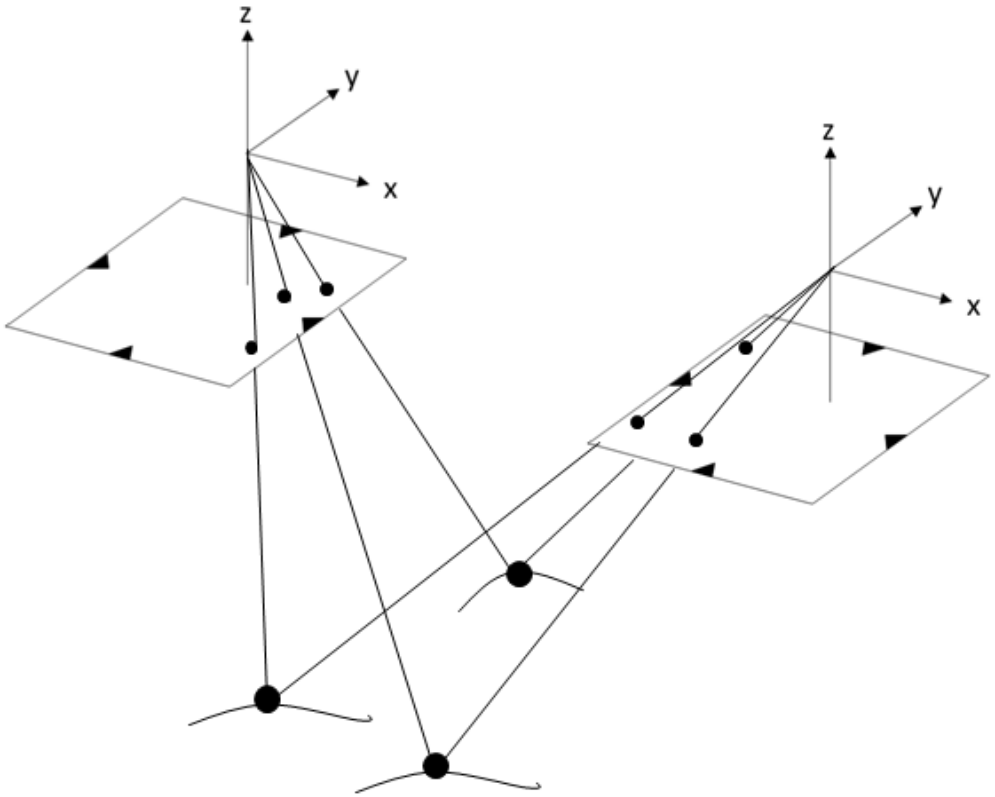
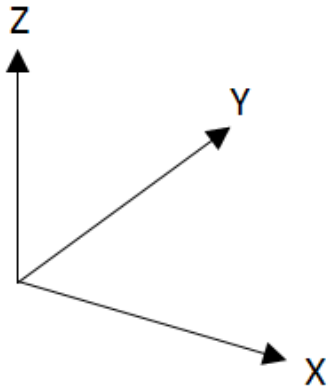
Intersection

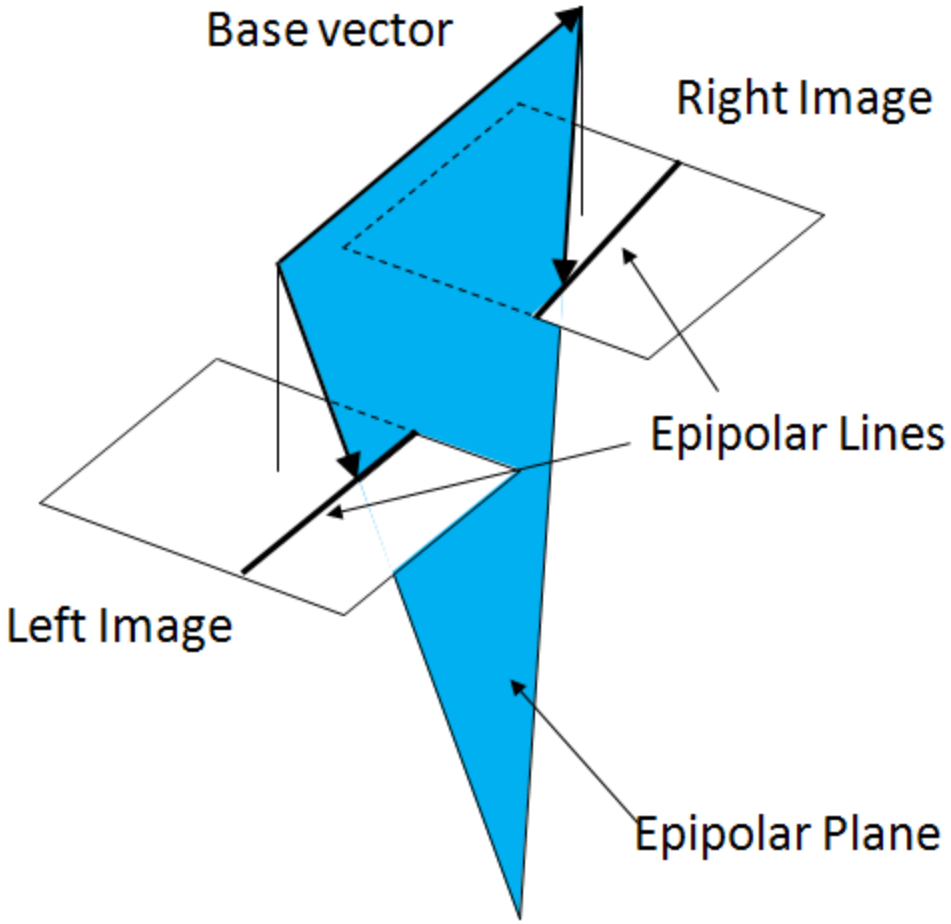




All Slides Courtesy of:

