Reverse Video

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Introduction

Project Aim:
One or two people walk, reverse the video so that people walk in the opposite direction

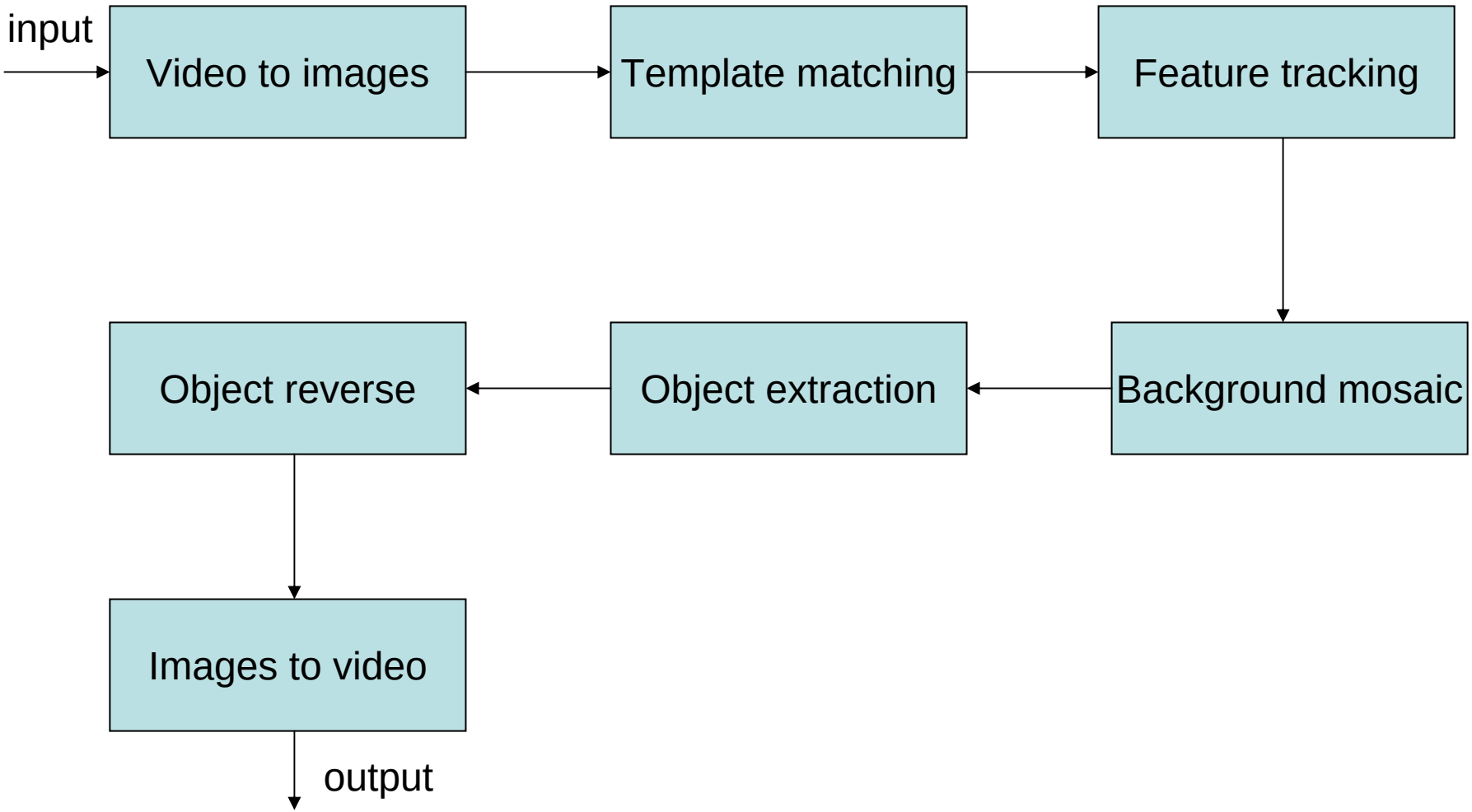
Assumption:
People walk not too fast
Camera moves slowly, following walking people

