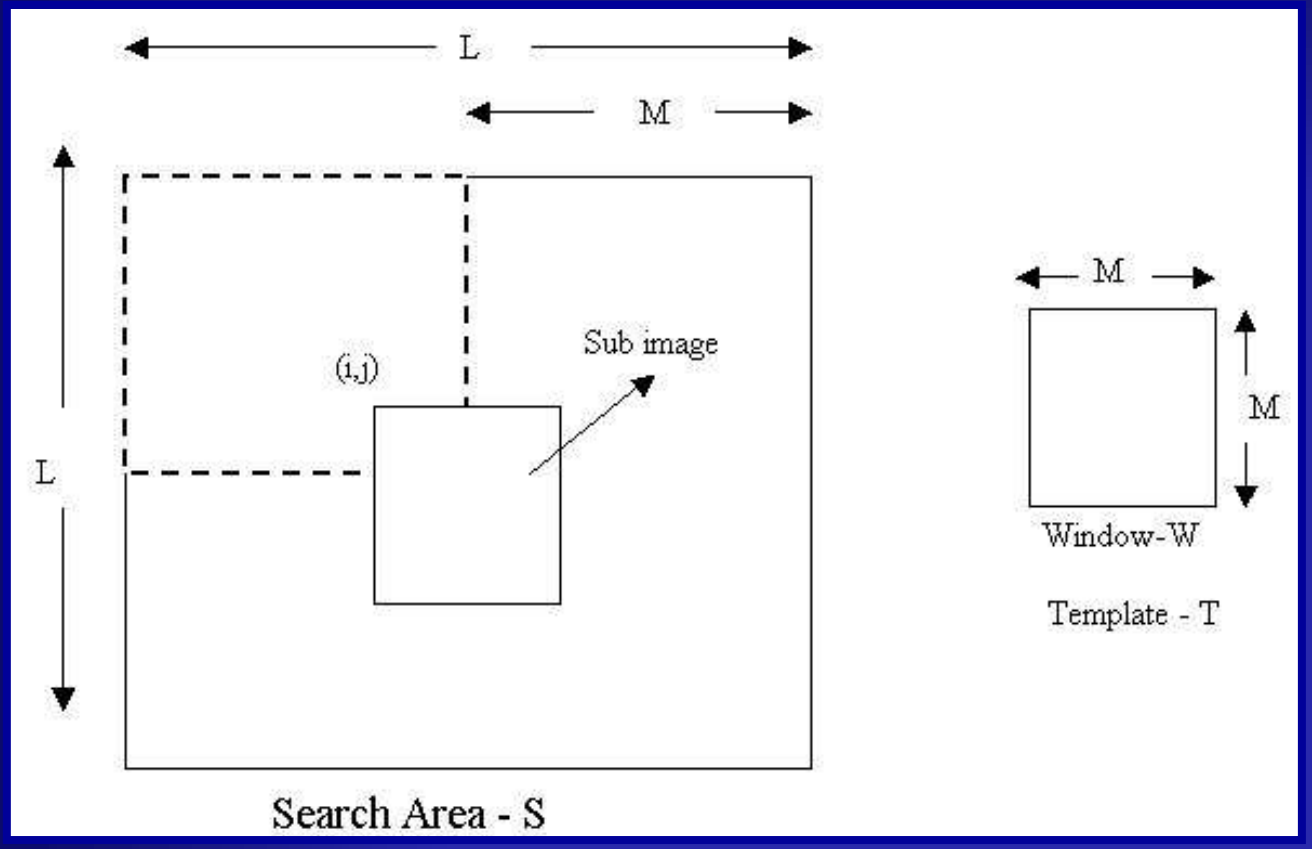
Increasing Accuracy of Registration

Area-Based Registration - Translational Registration



An image I and a template T used for Cross Correlation

For a reference image T and search image I, where T is small compared to I, a measures of similarity is calculated