Dr. Derek Lichti
University of Calgary

Epipolar Plane



Intersection Example

- Input data

Image Point Observations (reduced to PP)			
ID	**Image**	**x (mm)**	**y (mm)**
72	Left	70.964	4.907
127	Left	-0.931	-7.284
72	Right	-15.581	-0.387
127	Right	-85.407	-8.351

EO parameters determined by resection		
	Left	**Right**
X^c (m)	6349.488	7021.897
Y^c (m)	3965.252	3775.680
Z^c (m)	1458.095	1466.702
ω (°)	0.9885	1.8734
ϕ (°)	0.4071	1.6751
κ (°)	-18.9049	-15.7481

Intersection Example (cont'd)

- Input data

Approximate parameter values		
	72	**127**
X (m)	6869.168	6316.136
Y (m)	3844.536	3934.676
Z (m)	283.202	283.227

Other Information	
c (mm)	152.150
Approximate image format size (mm x mm)	229 x 229
σ_{obs} (μm)	15
Tol_{coords} (m)	0.012

Intersection Example (cont'd)

- Partial solution—first iteration (point 72)

A matrix			
	X_{72}	Y_{72}	Z_{72}
x_{left}	0.123571	-0.043199	0.059096
y_{left}	0.042202	0.123057	0.006023
x_{right}	0.122718	-0.034164	-0.017824
y_{right}	0.034704	0.123132	0.002685

w vector (mm)	
x_{left}	-0.00007
y_{left}	0.00118
x_{right}	0.00000
y_{right}	-0.00116

Intersection Example (cont'd)

- Final solution (point 72)

Residual vector v (mm)	
x_{left}	0.000
y_{left}	0.001
x_{right}	0.000
y_{right}	-0.001

Parameters and standard deviations		
X_{72} (m)	6869.168	0.094
Y_{72} (m)	3844.536	0.082
Z_{72} (m)	283.202	0.277

Intersection Example (cont'd)

- Final solution—first iteration (point 127)

A matrix			
	X_{127}	Y_{127}	Z_{127}
x_{left}	0.122561	-0.041942	-0.002388
y_{left}	0.041932	0.122664	-0.004383
x_{right}	0.119090	-0.031736	-0.075282
y_{right}	0.033963	0.121402	-0.003944

w vector (mm)	
x_{left}	-0.00015
y_{left}	0.00274
x_{right}	-0.00001
y_{right}	-0.00267

Intersection Example (cont'd)

- Final solution (point 127)

Residual vector v (mm)	
x_{left}	0.000
y_{left}	0.003
x_{right}	0.000
y_{right}	-0.003

Parameters and standard deviations		
X_{127} (m)	6316.136	0.119
Y_{127} (m)	3934.675	0.084
Z_{127} (m)	283.227	0.285

Intersection Example (cont'd)

- Final solution

Redundancy numbers	Point 72	Point 127
x_{left}	0.00	0.00
y_{left}	0.49	0.49
x_{right}	0.00	0.00
y_{right}	0.51	0.51
Sum	1.00	1.00

Questions for Discussion

- Comment on the residuals
- Comment on the precision of the co-ordinates
- How does the precision compare with that computed by the approximate equations?