Techniques of computer vision:
Template matching, Tomasi feature selction, Lucas-Kanade tracking, Mosaic, Background removal

Finished work

- A man walks along complex path in front of uniform background
- A man walks along straight line in front of the complex background
- Two people walks along straight line in front of the uniform background
- One person surpasses the other person

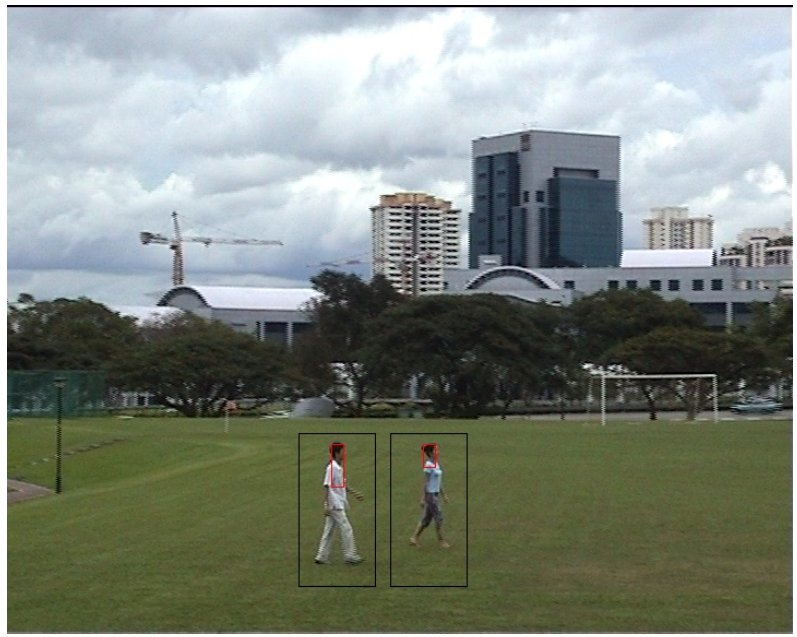
The Model


input
Video to images
Template matching
Feature tracking
Background mosaic
Object extraction
Object reverse
Images to video
output

Step 1: Track Moving Objects

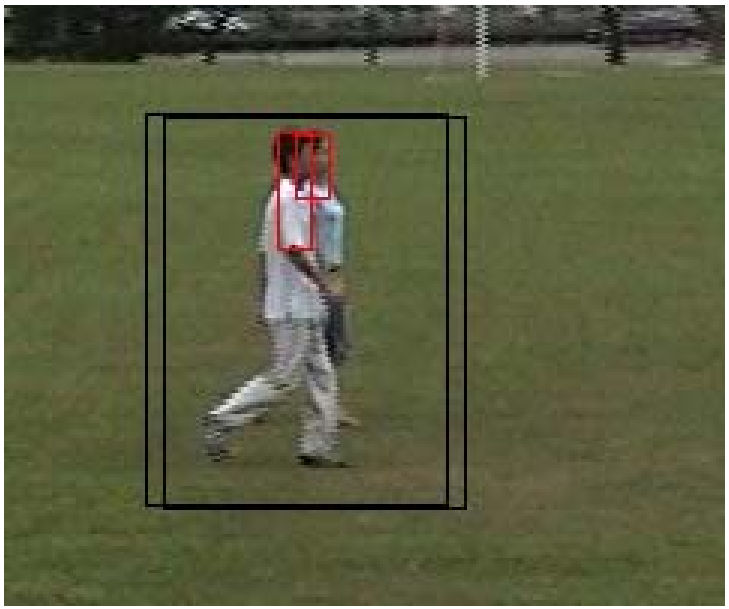
- In the first frame choose a template with relatively stable features (the head of the walking people)
- Template matching in the following frames. It is restricted within a neighborhood
- Matching criteria: Find the least Euclid distance $E(x, y) = \sum_i \sum_j (||F(x+i, y+j) - K(i, j)||^2)$