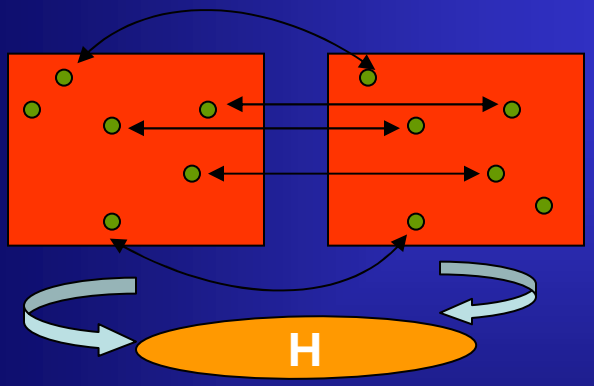
Registration is attained at the location where the measure of similarity is maximum

Registration (Alignment)

Global alignment

Feature based Image Registration

- Feature Extraction
- Feature Reduction
- Feature Matching



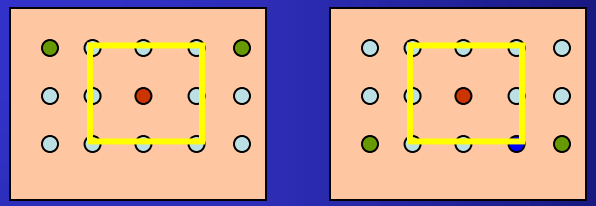
Reference image

Search image

Local alignment

Area based Image Registration

- Similarity measure
- Distance measure

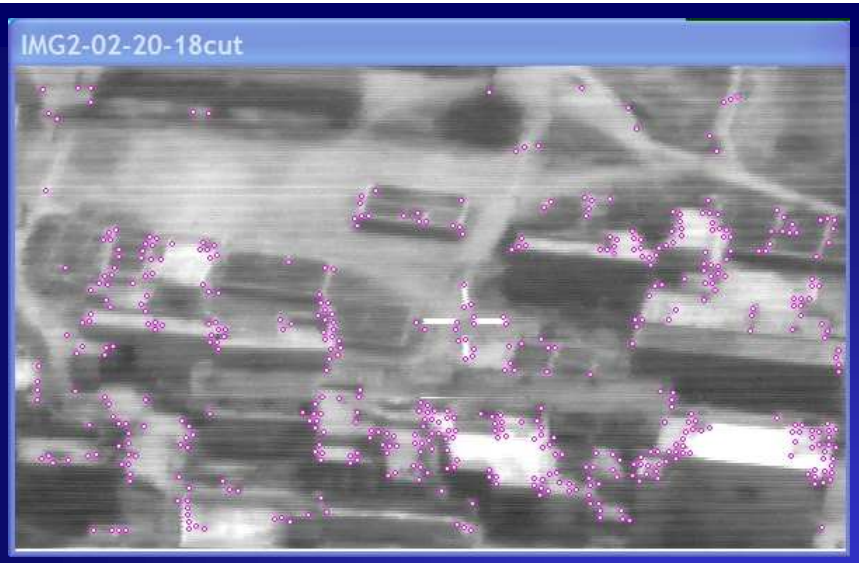


Global Matching and Local Matching

Image 1

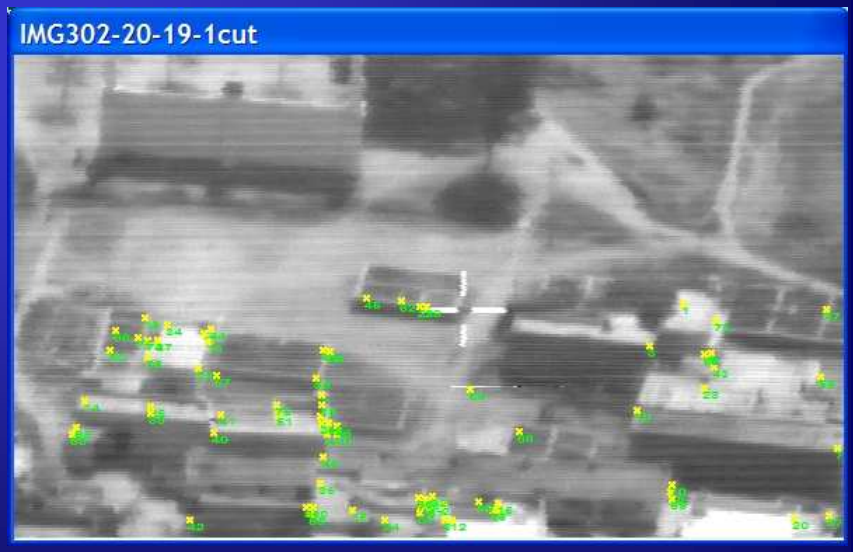
Image 2

Input Image Pair after preprocessing



KLT Corners 500

KLT Corners 500



No. of Match Points : 76

P1		P2	
472	104	475	175
306	249	304	318
450	135	451	205
223	200	221	268
345	252	344	322
494	140	495	210
219	172	217	240
307	258	305	329
218	188	216	255
213	251	211	320
135	129	133	196
312	258	310	329
137	135	136	202
51	180	48	244
344	247	343	317
241	252	239	322
295	250	294	320
292	245	291	314
94	120	91	185

P1		P2		Score
472	104	475	175	0.718279
306	249	304	318	0.939482
450	135	451	205	0.635410
223	200	221	268	0.945071
345	252	344	322	0.957956
494	140	495	210	0.608892
219	172	217	240	0.892419
307	258	305	329	0.848343
218	188	216	255	0.922484
213	251	211	320	0.960023
135	129	133	196	0.911485
312	258	310	329	0.877220
137	135	136	202	0.890039
51	180	48	244	0.236708
344	247	343	317	0.949990
241	252	239	322	0.913697
295	250	294	320	0.931407
292	245	291	314	0.750598
94	120	91	185	0.897379

InitialMatch

Total no of match points= 76

Fine Matching

Total no of match points= 56

P1	P2	Coeff1	NewP2	Coeff2
472 104	475 175	0.718279	472 170	0.974797
306 249	304 318	0.939482	304 317	0.951307
450 135	451 205	0.635410	450 201	0.957649
