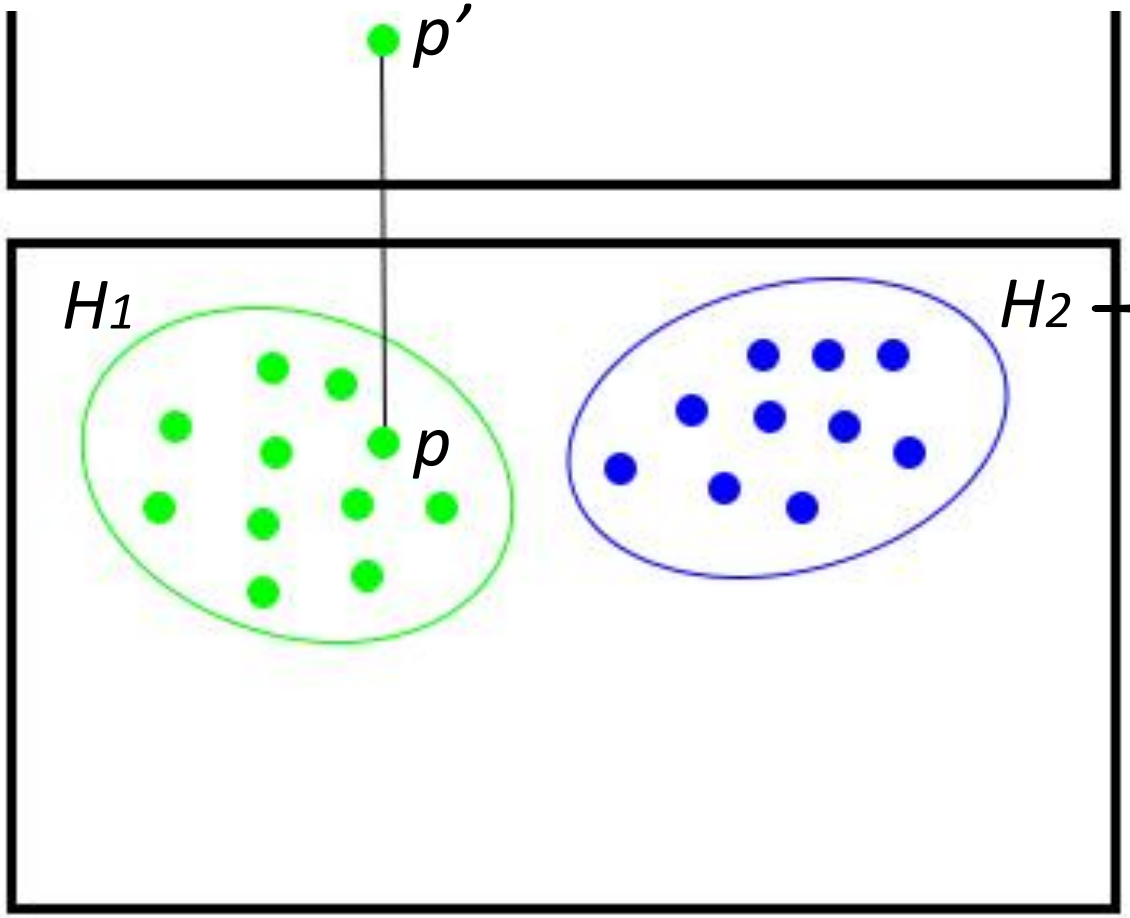
We propose a multi-homography warping,
which integrates multiple local homographies
with a global homography
for **accurate alignment** and **shape preservation**.

Inlier selection



Inliers selected by **RANSAC**
(random sampling)

Key idea: random sampling ➡ conditional sampling



- respect the local distorted structure
- cover more local inliers

RANSAC: homography hypotheses $\{H_i\}_{i=1}^{M}$

- Based on Multi-GS [Chin' 12], we use residual sorting information to perform a **conditional sampling**.
  - The probability of two points arising from the same homography can be encoded by residual sorting.
- For $P_i = \{p_i, p_i'\}$, we rank the $\{H_i\}_{i=1}^{M}$ in terms of their residuals as