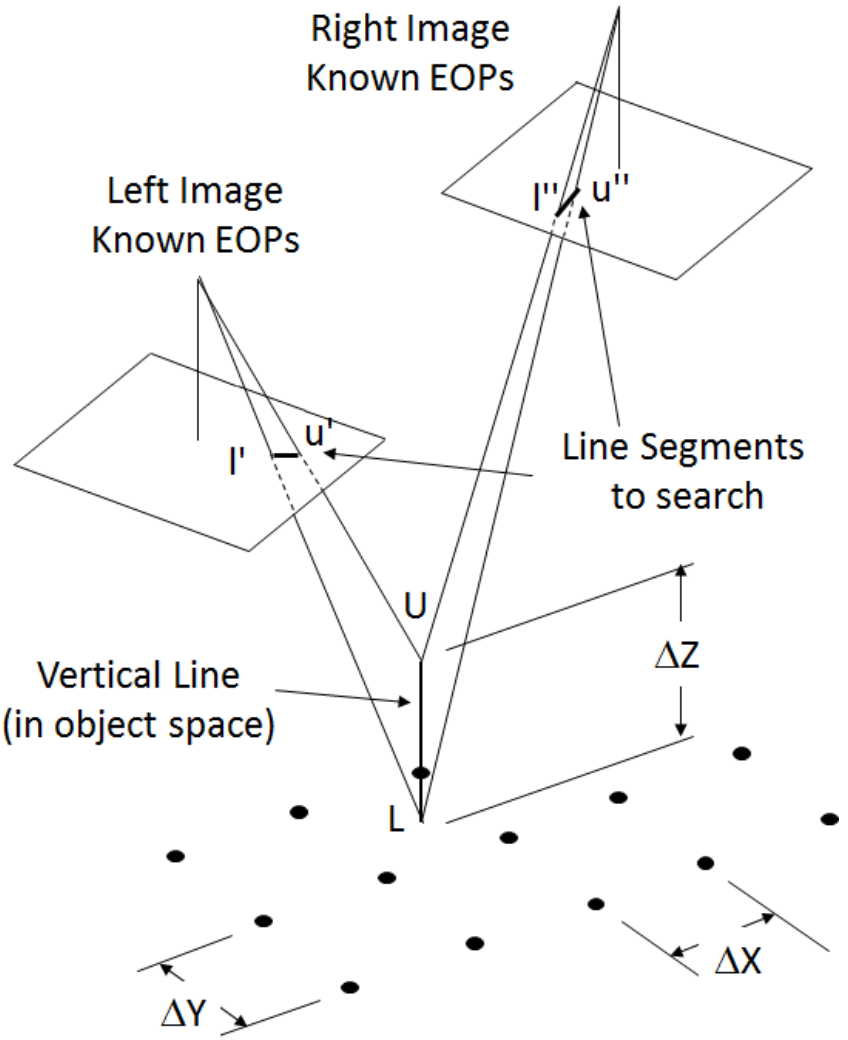
$$\sigma_X = S\sigma_{obs} \qquad \sigma_Y = S\sigma_{obs} \qquad \sigma_Z = \frac{\sqrt{2}S}{B/H}\sigma_{obs}$$

where $S \cong 7800$ and $B/H = 0.6$

- Is the precision realistic? Why or why not?

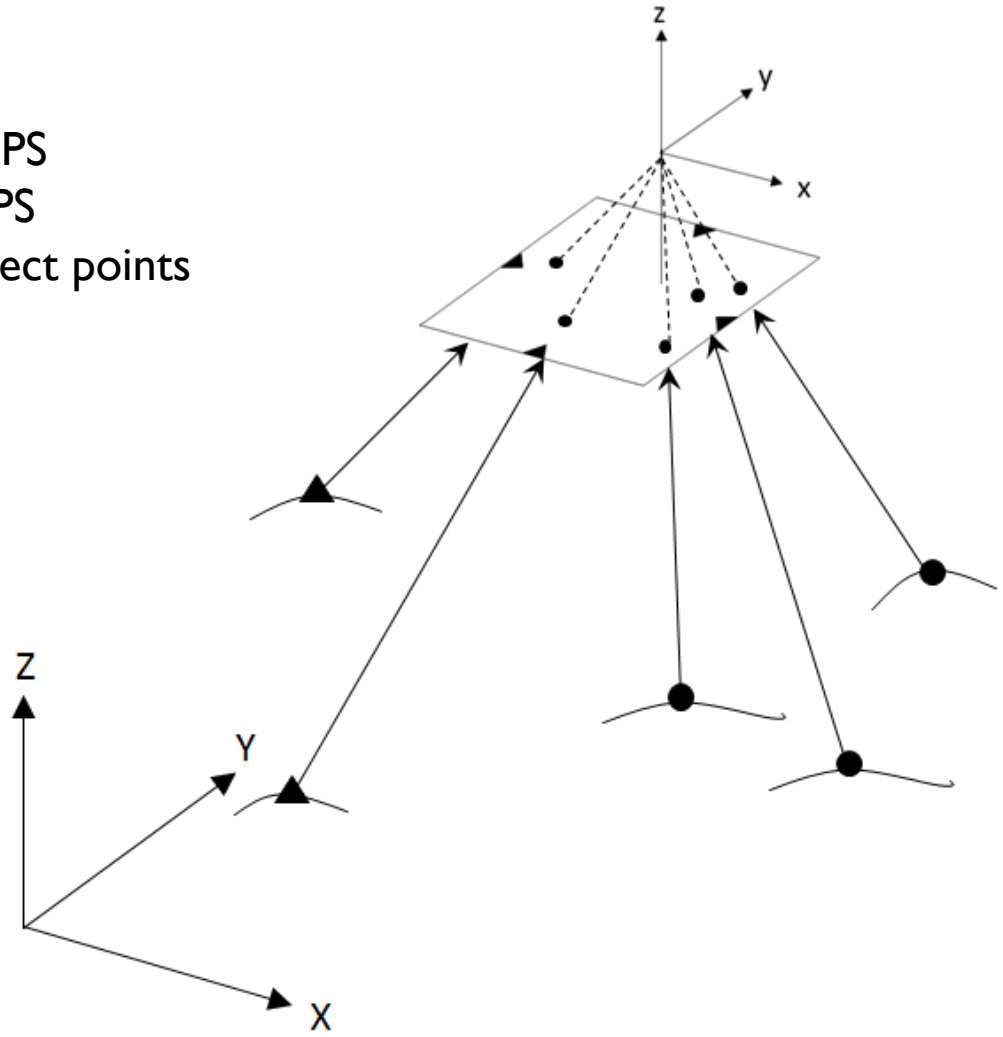
DEM Production

- Objective: estimate heights at regular intervals in object space by space intersection
- The search space for conjugate points in the image is reduced using the planimetric position of a feature point in object space as a constraint (vertical line locus method, VLL)—the space intersection is constrained with known X and Y co-ordinates
- Using the assumed height range from the elevation range constraint, ΔZ, the line segments to search in each image can be determined by back projection