223 200	221 268	0.945071	221 268	0.945071
345 252	344 322	0.957956	344 322	0.957956
494 140	495 210	0.608892	495 206	0.900213
307 258	305 329	0.848343	306 328	0.937160
218 188	216 255	0.922484	216 256	0.942415
213 251	211 320	0.960023	211 321	0.972816
135 129	133 196	0.911485	133 197	0.929553
312 258	310 329	0.877220	311 328	0.957610
137 135	136 202	0.890039	134 203	0.929691
51 180	48 244	0.236708	47 249	0.936936
344 247	343 317	0.949990	343 317	0.949990
241 252	239 322	0.913697	239 322	0.913697
295 250	294 320	0.931407	293 318	0.947415
94 120	91 185	0.897379	91 186	0.905071
554 254	554 328	0.833039	555 324	0.975777
132 154	129 221	0.939771	129 220	0.963065
219 193	217 260	0.888473	217 261	0.929320

Pair of Match Points : 362 with Correlation Coefficient > 0.95

166	37	161	37	0.651064	155	37	0.980182
75	146	70	146	0.978255	70	146	0.978255
178	229	173	228	0.912018	173	229	0.974003
101	35	97	35	0.988411	89	35	0.993600
92	182	86	182	0.978016	87	182	0.986044
44	63	39	63	0.987576	39	63	0.987576
147	63	142	63	0.710140	136	63	0.997282
48	81	43	81	0.976579	43	81	0.976579
45	170	41	171	0.530775	40	170	0.984941
141	86	135	86	0.518046	130	86	0.984292
66	80	61	80	0.983195	61	80	0.983195
126	257	120	257	0.893282	121	257	0.993871
82	153	76	153	0.715936	77	153	0.964818
126	90	120	90	0.433507	116	90	0.978628
32	51	27	51	0.934599	28	51	0.969053
63	63	59	63	0.945897	58	63	0.983533
49	153	44	154	0.917483	44	153	0.995375
304	89	298	89	0.574275	296	89	0.994670
32	221	27	221	0.997273	27	221	0.997273
147	139	143	139	0.767845	136	139	0.954292
96	153	91	153	0.966976	91	153	0.966976
211	258	205	257	0.694557	206	258	0.992437
174	62	169	62	0.629423	164	62	0.983768
114	91	108	91	0.735525	104	91	0.964054