$$h^i = \{h_1, ..., h_M\}$$

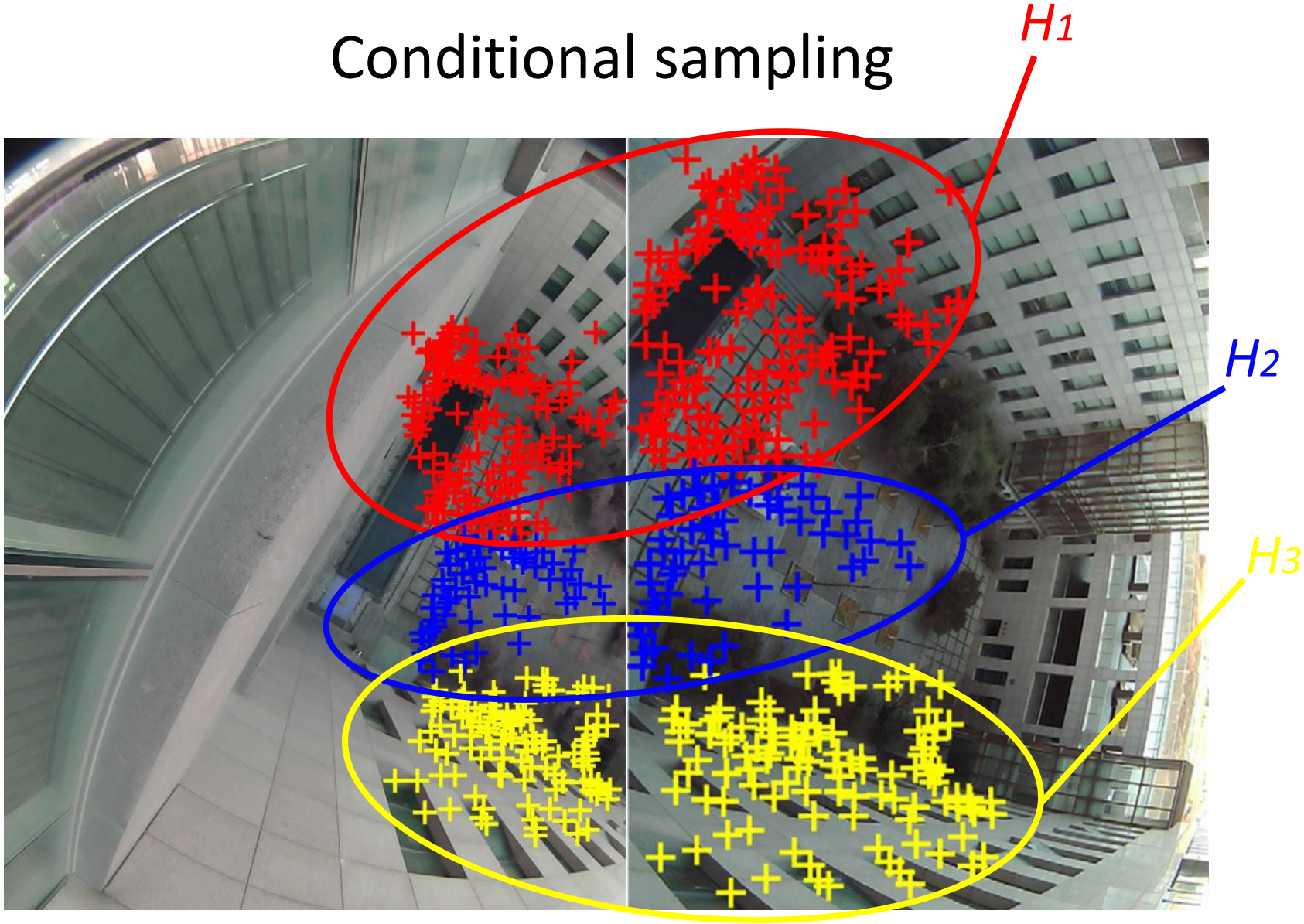
- If P_i has been chosen, the probability of choosing P_j as the next sample is

$$f(P_i, P_j) = \frac{1}{a}|h^i_{1:a} \bigcap h^j_{1:a}|$$

- New hypotheses can be generated by using conditional sampling.

- We find the optimal hypothesis with the largest number of inliers to select the local inliers, and repeat the above procedure.