Backprojection

Known EOPS
Known IOPS
Known object points



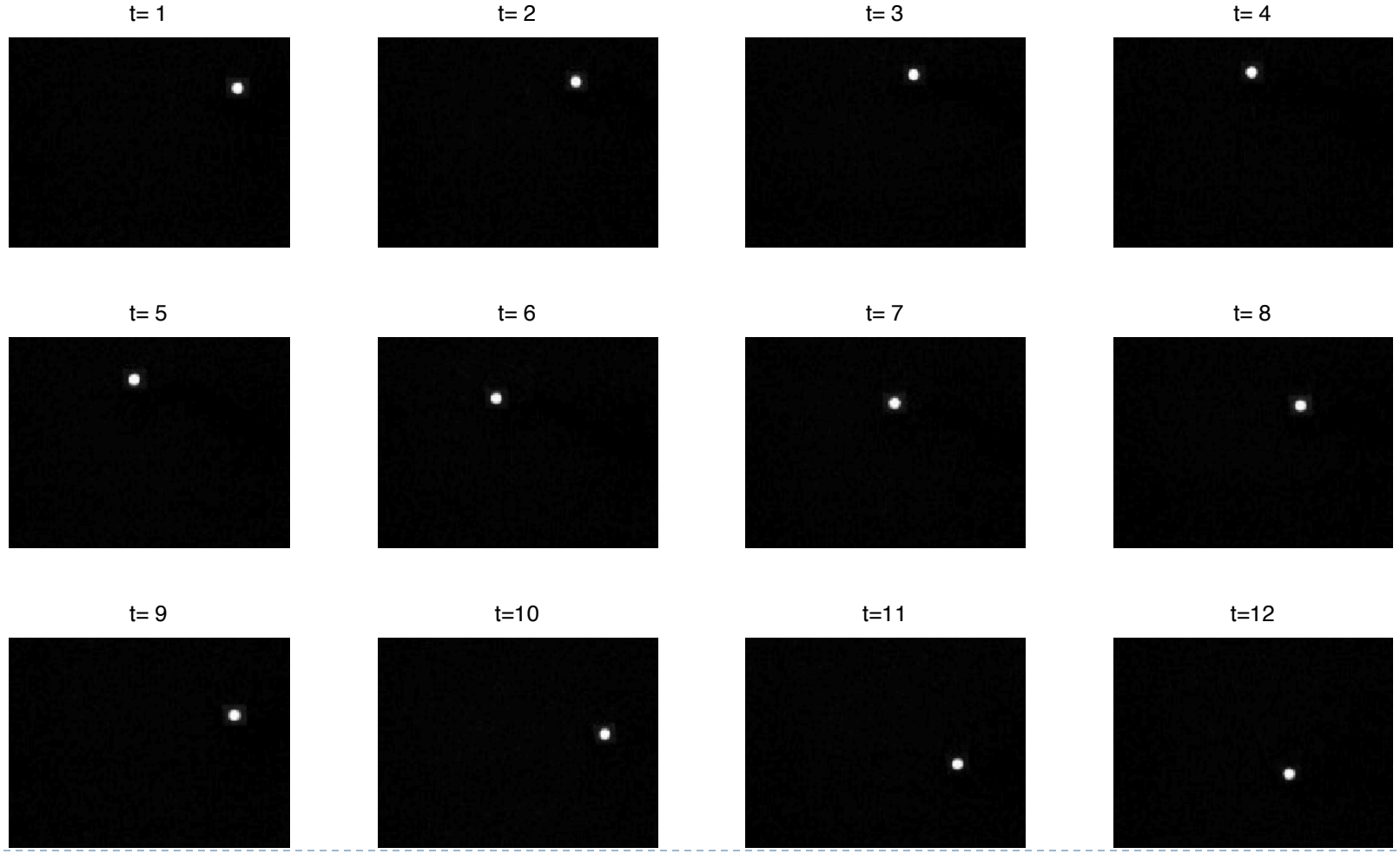
Backprojection Applications

- Automated target tracking and measurement
  - Motion capture systems
  - Computer-assisted surgery
- Orthoimage production

L: http://www.ccad.uiowa.edu/vsr/research/motion-capture/
R: http://www.vicon.com/applications/gait_analysis.html