Video Georegistration

Video Geo registration is the spatial Registration of Video Imagery to geodetically calibrated Reference Imagery so that the video can inherit the Reference coordinates (World Coordinate)

Application areas

- Visually guided navigation system
- Accurate geo-location for objects of interest
- Accurate targeting
- Updating of aerial maps
- Control the mission path of an aerial platform

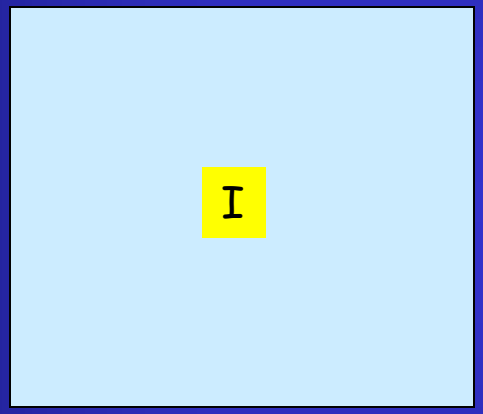
Reference Image I_{ref} (x), Wide area, High resolution orthographic image

Specifications:

Ground sampling distance of 0.5 to 1 meter taken from a high altitude camera

Reference Image

Low Resolution data



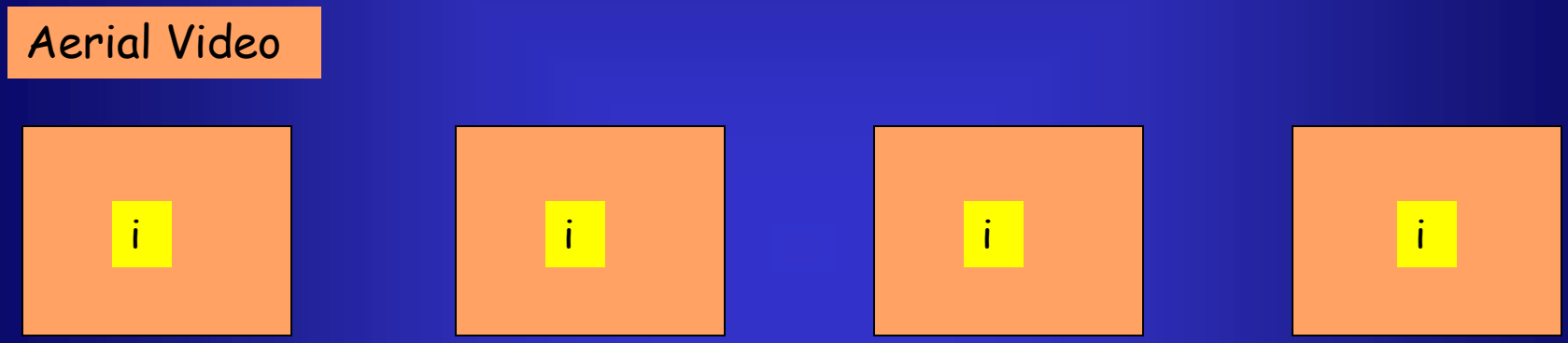
High Resolution data

Reference Image is geo-registered with a High Resolution DEM

Coordinate of each pixel in the Reference Image are available in : Latitude, Longitude, Elevation

(Elevation or Height measured from Average Mean Sea Level (AMSL)

Aerial Video Frame I_{video} (x), Small area, Low resolution perspective image with the associated meta data (telemetry)
Specifications: Captured from a camera mounted on an Aerial Reconnaissance platform



Telemetry parameters associated with the video frame :