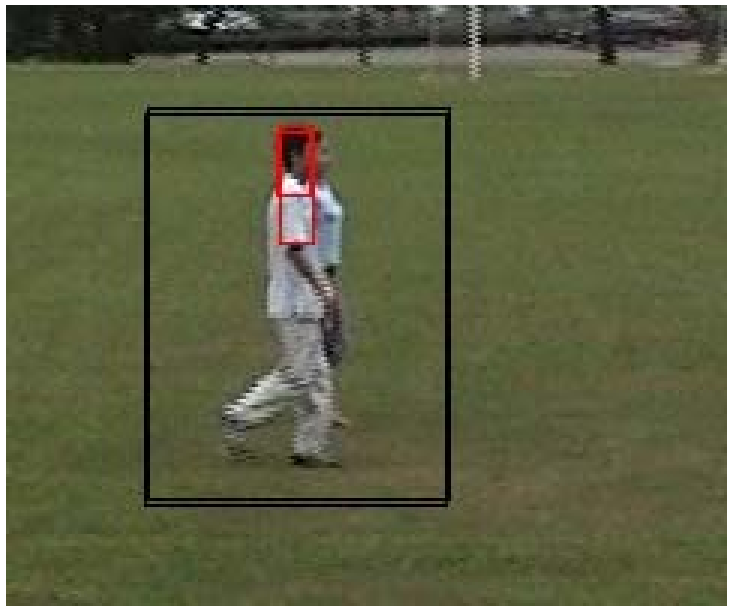
Step 1: Track the Moving Object Area



Use template matching to identify the region of the moving object

Step 1: Track Moving Objects





- When the two persons are close enough, the template matching also works well.

Step 2: Automatic Background Mosaic

Mosaic Steps: (two moving objects)

1) Select good features on image I (Tomasi method)

2) Feature tracking in the following images (Pyramid LK)

3) Extract the background of moving object 1 on image i from image f1; extract the background of moving object 2 on image I from image f2