Conditional sampling



- Global homography H_g

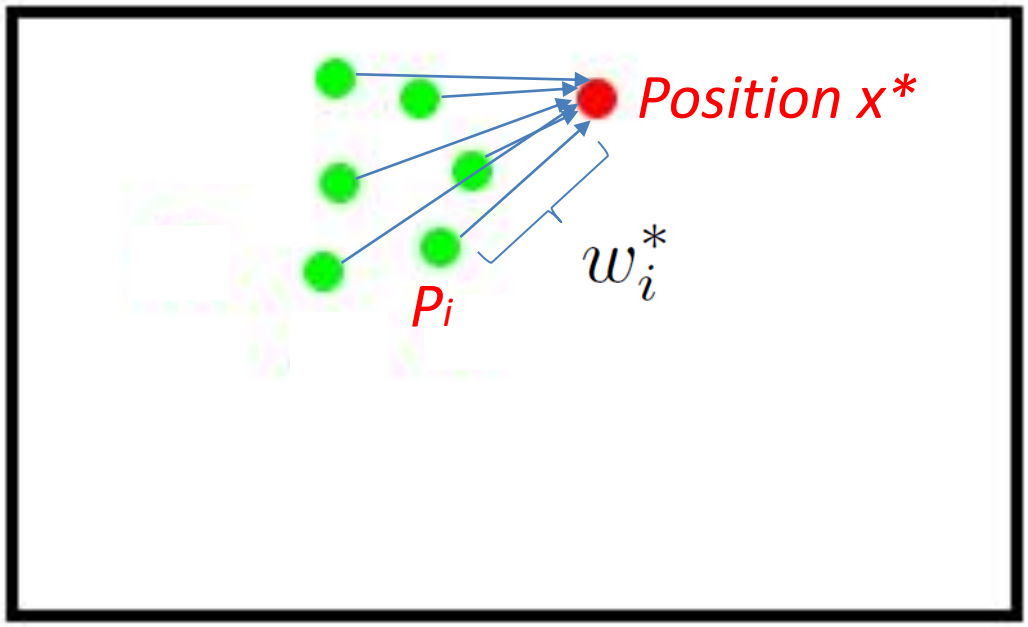
$$p' = H_g p \Rightarrow \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ h_7 & h_8 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

- Direct Linear Transformation (DLT)

$$0_{3\times 1} = ah = \begin{bmatrix} 0_{1\times 3} & -p^T & y'p^T \\ p^T & 0_{1\times 3} & -x'p^T \\ -y'p^T & x'p^T & 0_{1\times 3} \end{bmatrix} \begin{bmatrix} h_1 \\ \vdots \\ h_9 \end{bmatrix}$$

$$\hat{h} = \arg\min_h \sum_{i=1}^{n} ||a_i h||^2 = \arg\min_h ||Ah||^2$$

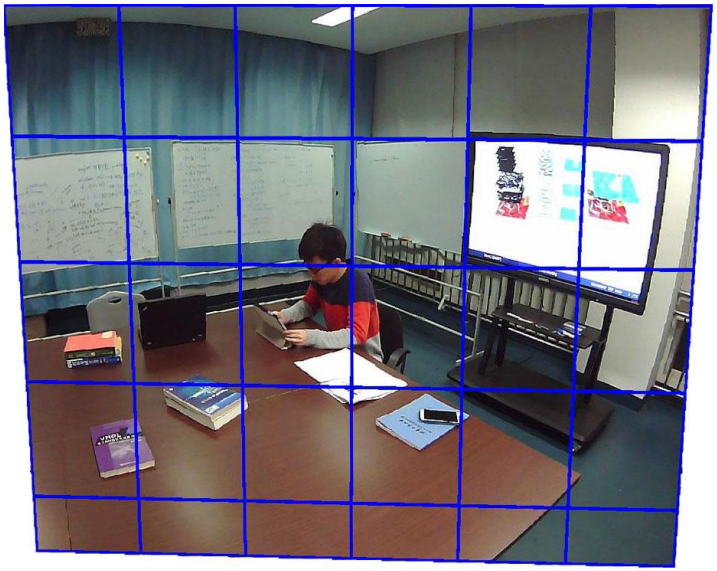
Moving DLT [Zaragoza' 13]