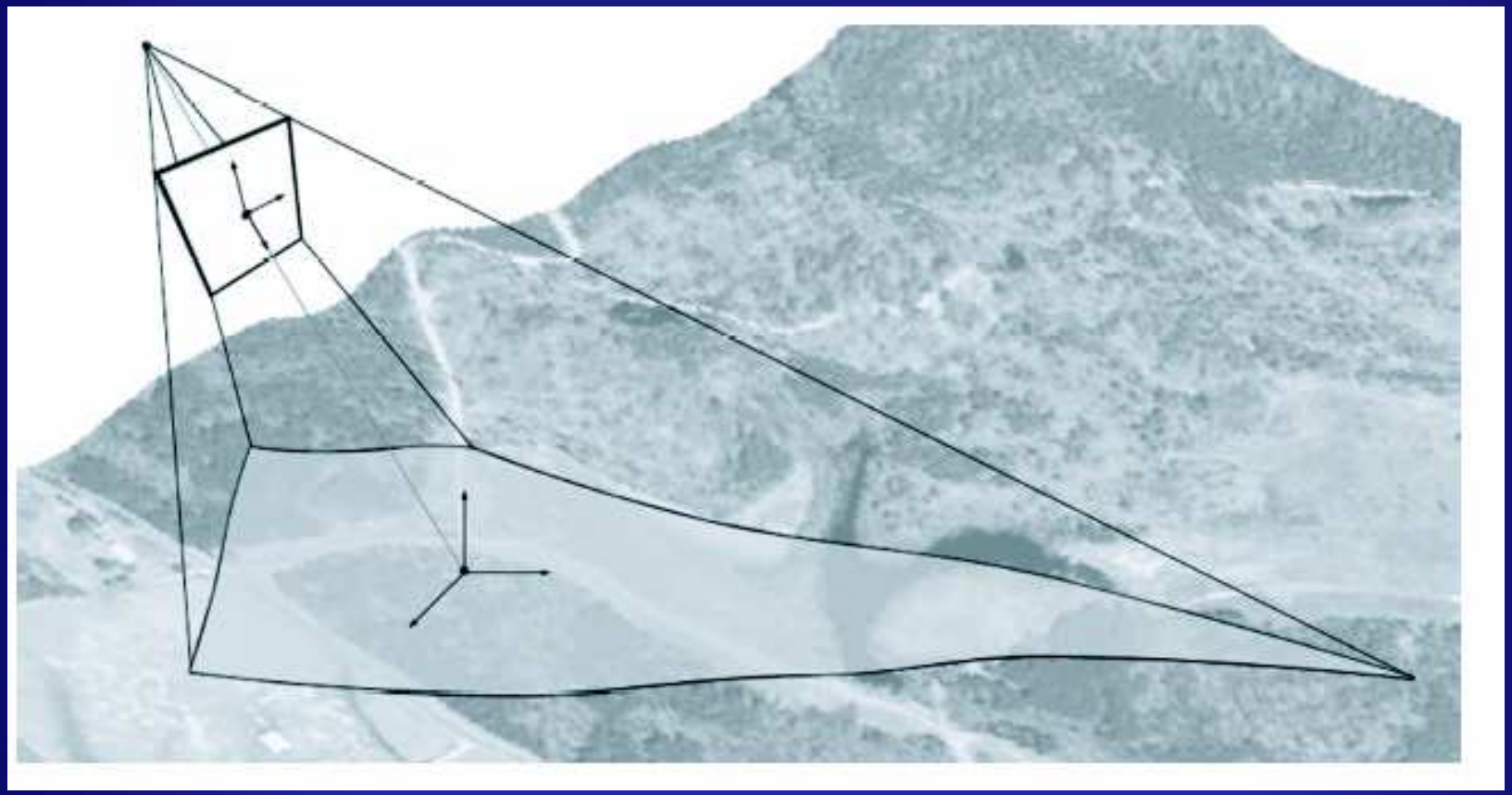
Platform parameters : Location (latitude, longitude), Roll, Pitch, Heading, Height

Sensor parameters : Azimuth, Elevation, Field of view

Example2: Dissimilarities between video frames due to change in Affine Parameters