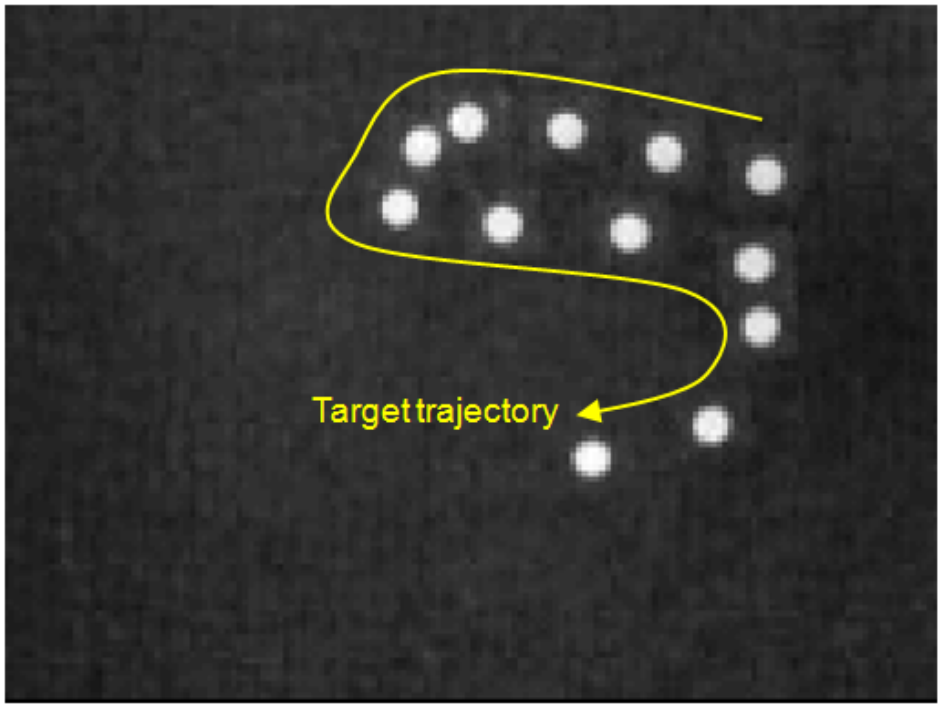
Backprojection Applications (cont'd)

- Image sequence

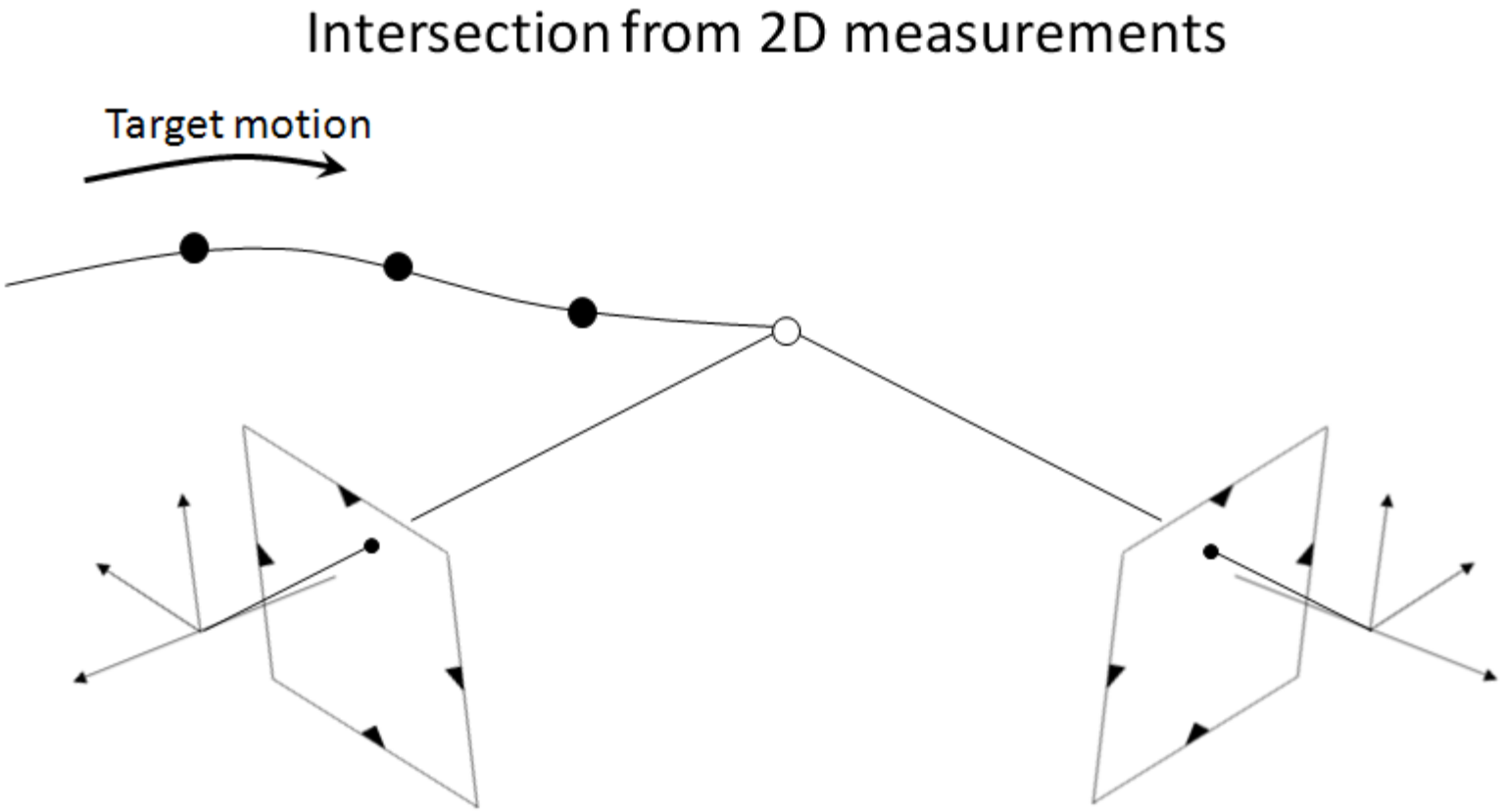


Backprojection Applications (cont'd)