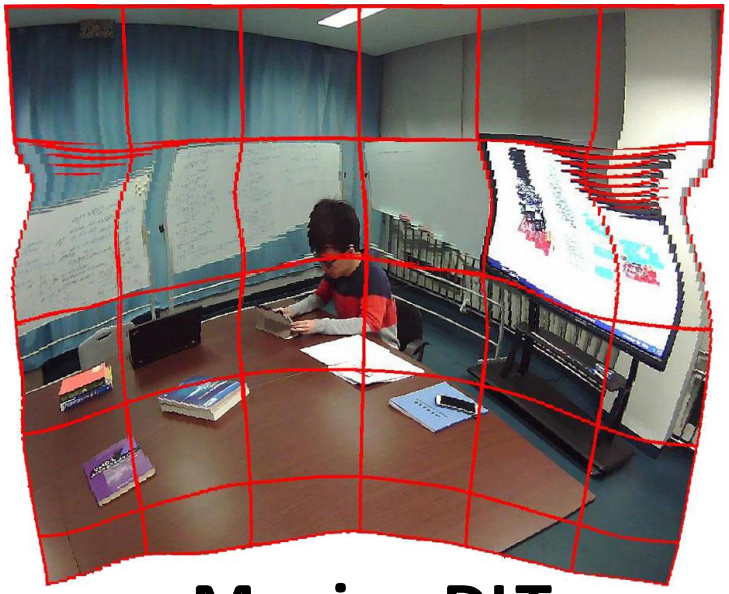
- Local homographies h^*

$$h^* = \arg\min_h \sum_{i=1}^{N} ||w_i^* a_i h||^2 = \arg\min_h ||W^* A h||^2$$

$$w_i^* = max(exp(-||x^* - p_i||^2/\sigma^2), \gamma)$$



DLT



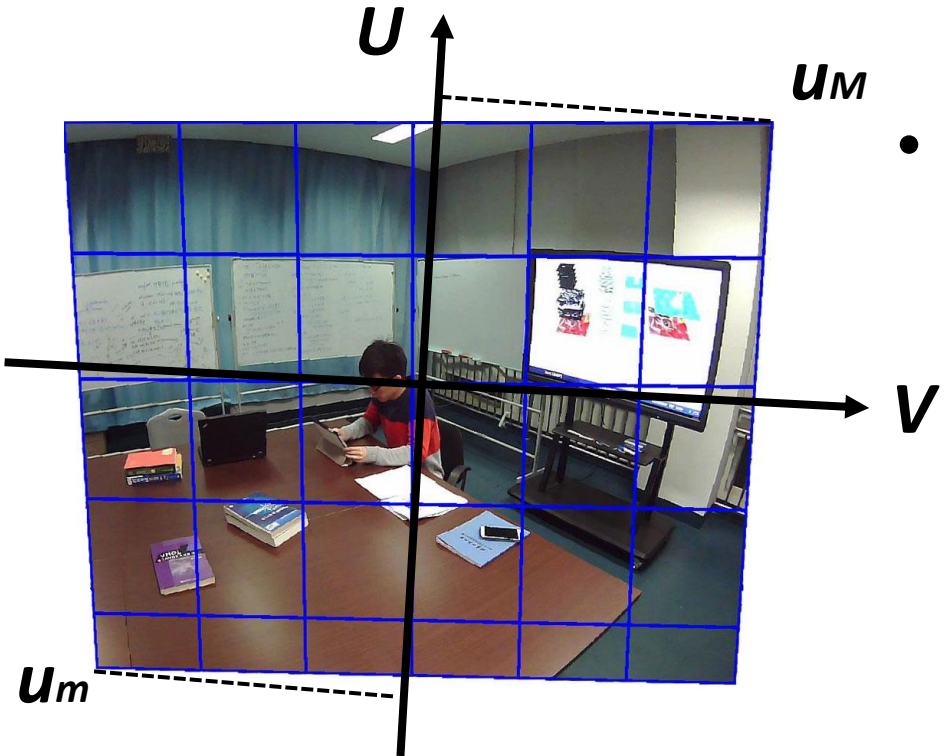
Moving DLT

Unnatural shape distortion

- We integrate the local h^* with global H_g as our ***multi-homography warping***