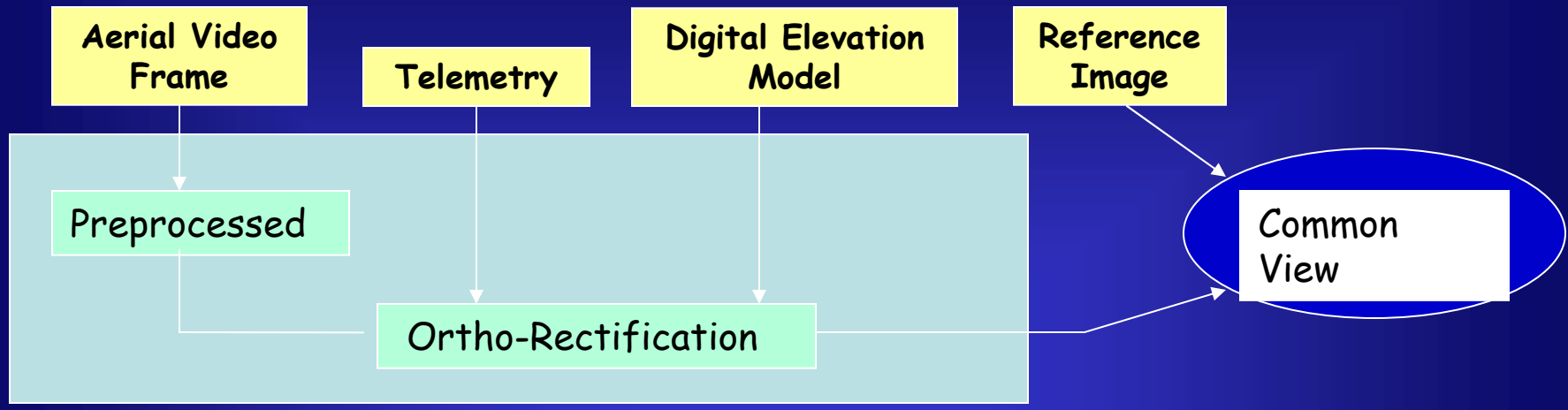
Example 3 : Dissimilarities between video frames from Multi Sensor Imagery

EO Sensor **IR Sensor**

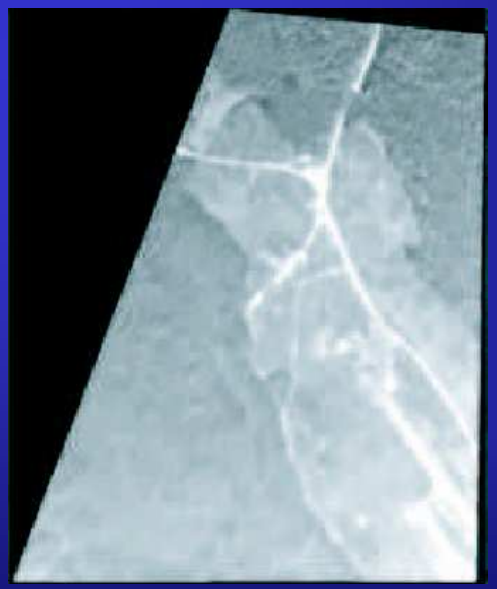


Relationship between the camera plane and projected area on the reference imagery