4) Mosaic from image i+1 to image max{f1, f2}

5) Recursively execute step 1), 2), 3) from image i = max{f1, f2}+1

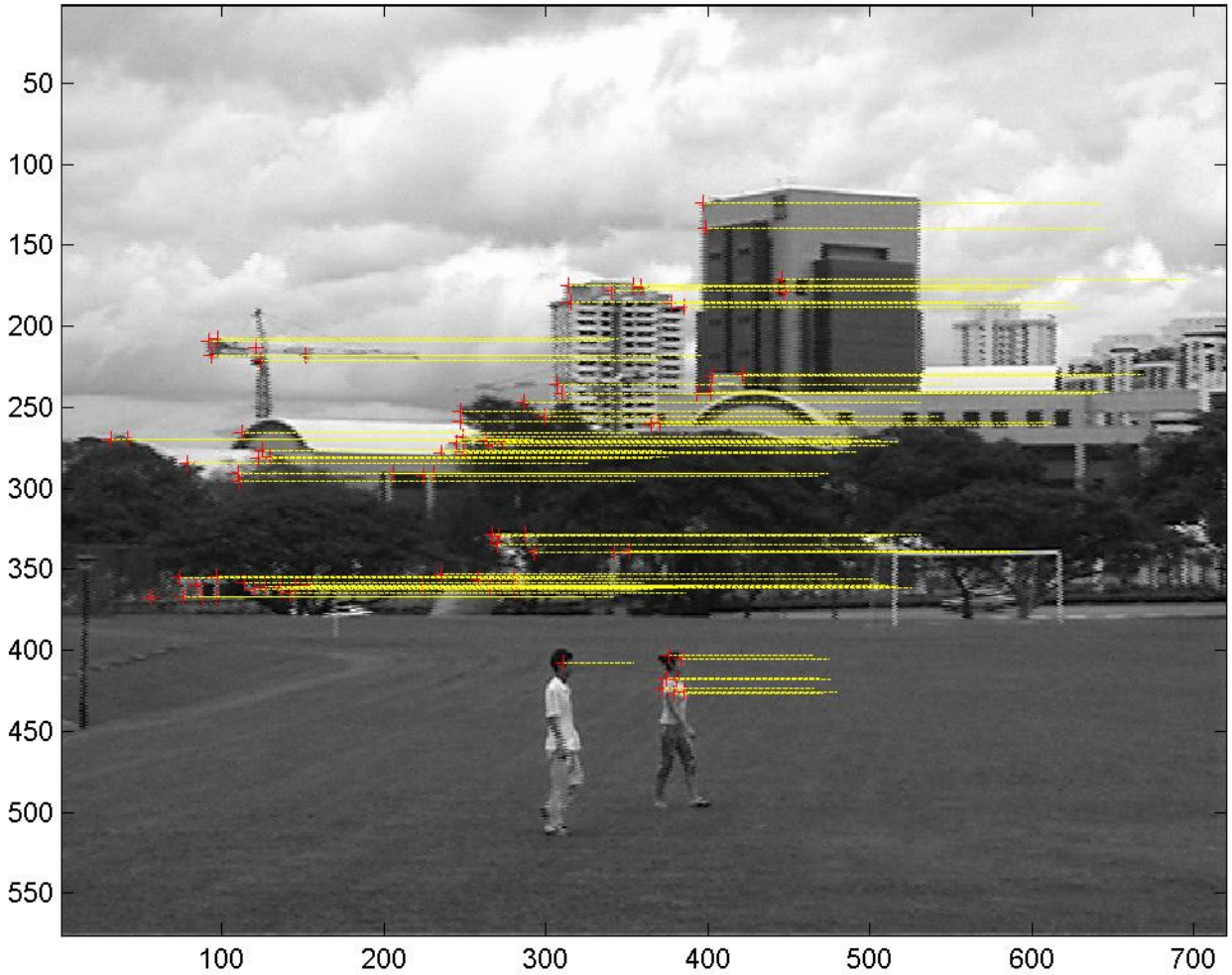
‘Where’ to extract the background

1)Good features are tracked between neighboring two images by pyramid Lucas-Kanade tracking

2) The good features on image i1=max{f1,f2} appear on all images from i to i1

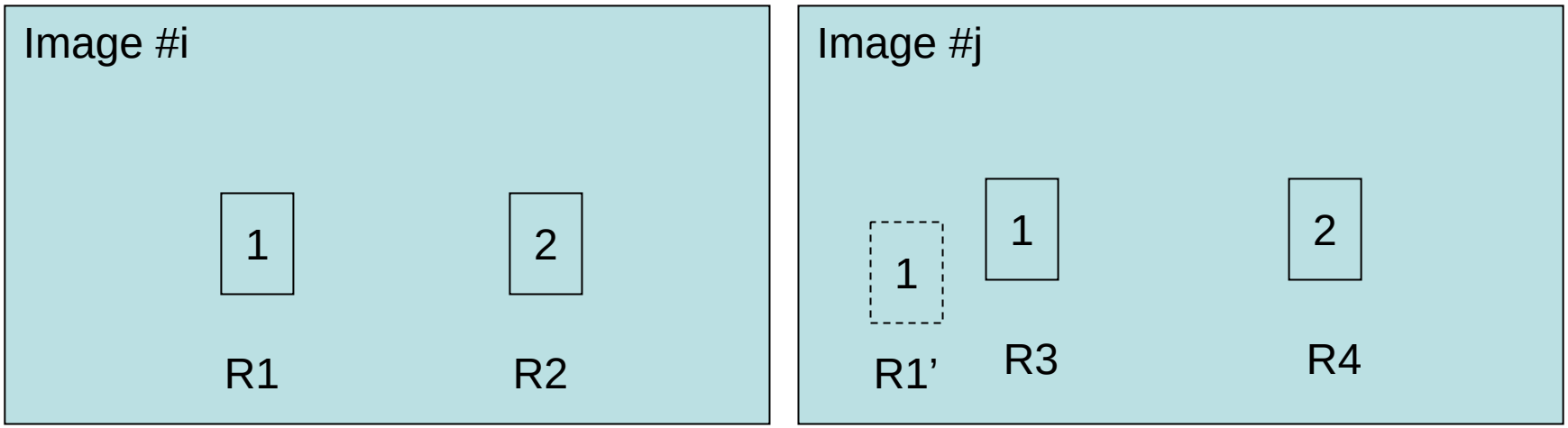
3) Filter out features of moving objects (next slide)