$$H_m^* = w_l^* h^* + (1 - w_l^*) H_g$$

$$w_l^* = (u^* - u_m)/(u_M - u_m)$$

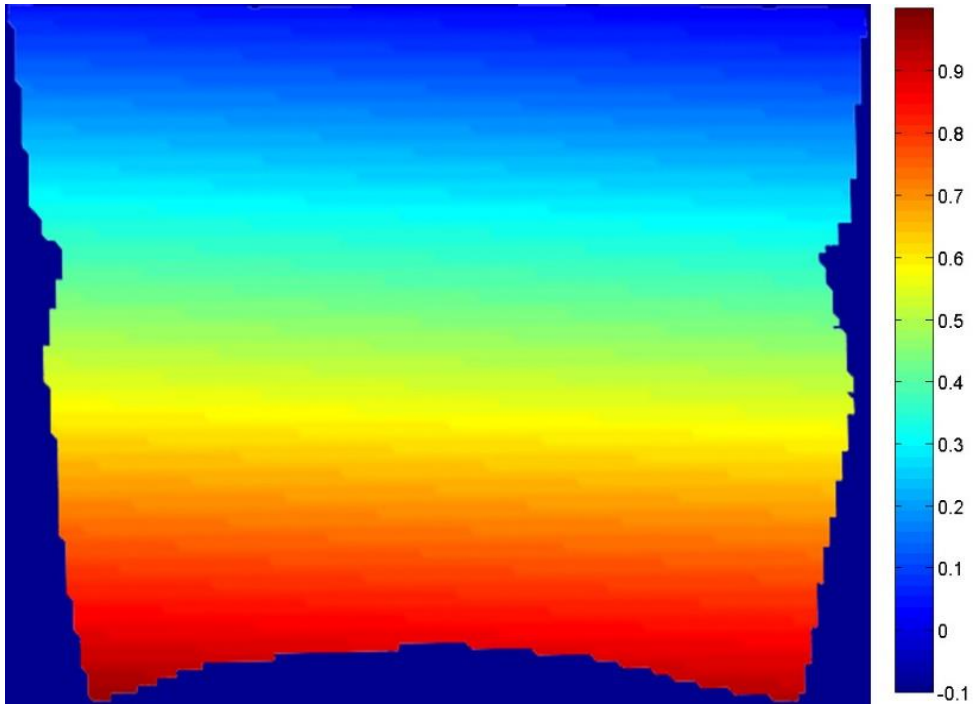


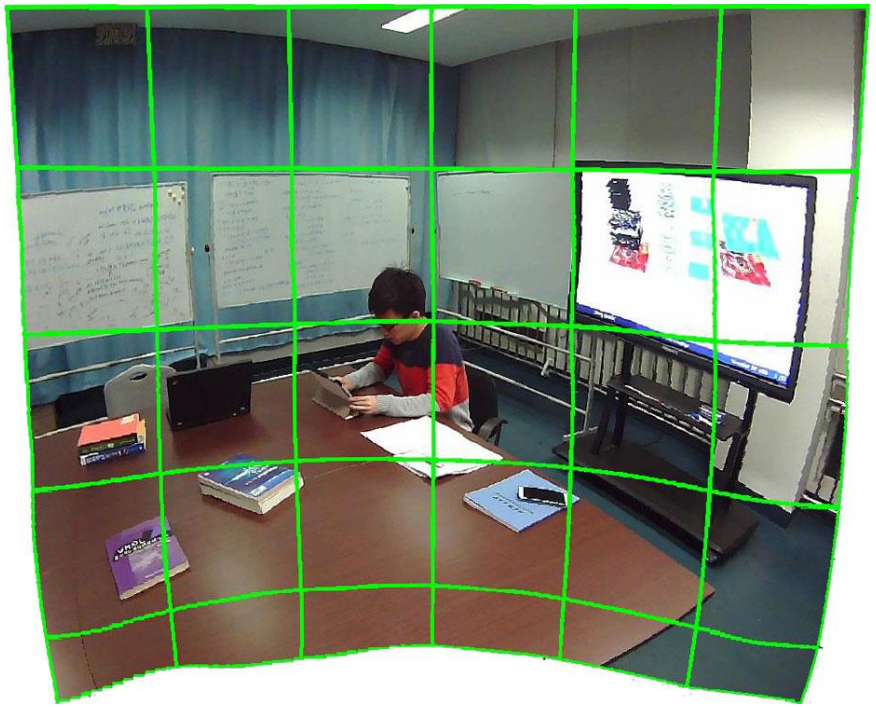
- A rotation of the original coordinate system of the image warped by H_g