- Objective: to automatically track and measure a set of tokens (e.g. targets) in a sequence of images captured at regular intervals in time
- Composite image compiled from a 12-image sequence

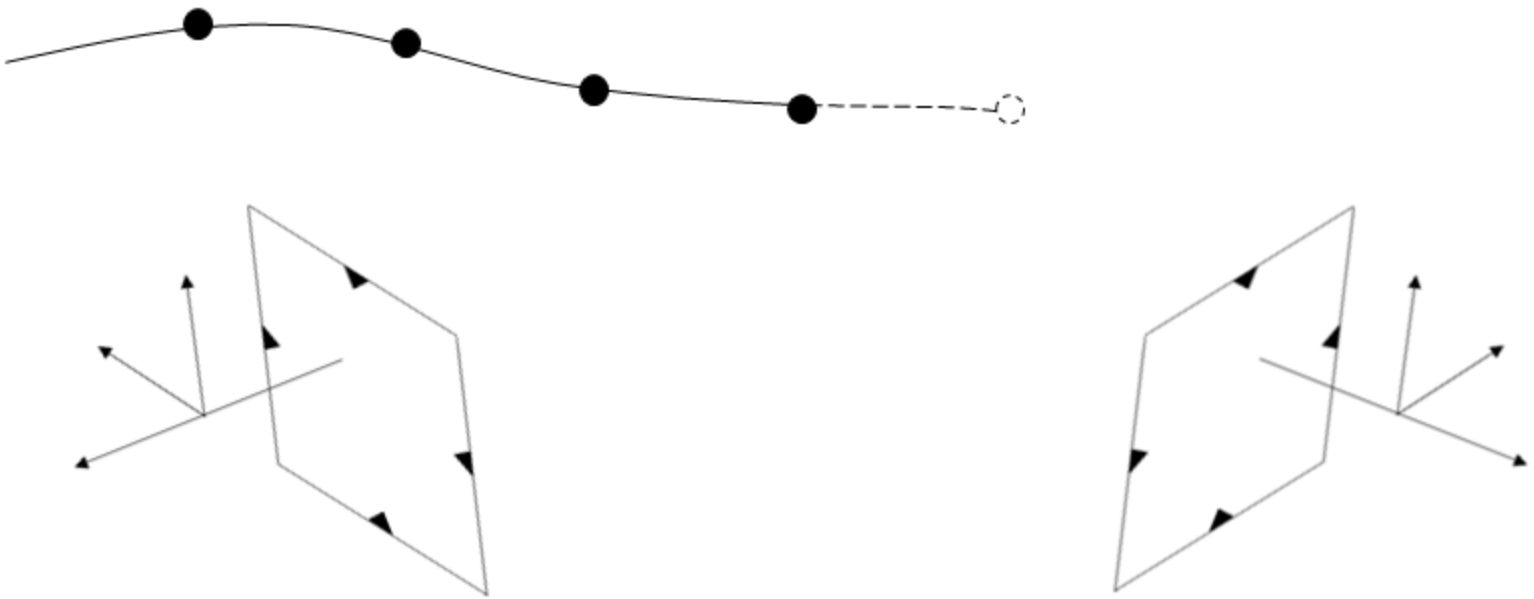


Backprojection Applications (cont'd)