4) Calculate homogeneous matrix between i and j, i<j<=i1, by the left ‘static’ good features



Dynamic features' Filter criteria: Their moving distance is smaller

‘which’ image is f1 or f2



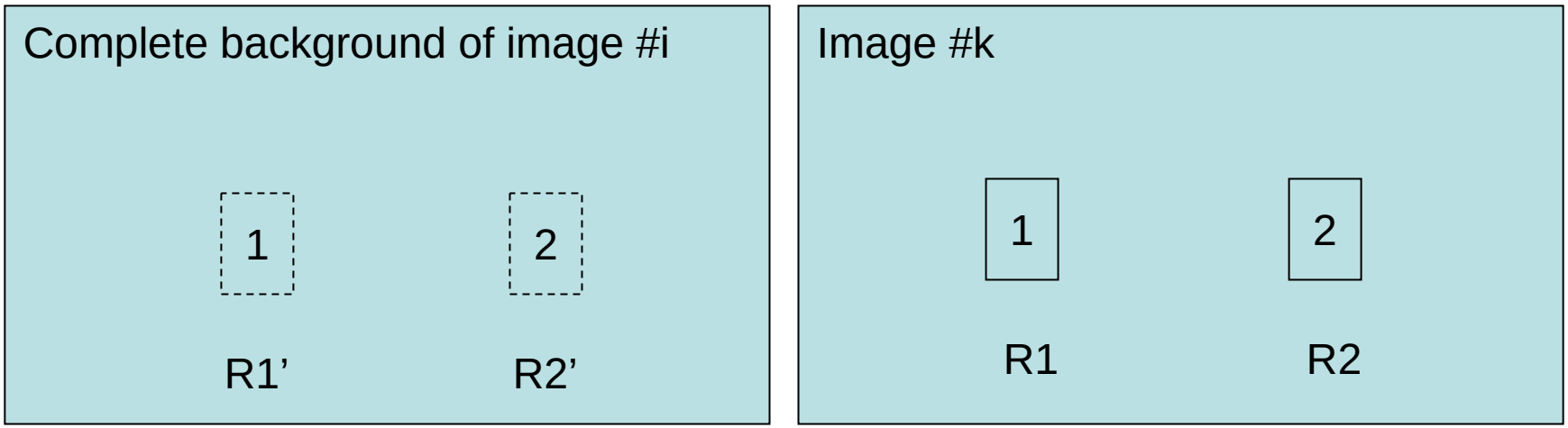
Is the background of 1 in image j?