$$\theta = atan2(-h_8, -h_7)$$

$(h_8, h_7$ from $H_g)$

- Result



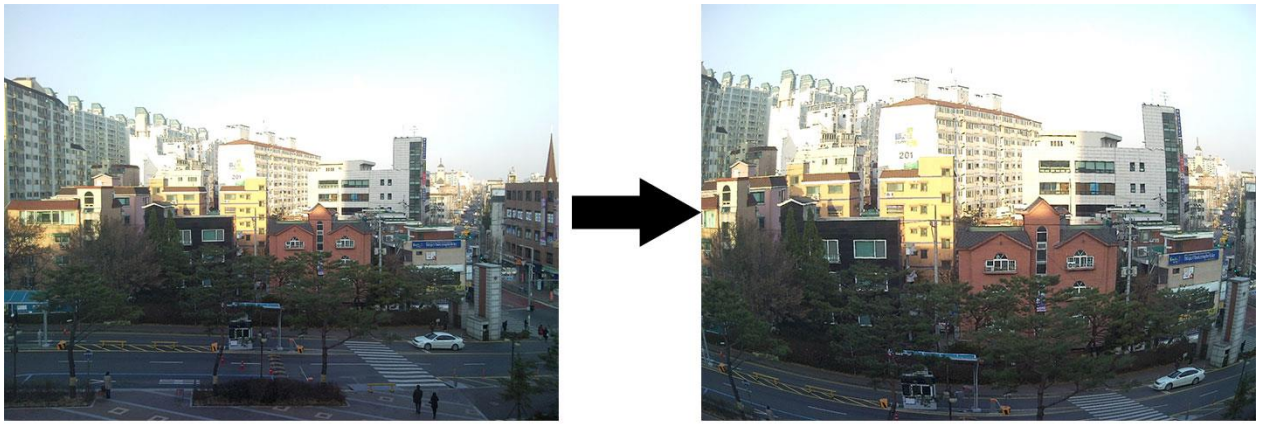


Weight map w_l^*

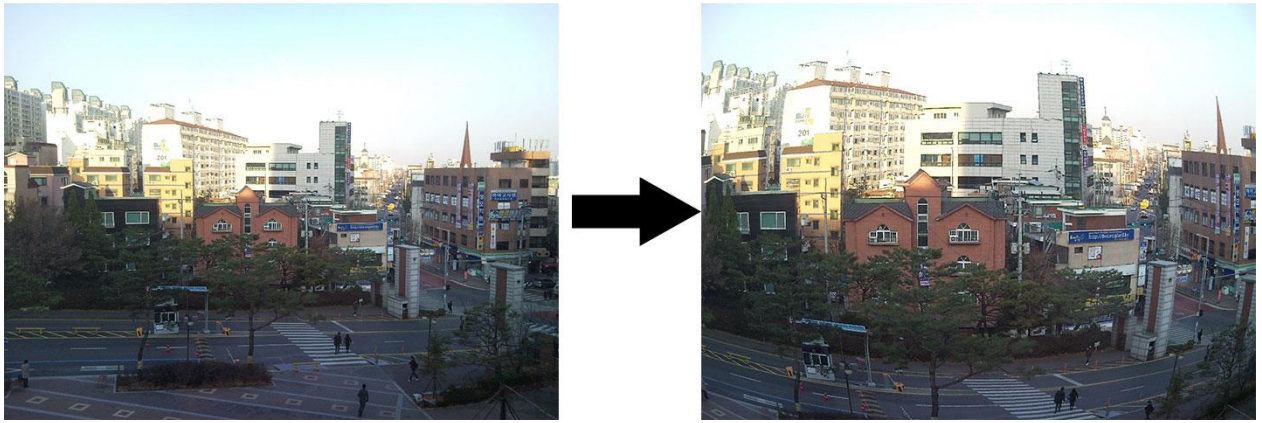
$$H_m^* = w_l^* h^* + (1 - w_l^*) H_g$$