Both Aerial and Reference in Ortho View

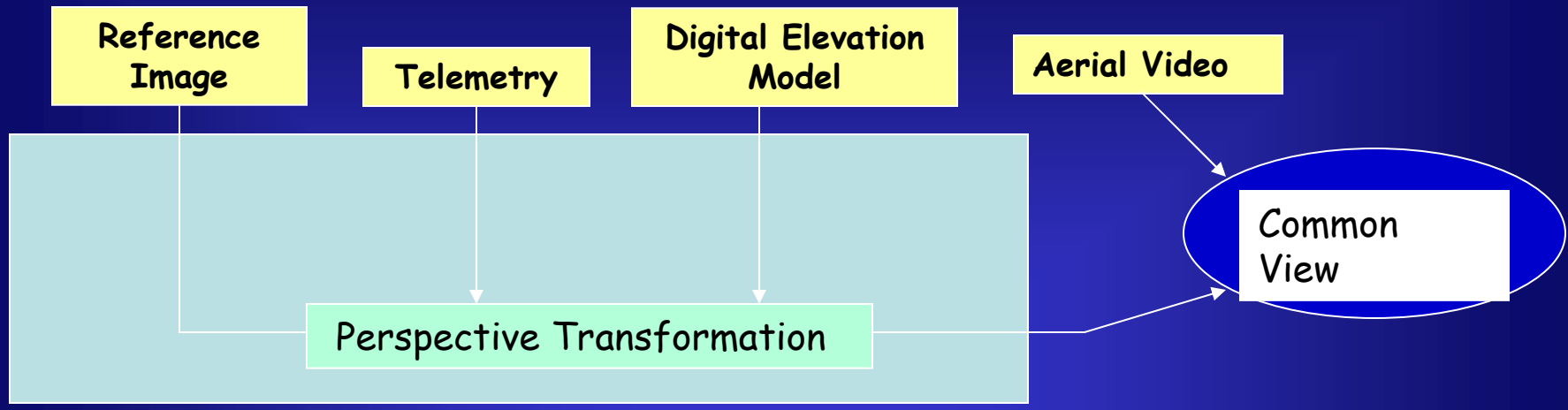


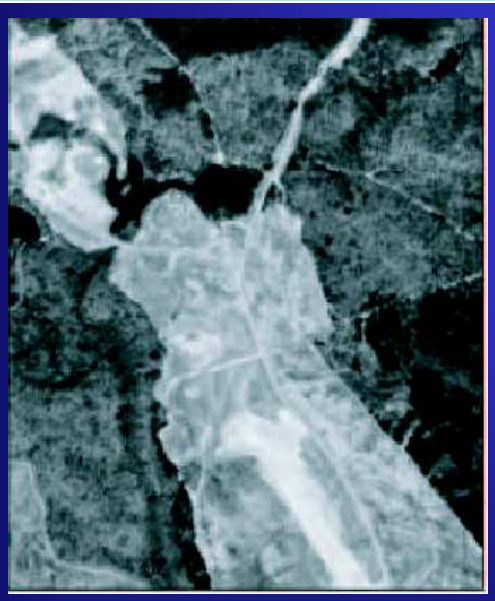
Reference Satellite Image in Ortho View



Aerial Video in Ortho View

Both Aerial and Reference in Perspective View



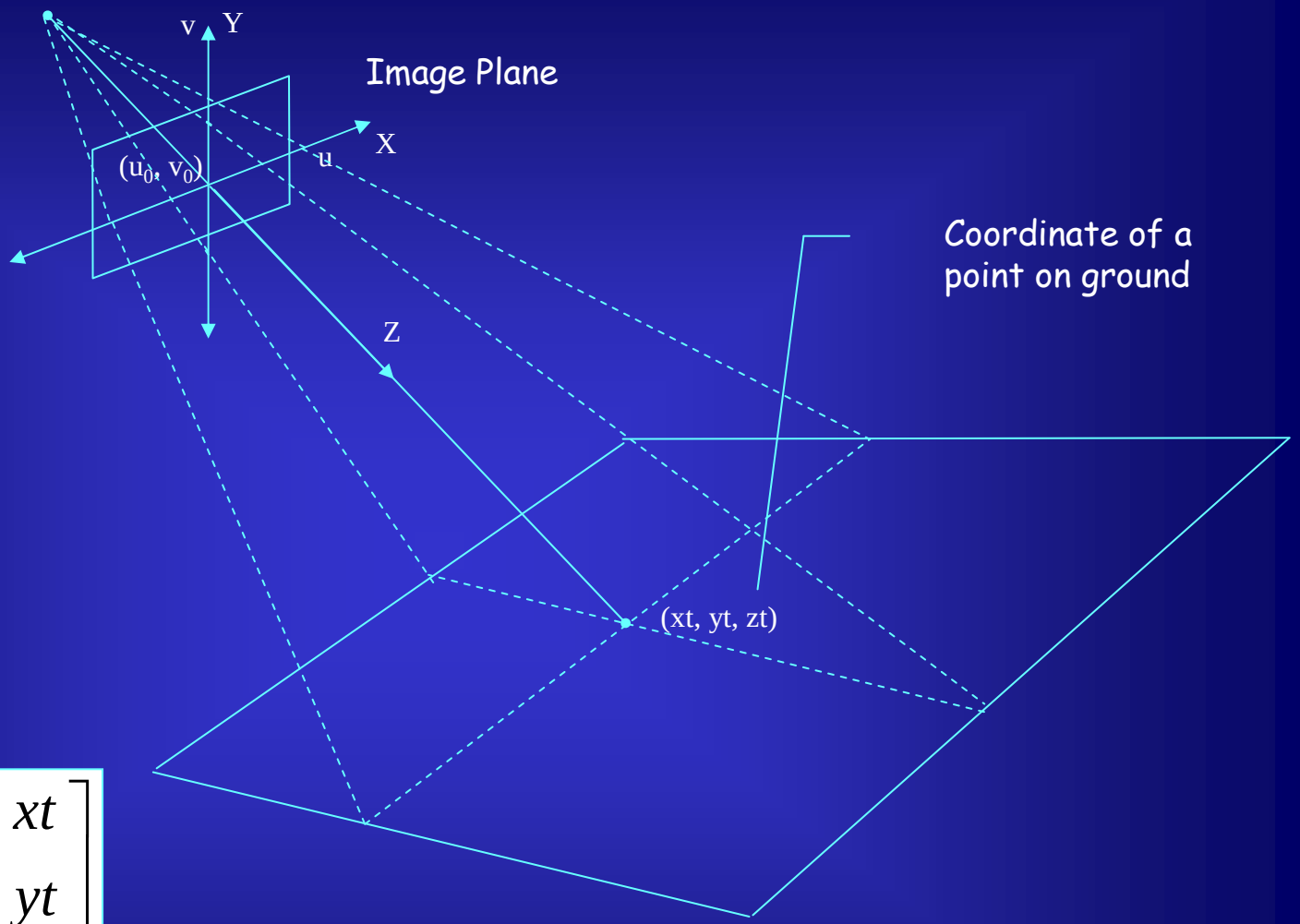


Cropped Reference Image in perspective view

Aerial Video in perspective view

Mathematical Formulation **(Work done at ADE)**

(x platform,
y platform,
z platform)



$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \prod_C \begin{bmatrix} xt \\ yt \\ -h \\ 1 \end{bmatrix}$$

Camera_Matrix

Geometry of the model
(Image Plane – XY axis)

Reference frame w.r.to World in homogeneous coordinate system may be written as:

$$\overset{ref}{\underset{->}{X}}_{world} = [X_{world}, Y_{world}, Z_{elev}, 1]$$

Z_{elev} = is obtained from co registered DEM

Reference frame in perspective coordinate system may be written as:

$$\overset{ref}{\underset{->}{X}}_{perspective} = [X_{perspective}, Y_{prespective}, Z_{perspective}, 1]$$