Let HM the homogeneous matrix from i to j

$$R1' = HM * R1 \subseteq j$$

$$R1' \cap R4 = \phi \qquad R1' \cap R3 = \phi$$

‘Mosaic’ from i+1 to max{f1,f2}



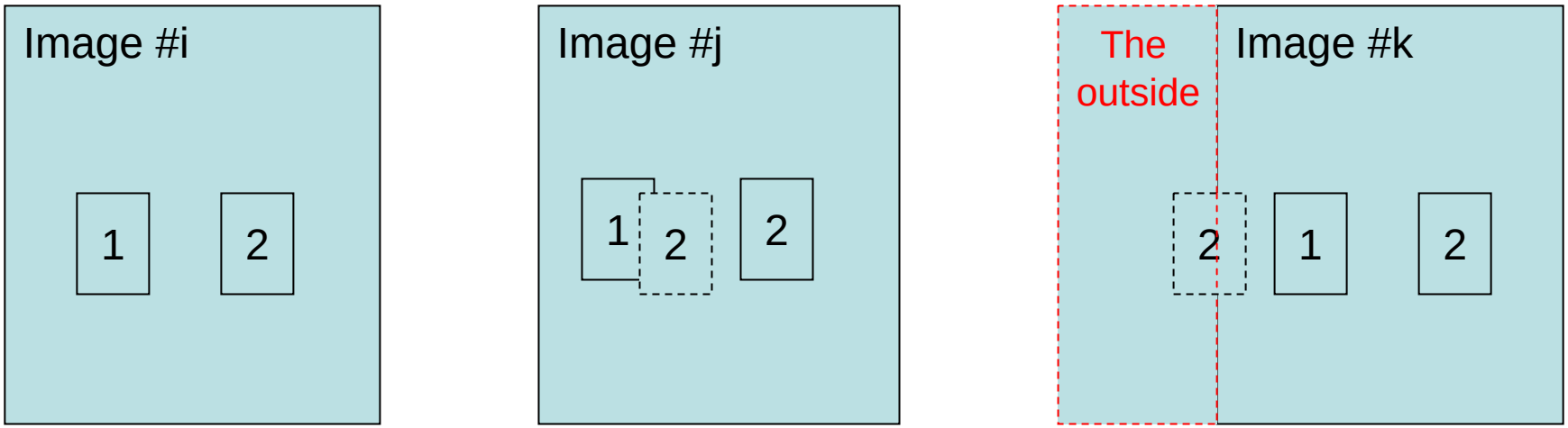
Let HM’ the homogeneous matrix from k to I

k= i+1, i+2,…max{f1,f2}

R1’ = HM’*R1

R2’ = HM’*R2

Algorithm's problem and solution



In image j, the background of object 2 is blocked by object 1

In image k, the background of object 2 is partially out of the image

In this case, one round of running the algorithm cannot mosaic the background for object 2

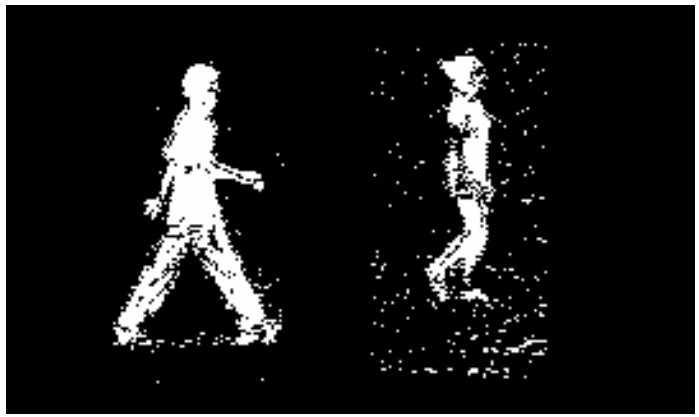
How to fix the problem?

Run the algorithm many rounds. In each round, mosaic as many objects as possible

Step 3: Distill the Moving Objects

- Background removal
  - Subtract the original image with the background image. Only the points in the small rectangle encompassing the moving objects are in the subtraction.
  - Setup a threshold to filter out background's points.