- Two-view stitching

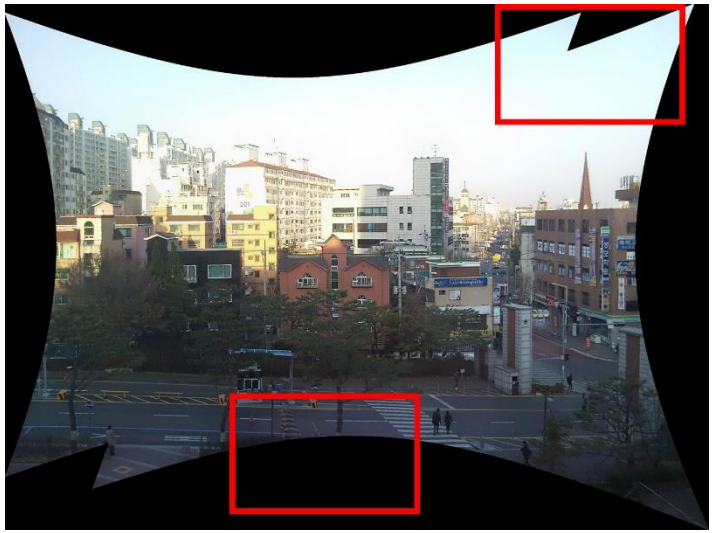
View 1



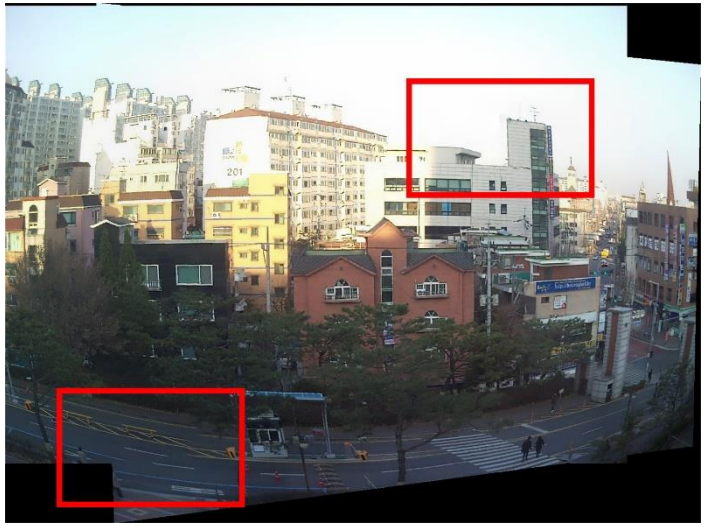
View 2



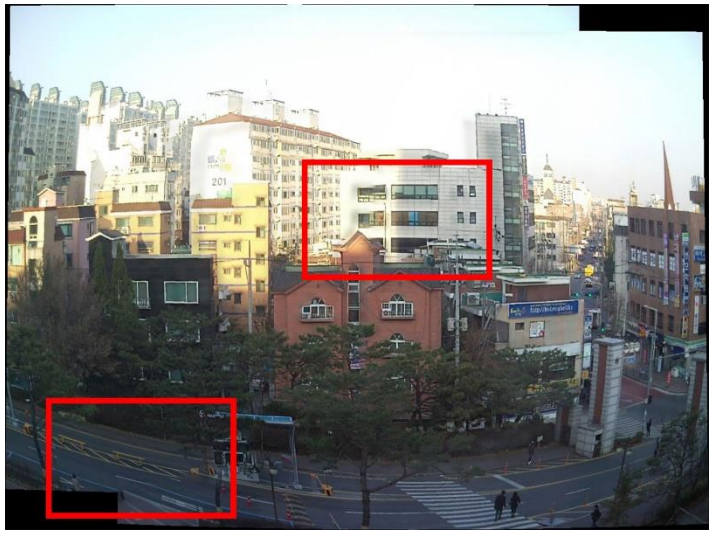
distortion factor $\lambda = -0.4$ [Ju' 13]