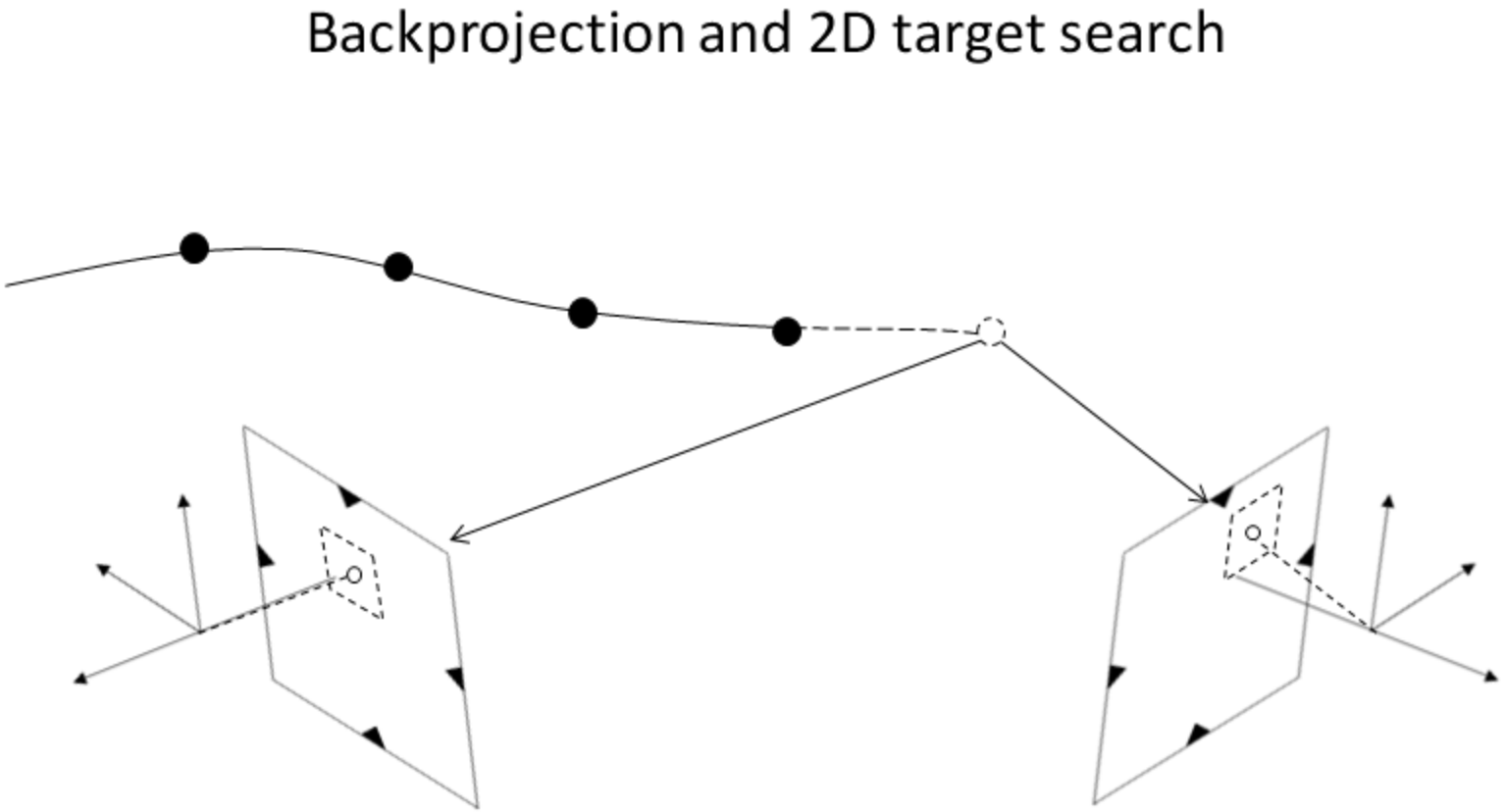


Backprojection Applications (cont'd)

Prediction of 3D target location

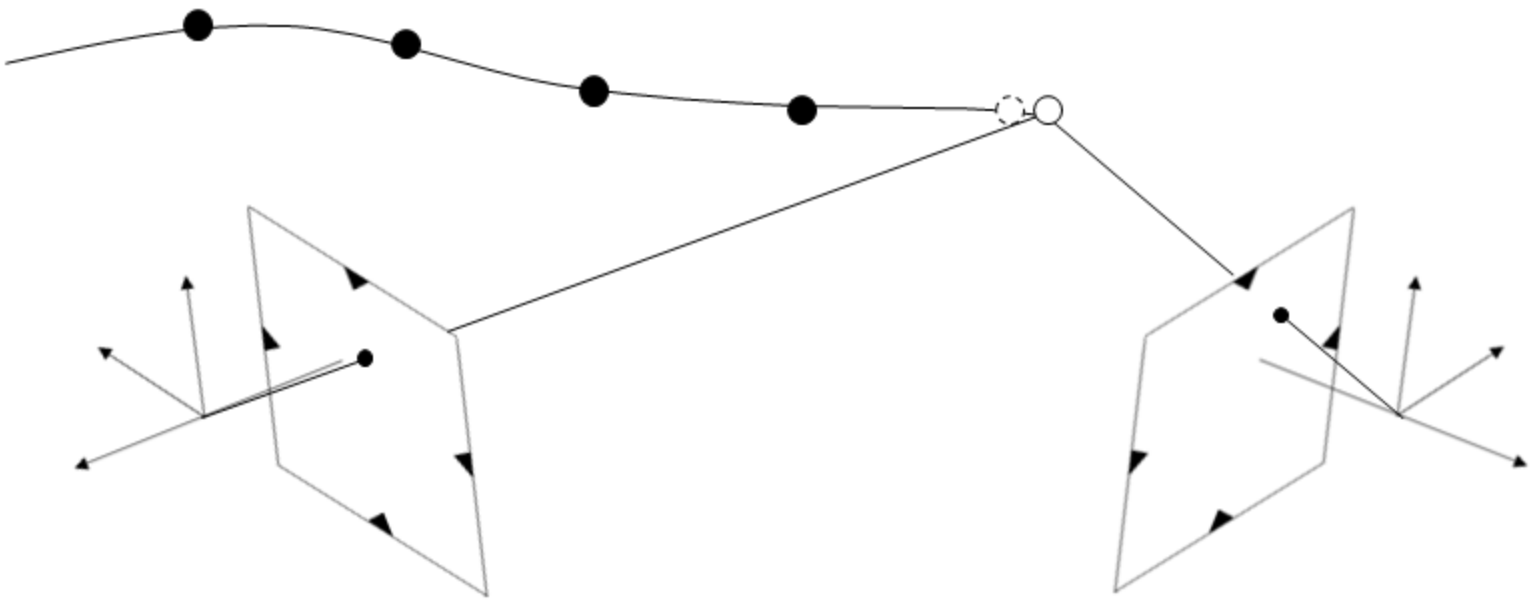


Backprojection Applications (cont'd)