Step 3: Distill the Moving Objects



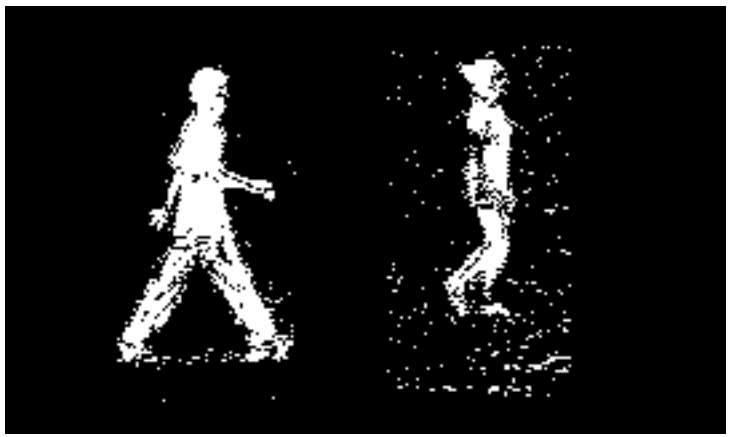
Distilled moving objects

Small-Square-Noise removal

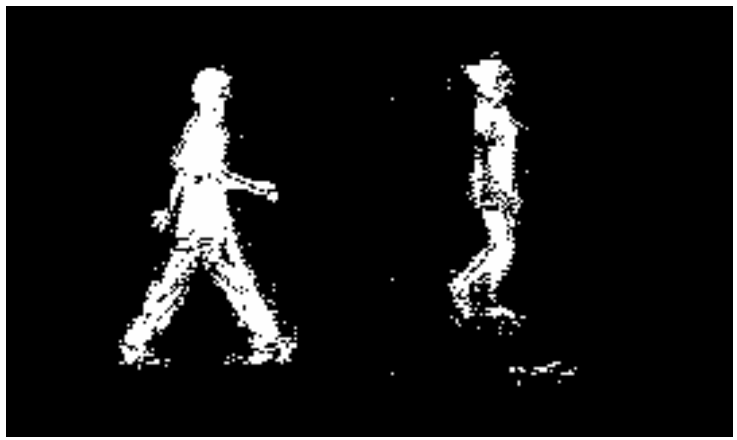
- Noises exist in the distilled person. (Small patches)
- Small-Square-Noise removal
  - Divide the image into many small squares (e.g.10 by 10)
  - If white points in a square is less than a certain number, remove all white points in this square
- Result

  Efficiently remove discrete noises.

Small-square-noise removal



Before the removal



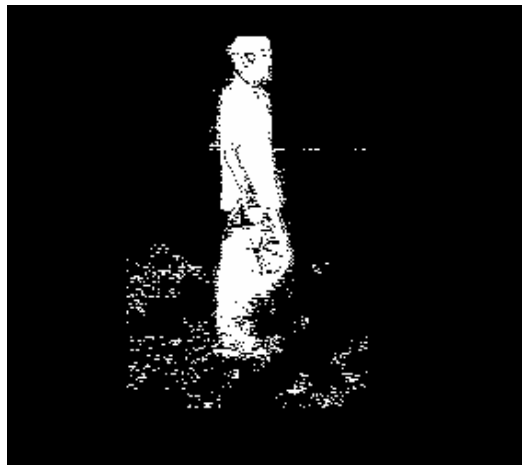
after the removal

After the application of the algorithm the noises around the moving objects are removed greatly

Further Steps for Distilling Persons

When people walk in front of the complex background, the noises are too much. In this case Small-Square-Noise removal keeps working, but less efficient.

Further Steps for Distilling Persons



- Note that most of the noise occurs on the top of the image.
- Solution: find the boundary of the moving object more accurately.

Step 4: Mirror the Person

Before mirror

After mirror

- Category one of the mirror
  - By the axis of each individual person

Step 4: Mirror the Person

Before mirror

After mirror

- Category two of the mirror
  - By the axis in the middle of the image

Conclusion

Done work:

1)uniform background: reverse the walking people seamlessly and clearly.

2)complex background: the reversed walking person is clear but with some noise

Highlights: we deal with the case of multiple walking people successfully.

Acknowledgement

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- Zhong Minxian
- Y. Ma, S. Soatto, J. Kosecka and S. Sastry (MASKS). "An Introduction to 3D Vision"