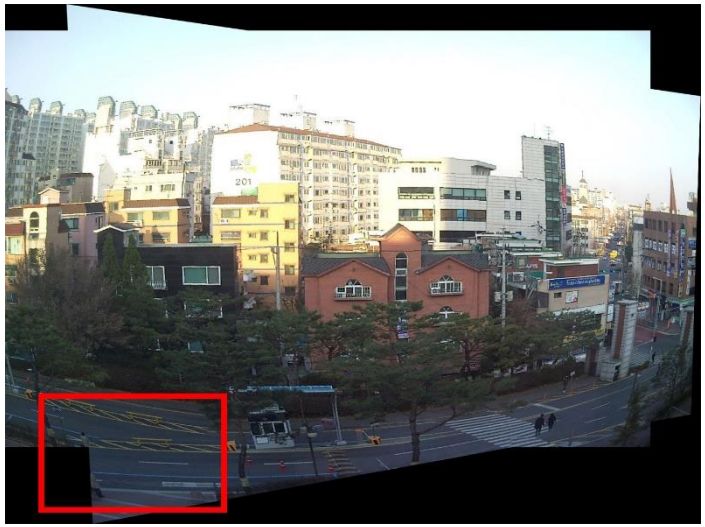
Ju’ 13



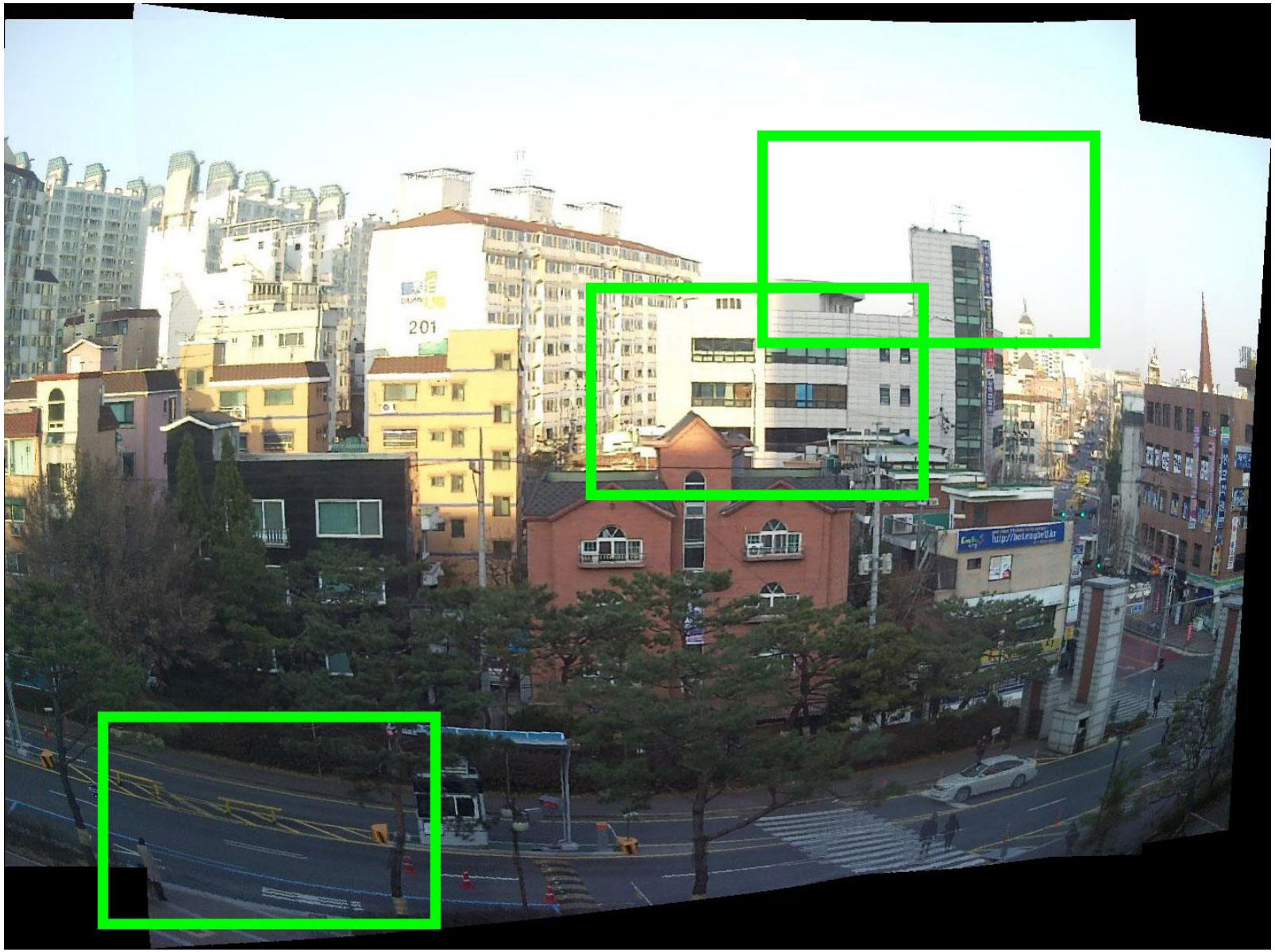
Stitching3pt



Autostitch

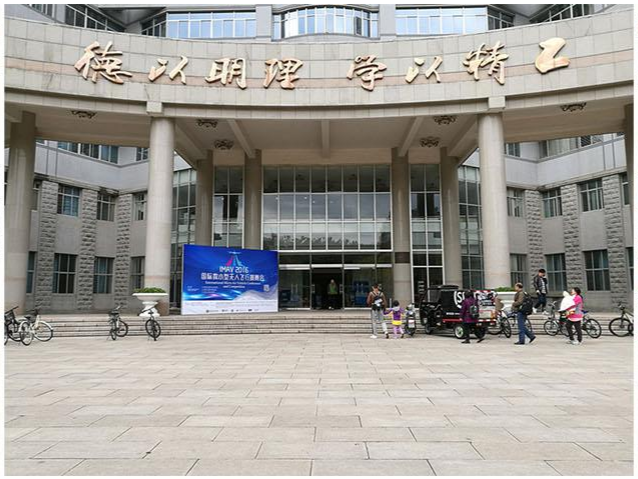


Microsoft ICE



Ours


德以明理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Thank you!