Camera matrix used to project the reference image

$$\overset{ref}{\underset{->}{X}}_{perspective} = \Pi_C \overset{ref}{\underset{->}{X}}_{world}$$

Π_C = Camera_matrix

Image formation process in Camera includes **perspective projection**, along with matrices for **internal** and **external** calibration

$$\Pi_C = T_{internal} * T_{Perspective} * T_{External}$$

$$\Pi_C = P * \Pi_t$$

Perspective matrix,

Coordinate Transformation matrix

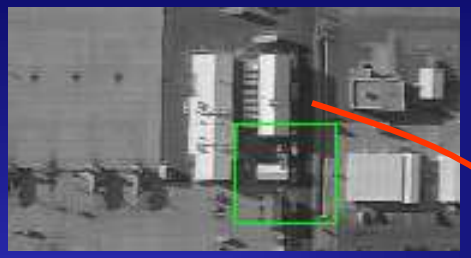
$$= \begin{bmatrix} k_u & 0 & U_0 \\ 0 & k_v & V_0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} -f & 0 & 0 \\ 0 & f & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} R & t \end{bmatrix}$$

Rotational matrix

$$[R] = [R_\psi \quad R_\theta \quad R_\phi \quad R_\beta \quad R_\alpha] = \begin{bmatrix} r_1 & r_2 & r_3 \\ r_4 & r_5 & r_6 \\ r_7 & r_8 & r_9 \end{bmatrix}$$

Translation matrix

$$[t] = \begin{bmatrix} X_{gps} \\ Y_{gps} \\ 0 \end{bmatrix}$$



REF: University of Central Florida, Orlando USA

Example - Aerial Video Geo registration


Thank You