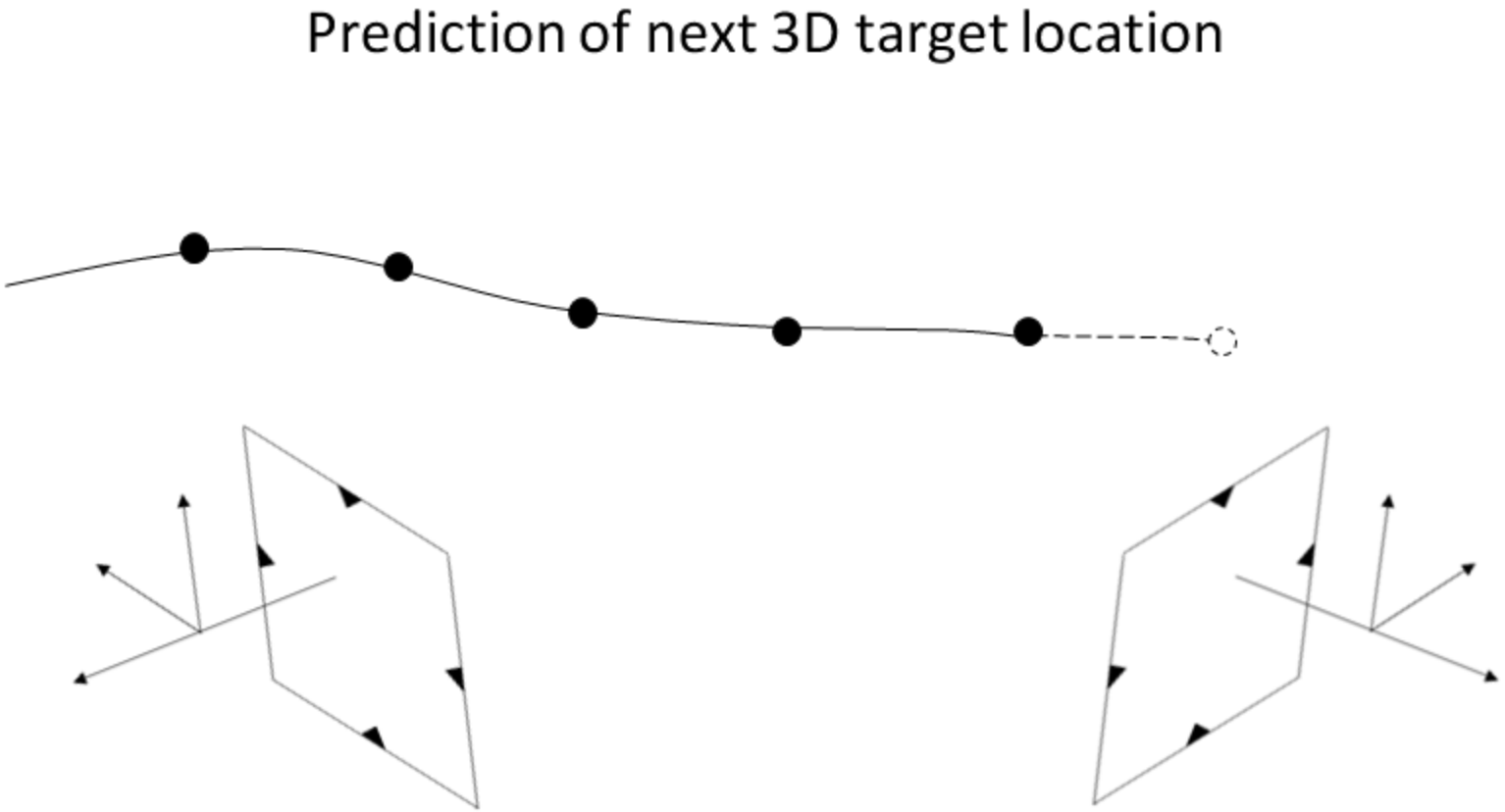


Backprojection Applications (cont'd)

Precise measurement and intersection



Backprojection Applications (cont'd)



Backprojection Applications (cont'd)

- Rectification
  - Rectification: the process of transforming an image from a perspective projection to an orthogonal projection
  - This removes the perspective distortion caused by tilted imagery
  - Ortho-rectification: rectification in which distortions due to relief displacement are also corrected
  - The effects of lens distortions are also corrected
- Methods
  - Polynomial
  - Projective transformation
  - Differential*

Backprojection Applications (cont'd)

- Perspective image (acquired)

- Orthoimage (product)

https://www.e-education.psu.edu/natureofgeoinfo/c6_p15.html

Backprojection Applications (cont'd)

- Differential rectification
  - Each point is individually transformed via back projection into the original image with the collinearity equations augmented with the lens distortion models
  - Inputs:
    - Exterior orientation parameters from AT
    - Interior orientation parameters from calibration
    - DEM from an external source or generated from the imagery after AT
  - Resampling or interpolation is needed to determine the grey value or RGB values at the non-integer, back-projected locations
  - The coarse DEM spacing can be overcome by interpolation

Backprojection Applications (cont'd)